

**“Exploring the barriers to achievement amongst working-class  
white British students in science at GCSE.”**

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## **Abstract**

This thesis examines the science experiences of twenty working-class white British students over two years. White British students typically account for 76.5% of secondary school students in the United Kingdom, of whom 20% are working-class students (DFE, 2019) However, the performance of these working-class students in science has gone under the radar because their underachievement is not prototypical of the larger White British group, whose GCSE academic attainment is often above the national average (ONS, 2021) The data were generated from 28 participants (20 students and 8 teachers) mainly through semi-structured interviews. The study employed a qualitative longitudinal design, drawing on Bourdieu's theory of reproduction (1987, 1992), Crenshaw's intersectionality theory (1990, 1992), and Butler's theory of gender performativity (2002) to frame the discussions.

The study's findings reveal that working-class white British students have distinct science experiences that affect their academic outcomes due to unequal access to cultural, social, and scientific capital required for success in GCSE science. These findings also reveal that working-class white British girls have more layers of disadvantage and marginalisation than do working-class boys in their science studies. I conclude that working-class white British students may face several disadvantages that hinder their scientific achievement, including limited social capital, family background, and future career prospects. I recommend a review of policy and practice to increase opportunities that embed the enhancement of science capital in schools with large working-class communities, and to enable all students to access the triple science course at GCSE, thereby improving students' prospects for a prosperous future in STEM-related professions.

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May God continue to bless all your endeavours and grant you lasting health and happiness.

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**Declaration**

“Exploring the barriers to achievement amongst working-class white British students in science at GCSE.”

I confirm that this thesis is my own work and that none of it has been submitted in substantially the same form for the award of a higher degree elsewhere.

Eno Anwana

Signature

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## Chapter 1: Introduction

### 1.1 Study Rationale

The underachievement of working-class white British students (WCWBS) in the General Certificate of Secondary Education (GCSE) examinations has been a concern for educators in the United Kingdom. It has been recognised since 2000-2020 (DFE, 2019; Strand, 2021; Demie *et al* , 2015) that working-class white British students (WCWBS) are *the* most likely group not to achieve a pass in English and Maths GCSE and the least likely to go to university (Chowdry, 2009; Demie, 2014; Archer, 2008, 2020). Studies have shown that several factors contribute to this issue, including socio-economic disadvantage, cultural attitudes, teacher expectations, curriculum, pedagogy, and self-perception (Archer, 2020; DFE, 2020; Bonal *et al* ., 2016). Various stakeholders in education have also raised this concern, noting that WCWBS who pass their GCSEs often do so less well (OFSTED, 2013; Strand, 2013; DFE, 2019). These studies also reveal that WCWB students are less likely to achieve 5 A\*-C passes at GCSE than their middle-class peers. We also know that working-class white British students (WCWB) do not perform as well as their peers from other ethnic backgrounds in the United Kingdom (not including Roma Gypsies, who are known to have a high incidence of non-attendance in school, resulting in poor results), Office for National Statistics, 2019. However, this difference in attainment amongst these social and ethnic groups was not bad enough. Figures for STEM subjects are even more damning, showing a pass rate of less than 50% for WCWBS (Royal Society of Science, 2008; UCAS, 2013; HESA, 2016).

Several factors contribute to the poor educational outcomes shown by working-class students. These factors include socio-economic status, cultural attitudes and aspirations, teacher expectations, curriculum, and pedagogy (Reardon, 2011). Working-class students are more likely to face financial constraints and limited resources, hindering their academic performance. Students not being able to acquire essential resources like textbooks and school equipment (pens, calculators, etc.) can hinder students' engagement and morale in lessons, as

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some parents cannot afford these basic demands. Several studies have shown a correlation between socio-economic status (SES) and academic achievement. The lower the SES status, the lower the academic achievement, particularly in STEM subjects (Liu *et al.* , 2020; Kim *et al.* , 2019; Edin *et al.* , 2010). Lack of resources and material deprivation are strongly tied to families with low SES. These families may not be able to afford books and computers, or internet and Wi-Fi available in the home. This might invariably affect completing homework and independent studies at home, unlike children from higher SES homes with readily available facilities (Javeria *et al.* , 2023). Although some working-class students from poor SES do well, it would be more accurate to say that the lack of resources disadvantages them and makes it more difficult for them to be successful. Research on social mobility also shows a link between poverty and lower academic achievement, particularly in STEM-related subjects (Sutton Trust, 2016; DFES, 2019; HESA, 2016).

Apart from impacts from lower family income, there are also lower aspirations among working-class families regarding higher education. This cultural disengagement with formal education can be easy to overlook. However, it can lead to a devastating impact on motivation. Without motivation from these students, science will often be seen as abstract, far-fetched, or irrelevant to WCWBS's daily life or futures. Francis and Wong (2013) argue that working-class students often feel disconnected from the academic culture promoted in schools. This academic culture can also result from the traditional methods of teaching science in school, which are often highly theoretical and exam-focused, and this entrenched teaching method may not engage working-class students as effectively. Reports from the Educational Endowment Foundation (EEF, 2018) suggest that hands-on, practical science teaching better motivates students from disadvantaged backgrounds. However, this approach is not always prevalent in schools.

It is all too common for teachers to forget that many of the students they teach come from varied backgrounds and often may unconsciously hold lower expectations for working-class white students, particularly in science, where

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they are perceived as less capable compared to their peers from other ethnic groups (Mongoon, 2008; Gilborn, 2000; Liu, 2016). These lower expectations can lead to less challenging teaching and a lack of encouragement to pursue science subjects (Dunne and Gazey, 2008). These factors combine to create a cycle of underachievement, especially in GCSE science, which is the pinnacle of a country's development and social mobility, as it forms the foundation for learning and creativity.

Most studies on working-class white British students seem to focus on how these students act or do not act in school, or negative attitudes toward formal education and academic endeavours. WCWB students' challenges and interactions with middle-class structures, such as traditional schools, have not gained similar attention (Reay, 2017; Coulson *et al.* , 2018). To understand the WCWBS experiences of school science, we need to contextualise it into the broader class hierarchy to challenge the attainment gap better. It would also be helpful to know how these students position themselves within the educational system, which is culturally different for them in their science learning.

Therefore, studying the underachievement of working-class white British students in GCSE science is essential for addressing educational inequality and improving social mobility. Understanding the root causes, whether **socio-economic**, cultural, or pedagogical, enables educators and policymakers to design targeted interventions that support these students in achieving their full potential. Considering the increasing significance of science, technology, engineering, and mathematics (STEM) in the contemporary labour market, guaranteeing equitable access to high-quality science education is imperative for cultivating a more inclusive and thriving society. Without such research, disparities in academic performance may persist, further entrenching social disadvantage amongst certain groups. This will consequently affect the future of the skilled technological workforce in Britain since the white British population is still recorded as the majority ethnic group with an estimated average of 81% of the total UK population, of which 44% of these are working class (Office for National Statistics, 2018; DFES, 2018; DFE, 2019).

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## 1.2 National context

The national picture about the educational attainment of working-class white British students at GCSE can be said to be unsatisfactory. White British students entitled to Free school meals (FSM) are one of the lowest attaining groups in the United Kingdom (Strand, 2015; Education Select Committee, 2021). Similarly, white British students on FSM (used as a proxy for class) on every measure performed poorly at the General certificate of secondary education (GCSE) than any other ethnicity on FSM (DFE, 2019, 2020) Figure 1.1 below shows that White British students eligible for FSM achieve 9-4 GCSEs in English and maths at 40%, compared to Chinese students at 85% and other ethnicities at 70%. The proportion of white British students meeting the expected standards falls at this stage in their education compared to other groups (school census, 2021).

Various scholars have advanced theories as to why working-class white British students performed poorly in education compared to other minority ethnic groups. These include several key areas like persistence, multi-generational disadvantage, family experience of education, social capital, disengagement from the curriculum, and a failure to address their low participation in higher education amongst others DFE, (201,5); EPI, (2020); Committee on Race and ethnic disparities (CORAED), 2021; Strand, (2014); Reay, (2010); Stahl, (2014) Other factors mitigating against working-class white British students may also include place-based factors like regional economic and underinvestment, and cultural factors, including family structure and access to community assets,

may also compound the impact on attainment for working-class white British students.

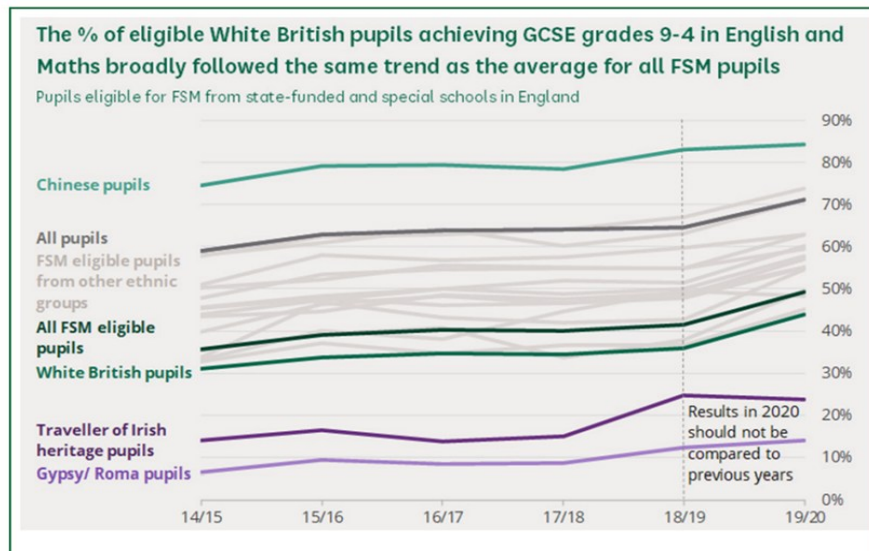


Figure 1.1 GCSE performance of students from different ethnicities on FSM

OFSTED (2013) report excerpt best describes the problem with the attainment of this group as follows.

“The underperformance of low-income white British pupils matters, particularly because they make up the majority, two-thirds of such pupils. So, the lowest-performing group of poor children is also the largest. If we do not crack the problem of low achievement by poor white British boys and girls, then we will not solve the problem overall “(Ofsted 2013, 5).

The attainment gap between working-class white British students and other groups on FSM has been steadily increasing, indicating that a new approach is needed to target these individuals and notably close the gap (OFSTED, 2014). The Education Policy Institute (EPI, 2020) annual report concluded that policymakers have not closed the widening gap. This gap in educational achievement was seen in science and all other compulsory GCSE subjects. Similarly, the number of working-class white British students studying science at A-level has declined. This likely reflects their GCSE science results, which are an important course-entry criterion. This decline has also been linked to socio-economic status and career choice (Kocak, 2021; Moote *et al.* , 2020; HESA, 2016).

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Lastly, working-class white British students lack science capital, a concept derived from Pierre Bourdieu's notion of cultural capital that encompasses the knowledge, attitudes, experiences, and resources that enable individuals to engage with and succeed in science (Archer and Black *et al.* , 2016). The more science capital you have, the more likely you feel that science is valuable or important to your life. Working-class students often have less access to science capital due to limited exposure to science-related activities, fewer science role models, and fewer opportunities to develop familiarity with scientific concepts outside of school. Research by Archer *et al.* , (2015) emphasizes that students with low science capital are less likely to see science as relevant to their lives or envision themselves in science-related careers. Without this cultural and practical engagement, students lack confidence in their scientific abilities or see science as "not for people like them". This gap in science capital can lead to a lack of enthusiasm for science subjects and further limit working-class students' academic performance and aspirations in science education.

### **1.3 Researcher's Position**

As a secondary science teacher and the school's coordinator overseeing the well-being and enrichment programs for gifted and talented students, I often work closely with high-ability students from diverse backgrounds, developing strategies to support their academic growth. I am also obliged to provide all my students, able, gifted or not, the highest standard of teaching in science and care. The Children's Care Act (1989) outlines roles like educating, guiding, and preventing discrimination and harm. As a rule, this guides my thoughts, actions, and responses to how I interact with and instruct the students within my care. This also makes me ponder about the difficulties that many diverse groups of students may face, whether physically, emotionally, or mentally, while schooling, which is rather worrisome.

My study participants (working-class white British students) are my students who come from a cohort of the school where over a shocking 60% underachieve at GCSE science with an average grade of 4 (grade C). Most working-class students (white British or not) are often faced with the generic

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hurdle of deprivation and lack of basic resources (Demie, 2014; Liu *et al.* , 2020) While some of the problems may point to factors such as social capital, self-perception, and family background, trends in my school data for the past five years (2015 - 2019) show a **notable** increase in the uptake of free school meals (FSM) from these working-class white British students. Also, in the school, we have noticed a gradual decline in triple science course uptake year on year to a peak of 15% by WCWB students (School database 2016 - 2020). Their GCSE results data from the school database for the past few years (2016 - 2020) similarly shows a 35% to 40% drop in attainment compared to working-class students from Asian, other European, or Black African backgrounds with similar starting points, entry data, and target grades. This constitutes a worry for me as a teacher and fuelled a desire to get to understand the problem to seek or offer solutions.

Another aspect of school life that has brought me into contact with many high-ability working-class white British students is my role as a Gifted and Talented Students coordinator. Over the years, I have met students with little or no interest in taking or studying triple science courses, even though they are capable, qualified, and fulfil all the basic entry criteria for the course.

The final notable point about my position in this research is that I offer a unique and valuable perspective as a Black British researcher, as my background provides insights that differ from those of the participants. This contrast enables me to approach the research with an understanding of systemic barriers and sensitivity to cultural nuances, thereby enriching the analysis and deepening the study's exploration of underachievement. Like most of my students, and many of the pupils who choose to move away from science subjects, also come from a modest working-class background and can empathise with the plight of students in this group. However, I had taken advantage of school facilities and resources to succeed in science, and I believe these students can achieve too.

Therefore, I seek to investigate their peculiar challenges to learning and attaining success in science. This thesis has arisen because of the totality of these factors mentioned earlier and makes informed recommendations to teachers, policymakers, and educators based on the outcomes on the effective

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ways to encourage these working-class white British students to thrive, achieve in GCSE science and have a greater desire to study science even at higher academic levels.

#### **1.4 Research questions, design, and methodology**

To investigate the barriers and problems associated with the learning experiences of working-class white British (WCWB) students, three main research questions were formed (details in chapter 4 methodology):

1. "How does social class influence achievement in GCSE science among working-class white British students?"
2. What value do WCWB students place on science subjects?
3. Is gender a barrier to GCSE science achievement amongst WCWB girls?

This research aims to explore the experiences of working-class white British students with science. This will draw primarily on qualitative data but will also be contextualised using some quantitative school data. The research questions warranted a thoughtful consideration of a mainly qualitative approach to ensure a comprehensive and nuanced response from participants. The methods included teacher interviews and individual and focus-group student interviews. This provided multiple forms of evidence highlighted from different perspectives and a clearer picture of the phenomenon from those directly affected.

The research design was longitudinal, qualitative, and exploratory. This method was used to show patterns of change over time. This also allowed data from the same participants to be collected over two years to determine whether opinions changed over time. The participants were 20 working-class white British students (10 boys and 10 girls), and 8 teachers were also interviewed to provide their views on experiences teaching WCWB students (4 science teachers and 4 non-science specialists) The data generated were sorted using thematic analysis (Braun and Clark, 2006) and analysed and framed using Bourdieu's theory of reproduction (1977, 1987, 1989, 1990), Butler's gender performativity theory (1998) and Crenshaw's intersectionality theory (1989,

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1991, 1992). More details of these theoretical frameworks will be discussed in the methodology chapter.

## **1.5 Outlines of chapters**

This research is organized and presented in ten chapters.

Chapter 2: This chapter reviews the relevant literature on the underachievement of working-class white British students in school and science. It examines the role of socio-economic factors, cultural attitudes, aspirations, teacher expectations, the national science curriculum and teachers' pedagogy. It also examines scientific fields that affect working-class students in education and how they have navigated their relationships with science over time.

Chapter 3: Theoretical concepts. This chapter outlines the theoretical concepts used to analyse this research. It draws on Pierre Bourdieu's theory of reproduction and expands on the key concepts of habitus, field, and capital. It enables us to see how education and schools function as a site of social reproduction for these students. The chapter also weaves in Kimberly Crenshaw's theory of intersectionality, which shows how some individuals can experience multiple overlapping layers of disadvantage while others remain unaffected. To address the research question regarding working-class white British girls, it was imperative to incorporate gender theory into the analysis. Here, Butler's gender theory on performativity was used to help analyse the data. The chapter will also highlight the limitations of these theories in framing the analysis.

Chapter 4: The methodology chapter. It outlines the philosophical paradigms I considered in studying the phenomenon and how these views informed my research design and methodological choices. This includes sampling procedures, study participants, and data analysis techniques. The justification for using this design is also explained in light of the epistemological and ontological stances. It also outlines the ethical issues and considerations and engages in my position as a researcher.

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Chapter 5: Family background. This chapter unfolds the core themes discussed and analysed for the study. This chapter is tagged family background. It reviews the impact of various family-related factors, such as socio-economic status, resources, parental education, occupation, and worldview, on these students and how these factors contribute to their marginalisation. This chapter also reports how these family-related factors collectively contributed to the participants' scientific underachievement.

Chapter 6: School factors. This chapter explores how various school factors and cultures, such as teacher pedagogy, exams, tiering, peer pressure, the type of science subject, and attendance, conflict with WCWB students' learner identities. These conflicts shape the participants' GCSE science outputs. It begins by highlighting the various factors and how they can inadvertently discourage WCWB students in their practice.

Chapter 7: Perception and motivation. This chapter is tagged students' perceptions and motivation. It highlights how students' self-perceptions of their science ability and motivation affect their overall engagement with the subject and subsequent science attainment. It also highlights how their learners' identities can influence, conflict with, and prompt disengagement from science and school goals.

Chapter 8: Influencers. The core message of this chapter centres on how the remarkable individuals in the participants' lives affected their science achievement and engagement with the subject. It closely examines these key drivers and how they shape participants' overall science attainment at GCSE.

Chapter 9: Conclusion. This is the final chapter of this research. It synthesises the study's main conclusions and overall findings, which address the research questions. It also outlines the contribution to knowledge, ethical considerations, recommendations, and limitations of the research, while providing suggestions for the way forward for educational stakeholders and policymakers, and recommended areas for future research.

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## **Chapter 2: Working-class white British students and school science.**

### **2.1 Introduction**

The preceding chapter introduced research on the low academic achievement of students from White British Working-Class (WCWB) backgrounds, both in their General Certificate of Secondary Education (GCSE) performance and specifically in science. This chapter examines the pertinent literature on the science education experiences of WCWB students undertaking GCSE science. The impediments to optimal performance in GCSE science have been closely associated with multiple factors that remain insufficiently substantiated. These factors comprise socio-economic status, family background, parental educational attainment, and lack of ambition (Demie & Lewis, 2010; Stahl, 2016). Moreover, this chapter will scrutinise the practice of ability grouping and tier entry, which, to some extent, determines the various science pathways accessible to students and whether it bears on these students' science attainment. Ability grouping has been a contentious issue, as Strand (2011) observed, who pointed out that teacher expectations disproportionately disadvantage underprivileged students in lower-ability tiers on exams, ultimately leading to poorer overall outcomes.

This chapter examines the achievement gaps amongst WCWB students at GCSE. It will further illuminate the areas of disparity and identify where gaps in achievement for this group exist. Minimal research has been conducted on WCWB experiences and engagement with science at any age. This chapter will also explore the role of other proximal factors such as gender, socio-economic status, and ethnicity (Demie *et al.* , 2010; Archer, 2020).

This study will also explore different facets of the science curriculum in schools and their potential impact on working-class students. It will highlight the triple science and double science routes students follow in schools and how these affect working-class students and their science attainment. It will also spotlight how gender and science interact and shape the engagement of working-class girls towards science.

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Overall, this chapter aims to illuminate the literature around the key areas that working-class white British (WCWB) students encounter while learning science, particularly at the GCSE level.

## **2.2 Socio-economic status and education**

Social class is a multifaceted concept encompassing economic, cultural, social, and symbolic capital (Bourdieu, 1986). It influences access to resources, opportunities, and power within society. Social class moves beyond income and occupation alone; it is a relational, structural concept shaped by several social and economic forces. Savage *et al.* (2013) similarly describes social class as multidimensional, with accumulated capitals and lived identities. Savage further suggests how class distinctions persist through variations in cultural capital, lifestyles, and social networks, shaping individuals' experiences in institutions such as schools.

However, the works of Smith (2011, 2014, 2018) further extends this definition by explaining social class being produced as a structural and institutionalised process that shapes access to valued forms of capital and also socio-economic constraints. Smith (2018) elaborates how social class shapes inequalities by connecting family background income, wealth and occupation to children's inequalities, students' outcomes and progression to higher education with working class students' consistent disadvantage at each stage of their educational trajectories. Smith shows how social class is powerfully shaped and designed to intentionally disadvantage the working class and favour the middle and upper class. This research aligns with Smith's (2011, 2014, 2018) conceptualisation of social class as a structural and institutionalised process that shapes access to valued capital and constrains educational trajectories. Smith's findings reveal that family income, occupation and wealth powerfully influence attainment and progression in STEM, this study demonstrates how GCSE science functions as a key institutional site where classed inequalities are and can be reproduced. Working-class students are typically those whose families have lower incomes, less wealth, and occupations in lower socio-economic groups, and who therefore have reduced access to valued economic, social and cultural capital compared with middle-class peers. Working-class

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White British students are not disadvantaged due to lack of aspiration or ability. Rather, they encounter cumulative structural constraints embedded within tiering, assessment, guidance practices and institutional expectations of them which might run contrary to their norms or upbringing. In doing so, this research provides micro-level evidence of the mechanisms through which social class continues to shape educational outcomes and progression in education for some disadvantaged individuals (Reay, 2005; Archer & Francis, 2007; Archer *et al.*, 2017). Consequently, social class continues to notably determine academic achievement and aspirations, influencing both outcomes and the educational experience. Socio-economic status, therefore, can be said to be a comprehensive gauge of sociological and economic determinants that demarcate an individual's social standing. In this study, however, specific metrics and criteria are needed to identify students from the sample who belong to the working-class social class. These were sampled using measures like the socio-economic classification based on parental occupation and the common free school meal metrics often used in educational studies. Using parental occupation and free school meals (FSM) helps identify broad patterns, but both are blunt tools for defining the working class. Parental occupation can be inaccurate, out of date and ignores wealth, insecurity, and cultural/social capital. FSM, on the other hand, is a rough, shifting poverty threshold; it often misses many low-income families, and some eligible pupils do not claim it. Both indices treat class as a simple, often binary category and overlook how class intersects with race, gender and migration, so they risk oversimplifying and underestimating inequality. However, they offer clear, standardised indicators that are easy to collect and compare across large samples, allowing researchers to identify broad patterns of disadvantage and track class inequalities over time. They are also widely recognised in policy and research, so findings based on them can speak into existing debates, even if they do not capture all dimensions of class.

This was a socio-economic classification; however, in the United Kingdom, it is quite complex. In 2020, the Office for National Statistics (ONS) conducted a comprehensive review. It developed an 8-5-3 classification system, further expanding the middle class by job roles. This 8-5-3 system has only reduced

the upper (1) and middle classes (3-2) and expanded the working class (8-5) . See Table 2:1 below. Therefore, working-class individuals may be defined as those engaged in low-wage jobs, as shown in Table 2.1, from groups 5-8. The three system classifications divide society into three broad categories, providing a clear overview of inequality in the UK. The system focuses on linking social class to economic and occupational status, which are central to understanding class dynamics in the UK. This simple 3-system classification table is well-suited to showing the hierarchy of working-class families as Pierre Bourdieu (1990) posited and also Smith's (2011) use of socio-economic status as a partial way of looking at social class.

<b>Group</b>	<b>Description</b>	<b>NRS equivalent</b>	<b>Groups used in the study</b>
1	Higher professions and managerial occupations	A	
2	Lower managerial and professional occupations	B	
3	Immediate occupations	C1 and C2	
4	Small employers and own-account workers	C1 and C2	✓
5	Lower supervisory and technical occupations	C1 and C2	✓
6	Semi-routine occupations	D	✓
7	Routine occupations	D	✓
8	Never worked and long-term unemployed	E	✓

Table 2.1 Job classifications in the UK

In view of this, social class here captures who is working class and the more complex discussion of structural concepts shaped by economic and social forces. The table on parental occupation provides a systematic way of locating students in the class structure, which is essential for empirical work, whilst also using free school meals as a proxy for unequal starting conditions that shape educational chances. Social class is, by all means, complex, layered, and

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shaped by a relational focus on inequality that shapes trajectories, as Smith (2014) describes.

Poverty has often been very closely linked to the working class, as most students who receive FSM are from working-class families (DFE, 2019). Most studies on socio-economic status use receiving free school meals as a proxy for social class (Demi *et al.* , 2015). Others use a combination of parents' occupations and dependence on the welfare state for sustenance, alongside free school meals as a determinant of social class (Mongoon and Chapman 2008, DFE, 2019, ONS, 2018). Although free school meals are not a perfect indicator, they show disadvantages amongst the different populations, especially in schools. This research used FSM with a combination of other poverty indicators, like ACORN data (a geodemographic tool that segments people's characteristics in different areas), and IDACI (Income deprivation affecting children's index) data to select participants for the research (Hobbs & Vignoles, 2010). This provided a holistic perspective on the study participants, as it used multiple measures to select students rather than relying on a single criterion, thereby enhancing the validity of the selection and classification as working-class individuals. Studies such as Stumm *et al* (2022) and Kaye (2023) have shown that the United Kingdom had the highest association of social classes with low educational participation of all the Organisation for Economic Co-operation and Development (OECD) countries in 2022. This data is not limited to maths and science but extends to other subjects across the curriculum. There are differences in science participation by ethnicity and social class. In science and mathematics, the highest participating group was Chinese at 78%, whilst the lowest was white British at 45% at GCSE among Free School Meals (DFE, 2020).

There is a similar strong association between FSM eligibility and low educational attainment. Studies have shown that financial resources can adversely affect students' attainment, particularly among working-class students (Stand & Demie, 2006). The inability to provide basic resources, such as books, computers, and a study room, is a major hindrance for most students from lower- or working-class families. Socio-economic disadvantages are also linked

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to health equality, and poor children are more likely to suffer disabilities, which, often with little support, may not be able to achieve their full academic potential (Parsons & Platt, 2013). On the other hand, according to the DFE (2022), working-class students from Bangladeshi and Pakistani ethnicities had a positive progress 8 score. This measures students' progress between the end of primary and secondary school, comparing their actual GCSE results with those of students with similar starting points. (A score above zero means pupils in an ethnic group are doing better than average, as used by DFE), which made them the only working-class groups to break the trend of poor performance at GCSE. Working-class white British students, unlike their Bangladeshi counterparts, seem to have lower academic attainment with negative progress 8 scores, followed closely by Caribbean students (Strand, 2014). This refutes the notion that all low-SES students underperform in school. Strand, however, notes that the achievement gaps amongst working-class white British students are twice as notable as the largest ethnic gap amongst students in the United Kingdom at age 16.

Researchers have long studied how socio-economic class affects educational achievement. Consistent findings show a strong link between socio-economic factors and academic achievement (Durk *et al.* , 2020; Keith & Kerr, 2022; Strand, 2014). Charlotte (2021) further explains that these factors are complex and interconnected. They include limited access to science activities, language and communication barriers, parental education, and socio-cultural stereotypes, among others. On average, these achievement gaps can be equivalent to 2 years of learning behind more affluent peers (Goodall, 2017).

Smith (2011) repeatedly demonstrates that indicators such as parental occupation and income are the strongest predictors of educational outcomes and later life chances. Smith claims that political discourses of equality of opportunity and social mobility often ignore these variables and class differences, casting outcomes as the result of individual effort rather than unequal starting points. Smith shows that family income, wealth and occupation shape children's attainment, choices and chances from early schooling through to higher education, so that working-class students are systematically

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disadvantaged at every stage of their educational trajectories. The influence of socio-economic status on outcomes at GCSE achievement appears more prominent for white British students and Roma gypsies than for any other subgroup in the United Kingdom (Gilburn & Mirza, 2015). White British students not receiving free school meals have an overall pass achievement rate of 58.5% (5 A\*-C), and those receiving free meals have 20.9% (DFE, 2019, 2021). However, Strand (2014) argues that socio-economic status is not the only factor that can be used to explain these low achievement outcomes. Strand indicates other aggravating issues like teacher expectations, cultural differences, parents' changing attitudes, and availability of resources. This view is supported by Collins *et al.*, (2015), who remind us that the connection between social and educational attainment is complex and might often be intermingled with a range of social and cultural factors like parental upbringing, parental education, and finances, amongst others, to support their progress.

A person's social class makes it easier to highlight disparities in attainment across diverse groups. There is a lack of vigorous research on social class and GCSE science achievement in England. Gorard (2009) agrees that patterns of science attainment can be seen when socio-economic class is analysed. The pattern showed that students from lower-SES homes did not perform and those from higher-SES, more socially advantaged homes. This suggests that socio-economic status (SES) may affect GCSE science achievement. This SES effect was also observed when examining science attainment among 5–11-year-olds in the UK (Paterson, 2022; Connelly, 2019). The data indicate a negative correlation between living in a deprived neighbourhood and science attainment at KS2 and KS3. Additionally, at the GCSE level (KS4), students from lower-SES or working-class backgrounds are less likely to attain a science degree than those from higher-SES backgrounds. This SES background effect and how it correlates with attainment, though seen in other subjects, the gap persists in science more than any other subject (Gorard *et al.*, 2008). According to the National Pupil Data, when attainment and SES were assessed by the deprivation of the area of residence, they seem to have improved between 2005 and 2009 across all other subjects, but remained at the same level for science.

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According to the Royal Society of Science (RSOS, 2008, 2010), analyses of international test scores, such as TIMSS, suggest that family background is a notable determinant of attainment across most countries surveyed. Parents with higher SES were found to support their children's science attainment by providing relevant resources, such as books, private tuition, homework supervision, and funding for school trips (Okpala et al ., 2001; Cook & Evans, 2000). Students' science subject choices can also be linked to their families' SES. Students from lower-SES backgrounds tend to choose combined sciences rather than triple science. This is often thought to require more effort and cost more to get the needed books for separate science (Bicknell & Horley, 2003). It is also associated with future career choices of these students, whose families often influence them (Lyons, 2004). Students in low SES families often fail to develop the right academic skills needed for successful outcomes comparable to their peers from higher SES groups, such as a love for reading and learning. This is mainly because the students are less likely to have experiences that encourage early cognitive development and fundamental reading, language, and logical skills (Beamen-Wheldall, 2013). Additionally, the majority of schools serving these low SES communities are frequently understaffed with the right teachers and underfunded poorly by the government. They are not in a position to fill those staffing gaps and provide a program that can frequently cater to these students, which can hurt students' academic results and future development.

Social class has been shown to greatly affect educational outcomes and future life chances even when educational achievement is moderate (Demie & Lewis, 2010; Runnymede Trust, 2009). Demie *et al.* (2010) explain that working-class students are less likely to achieve a 5 A\*-C pass at GCSE because of the socio-economic variables working against them. The Youth Cohort Study of England and Wales (YCS) also supported this using parental occupations. Similarly, Strand (2008) admits that white British students from managerial homes are among the highest attaining, whilst white working-class British students from working-class backgrounds were the lowest attaining at age 16. Some studies, however, reported no substantial relationship between social class and science uptake, participation, and attainment. Instead, students' prior

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attainment or starting points were credited for science failures (Coe, 2008; Kabueman & Tversky, 2000) Gottfredson (2004) claims that variation in science attainment between social classes results from “general intelligence”. However, her claim was not backed by her findings, as many of her explanations were subject to various external factors, as reviewed by Wallace (2005). Nonetheless, family background is, by many researchers, found to be influential in many ways. Families lay a foundation for how success and failure at school are defined. This has a knock-on effect on subject choice and career choice. Others like Selwyn *et al.* (2015) argue that the lack of role models and regular attitude to learning amongst families with low SES adversely affects science attainment and participation.

### **2.3 Working-class white British students’ achievement gaps.**

This study defines achievement as the performance outcomes of accomplishing something with effort, skill, and courage (Steinmayr *et al.* , 2014. The words achievement and attainment will be used interchangeably. It can further be explained as an individual’s level of educational success after a rigorous assessment and standardised moderation (Gorard & See, 2013). In the United Kingdom, the benchmark requirement for all students at age 16 for GCSE exams is 5 A\* - C or Grade 9 - 4, which is a pass in 5 subjects, as highlighted in KS4 performance tables. These KS4 results from schools are then compared with the national average. This process, however, is purely summative and does not account for extraneous factors such as timing, ill health, bereavement, SEN-related barriers, or other unforeseen circumstances. As such, evaluating these results often does not provide a clear, definitive picture of one’s ability, especially if they do not reflect their current formative assessment grades. Students who fall below these benchmarks are often classed as underachieving (DFE, 2019).

WCWB students have been labelled “underachievers” because they underperform relative to the national average. The Ofsted Unseen Children Report (2013) sums up this group’s academic achievement gap. It found that WCWB students had the lowest academic achievement gaps in England, excluding Roma Gypsies. Subsequently, the Parliamentary Education Common

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Report (2013) also submitted that working-class children, especially White British, needed to be supported by schools to tackle the growing achievement gaps that are widening between ethnicities. However, these reports revealed that boys, more than girls, were failing at GCSE. It states that girls outperform boys by 11.6% in GCSE attainment (5A\*-C; DFE, 2019, 2023). It also shows the performance of KS4 pupils eligible for free school meals: achievement at 5A\*-C was low at 35%, compared with 67% for students not receiving FSM. This trend of low achievement was observed among several other ethnic groups, which further strongly associates FSM with low achievement. Lucy Yeoman's 2019 thesis on White British working-class students shows that many feel science is "not for people like us." She explains that classroom cultures, assessment styles, and ideas about the "ideal science student" often favour White, middle-class, and mostly masculine traits. Yeoman believes that achievement gaps are not caused by a lack of interest or ambition, but by unequal access to science-related social and cultural resources (science capital) and by school practices that quietly undervalue working-class ways of speaking, acting, and thinking about the future.

Yeoman's research (Archer *et al.*, 2017, 2020), along with the ASPIRES findings, shows that class, gender, and ethnicity all shape how young people see themselves in science and whether they keep studying it. Young people from poorer backgrounds are less likely to see science as a realistic or welcoming choice, even if they do well in school. The research suggests that working-class achievement gaps in science continue because of limited science capital, narrow ideas about who belongs in science, and school cultures that treat middle-class paths as the standard. Because of this, many capable working-class students choose not to pursue advanced science. Keith and Kerr (2022) explain that working-class students' success in science depends on more than just their ability or ambition. They note that working-class students often show resilience and practical problem-solving, but these strengths are usually overlooked; therefore, they suggest that teaching, curriculum, and assessment should value different ways of engaging with and succeeding in science, rather than expecting working-class students to fit existing norms.

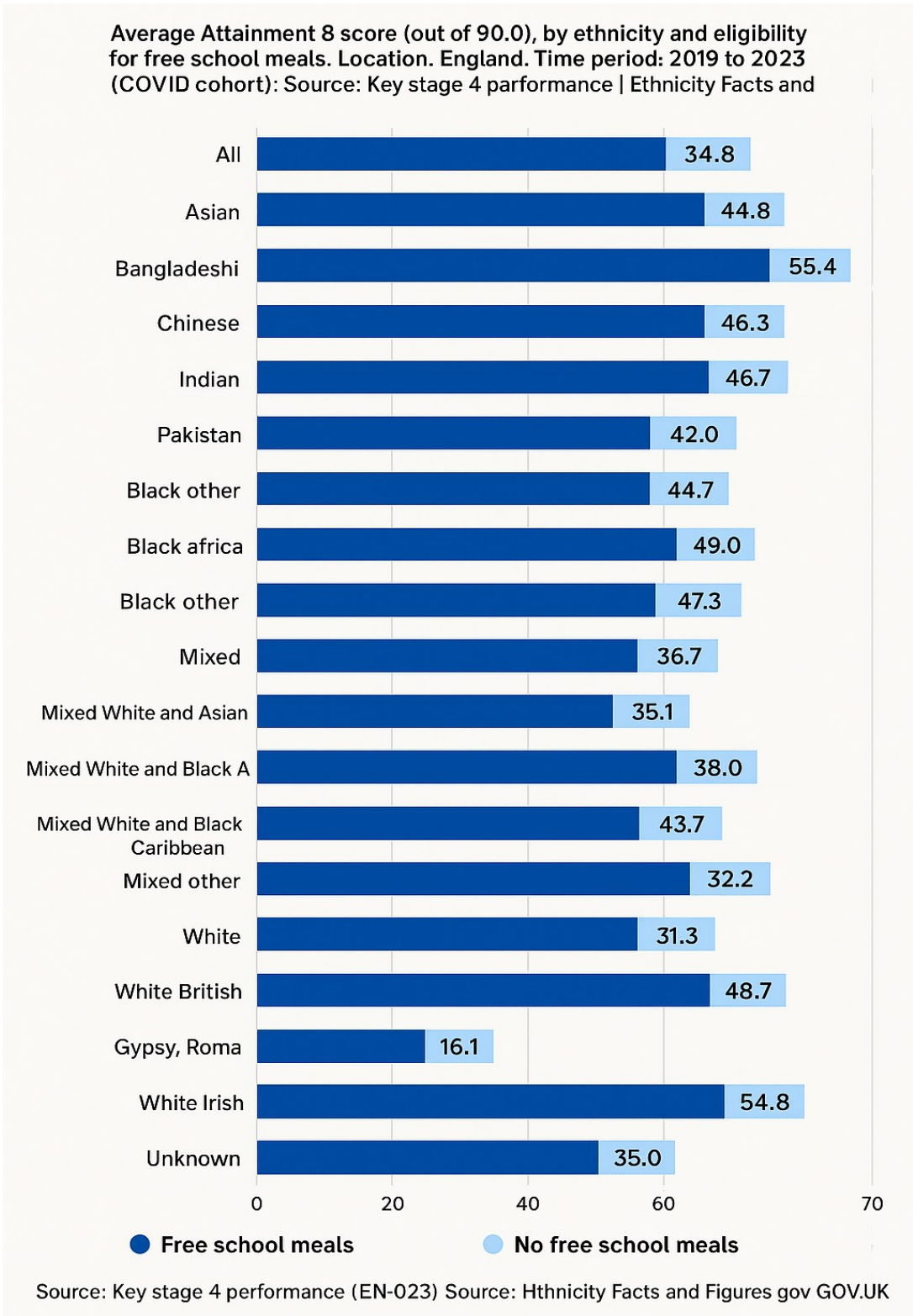


Figure 2.1 Average attainment 8 scores by ethnicities 2019-2023

Source: [https://www.ethnicity-facts-figures.service.gov.uk/education-skills-and-training/11-to-16-years-old/gcse-results-attainment-8-for-children-aged-14-to-16-key-stage-4/latest/?utm\\_source=chatgpt.com#by-ethnicity-and-eligibility-for-free-school-meals](https://www.ethnicity-facts-figures.service.gov.uk/education-skills-and-training/11-to-16-years-old/gcse-results-attainment-8-for-children-aged-14-to-16-key-stage-4/latest/?utm_source=chatgpt.com#by-ethnicity-and-eligibility-for-free-school-meals)

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The data from Figure 2.1 above suggest that white British students eligible for FSM were the worst-performing students, with a percentage below the national average, followed by Roma gypsies. Contrary to expectations, Chinese students receiving FSM still achieved a 60.3% pass rate. This suggests that poverty or socio-economic factors alone cannot account for the poor performance of WCWBS. Other factors must be at play for this group (Strand, 2014). The substantial differences in SES between white British people and other groups do not fully account for ethnic disparities in educational attainment. Strand (2004) argues that this area has not been explored thoroughly and that, in England, there has been no longitudinal study covering the educational attainment of 14-16 year-olds since the Birth Cohort Study of 1970. He posits that other mitigating factors may have contributed to this achievement gap and that SES alone cannot convincingly account for the difference.

These gaps in WCWBS achievement compared to other ethnicities have expanded considerably over the years. SES GCSE results from 2010-2020 show a 5% increase compared to other ethnicities. Before 2013, the focus was on working-class Caribbean boys in the limelight for failing (Demie, 2014). The focus now is WCWB students. It is somewhat discouraging to compare these results, as they suggest a retrogressive effect rather than an improvement. The Youth Cohort study (2006) has provided the most extensive dataset on ethnicity and academic attainment. These gaps in attainment at age 16 were first identified in 2004, and no notable improvement has been observed since then.

#### **2.4 The role of schools in working-class achievement gaps**

The national science curriculum for England was designed to help students understand the workings of science through disciplinary literacy, i.e., writing, talking, and representing science (Osbourne *et al.*, 2016). This differs from teaching generic literacy for interpreting text. Students are, however, expected to grasp this literacy implicitly and use it to form arguments and structure their scientific discourse. This is akin to excluding certain groups of students, particularly those from different social classes, who will find it challenging (Hobbs, 2016) Bourdieu and Passeron (1990) claim that education shapes

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attitudes and reflects the attributes of the middle class. This intersection of race, class, and gender produces experiences and academic outcomes that are inequitable for working-class students. Schools, however, are intended to serve as guardians of academic knowledge and information for all communities, not just the middle or upper classes (Bernstein, 2000; Young, 2011).

Teachers similarly play a pivotal role in schools in raising students' attainment. Teachers' specific pedagogies frame the learning experiences of all students. Learning to teach effectively to accommodate all students' misconceptions, biases, and socio-economic backgrounds is essential to students' attainment. According to Hammond (1999), the difficulty is that teachers often teach students as they were taught themselves, which may not be favourable to all learners, especially those from different backgrounds. However, teaching science poses an additional layer of difficulty for teachers, as it is embedded in specialist language and terminology that are predominantly middle-class. Therefore, for working-class students to thrive, they may need to develop substantial science capital to compete in the school environment (Bourdieu & Passeron, 2000). It has also been suggested that there has been a national shortage of specialist science teachers in England (Sims, 2019). Research also shows that schools in deprived areas with a high proportion of working-class students using FSM as an indicator usually have the highest proportion of unqualified teachers, especially in science and maths, as less experienced teachers are more likely to work in areas where there are gaps (Nunes *et al* , 2017).

Teaching science in schools in England and Wales is delivered through several routes, as detailed in the introduction. This allows schools to pick science examination boards and favourable teaching routes for their students. Most schools typically choose the triple science route, in which students take biology, chemistry, and physics separately to obtain three grades, whereas the combined science or double science routes offer two science grades with less subject content. Schools often prefer the former because it helps them improve their league table positions by satisfying the depth and breadth of knowledge in

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science criteria, but these routes are not suitable for some students who may lack a broad science foundation, especially from primary school (DFE, 2016).

A report commissioned by the Department for Business, Innovation, and Skills (2020) reveals that a survey of 14-16 year olds in England unveils a common trend in the attitude of students towards science. The report suggests students are positive about science. However, more boys than girls from high SES and younger teenagers are positive about science. Banner *et al.*, (2007) similarly suggest that attitudes toward science depend on socio-cultural outlooks, self-concepts, and career motivations. Science, however, appears to have limited traction among students' enrolments in higher education, as several surveys indicate low appeal for the career choice (OECD, 2010). This also begs the question where the achievement gap came from. Another similar survey reveals that students' achievement in science varies with SES, ethnic background, and gender revealing a contrast with previous reports of all round success and acceptance of science by all students (Strand, 2007; DFE, 2010a).

Schools, as learning hubs, are critical to mitigating the achievement gap among students from working-class and ethnic minority backgrounds by offering programs and interventions that improve students' academic performance, expectations, curiosity, engagement, and self-assurance. This crucial objective can be accomplished through diverse programmes and interventions that have demonstrated efficacy in enhancing students' attainment, expectations, curiosity, engagement, and self-belief in their academic abilities (Strand, 2007; Demie, 2009). Among these programmes, the Gifted and Talented programme has emerged as a promising strategy for most schools that adopt it, enabling them to identify competent students from disadvantaged families who may lack the requisite motivation, aspiration, or science capital to succeed on their own (DCSF, 2008; Duckworth *et al.*, 2009). Additionally, schools can go further to support students' self-confidence and efficacy in a subject area by providing them with enriching experiences, trips, and exposure to opportunities that may be beyond their reach otherwise, thereby broadening their horizons and creating a positive cycle of achievement and engagement (Goodman & Gregg, 2010; Demie & Lewis, 2010). These interventions may be necessary to help fill

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the knowledge gap among students from low-SES homes and to address the opportunity gap.

However, for these school strategies to inspire and motivate students from working-class communities to achieve and compete favourably with others, extensive work must also be conducted with parents or family members. Studies have shown that when parental involvement is high in schools, the achievement of working-class families surpasses 50% (Scott et al ., 2010).

## **2.5 GCSE science at age 16 in the United Kingdom**

Secondary schools' General Certificate of Secondary Education (GCSE) is the principal examination taken at age 16 (year 11) in England, Northern Ireland, and Wales (DFE, 2019). It provides the first formal certified assessment of your academic abilities, progress, and potential. It is equivalent to the Scottish National 5 Certificate in Scotland.

GCSEs are a foundation for a range of subjects that students can pursue in the advanced courses called 'A 'levels. You cannot advance to these advanced courses without fulfilling the requirements and attaining a GCSE. It also equips and provides students with transferable skills essential to life and can help in future work or advanced schooling. Such skills include decision-making, meeting challenges, problem-solving, communicating, receiving feedback, and leadership skills.

Some educational reforms were implemented in 2015 regarding the grading of GCSEs. These reforms to GCSEs and A-level exams were a call for greater rigour in testing. The first cohort to take the new exams was in 2017 across various subjects. These changes included more challenging materials, a revised grading system, increased differentiation, and a shift from modular unit exams to a more streamlined focus on final exams (DFE, 2019). This reform aimed to reduce the attainment gap between the top and lower grades, make exams more difficult, increase differentiation by making the top grades rarer, and improve the overall quality of the examination. However, many would argue that these changes in the format, depth, and structure of GCSEs further

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disadvantaged working-class and poorer students, as the language was more academic, favouring middle-class students (NUT, 2019; Runnymede Trust, 2018). This is evident in attainment gaps further widening among SES groups since 2017 (NEU 2018; Sutton Trust, 2020).

Under the former GCSE system, 3% of working-class students achieved the top grade of A\*, whereas, on average, just 1% now achieve a grade of 9 (DFE, 2018, 2020). Across most subjects, attainment gaps in science have increased slightly or remained unchanged, with only the triple science subjects showing a more substantial increase. Educators have also questioned the added discrimination the reforms have introduced through new pass descriptors. The new descriptors introduced are “strong pass” defined by grades 5 and above (in English, Maths, and Science inclusive), and “standard pass” defined by grades 4 and above. This implies a much higher failure rate among certain groups, undermining the reforms' core purpose. It is noted that the grade 5 boundary is where most adverse effects are observed, particularly for working-class students, especially in triple science (DFE, 2021). The National Pupil Database (2017) statistics in England survey show that 44.5% of disadvantaged students achieved grades 9-4 in both GCSEs English and Maths compared to 71.5% of those from more affluent backgrounds. This attainment gap has widened gradually over the years, reducing opportunities for further education and employment for disadvantaged students.

## **2.6 Science curriculum, key stages, and working-class participation**

Another notable role the school system plays in students' academic performance is the structure of its science curriculum and its instruction. Science is taught in the United Kingdom in different phases, called key stages. This ranges from Key Stages 1 to 5. The primary phase comprises key stages one and two. In the secondary school phase, students undergo key stages three and four. Key Stage three is the lower classes of years seven and eight, whilst Key Stage four is the upper secondary classes of years nine, ten, and eleven. Most schools that offer six forms may also offer Key Stage 5, which is the higher school Advanced levels. The focus of each key stage is to enable

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students to experience science through different methods of inquiry and experimentation appropriate to the age group being taught (NCE, 2023).

At key stage four, often called the GCSE phase, which is the focus for the research, science is divided into three disciplines: biology, chemistry, and physics. These three distinct areas of science are taught differently and examined using the National Curriculum Framework for Science through various examination boards (DFE, 2015). This division of science further increases the difficulty of understanding and learning required to succeed in the subject for some students. Jenkins (2000) similarly raised this issue of difficulty in his study about the implementation and highlighted that a substantial proportion of teachers feel the national curriculum is not flexible enough to meet the needs of all students and that it would marginalise certain minority groups that could not cope with the new depth of terminology involved in the GCSE stage. This phase provides teachers with less time to engage in practical work or other activities that enhance learning and meet the diverse needs of all pupils. The perceived inflexibility of the National Curriculum for Science may hinder the engagement of all students in the subject (ASE, 2014).

Working-class pupils generally experience the adverse effects of the national science curriculum in England and Wales. This manifests as a notable lack of science knowledge and capital that these students may require to fully engage in the available science programs (Gorard, 2009). Measuring these students' low science capital may reflect various factors. This can include things like science literacy, vocabulary, practices, and experiences related to science education. Students from lower socio-economic classes may also have less access to science materials, including textbooks, contemporary technology, computers and laptops for study, and fundamental tools such as scientific calculators. The disparity also gets wider as greater emphasis is placed on tests and exams. As a result, working-class students are under even more pressure to study effectively for the exams. This reinforces the false perception that science is a middle-class phenomenon (Murphy *et al.* , 2006; Archer *et al.* , 2015; Educational Policy Institute, 2019).

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It is worth noting, however, that there are substantial differences in science attainment between Key Stages 3 and 4, as reported by the Department for Education. In 2000, the percentage of students achieving the expected standards in science was 68% at Key Stage 3 and 82% at Key Stage 4 (DFE, 2021). This suggests that students should make better progress in science after key stage four, but the data show that working-class students are still underachieving. However, the Educational Policy Institute (2019) contends that changes in the science literature across the key stages are responsible for the achievement gap between them. Schultz (2009), on the other hand, suggests that scientific teaching and learning should return to developing the philosophy of education to frame dialogue that is favourable to all classes of students and to enable teachers to take greater ownership of the curriculum.

Furthermore, the recent review of the education system, particularly in England, is ongoing. From the Dearing review (2013) to the ROSE review (2008) to the students' review of the science curriculum and presently the Francis Review 2025, all are geared towards making the curriculum more accessible, and relevant to changing times (Oates, 2014; McGregor & Frodsham, 2019; Cerini *et al.*, 2019; Francis, 2015). The Francis curriculum in science, however, contained three notable recommendations worth highlighting. These are assessment reforms in science, equity and accessibility for all and more technical support for science teachers. These recommendations, whilst not yet in effect, would help address limitations in science for underrepresented or marginalised backgrounds.

## **2.7 Triple science versus double science**

The current national curriculum in England allows students to choose between triple and combined science as a GCSE subject at Key Stage 4. The triple science route allows students to study the three distinct sciences (biology, chemistry, and physics). It is broad and requires in-depth knowledge, and it may be helpful for individuals who want to work in science. Additionally, the workload requirements are higher, and the focus on the curriculum content can be pretty narrow. As a result, it can be rigid and unsuitable for some students with different learning needs (ASE, 2014; DFE, 2016; RS, 2014).

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However, the combined science route integrates the three science topics into a single course, which may enable more flexible teaching and reduce the workload and content that teachers and students must cover. Combined science has less knowledge and depth of content; it is suitable for students who do not intend to pursue higher education or a career in science (RS Chemistry, 2017; ASE, 2014; EPI, 2017). This is the most common route for most students (Francis *et al*, 2023, 2025). Consequently, students' socio-economic circumstances may influence their decision to enrol in triple or double science. Working-class students face mitigating circumstances that provide reasons for certain decisions. These factors include students' confidence in their scientific abilities, parental or family influence, access to necessary science materials and resources, and teacher expectations (Robinson *et al* ., 2011).

The triple science route was introduced in 2008 as an entitlement for higher-attaining students to study science with greater depth and breadth.

“From September 2008, all 14-year-olds achieving level 6 at key stage 3 would be entitled to study a Triple Science GCSE course, covering physics, chemistry and biology. The policy view of the Department for Children, Schools and Families (DCSF) is that Triple Science is not for everyone and should be offered only to students who achieve level 6 or above and would benefit from the course.” (Fairbrother and Dillon 2008, 65).

Its uneven distribution, however, and the vagueness of who qualifies mean that working-class white British students are less likely to access this opportunity. This can further widen the achievement gap, as they are subsequently less likely to be prepared for lucrative STEM careers (Archer *et al* ., 2017, 2024)

## **2.8 Gender and GCSE science attainment**

The gender of students participating in school science shows a marked difference in engagement and future science career choices. Early DFE statistics also indicate a disparity in the uptake of GCSE science subjects by gender. The girls' subject uptake decreased from biology and chemistry to physics, whilst the boys' uptake decreased in the reverse order. This was similarly reflected in the science options for triple science, which showed more

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boys enrolling than girls in double or combined sciences (DFE, 2000) The International Association for the Evaluation of Educational Attainment (IAE) survey (1973) first noted this trend and initiated a discussion of gender-based gaps in science attainment worldwide. Since then, a series of explanatory hypotheses has emerged to explain the gender gap in science. They broadly centre on culture, attitude, and social factors. The culture hypothesis suggests that girls perform poorly in science compared to boys because society does not support or expect girls to perform as well as boys, as it perceives science as more masculine (Gorard *et al.*, 2020) On another note, the attitude hypothesis claims that boys are more inclined to be positive and enjoy science than girls. This optimistic outlook is thought to affect their success in science. Finally, the school hypothesis holds that science is presented and taught in a biased manner, favouring boys over girls, and that this bias is ingrained in its ideas and pedagogy (Kelly, 1996; Gorard, 2023).

However, to assess the significance of these factors on the science gender gap, the school and attitude hypotheses have been applied in recent studies of gender disparities in science. The Longitudinal Study of Young People in England (LSYPE2) 2015 study, which examined young people's attitudes towards science in a nationwide survey and found that boys outperformed girls in STEM disciplines such as maths and science, has shed some light on contributing variables. Boys outperformed girls in the rankings by 59% to 32%, a noteworthy 20% margin. Subject-wise, girls outperformed boys in biology and chemistry. However, the challenges girls face in negotiating their positions in science are increasingly more complex for girls from working-class backgrounds than for others. This is primarily because of family background and norms. Archer *et al.* (2013) argue that most working-class girls perceive science as masculine and, as such, cannot readily identify with the subject. Brickhouse (2000) asserts that parenting values and stereotypes may have contributed to this notion of instilling through socialisation of gender roles in their children. Thus, the early-life expectations they hold, the books, toys, clothes, and way of life all transmit ideas about stereotypical roles that children are expected to play. It is therefore highly possible that parents can influence a child's early affinity to science if they perceive that science is relevant to their

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child's gender and prosperous future. However, this is a malleable factor, as many females might receive more encouragement from their parents than from others around them, such as teachers and peers (Aschbacher *et al.*, 2010). These subtle messages might influence their attitudes and self-concept about science. In similar studies, parents' educational level was noted to influence the attitude and perception of the difficulty and masculinity of science. This is reported as capable of having a notable influence on working-class girls' science (Duveen, 2000) These social and cultural norms and stereotypes have been widely associated with girls' low uptake of science-related courses. The relationship between science and the girls' views of science seems influenced by their overall socialisation experiences from home to school. This can affect how girls view their role in science. Therefore, there was a stark ripple effect resulting in the underrepresentation of girls in science uptake from GCSE to undergraduate science courses in universities. This gender imbalance was widely documented by several researchers and agencies (Bosworth *et al.*, 2013; HESA, 2021; Greenwood *et al.*, 2011; Aucejo *et al.*, 2020). These gaps, however, are in science choices and participation but not in overall GCSE performance (ASPIRES, 2020; WISE, 2017). Data over time shows that girls consistently outperform boys in GCSE science in the UK (DFE 2015, 2019, 2020, but most do not choose to pursue science as a career or at A level, thus over time producing the gender gaps in STEM. Strangely, there has not been one main factor that has adequately explained the gender gap in science; however, several factors like SES, subject difficulties, and job prospects, amongst others, have topped the list of probable factors that can be postulated to have formed the gap (Mendez, 2018; Labour Force Survey 2011-2017).

## **2.9 Summary**

The chapter discusses the issues facing working-class white British students and school science. Various issues related to WCWBS science experiences and other forms of oppression that work against these working-class students have been explored in the literature. Factors such as family background, gender, socio-economic status, self-perception, motivation, and science ability provide a comprehensive overview of the factors influencing working-class

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students' GCSE achievement in science. Using Smith's (2018) definition of social class as a relational, structural position in a hierarchy of access to economic, social and cultural capital, institutionally produced and reproduced through processes in education and other systems, which organises unequal trajectories so that working-class students experience consistent, staged disadvantage in attainment and progression. The inequality in students' science attainment, as documented in the literature reviewed, can be linked to multiple social axes, often beyond students' control. It also highlights how these hindrances contribute to patterns of inequality in science in secondary schools. However, science is a major STEM subject with limited GCSE data on social-class attainment, which limits the research's contribution to this area.

Overall, White British disadvantaged girls across the country tend to perform less well than their non-disadvantaged peers (Charlotte, 2021) They often face additional societal pressures and encounter more obstacles to success. Family and community expectations, such as early marriage, motherhood, and limited local job opportunities, can restrict their choices and ambitions. Furthermore, girls in this group may have lower resilience than boys, impacting their motivation, determination, attitudes, and achievement. Many are also the first in their families to consider attending university, as they lack relatives with experience in higher education (Archer *et al.* , 2020).

It is widely agreed that students' social class plays a notable role in shaping their experiences and outcomes in pursuing science. The intersection of social class and science shows disparities in access, achievement, and perceptions of success (Smith, 2005). These disparities are influenced by several factors, which will be explored in detail later in chapters 4-7.

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## Chapter 3: Theoretical frameworks

### 3.1 Introduction

Research is in the interpretive paradigm. It will also utilise three research theories, namely Pierre Bourdieu's theory of reproduction (1977, 1987, 1990), Kimberley Crenshaw's intersectionality theory (1989, 1991, 1992), and Butler's theory of gender performativity (1998), as frameworks for examining the data. These theories are valuable because they elucidate why individuals from particular backgrounds may experience varying degrees of marginalisation, bias, or privilege within the same community. Additionally, they analyse the nuanced mechanisms through which power is transferred and exercised within social structures and ideologies (Reay, 2004). Also, the gender performativity theory shows how gender is something shaped by repeated behaviour, societal expectations and performed into being. Lastly, all the theories focus on barriers, biases and societal expectations and norms (Thompson, 2017).

The concept of reproduction, developed by Pierre Bourdieu (1980-2002), helps us examine how social disorder and marginalisation are subtly reproduced. This theory of reproduction, I argue, sheds considerable light on how WCWBS are disadvantaged in school science through its key notions of habitus, capital, and field. According to Bourdieu's theory, educational institutions serve as the primary focal point for cultural attributes and beliefs, which are typically favoured views and standpoints upheld by members of the middle and upper classes. Moreover, Bourdieu (1977) postulates that schools facilitate the family-based perpetuation of social capital and habitus. Bourdieu's theory also suggests a connection between students' social class and their success in education, since schools operate within a middle-class culture in which teachers and other school stakeholders are primarily drawn from that class. Bourdieu and Passeron's study (2009, 2010) claims that teachers' pedagogies frequently support middle-class cultural capital while excluding or not considering the working-class students they teach. Bourdieu suggests that this difference in social class will make teachers relate better with middle-class pupils than working-class pupils and describes this as a type of "symbolic violence" (which is the unconscious model of sociocultural dissemination

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between social groups) against them. Some academics (Archer *et al.* , 2021) refer to the use of Bourdieu's symbolic violence to promote capital transfer as opposed to reproduction. In these cases, teachers can operate consciously, aware of obstacles, and transfer capital to their underprivileged students, converting it primarily into capability (Mills, 2008; UNESCO, 2017).

On a similar note, Kimberlé Crenshaw's (1989, 1991) theory posits that working-class students may experience multiple layers of disadvantage that their peers from other racial or socio-economic backgrounds do not. Crenshaw described this as intersectionality. Intersectionality for a group, she says, often leads to marginalisation, discrimination, and other forms of oppression. Intersectionality theory initially focused on the experiences of Black women, but it has since expanded to encompass other intersections, identities, and races (Harris 1990). This layered effect of one's multiple identities can include a range of factors like race, gender, religion, disability, age, and sexual orientation. These overlapping identities can influence one's perception of one's success and the opportunities available to one. These differences are observed both between groups and within each group (Nash, 2008) Using Crenshaw's theoretical framework in educational studies facilitates the identification of multiple factors contributing to the disadvantages experienced by different pupils in schools and social contexts. This approach is instrumental in promoting inclusive education for all students, as UNESCO (2005) rightly advocates. Moreover, intersectionality can be conceptualised as an explanatory tool that highlights how certain identity groups are marginalised, while others enjoy inherent privileges that confer advantages (Grant *et al.*, 2011; Waitoller *et al.*, 2013).

Essentially, these three theoretical constructs together illuminate the research questions by challenging educational marginalisation in schools and provide a fresh understanding of how differences in cultural and social orientation can lead to under attainment among groups.

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## **3.2 Bourdieu's theory of reproduction**

The theoretical framework employed in the research draws on Pierre Bourdieu's theory of social reproduction. This theory helps explain the intergenerational persistence of social inequalities and social hierarchy and how it's reproduced and passed on to the next generation. Bourdieu's reproduction theory is explained through three main concepts: capital, habitus, and field (Bourdieu 1977, 1990, 2010). In understanding the views of Bourdieu, one has to look closely at the key terms involved in his theory of reproduction. This is done through the lens of 'Field', 'Habitus', and 'Capital'.

### **3.2.1 The concept of capital**

The term "Capital" as employed in this context denotes an accumulation of power in specific domains of existence. Previously, it was frequently associated with financial resources. However, Bourdieu (1987) posits that capital encompasses social tendencies, dispositions, or tastes that are strategically used to gain advantage in particular domains and that have greater value than financial resources. He further identifies three broad types of capital: economic, social, and cultural. Cultural capital, according to Wildengren (2009) and Kingston (2001), shapes the attitudes and outlooks of students from disadvantaged backgrounds. This attitude creates a negative disposition towards school, academics, and educational attainment. Bourdieu's theory holds that the school system requires cultural capital that can be reproduced and is acquired only by those with higher SES or by families. Kingston (2001) argues that this harms students' academic outcomes, particularly among those from lower-SES backgrounds. Kingston's notion is supported by Lareau and Weininger (2003), who argue that socio-economic advantage translates into academic advantage because higher-SES families cultivate the cognitive skills that schools reward.

One of those skills proposed by Lareau and Weininger (2003) and Farkas (2004) is the use of language. Language use is one way that cultural capital prevents working-class students from achieving educational success. The language used in schools usually differs from that used at home and in day-to-

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day life. Students from working-class homes may find the language used in schools different and difficult to understand. This makes their classroom participation, particularly in reading and writing, somewhat more tedious, which may, in turn, affect their academic outcomes. This is especially true for those who fail to speak or use the required academic terms correctly and fluently at home (Lareau & Weininger, 2003; Lee *et al* , 2006) It can be said that working-class students' unfamiliarity with academic norms or language is another way that cultural capital limits their ability to succeed in school. Citing sources, adopting the right formatting, and writing in a formal tone are only a few examples of academic traditions. Even though these customs are not always explicitly taught in school, students from privileged backgrounds or higher social classes frequently assume that they are familiar with them because they are surrounded by people who use those terms. Even when they have good ideas, working-class students may receive lower grades on tasks or papers if they are unfamiliar with using these norms and traditions (Perry *et al* , 2003; Anyon, 1980).

In contrast, DiMaggio (1982), De Graff *et al* . (2000), and Dunamis (2006) suggest that accumulating cultural capital can benefit students from low-SES backgrounds by enabling them to integrate into middle- and high-SES cultures. They further imply that this can promote the rapid upward mobility of these groups. This is achieved through frequent exposure to activities, places of interest, art, music, and broader networks and interactions that their cultural capital would not otherwise have allowed them to access. Social capital refers to the intricate social networks, interpersonal connections that individuals possess, and the resources these associations provide. These resources may offer multiple benefits, including information, emotional support, and opportunities for growth. Social capital is important in schools, as it is a core determinant of how students adapt to the school's habitus and a key to working-class students' educational success in a predominantly middle-class field.

Working-class students may also have fewer and different important social connections compared to middle- or upper-class peers, making them more disadvantaged in opportunities and resources that would provide substantial

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academic advantages. Bourdieu (1986) characterises wealth as economic capital, which often has a noteworthy impact on one's resources for success, particularly in educational settings. This greater access to economic capital creates inequality for some students and may enhance outcomes for others. This enhancement can manifest as educational resources, extracurricular activities that provide exposure to opportunities, technological advancements, supplementary tutoring, and stable living conditions that bolster academic achievement. However, it is crucial to recognise that other factors influence academic success beyond the availability of financial resources.

The mere possession of resources in the form of capital does not ensure triumph, nor does the lack thereof indicate inevitable failure. Success is more likely for students who possess these resources, though they are not a guaranteed path to success. Furthermore, other types of capital are equally noteworthy in education (Coleman, 1988; Sirin, 2005) Economic capital is just one. In shaping academic outcomes, social and cultural capital can also be important. For students who aim to succeed in science, acquiring science capital would be an added advantage (Archer et al ., 2015; Yeoman, 2019).

### **3.2.2 Science Capital**

Science capital, which is derived from Bourdieu's theory of reproduction, refers to the science-related resources that are available to students. This comprises known attitudes, skills, and experiences (Archer *et al* . 2013). This intricate notion can be further dissected into your acquired knowledge, your analytical thought processes, your actions and behaviours, and your network of acquaintances and connections. The key forms of science capital include science attitude, values, dispositions, science literacy, role models in science, media consumption, and job experiences (Archer *et al* ., 2015).

Drawing upon Bourdieu's (1985) conceptualisation of capital, science capital is a manifestation of social capital, and all individuals in some way possess a certain quantum of it. The extent of one's science capital is contingent upon their ability to avail themselves of diverse sources of science resources, which may emanate from familial, educational, experiential, and exemplary sources,

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among others. This acquisition of science capital is known to be often limited for working-class students due to their restricted access to these resources, unlike their middle-class counterparts (Grenell *et al.* , 2022; Dewitt *et al.* , 2017). In addition, these students face other hindrances that can accumulate and become a notable disadvantage over time. As a result, science capital is distributed disproportionately among various socio-economic and class groups (William *et al.* , 2016). However, this may mean that certain groups have greater access to resources, networks, and values within specific fields, such as science, thereby creating disparities in educational attainment across socio-economic groups.

One needs to observe that different socio-economic groups often accumulate varying amounts of science capital, which can either confer leverage over others or impose disadvantages whilst at school. Archer *et al.* (2015) reported that among 11–15-year-olds in the UK, 5% have high science capital, 68% have medium science capital, and 27% have low science capital and perceive science as not for them. Science capital thus has several different dimensions of build-up. Schools or educational institutions that provide learning experiences that encourage more individuals to interact positively with science by connecting with and understanding its various dimensions often have students with high science capital. These dimensions include science literacy, science-related attitudes and values, understanding of the transferability of science, consumption of science-related media, involvement in extracurricular activities, family science knowledge and qualifications, knowing people in science-related roles and careers, and talking to others about science (Archer *et al.* , 2012, 2015; Wong, 2012) Dewitt *et al.* (2011) also highlighted that increased science capital and improved science attitudes or behaviours for learning science constitute an advantage for upper-class individuals.

On another note, there seems to be a strong relationship between science capital and science attitudes. By "science attitudes" I refer to how young people perceive science's relevance to their everyday lives. The more positive one's attitude towards science is, the more value they will place on it (Crano & Pistin, 2006; Lin *et al.* , 2013; Hazari *et al.* , 2013). A positive attitude is often regarded

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as a strong driver of science capital, as it fosters engagement and interest in acquiring knowledge and scientific experiences that ultimately lead to a rich accumulation of science capital. This position is similarly supported by Bourner & Dorneich (2016), who report that a great science attitude often leads to a drive to pursue science careers and related opportunities. Science capital, however, has also been shown to be enhanced by factors such as science literacy, modern teaching methods, and technology.

The amount of science literacy, which refers to the knowledge about how science works, is a key component of science capital and is believed to greatly improve one's science capital. It generally facilitates the transferability and application of scientific knowledge in a given field. This can be improved by participating in out-of-school science activities and learning in various informal contexts. These include museums, science clubs, competitions, TV programs, and fairs (Black & Hernandez, 2021). Moreover, power and privilege can materialise in science classrooms via the teaching and evaluation methodologies. For example, science instruction may lean heavily towards rote memorisation and standardised testing, impeding students from non-conventional educational backgrounds or who possess distinct learning styles (Calabrese *et al.*, 2018). Furthermore, Piqueras *et al.* (2006) argue that power and privilege can influence students' science-related encounters through the social dynamics present in classrooms. For instance, students from underrepresented communities may be encumbered by stereotype threat, which refers to the apprehension of confirming negative stereotypes about their group, thereby affecting their scientific performance and impeding their motivation to pursue science-based careers.

The notion of science capital has been useful for understanding why some working-class students feel out of place in science despite their high ability and enjoyment of the subject. Archer *et al.* (2015) report that science capital is not distributed equally and is not patterned along strict social axes. The notion of science capital, therefore, is fitting to use in this research. Finally, establishing connections with individuals in the scientific community, particularly those within one's familial sphere, bolsters scientific confidence and cultivates scientific

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capital. This may prove beneficial to numerous socio-economically disadvantaged students, giving them resilience and motivating them to persist in science endeavours through interaction with these proximal associates who exemplify the possibilities in the field, particularly among those of working-class backgrounds (Dawson *et al.* , 2017; Archer *et al.* , 2016; King *et al.* , 2017).

Although Bourdieu's framework is useful in discussing social inequalities and how they are reproduced in society, other factors, such as gender and race, are not explored with Bourdieu. Thus, the intersectionality theory by Kimberley Crenshaw (2015) is quite complementary in unpicking these overlapping intersections.

### **3.2.3 The concept of habitus**

Habitus is a set of ingrained habits, skills, attitudes, dispositions, inclinations, and socialised norms picked up by a person or group, often through life experiences and the social environment. This is usually created and reproduced unconsciously without much effort, thought, or concentration. This habitus is inscribed into people's minds through cultural products and values in everyday life. This consequently leads to the acceptance of social stratification, worldviews, and expectations of social life or class. Bourdieu, however, believes it is not a fixed position of being, and that there is a possibility of learning, movement, and change on the part of individuals or groups (Jurgen, 1979; Graham, 2015). However, on a different note, this change is not immediate and that it needs to happen more consciously over time and with a change of attitude, disposition, and value system. Habitus is the most misunderstood idea of Bourdieu's Theory. On one hand, it deals with how individuals become themselves, treat and perceive others, and on the other hand, how they engage in and practice what they believe in (Webb *et al.* ,2002; Navarro, 2006).

The utilization of the habitus concept in educational research allows for comprehension of the reasoning behind specific groups possessing certain notions, thoughts, or apathy regarding aspiration, self-perception, or the significance of schooling in their lives (Nash, 2002). Some people feel that

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certain careers and opportunities exist for them, while others think or are meant to believe it if not suitable for them because of certain societal expectations. Bourdieu's (1990) standpoint about students from working-class families is that they lack the prerequisite habitus that is suitable to be highly successful in school.

Schools and other educational institutions are believed to operate a middle-class habitus and have a pivotal function in shaping the habitus of their students. Reay (2017) in her work, posits that schools can either reinforce or challenge the pre-existing habitus of working-class students by providing for students to develop and accrue novel cultural capital. Even so, Reay explains that schools often unintentionally function as places of exclusion for these working-class students who do not adhere to the cultural norms or habitus of the school culture. This contrast in habitus may make students feel a sense of disenfranchisement or resentment towards schooling. This might also make it more difficult for them to navigate the academic requirements needed to be successful in the educational system.

It may, therefore, be implied that students from lower socio-economic backgrounds may have habits that place more value on hard, laborious work and practical abilities than on academic performance. They may, in turn, find it difficult to adjust to the academic requirements of the educational system, which may cause poorer academic performance and disengagement from school because of a lack of social capital (Evans, 2008; Skeggs, 1997). It is Bourdieu's position that the accumulation of capital in any form gives power to any dominant social group and is highly dependent on their habits (Bourdieu, 1986).

### **3.2.4 The concept of field**

A "field" is an area or setting where people engage in conflict about who has the right to control it and how much power they have. It is also known as a system of social position, production arenas, information circulation, status, and competitive positions. The concept of field can also be described as a social space that has its own set of rules and uses capital to secure positions of

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advantage within it. Examples of such fields are the Arts, Medicine, and Education. Bourdieu's (1983) framework believes that every field has its distinct set of rules, practices, knowledge, and forms of capital associated with it. Although there may be instances where these fields intersect, Bourdieu (2000) posited that they are predominantly autonomous in their functioning. Bourdieu claims each of these fields is governed by a hierarchy of power and influences. These power positions are primarily determined by the magnitude of their capital structures (Hilgers *et al.* , 2015).

The relationship between the volume of social capital and the position of one's membership within the field often contributes to social inequalities. This is because the hierarchy of members depends on the amount of capital one brings to the field, where those with the most capital protect the field (Bourdieu, 1983, 1986) Capital here confers power to the field. Such power structures constitute a critical resource in research, as they facilitate a specific unit of analysis while emphasizing reflexivity and comprehension of the intellectual domain of the research area. Fields thus explain nuanced variations in power dynamics among groups and individuals, shedding light on the socialisation processes that dictate their public and private behaviours, in which schools are typical examples.

Naidio (2004) expounded upon Bourdieu's conceptualisation of fields as a domain of activity. Bourdieu posits that,

"Social formations are structured around a multifaceted model of social fields wherein diverse manifestations of power are in circulation. The hierarchical position within these fields is contingent upon the quantity of resources at one's disposal compared to other occupants" (Bourdieu, 1993, 458).

Bourdieu (1996) suggests that individuals who join a social field typically bring varying degrees of knowledge about the guiding principles of that field, and one needs to know how to navigate it to become successful. According to Bourdieu (1975), the field is a "locus of struggles" where various groups are constantly engaged in a tug-of-war to gain an advantage over the other. Because conditions are more favourable for the middle class, it is suggested that working-class individuals will not have the best opportunities in this professional

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field. Thus, to succeed in the educational field, one must have the right habitus and capital to be positioned favourably to succeed (Naidoo, 2004).

### **3.3 Intersectionality theory**

Kimberly Crenshaw (2015) is known for originating the terminology of intersectionality and pioneering the theory as a retort to the discernment that black women were not solely vulnerable to racism but also to other interwoven factors such as gender and age. She noted that government legislation on racism predominantly shielded black men to a considerable extent, whereas legislation on sexism primarily protected white women, leaving black women unprotected. The concept of intersectionality pertains to the multiple identities that revolve around privilege and power, thereby impacting specific groups of individuals. The Intersectionality theory recognizes how the different aspects of one's social life overlap and form disadvantages and discrimination for some groups of people more than others. These overlapping factors form a contextual lens for exploring the experiences of different groups and social strata and how they deprive them of certain privileges and opportunities (Kimberly Crenshaw, 1989). By considering aspects such as ethnicity, race, social class, gender, and age, intersectionality helps individuals understand oppression and draws upon the different facets of their experiences and struggles with social stratification. These overlapping factors band together to shape the trajectories of one's unique experience. Intersectionality offers an alternative approach to traditional modes of understanding the subjugation experienced by women, whose marginalization stems from multiple angles of larger ideological structures and problems (Cho *et al.*, 2013) The common intersections are race, age, gender, class, ethnicity, disability, nationality, colourism, and sexuality, as shown in the figure below (Besic, 2020).

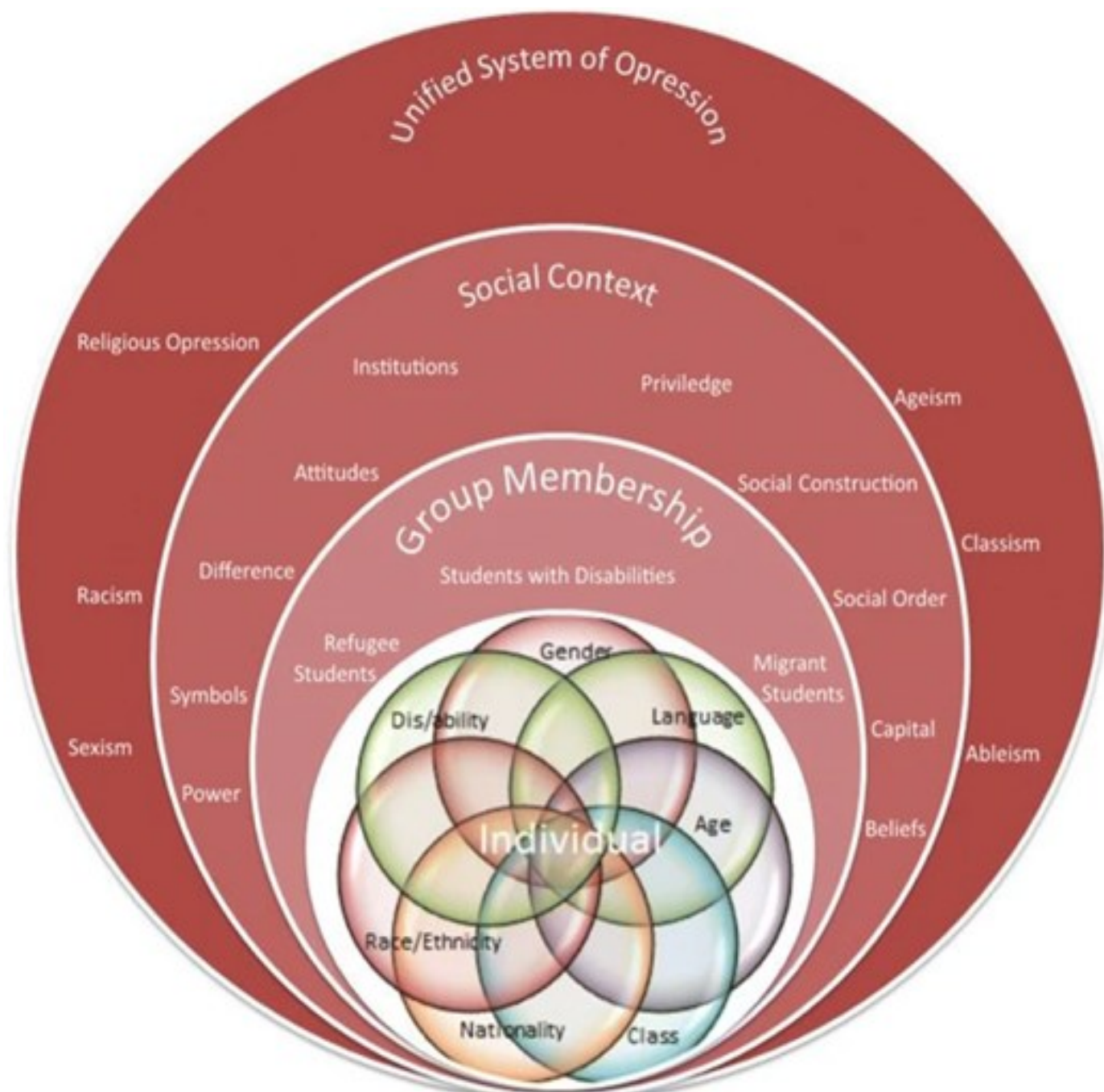


Figure 3.1 Onion of intersectionality

The core ideas of intersectionality are social inequality, power, reality, and social justice (Collins & Blige, 2016). Intersectionality can therefore be described as a way of understanding and analysing the complexity of the world in which people have multiple layers of identity and, as such, different human experiences with various institutions. The phrase "onion of intersectionality" refers to the multiple overlapping layers of social identities that shape a

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person's opportunities and experiences. The Onion illustrates how various factors symbolically overlap and marginalise specific individuals relative to others (Figure 3) Intersectionality can be applied in the context of education as a central pillar of educational inclusion (UNESCO, 2005).

Various factors shape an educational system, and one's experiences of its forms of discrimination, exclusion, and marginalisation affect how people interact with it. These interlocking factors, which are often overlooked, appear to affect some people more than others, and this theory seeks to highlight them (Erikson, 2004; Waitoller, 2014). Additionally, by using intersectionality in educational research, one can analyse overlapping interactions among students of different genders, migrant backgrounds, races, ethnicities, and classes, and how these factors interplay to affect students' academic outcomes. It has been reported that the intersection of multiple identities has made students feel excluded, undervalued, and marginalised, whilst others were more confident and felt a sense of belonging in their various academic endeavours (Grant & Zwier, 2011) Walgenbach (2017) also notably points out that since these identity markers are not clearly defined, promoted, or defined in schools, students who fall into these categories are often left behind and do not get the required support, guidance, or protection they need to achieve within those fields, as it often goes undetected. Intersectionality thus can be very useful in schools as it offers an approach that can comprehensively cater to the needs and justify equitably in looking at the mixed identity approach of all students and recognising them (Slee, 2001; Grant & Zwier, 2011).

Intersectionality as an analytical framework also helps educational researchers understand how race, gender, and other identities intersect to derive varying amounts of penalty or privileges to certain students over others (Collins 1990, 226). Working-class white British girls, who are one of the focal points for this study, experience race, class, and gender as the three fundamental emblematic systems of oppression that seem to impact their relationship with school in distinctive ways compared to other groups. Several factors, such as ability grouping and socio-economic status, may also negatively affect them, while others, such as race, may offer some degree of privilege. Gender, however, is

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one of the traditional axes of analysis referred to by many intersectional scholars. Intersectionality can often be used to show how these overlapping overt factors disadvantage female students. These interacting systems of oppression have comprehensive impacts and can cause harm if they go unchallenged (Ibokessien, 2020). Therefore, calling for inclusive systems that can level the playing field for everyone, i.e., marginalised groups/ individuals, and make education inclusive for everyone can be achieved through using intersectionality.

Similarly, UNESCO (2005) describes inclusive education as catering to complex identities. These include race, class, language, ethnicity, gender, age, ability, sexual orientation, etc. Since people have multiple identities and group memberships with which they identify, these identities shape their everyday lives. These interfaces of identities often determine, to an extent, how one is afforded privilege that makes navigating certain institutions like schools accessible. It also assesses resources and exerts power within these systems, either to make it easier or to make it more difficult. Intersectionality can impact attainment in schools where a combination of class and race commonly exists. This combination often disproportionately affects students of colour and working-class students (Nanda, 2015) Thus, this study also adopted a realist approach, as several of these may affect one person differently from another. The key questions will centre on cause and attribution.

### **3.4 Gender Performativity Theory**

Gender performativity theory, developed by Judith Butler, conceptualises gender as a socially constructed phenomenon shaped by behaviours, norms, and expectations rather than as an inherent or fixed trait (Butler, 1988). Butler argues that gender is constituted through performativity, the repeated, often unconscious acts that produce the illusion of a stable identity, distinguishing this from performance, which is deliberate and conscious. This perspective challenges essentialist views of gender as biologically determined. Through the reiteration of gendered practices, roles, and expressions, gender becomes naturalised within society (Greco, 2021). Disruptive practices such as drag

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expose the constructed nature of gender, demonstrating its contingency (Cameron, 2020; Purker & Sedgwick, 2013).

Within educational contexts, gender performativity theory illuminates how stereotypes are reproduced. In STEM subjects, boys are frequently perceived as inherently more technically competent, while girls are characterised as diligent but lacking innate scientific ability (Francis, 2000). These assumptions promote the masculinization of science, discouraging female participation. Pedagogical practices, such as teachers directing complex tasks and questions toward boys, further undermine girls' confidence and engagement. Some scholars suggest that girls' underperformance in science may function as a strategy for maintaining social acceptance (Brickell, 2005; Francis, 2009; Paechter, 2007). This is often shown when girls hold back or have self-deprecating talk like "I am rubbish at science", which often fits the mould of a non-science person. Brickell's work argues that identities are secured through repeated acts that, once normalised by peer or societal compliance, become the norm rather than the result of choice. Brickell, therefore, posits that girls are engaging in less visible acts of resistance, preserving social belonging even at an academic cost. Paechter's account similarly portrays a girly girl as appearance-focused and incompatible with a serious science student. However, Francis suggests that in rare circumstances girly girls can be compatible with science only when boys are not outshone. Underperformance thus seems to act like a safe space for girls in science who are navigating the society's norms of a 'proper girl' to teachers and peers,

If working-class White British girls do not get recognition as "sciencey" across home/ school/ community, or if science is not presented in ways that fit their valued girlhood, they are less likely to persist to high attainment, even if they are capable. Recognition is therefore crucial in developing girls' science identities (Barton *et al.*, 2013). Carlone & Johnson (2007) further emphasise that working-class White British girls may be competent, but if the "proper scientist" is still imagined as male and middle-class, their performances may not be recognised as such, which can depress confidence, participation and, over

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time, attainment. Carlone argues that recognition is uneven, tilting more toward boys than toward girls.

Similarly, Holmegaard *et al.* (2014) confirm that working-class White British girls may view high-attaining science pathways as incompatible with being a “*down-to-earth*”, socially accepted girl, and therefore may hold back, even if they could achieve more. A frequently asked question is: “Do I belong here?” Holmegaard explains that some WCWBG feel that the Top set science girl and the down-to-earth girl do not fit together. They worry that if they work hard and get top grades, they will stand out, be seen as too clever, and not fit in with their friends. Holmegaard thus concludes that if girls continue to adapt to dominant cultural norms, they may cease pursuing higher grades or further studies in science.

Despite its contributions, the theory has notable limitations. Critics contend that Butler’s emphasis on performativity neglects biological dimensions, such as hormonal influences and embodied experiences like pregnancy and menstruation, which cannot be fully understood as performative acts. Furthermore, the theory insufficiently addresses the intersection of gender with broader social structures, including race, class, and culture, and fails to explain the persistence of gender norms across diverse historical and cultural contexts (Li, 2017). It also underplays material issues such as poverty, housing and school resources that might also shape students' chances. To address these gaps, this study integrates Butler’s framework with Crenshaw’s (1991) intersectionality theory, enabling a more comprehensive analysis of the structural and cultural factors shaping the experiences of working-class white British girls in science education (Butler, 1988, 1993, 2020)

### **3.5 Summary**

This chapter overviews the theoretical frameworks used to analyse the data. It’s a combination of Bourdieu's (1990) theory of reproduction, Crenshaw's (1991) theory of intersectionality and Butler's (1988) theory of gender performativity. Pierre Bourdieu’s theory of reproduction and the different aspects of capital, field, and habitus show how marginalisation and social disparities can

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perpetuate the reproduction of privileges for certain people and poverty for others. Bourdieu's theory not only shows how these disadvantages or privileges are produced but also how they are transmitted intergenerationally within the same family. On the other hand, the chapter also highlights Kimberle Crenshaw's (1991). Intersectionality theory, which posits that individuals have multiple identities that intersect to shape their experiences of discrimination, making them more susceptible than others to deprivation and prejudice. Crenshaw's theory also advocates the use of nuanced methods to address structural inequalities. This nuanced way of negotiating gender, in combination with the gender performativity theory, challenges the notion that gender is fixed but instead is performed into being. Gender performativity theory is explored in this chapter to examine how girls "do" gender in science, but it also has important limits, particularly for understanding working-class girls' involvement and attainment.

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## **Chapter 4: Methodology**

### **4.1 Introduction**

This chapter presents an overview of the research questions, the specifics of the research design, the employed research strategy, the methods used for data generation, the limitations encountered during the study, the rationale underlying the research approach, and the analytical techniques applied to address the following research questions:

1. How does social class influence achievement in GCSE science among working-class white British students?
2. What value do Working Class White British students place on different science subjects?
3. Is gender a barrier to GCSE science achievement amongst Working Class White British girls?

This chapter describes the methodology informed by the interpretivist paradigm and mainly qualitative research. The rationales for the research methods are then detailed, followed by the analytical processes undertaken to ensure appropriateness and validity, including sampling procedures and justification for using specific techniques and excluding other unsuitable ones. Likewise, the nature of the pilot study was reviewed, and details of data collection phases of the research were explained. The chapter also outlines the data analysis method in each phase and how the generated outcomes contributed to addressing the research questions.

### **4.2 Ontology and Epistemological Position**

An interpretivist ontology underpins this qualitative study by recognising that barriers to achievement in GCSE science are socially constructed and experienced differently by students, shaped by their interactions, identities, and school contexts. By adopting an interpretivist ontology, this study therefore resists reductionist explanations of underachievement that locate the problem solely within the individual student. Instead, it situates barriers within a web of social, relational, and contextual meanings that can only be accessed and

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understood through close, interpretive engagement with the perspectives of those who live them.

This ontology gave me an open-minded view of exploring the phenomenon and critically observing the outcomes. It also emphasized that knowledge was often negotiated with cultures, different social settings, and relationships with others. Given this, it was a useful worldview to explore the underachievement of working-class white British students in science because the critical realist often moves away from the observed phenomenon to looking at structures that generated it, which may lie beyond what is observed (Haig & Evans, 2016) This also ties in with the interpretivist paradigm guiding the research perspective and design.

From this perspective, barriers to achievement in science are not treated as fixed or universally experienced phenomena, but as contextual and subjective experiences that are shaped by students' interactions with teachers, peers, families, and school structures. What counts as a "barrier" is therefore understood through the meanings students themselves attach to classroom practices, assessment, expectations, and their own identities as learners of science.

An interpretivist ontology is particularly well-suited to this research because it prioritises student voice and seeks to understand how working-class White British students make sense of science achievement within their specific social and educational contexts. It allows the study to explore how feelings of belonging, confidence, relevance, and recognition influence engagement and attainment in GCSE science. Rather than aiming to generalise findings or identify causal laws, this approach seeks a rich, in-depth understanding of how achievement gaps are produced and sustained through everyday interactions and shared understandings within schools. In doing so, the research challenges deficit narratives by revealing how perceived barriers emerge from meaning-making processes, not simply from individual ability or motivation.

The Interpretivist paradigm was used here to understand the human thoughts, views, and experiences of working-class white British students regarding science, and to relate these to the causes, why, and how they, as individuals or groups, viewed the world. This view may often vary from one society to another

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(Cohen *et al.* , 2000). This also facilitated the exploration of different viewpoints and perspectives, thereby giving meaning to the analysis of various problems or barriers that arose. Finally, it utilised interactive interviews to further investigate and probe previously unacknowledged values, prejudices, perceptions, and perspectives. This was useful for the research design employed, which allowed me to immerse myself in the study to fully observe the phenomenon in detail (Tuli, 2010).

The interpretivist paradigm was notably appropriate for this research for several reasons. Firstly, its flexibility allows me to explore different perspectives on students' worldviews about science and how the experiences of others around them are interrelated with theirs (Gorard, 2008). It was also a valuable paradigm for probing and understanding others' perceptions and prejudices regarding the prevailing phenomenon. This paradigm requires openness and a willingness to step away from prior assumptions and attitudes to fully understand the cultural attitudes of the phenomenon under study.

On balance, there are more advantages than limitations to using the interpretivist paradigm. Using the Interpretivist paradigm to explore this required the researcher to adopt a more qualitative than quantitative strategy, which involved understanding the issues rather than measuring differences among individuals within the groups (Lewis, 2003). The use of mixed methods in this study provides a wide range of information to validate and triangulate the data, supporting the enquiry.

#### **4.3 Limitations of using the interpretivist paradigm**

This paradigm, however, did not address the political and ideological impacts of knowledge and socio-cultural reality (Mack, 2010). Furthermore, the subjective nature of the interpretive paradigm created room for discrepancies and bias on my part, as it was based solely on my interpretation. The primary data generated could also be heavily influenced by a preconceived viewpoint or by the researcher's values, as it requires little scientific verification or scrutiny. Thus, results can often be generalised.

Finally, interpretivism is often criticised for adopting an ontological position that is too subjective rather than objective (Rubin *et al.* , 2017). However, the

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researcher's openness of mind and attitude while analysing the data generated, therefore, limited many preconceptions. Overall, the interpretive goal was to create embedded local theories of good practice, to understand the reality underlying the WCWB phenomenon, and to motivate action rather than to explain general findings.

#### **4.4 Positionality as a teacher-researcher**

Since the research was conducted in a school where I worked, this was considered teacher-led or insider research (Floyd & Linet, 2010). Insider researchers can therefore be defined as individuals who share characteristics, such as environment, gender, ethnicity, or culture, whilst outsider researchers do not share most of those characteristics. (Mercer, 2007). Other scholars describe insider researchers differently, as one of the members of the group, phenomenon or environment being studied (Breen, 2007; Alder & Alder, 1994) For this research, I prefer to use Humphrey's (2013) definition.

‘The insider researcher as one who immerses oneself in the field being studied’ (Humphrey, 2013, 572)

This was because it aligned with how I planned to conduct the research. In this case, the school environment was the context in which I was fully immersed. The research outcomes aim to provide meaningful recommendations for policies and school practices to improve outcomes for students from working-class backgrounds and other marginalised groups. There were, however, both advantages and challenges of being an insider researcher. I can argue that there were several advantages to being a teacher-researcher, including the ability to obtain in-depth access to the phenomenon under study from a comfortable distance. Being an insider researcher also afforded me easy access to participants and the advantage of building strong rapport and trust, as Humphrey (2007) reported to be a notable advantage. Finally, my being a teacher researcher gave me the advantage of understanding the group jargon, language, friendship dynamics, and school culture, which allowed me to fashion my focus groups accordingly. Similarly, Sikes (2006) and Bonner & Tolhurst (2002) report that teacher researchers are more familiar with friendship groups, their nuances, and culture, and are better able to navigate these dynamics to get the best from their participants than outsider researchers.

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On the other hand, there could be a few challenges to being an insider teacher-researcher. This included bias in interpretation and findings, often unconsciously making incorrect assumptions about the research process based on prior knowledge (Hewitt-Taylor, 2002). Some participants may also misinterpret the researcher as an advocate rather than a researcher. They often experienced role conflicts, such as authority and power dynamics, and influences on their responses. This role duality often occurs both ways and requires balance to keep the research goal in focus (DeLyser, 2001). I mitigated these potential disadvantages by consistently reintroducing myself to the students as a researcher rather than their teacher during the interview, thereby setting clear boundaries. I was also very mindful of my body language to be friendly and my tone of voice to be measured to ensure students felt relaxed and supported. I also often reminded them that if they needed to withdraw or speak with someone, the school counsellor was always available. Furthermore, there was also the issue of coercion, compliance, and access to prior information, which needed to adhere to strict data protection to make the research credible; hence, all data from the school was obtained with the approval of the school's data manager before use (Smyth & Holian, 2008).

Several other measures were implemented to mitigate these insider-researcher challenges. First, familiarity with the participants could have led to issues being taken for granted and assuming specific facts already known. To address this, during the research, participants were asked probing questions to confirm that their intended statements were understood clearly, rather than to elicit information about me. During the research, I sought to remain as objective as possible and to be aware that, as a teacher, my views might influence participants, so I was careful not to share my opinions. I also used collaborative terms such as "we" and "us" to make the research inclusive.

It was also important for me to reflect at every stage, challenging what I perceived as bad practice. Bourdieu (1992) encourages self-questioning of one's perceptions to avoid bias in data interpretation. Finally, as an insider researcher, I kept my distance socially and emotionally to aid the reflexive process after data collection by stepping back from the work, often reflecting on it and querying the process as would an outsider by adopting a reflexive

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approach, keeping a research journal, peer-reviewing to challenge assumptions, checking trends and taking breaks, occasionally stepping away from the data. Maurice (2009) also suggested continually asking participants probing questions to make sense of the data as accurate and reliable.

#### **4.5 Research design**

A longitudinal qualitative approach with supporting quantitative school data for context was deemed suitable for the research because it enabled broad exploration of the study participants' practices, behaviours, values, and preferences over time. This helped place individual stories within larger organisational trends and added depth to the qualitative findings, resulting in a clear understanding of the phenomenon, whereby findings from one phase inform the instruments used in the next phase to further unpick the problem (BERA 2020). This approach was highly advantageous because the output from one collection phase helped assess changes over time, which were used to create an interface that made the outcomes more reliable (Berman, 2017).

The study followed a cohort of twenty WCWB students for two years (from year 10 to 11, i.e., 2019/2020 and 2020/2021 school year), which was the GCSE examination class. This was achieved by conducting two individual interviews and two focus group interviews each year to explore different aspects of their science experiences and whether anything had changed over the period. The longitudinal nature of the research similarly enabled data from the same participants to be collected over this period. This was advantageous because it allowed flexibility in data-collection arrangements, given time and place, and the focus could be altered during data collection through repeated observations, thereby yielding more reproducible data (Anastas, 1999).

However, this longitudinal approach had several disadvantages. One challenge that emerged was that only a small number of students were willing to participate and commit to the two-year research, which meant I had to work with a small sample of twenty students. None of the research participants withdrew before the study concluded. The longitudinal approach also required much time to generate sufficient data. As a full-time teacher and researcher, I required extensive time management and coordination with my own and the

students' and teachers' free time when scheduling interviews. This made the data collection process longer over time (Cohen *et al.*, 2000). However, this disadvantage only prolonged the data-collection period, which revealed clear patterns that shed light on the phenomenon under study.

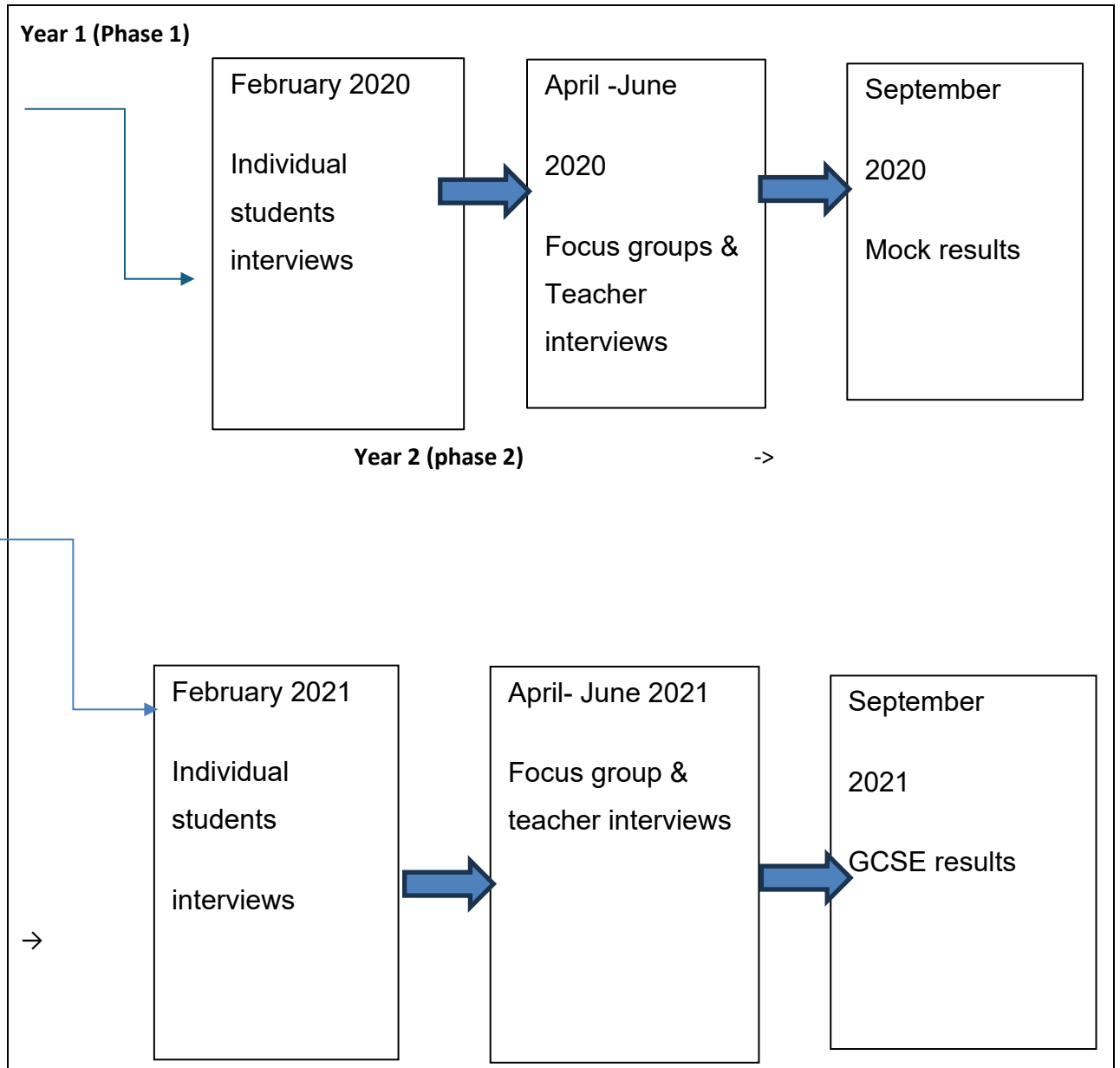


Table 4.1 Timeframe for data collection

The research steps, shown in Table 4.1 above, show the time frame of the data collection over the two years. Firstly, survey questions were distributed and collected amongst 126 year 10 students in phase 1 (February 2020). The responses obtained in phase 1 helped streamline and formulate interview questions for the interviews. Individual and focus group interviews were

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conducted amongst 20 year 10 students (between February and June 2020). In the same period, eight teachers were also interviewed individually to ascertain their views about the perceived science experiences of working-class white British students, and the data generated from them were analysed. Finally, at the end of the school year, the school data (Mock GCSE, attendance, KS2 scores, etc.) was used to contextualise the explanations and interview responses of participants to gain an overall perspective of the effect of the phenomenon in question. These interviews were repeated the following year amongst the 20 study participants to determine if they had a different view or experience of science over the period. Their final GCSE data were also collected for analysis. No surveys were conducted in year two.

#### **4.6 Methods**

The methods used here included individual teacher interviews, student interviews, and focus groups. However, surveys and school data were used only to contextualise the data from participants for the research (Osborne, 2003; Demie, 2012). This provided multiple forms of evidence highlighted from different perspectives and a clear picture of the prevailing phenomenon. In keeping with the overall research aim to explore working-class white British students' experiences with science and attainment at GCSE, this research drew mainly on qualitative interview data with students and teacher participants.

The research process started after I sought ethical approval from the University of Lancaster and obtained ethics clearance to conduct the research after undergoing due process and meeting all necessary obligations. Next, permission was obtained from the school's head teacher to conduct the research within the school. The Headteacher approved access to research participants (students and teachers). The research students were first selected with the school data manager's help and invited to participate in the research voluntarily. Details provided in Table 4.3 sampling participants. Consent letters were drafted and sent out to all parents of students who met the research selection criteria and were happy to volunteer to participate in the longitudinal research. A detailed explanation of the research, the interview period, and the

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research aims was provided, and the options to defer or opt out from the research at any time were made clear to all participants involved.

#### **4.6.1 Sampling participants:**

Student sampling: The sampling of WCWB students was within the same year group. The research sought a sample of twenty WCWB student participants for two years, from year ten to eleven, for their views on science and the research topic. Using the same cohort of students enabled me to examine dispositions and changes in opinions or views over those two years. The following criteria were used to select and recruit student participants, with the outcomes representative of students with similar backgrounds.

##### Criteria for selection

Students had to be registered as White British in the school database to avoid doubt of ethnicity and capture data of the right group. For a fair comparison, students must have started the year even at the research school (no mid-year entries). Students selected must have Key Stage Two data on entry from their primary school to ensure the same measures for all are the same. Students must have Midyis (Middle years information systems aptitude test) scores upon entry into the school to ease the selection of students with the same entry point data. Students must also live within a 5-10-mile radius of the school to experience the same geographical environment. Students should have low-income deprivation affecting children index scores (IDACI) obtained from their home postcodes, which qualify them for free school meals. Students must be eligible for Free school meals in the school, which is a proxy for identifying working-class students. Students should have no breaks in educational records, so all participants share similar educational experiences. Students should not be on the Special Education Needs Register, as this will be an academic disadvantage to these students. Those meeting these criteria were invited to participate in the research.

Teacher sampling:

Eight teachers from the school were sought for interviews about their varied experiences teaching WCWB students. Unlike student participants, teachers came from mixed backgrounds, races, and ethnicities.

Four teachers were drawn from science specialism, and a mix of experienced and new teachers was sought to have varying views across age groups.

Similarly, four teachers from non-science specialist subject areas were selected to ensure a holistic view and disciplines across the school. A mix of experienced and new teachers was also engaged. The teachers enlisted for the interview sessions were four from the science department, whilst the other four from other departments (Maths, English, Geography, and History) to have a holistic view of the phenomenon across the school and other subjects. The participation of teachers in the research was also voluntary. Teachers also were given consent and information letters with the options to withdraw at any time. The profile of teachers who volunteered varied as shown in Table 4.2 below.

Teachers	Teaching subject	Experience
SC	Science	18 years
DO	Science	5 years
EB	Science	10 years
NS	Science	12years
MK	History	5 years
OO	Maths	10 years
FL	Languages	6 years
JZ	English	8 years

Table 4.2 Teacher participants profiles

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#### 4.6.2 The research pilot

A pilot was undertaken to evaluate lapses in the way the questions were asked and identify mistakes, misunderstandings with wordings, structure, and any other issues that may arise from it and improve them before the main study takes place. It also predicted how long it would take students to complete the survey questions, which helped reduce administrative time, ascertain whether the survey items were clearly understood, and evaluate the adequacy of the research instrument. Lastly, it was intended to provide preliminary data and to develop the questions for the actual study.

The pilot survey questions were devised by developing a rough outline of the topic areas needed to address the research objectives. I also reviewed existing surveys in the subject area to identify best-practice designs. Finally, the clarity of questions and their relevance to the research aims were considered and addressed by adjusting or eliminating irrelevant material included in the pilot.

These pilot questions were then divided into three distinct areas, each addressing one of the three main research questions. Also included were two open-ended questions at the end of the survey, which provided guidance for subsequent interview follow-up questions for the students. Both the survey and interview questions were piloted with a group of 15 year ten students who non-participants were. This was done primarily to ensure that the questions and scale items were clear, that the language was not overly complex, and that the appropriate time for completing the survey was adjusted accordingly (see Appendix N).

Upon completion of the pilot, the following findings were discovered and acted on. (a) The average time required for each respondent to complete the questionnaire was 15-25 minutes. During the pilot, students complained about the length of the survey questions, which were to be completed within the allotted form time. This required that some questions be removed to enable completion within the allocated 25-minute time. (b) There was some misunderstanding of the word 'science,' which the students needed clarification about, whether it was science in general or a particular science subject. I had to be specific about science subjects, so I was not generalising. (c) In the interview questions, students were confused about a few phrases, i.e., What is

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your opinion about science?” and the word “science aptitude.” All other questions were clear. I therefore replaced the word aptitude with knowledge.

The pilot outcomes were used to improve and streamline the research survey as follows. i). The number of questions asked was carefully reduced from 34 to 29 to shorten the proposed completion time of the survey questions. ii)

Questions were asked specific to biology, chemistry, or physics for clarity in the structured interviews. Additionally, the problematic interview questions from the pilot were modified as follows to facilitate students' understanding. ‘What is your opinion’ was changed to ‘Do you like’... Science aptitude was changed to ‘science knowledge.’

#### **4.6.3 Student surveys**

To determine the barriers to learning science among the student participants, a survey with closed- and open-ended questions was administered. Although this was primarily qualitative research, it was necessary to collect some quantitative data, such as a survey, to provide context for the phenomenon. This was a Likert-scale survey. Some of their comments were used to formulate interview questions, and two open-ended questions were provided at the end for students to write and comment anonymously. This was to allow participants to express their views truthfully without being judged.

The survey examined the following: science engagement, self-perceptions of science, views on science subjects, gender, and science. A questionnaire was administered to assess students' general views of science (Appendix B) The survey sample comprised 123 students (74% of the year group), representing mixed ethnicities and socio-economic backgrounds, who voluntarily agreed to participate. Although the research was predominantly about working-class white British students, the survey was distributed to the whole year group to have an overall picture of the phenomenon and the science experiences of the students in the same year group. All student participants completed a survey about their science experiences. This included questions about specific scientific subjects, their perceptions, and their views regarding science and gender. Students could select only one answer per question that best reflected their views. The

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responses to the survey questions provided insight into students' general views on science and informed the development of interview questions.

The survey was distributed to the students in their different pastoral form rooms and administered by their form tutors. This delegation of survey administration created a more relaxed environment in which students could answer the questions honestly, away from the scrutiny of their science teachers. The survey was also class-based only to provide a degree of anonymity. All 123 participants completed the survey during form time. The use of simple language made the survey accessible to most students, as confusing terms were addressed appropriately during the pilot session.

The form tutors, who managed any unclear survey questions, were invigilators and had been adequately instructed on completion expectations before administration. This data collection method was conducted relatively quickly (25 minutes) and allowed participants to respond carefully within the allocated time. The surveys were collected by the various form tutors after completion by the students and kept in sealed envelopes until I collected them on the day of administration. (See sample of students' survey in Appendix B).

#### **4.6.4 Interview schedules with teachers and students**

The interviews were semi-structured and designed to elicit participants' views on science. The questions ensured consistency and comparability across participant interviews (Arksey & Knight, 1999). It also provided flexibility to probe concepts and ideas that arose from the answers provided. This interview process was guided by the research questions and probed further by outcomes from the students' 'science view survey' previously obtained from the students in the quantitative phase one. The interviews aimed to elicit insights into the science experiences of working-class white British students throughout their secondary education. It also allowed me to interview their teachers on working-class white British students' general engagement with school, and specifically their engagement with science as a subject.

Rationale for individual interviews

- It allowed deeper insights into students' personal experiences.

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- It also allows for the researcher to probe further into complex narratives and more personalised inquiry.
  - It allows flexibility to explore specific lines of questioning based on previous responses.
  - It is suitable for students who may feel uncomfortable sharing truthfully in large groups.

#### Rationale for focus group interviews

- It allows for the observance of group dynamics.
- It helps some students realise they have similar experiences and opinions.
- It enables peer support and validation.
- It is used for cross-checking ideas that emerged in individual interviews.
- It allows collecting data from multiple participants at once.

The interviews were conducted individually in the school hall to enable social distancing as COVID-19 restrictions were still in place. Additionally, using the hall for the interviews worked well when COVID-19 restrictions on adequate spacing and social distancing were in place. The COVID-19 restrictions lengthened the interview intervals between students beyond the proposed schedule because they interviewed only those available at school. Not all participants were in simultaneously, as students were on a gradual phased return to school. This, however, did not affect the quality of the interviews conducted. Adequate COVID-19 rules were obeyed, and masks were used, etc., when necessary. The individual interviews typically lasted 20-25 minutes per person, and the focus group interviews were slightly longer (approximately 30-40 minutes). The anonymity protocols were adhered to, and the option to decline to answer questions with which they felt uncomfortable was offered before every interview session. All interviews were audio-taped and transcribed using Otter AI software, and errors through transcription were corrected. Individual interviews with students were a valuable tool that enabled me to follow up on ideas, probe responses, and investigate the motives behind participants' on-the-spot answers (Robson, 2002). Interviews have generally

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been considered an appropriate method of exploring subtle and complex ideas and phenomena. It tends to draw on participants' interactions and responses to questions in real time (Denscombe, 2012). This was the primary tool used to provide an in-depth understanding of the experiences of twenty working-class white British students in school science. The interviews were semi-structured to allow flexibility to probe further into interesting insights that emerged during the interviews. These semi-structured interviews are well-suited to exploring complex yet subtle social phenomena. This flexibility allowed participants to speak freely about the issues raised throughout the interview sessions, making the interaction more conversational than interrogative (Bryman, 2012). Student interview schedules are provided in Appendix F.

The teacher interviews took the same format as the students' interviews. They lasted slightly longer (30-40 minutes), as this was conducted after school, and there was more flexibility with time and venue. These interviews were also recorded and transcribed using Otter ai software. However, two teacher interviews had to be conducted virtually via Zoom due to COVID-19 lockdown restrictions, which affected the timing of these sessions. The interviews generated much data from the perspectives of students and the eight teachers. Interview schedules for teachers included questions designed to elicit their views on their experiences teaching working-class students in science or other subject areas, their explanations for the decline in science, and their stance on whether there are gender differences in science attainment. Teacher interview schedules are in Appendix G.

#### **4.6.5 Focus group interviews:**

Much of my data collection was through interviews. In addition to individual interviews with students and teachers, I conducted focus group interviews with a mix of students from the same year group as my main participants. These focus groups included five demographically similar students (often from the same friendship group) from the same year across four groups. This was a suitable instrument because the students were from similar friendship groups, making participation in the sessions easy, and they were willing to participate

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(Brady & Cronin, 2001) These focus group interviews were conducted for the four groups over two years. In all, eight focus group sessions were held.

Questions were designed to elicit the students' science experiences over the years and to identify common patterns across their collective and individual narratives. Questions were also asked about what hindered their engagement in science and how science related to their future career pathways. During this focus group process, I maintained a flexible approach to the interview schedule, as some sessions ran over their allotted time due to their high level of engagement. This was highly beneficial in gaining insights into the group's shared understanding and experiences with science. Finally, although moderator bias is difficult to prevent when hosting focus groups, I avoided making assumptions and refrained from elaborating on participants' answers to avoid leading them, instead probing unclear responses further.

Each study participant's academic data was obtained from the school database with the assistance of the school's data manager, after obtaining informed consent. These included KS2 grades, which provided a baseline entry grade for each student participant, or Midyis (Middle Years Information System) data, a diagnostic test typically taken in Year 7, particularly when KS2 data were unavailable. It is also a baseline test useful in tracking students' progress. Additionally, students' predicted science grades, and the teacher assessment targets were generated by tracking over time to predict final GCSE grades.

The term "mock results" in Table 4.3 refers to the practice exam taken by students before the final exams. It is designed to simulate the actual exams and provide useful indicators of how students will likely perform in real exams. At the end of Table 4.3 below are the actual GCSE exam results, which are the official final exam that determines academic achievement at the end of secondary school.

Student ID	KS2 Entry data	Mid-year Scores	Attendance	Class set	Predicted GCSE Grade	Actual GCSE Grade
KA	5-5	116/A	90.0	Triple	55-5-5	44-4-5
DZ	4-4	90/D	96.7	Triple	55-5-5	55-6-5
FW	4-4	112/A	96.6	Triple	66-5-5	55-5-5
SC	5-5	109/B	100	Triple	66-5-5	44-5-4
JB	4-4	94/C	100	Triple	54-5-5	44-4-4
LC	5-5	114/A	100	Triple	66-5-5	44-5-5
KM	4-4	99/C	100	Comb	5-5	4-4
JB	4-4	92/C	92.2	Comb	4-4	4-4
CM	5-5	4107/B	88.5	Comb	65-5	54-5
BG	4-4	83/D	100	Co	55-4	33-3
NS	5-5	115/A	96.7	Comb	55-4	33-3
CO	6-4	104/B	94	T8riple	98-9-8	88-8-8
KH	5-5	110/B	100	Triple	66-6-6	77-7-6
JA	4-4	87/D	66.7	Comb	55-4	44-4
SR	6-6	138/A	100	Triple	88-8-8	99-9-9
TB	4-5	91/C	95	Comb	5-5-4	4-4-4
ZS	5-5	123/A	95	Triple	6-6-6	6-6-6
DB	4-4	115/B	100	Triple	8-7-7	8-8-8
LA	5-5	128/A	100	Trip	7-8-8	8-9-8

Table 4.3 Participants school academic data

#### 4.6.6 School data

The school records of the participants were obtained from the school's data manager after the school's Headteacher, students, and parents had approved. This data was mainly used as supporting data to form context for the interviews and to compare the attainment of participants. The school data manager assisted in selecting students who might be interested in volunteering for the research and who met the established criteria. Records collected from the school were strictly used for research purposes, which included attendance percentages, key stage two entry data, students' KS3 data, Midyis test scores, termly reports, mock results, and final GCSE results (see table 4.3) This table shows that most triple science students (class set 1) were predicted to have very high GCSE target grades from 5-9, whilst the combined science students (class set 2) were predicted to have lower outcomes of 3-5.

Student ID	Housing categories	Acorn data	Financial category	IDACI score	No of siblings	Parents Graduates
KA	Deprived	Struggling estates	Urban adversity	0.3	7	No
DZ	First-time buyer	Struggling estates	Rising adversity	0.1	None	Yes, Mother
FW	Low-income terrace	Struggling estates	Urban adversity	0.2	2	No
SC	Low-income terrace	Struggling estates	Urban adversity	0.2	2	No
JB	Low-income terrace	Struggling estates	Urban adversity	0.2	3	No
LC	Low-income terrace	Struggling estates	Urban adversity	0.2	2	No
KM	Low-income terrace	Struggling estates	Urban adversity	0.2	1	No
GB	Families' right to buy	Steady neighbourhoods	Comfortable communities	0.2	3	No
CM	Owner occupied	Steady neighbourhoods	Comfortable communities	0.1	4	No
BG	Low income	Struggling estates	Urban adversity	0.2	2	No
NS	Low income	Struggling estates	Urban adversity	0.2	3	No
MK	Young families in terraces	Steady neighbourhoods	Urban adversity	0.3	2	No
KH	Young families in terraces	Steady neighbourhoods	Comfortable communities	0.2	2	No
JA	Young families in terraces	Steady neighbourhoods	Comfortable communities	0.2	4	Yes, Father
SR	Owner occupied	Steady neighbourhoods	Comfortable communities	0.2	2	Yes, Both parents
SH	Educated young families	Steady neighbourhoods	Comfortable communities	0.3	4	No
TB	Low income	Struggling estates	Urban adversity	0.2	6	No
ZS	Young families in terraces	Steady neighbourhoods	Comfortable communities	0.3	3	Yes, Father
DB	Low income	Struggling estates	Urban adversity	0.2	3	Yes, Mother
LA	Owner occupied	Steady neighbourhoods	Comfortable communities	0.3	2	Yes, both parents

Table 4.4 Participants demographic data

#### 4.6.7 Demographic data

The demographic data were obtained from the school's data manager via the school's database, including race, age, sex, and parents' marital status. Other demographic information, such as the number of siblings and parents'

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educational status, was obtained during interviews with students. The others, such as IDACI and ACORN data, were obtained from publicly available government databases using students' home postcodes. This showed the measures used in the initial participant selection to ensure that all students came from similar working-class backgrounds and had similar household structures. This is shown in Table 4.3 above. These measures collectively depict the household structures from which these students come, which are similar to one another, making the sample participants appropriate for the research.

## **Notes**

*IDACI score is defined as the proportion of children under 15 living in families that are income-deprived. The index scores range from 0 to 1, where 0 is representative of the most deprived and 1 is the least deprived.*

## **4.7 Data analysis procedure**

### **Recording and Transcription**

All interviews were recorded with participants' consent using a voice recorder. Some of the teacher interviews that were conducted on virtual platforms like Zoom were also recorded and transcribed using the built-in transcriber. This was done after written permission had been duly obtained and a verbal reminder to opt-out or the right to refuse to answer any question that might be uncomfortable to answer was done before every interview. The recording enhanced the quality of the interview captured in detail and also allowed active listening and attentiveness instead of intensive notetaking during the interviews (Bryman,2012).

Most audio recordings were transcribed using Otter; others were transcribed using Zoom Transcribe. Notable playback editing was required because the software did not recognise words that were not pronounced fluently or that featured unfamiliar accents.

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#### 4.7.1 Thematic analysis and coding

The interview data was read several times to gain an overall view and to become familiar with its overall meaning. The next step was to manually identify and colour-code similar responses that were later identified as a particular code by using Bourdieu's lens of capital, field, and habitus, and grouping those with similar patterns around the discourse. This deductive coding, using Bourdieu's theoretical framework, comprised various strands. The codes of 'capital' allowed me to look at the major influences that made up the science capital of the participants and how it affected their engagement with science. Secondly, 'habitus helped me unpick the participants' students' worldview of science and how this shaped their relationship with science over time using Bourdieu's lens. Finally, the codes for 'field' provided a picture of students' influences across various science subjects, school, teachers, and individuals. These factors were then observed in relation to underachievement or achievement in science. These ideas (codes) and patterns were further refined for relevance and grouped into themes aligned with the research questions. This was influenced by the works of Archer & Francis (2007), and Braun & Parker (1993) The final themes that emerged represented broad categories that conveyed the same message. A list of codes and their descriptions from the data is provided in Appendix P.

These codes were presented in a thematic chart to organise and reduce the information, refine it into a manageable number of themes, and facilitate further probing. It was then organised to link themes with codes and subcodes. The identified themes were then analysed using Bourdieu's lens to explore the scientific views of the participants. The aim was to explore the scientific views, tendencies, and theorized factors influencing students' underachievement in GCSE science. Several initial codes considered Bourdieu's theory of capital, habitus, and field to streamline the subthemes under these broad themes (Bourdieu, 1977, 1990, 2010) These thematic charts are shown in Appendices L and M.

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#### **4.8 Ethical consideration**

Ethics was a vital learning curve of the research project for me, which embodied the basic principle of informed consent and prevention of harm to research participants. This ethical awareness ran through every aspect of the research, from planning and participant recruitment to conducting the research and presenting the findings in a way that safeguarded participants' rights (Spradley, 1980). As a teacher, safeguarding is central to our practice, so I was well aware of the expectations and duty of care.

Approval for the study by the University of Lancaster ethics committee was the first step towards ensuring the research met standards aligned with the University's standards (BERA, 2011). Permission to undertake the study in the research school was obtained, along with access to student and teacher participants from the school's Head Teacher. As a teacher-researcher, I already have my updated Criminal & Baring certificate with the school. Finally, I obtained written consent from the parents of the students and student participants who volunteered for the study.

The students' participants were reminded that they were not bound to participate in the research and were allowed to withdraw their consent at any time they felt uncomfortable. I was also very conscious of the teacher-pupil power dynamics and how it can sometimes influence the participants to give specific responses or cause them to feel pressured or coerced to continue. I tried to overcome this by reassuring them that it would not influence their grades, and as much as I could, did not involve students from classes that I directly taught. Care was also taken in the wording of questions for the interviews, as words like "White working class" can often be misunderstood by many as a negative label. This was explained cautiously during the introductory sessions when the call for volunteers was made.

Participants for the study were also made to understand the nature of the research and what they were signing up for by having an interactive session to explain to them in detail the purpose of the research, the data I was collecting, and how I would be using the data. The participants were also informed about potential risks, such as time commitment and possible anxiety about performing, and benefits, including contributions to a larger cause and the

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possibility of influencing future educational practice and policies. Thereafter, I obtained signed consent from each participant before the interview sessions began.

#### **4.8.1 Trustworthiness, Transparency and Credibility**

Trustworthiness was established through rigorous qualitative procedures designed to enhance the depth, reliability, and validity of the findings. Following Lincoln and Guba's (1985) framework, the consistency of processes and data-driven interpretations was prioritised. Prolonged engagement within the research context facilitated a nuanced understanding of participants' lived experiences. Semi-structured interviews and focus groups enabled participants to articulate barriers to GCSE science in their own words, generating rich, contextualised data (Creswell & Poth, 2018). Thematic analysis was conducted using Braun and Clarke's (2006) six-phase approach, ensuring a systematic progression from initial coding to theme refinement. Reflexive notes documented analytic decisions, assumptions, and interpretations, promoting transparency and rigour (Finlay, 2012). Detailed field notes, memos, and a structured coding framework supported clarity and consistency, allowing for external audit and strengthening dependability.

Transparency was achieved through comprehensive documentation of all methodological decisions. An audit trail was recorded at each stage of the research process, including sampling, recruitment, interviews, transcription, and analysis, thereby enabling traceability of conclusions (Lincoln & Guba, 1985). Sampling criteria were justified by the need to capture the experiences of working-class White British students in science, a group identified as underachieving in national data (Department for Education, 2023). Interviews were audio-recorded with informed consent and transcribed verbatim to ensure accuracy (Kvale & Brinkmann, 2015). The rationale for methodological choices, including thematic analysis and triangulation across participant groups, was explicitly documented. These practices align with the Consolidated Criteria for

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Reporting Qualitative Studies (COREQ) guidelines for transparent qualitative reporting (Tong *et al.* , 2007), thereby ensuring openness and ethical integrity.

Credibility was enhanced through strategies that ensured findings authentically represented participants' perspectives. Data triangulation across students and science teachers provided a comprehensive understanding of factors influencing science achievement, reducing single-source bias (Patton, 2015). Prolonged engagement as a teaching staff member of the school helped build trust with staff and students, and also, combining data sources of students and teachers to corroborate barriers identified (Lincoln & Guba, 1985). I had also discussed my coding strategy and interpretation with my supervisor, which helped identify overstatement or bias (Birt *et al.* , 2016). Finally, the thorough description of school contexts, participant demographics, and socio-economic factors further supported the credibility of the findings by situating them within their specific context (Geertz, 1973). Collectively, these strategies ensured interpretations were grounded and reflective of participants' lived realities.

Researcher reflexivity during the study involved recognising and addressing the potential influence of personal biases and assumptions on the research process. In this study, I acknowledged that interpretations could vary across researchers and that my own perspectives might shape the analysis. To minimise this, scenarios and themes were selected in line with the research question and supported by the existing literature, thereby ensuring alignment with scholarly evidence. Reflexive awareness guided decisions throughout data collection and analysis, helping maintain objectivity and relevance. Strategies such as keeping reflexive notes and consulting prior studies were used to monitor and challenge assumptions. Although the study was primarily qualitative, quantitative data such as school performance records and survey responses were incorporated to provide additional context and strengthen the validity of interpretations.

#### **4.9 Summary**

This chapter outlines the research methodology, which is grounded in the interpretive paradigm. The study seeks to explore the subjective experiences of

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twenty working-class white British students with science. The interpretive paradigm was chosen to emphasise understanding human behaviour and phenomena from the perspective of those experiencing them. The study collected data primarily through qualitative methods, including semi-structured interviews, participant observation, and document analysis. These methods align with the interpretive paradigm's emphasis on capturing nuanced, context-specific understandings. Thematic analysis was used to analyse the data, following an iterative process of coding, categorising, and identifying patterns. Data were reviewed multiple times to ensure a deep engagement with participants' narratives. Themes were derived inductively, allowing the findings to emerge organically from the data while maintaining alignment with the interpretive paradigm. The three theories used to frame the discussions were Bourdieu's theory of reproduction (1990), Crenshaw's theory of intersectionality (1991) and Butler's theory of gender performativity (1988).

Reflexivity was essential to the study. Throughout the research process, I constantly actively reflected on my positionality and potential biases. The study adhered to ethical principles, including informed consent, confidentiality, and the right to withdraw. Participants were treated with respect, and their voices were represented authentically.

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## Chapter 5: Family Background

### 5.1 Introduction

This chapter begins by introducing the broad issue of family background, the first theme to emerge from the data analysis. It will involve discussions highlighting how various socio-economic factors and the lack of essential learning opportunities within families can hinder working-class students' science attainment and, in turn, shape their engagement with the subject. The first section examines the resources available to working-class students that may help or hinder their success in science. The availability of books, access to private tuition, exposure to science places, and homework resources collectively build social capital, giving students an advantage over others in the same field. Bourdieu's theory (1997) describes this as 'cultural capital' that can be built up and passed on to household members. The Bourdieusian perspective on family influence on students' outcomes is summarised as a synthesis of cultural capital and habitus. Cultural capital refers to the transmissible parental values, codes, and practices that can be passed on to children over time, directly through instruction or indirectly through actions. This transfer often is in the form of 'habitus,' which is the socially ingrained habits, skills, and dispositions one acquires through close associations. Bourdieu (1987) argues that this reproduces the way certain groups see the world and respond to it.

The second part of this chapter will examine the impact of various facets of parental involvement and how these facets contribute to working-class students' engagement with science. This will highlight, using data from interviews with students and teachers, how parents' engagement with school, the type of housing area or provision, and parental educational background all contribute to students' attainment. Hoskin & Barker (2017) suggest that working-class students tend to follow their parents' lead and reproduce the habitus with which they are familiar. The type of habitus children are exposed to is important for this cultural inheritance to be passed on from parents to children. Bourdieu (1997) argues that family is central to shaping an individual's outlook and can notably influence the trajectory of future involvement and social

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advancement (Bourdieu, 1977). He further argues that one's habits often reflect social class position and suggests that only middle-class or elite-class resources can be converted into unique cultural capital valued in society.

The final section of this chapter will argue that students' family worldview or perception of life and science influences their engagement with science. Issues of family role models and having family members who participated in science and held positive views of it were important in raising students' resilience and affinity for the subject. This chapter concludes with a summary of all the important key points about how family background determines the student's social capital and how this directly affects attainment. Overall, the family background theme was interpreted through the theoretical lenses of Bourdieu's theory of reproduction (1996), Crenshaw's intersectionality theory (1989), and Butler's gender performativity theory (2002), where applicable. Family resources play a notable role in determining students' science engagement. This will be fully detailed in the next section. This chapter will also show how family worldview and societal norms create barriers for working-class girls and subtly discourage them from pursuing science as a viable career path. These norms, expressions, and expectations, when repeated over time, become constructed as acts associated with certain genders, as Butler's gender performativity theory suggests.

## **5.2 Available resources**

The family is usually the first foundation of children's socialisation and the site of initial learning and informal education. Families often provide a safe, nurturing environment where children thrive, develop character, and acquire the tools to learn and integrate into society (Lovell, 1999). Families have also been suggested to strongly influence students' attitudes, engagement, and attainment in schools (Sewell *et al.*, 1969; Card & Payne, 2002). This can be mediated by the family's economic position or by parents' cultural practices, postures, or beliefs (Douglas, 2006). Several studies and reports show that family background is the main predictor of a student's academic success or

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failure. The type of family background can limit intergenerational mobility and success, especially among poorer families (Chowdry *et al.*, 2009; Geske *et al.*, 2006; Carnoy & Loeb, 2002). Similarly, Von Stumm *et al.* (2022) studied families in the UK and claim that at the GCSE level, family background can account for a quarter of a student's grade. However, the working-class white British students (WCWBS) who are the subjects of this research come from modest families characterised by living in deprived areas/communities and obtaining Free school meals. The chapter aims to highlight how these students have navigated the barriers posed by family disadvantage to succeed or fail in GCSE science.

My analysis identified several indicators showing how a student's socio-economic status (SES), i.e., family background, can influence the availability of resources to which students have access. It has been observed to have a notable influence on students' science engagement and, subsequently, on their academic performance. These resources include books, private tuition, and science-related clubs, trips, and memberships, among others. The level of resources available depended heavily on how much individual families could afford to spend on their children and on how students used these resources to their advantage. Most students alluded to these resources in interviews. However, if resources were made available to every student, it seems they would be better able to engage with the subject and therefore have a higher likelihood of excelling in it. There seems to be some correlation between the availability of these resources and improved science grades. This will be explained in detail as we examine the sections of the first sub-theme on resources.

### **5.2.1 Books**

Textbooks are a key learning aid that facilitates the process of remembering and understanding content and its assimilation. It also helps one develop a unique perspective on a particular topic. Some scholars have described textbooks as low-maintenance, requiring no technology to use (UNESCO, 2009; Muller, 2012).

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When interviewing the students, I asked what they believed would best support their science studies. Some examples of responses were.

“I think maybe if more resources like textbooks were given to us to use at home, it would help a lot. I often struggle at home to find relevant material for homework or revision”, **KM (male, set 2, phase 1)**.

**KA (female, set 1, phase 1)** made a similar statement.

“I think I do better when I have the right books to use at home, like in sociology. So, I have to use Google search, which sometimes is confusing or wrong.”

NS, also reflecting on the question, shared a similar view on the importance of books.

“My older brother offered triple science when he was in school, so I was lucky to have lots of his books available to me to use, so I had no excuse not to complete homework or study”, **NS (male, set 2, phase 1)**

These students see the unavailability of home science textbooks as a major barrier to their learning. This may suggest that these resources, such as textbooks, add intrinsic value to their understanding of science. One of the students (KA) even compares science with her other subjects, and she has free textbooks that help her study at home or outside school hours for that subject, which she claims helps her remember key facts.

Only 6 (30%) students responded to resources like books. Those who did seemed strongly convinced that this was vital to their pursuit of better grades. When analysing the final GCSE results of the six students above who reported a lack of books, it was found that none of them achieved their target grades in science. Would having those textbooks be effective in improving their overall performance? KA did not achieve her target grade in science but did in sociology, for which she had earlier claimed she had textbooks to take home for independent study. Was the textbook the game-changer? Adeogun & Osifila (2008) argue that there is a positive correlation between material resources, such as books, and students' academic performance. The PISA (2003) report

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also shares a similar view on books but adds that they are most prevalent in developing countries.

The final GCSE results of all the participants indicated that the majority of students who had access to resources, especially textbooks for independent study, 75% of them achieved their target grades in science, whilst 25% who had no access to textbooks at home for science studies did not achieve their target grades in science. It is worth noting that most of the students who reported not having access to science textbooks were in the combined science set 2; none were in the triple group (set 1). It is also possible that the class set may contribute to these students' poor grades, rather than simply the lack of textbooks (see Appendix T). The above findings, however, are consistent with (Adamson *et al* .'s 2016) work, which found that raising 15-year-olds' science literacy by providing them with science textbooks substantially improved science attainment. The link between the availability of books and science attainment is quite robust, as researchers at Oxford University, Department for Education discovered in their large-scale research on science education. They identified science literacy as a major factor contributing to achievement gaps among predominantly disadvantaged students. This follows the logic that students must be able to read, interpret, and apply scientific reasoning outside the classroom to achieve the level of scientific literacy required for good outcomes (Nunes *et al* ., 2017). One teacher supported this view during the interview, who said.

“Unless students do some work outside of the classroom and revise at home, learn the keywords and language, they are not likely to do well in the subject. Science is very specific and wide. There is not enough time to teach everything they need to know in school” **DO (female, science teacher).**

Her remark appears to echo what one participant reported: having the books yet not understanding the text. NS (student, set 2) further elaborated that even though he had the science books he inherited from his older brother available to him, he still had to study a lot to make sense of what he was reading, as the texts were often very confusing for him to understand by himself. It appears that having science textbooks alone is insufficient to improve attainment for some

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students. Science literacy and understanding must also be considered alongside it.

It was also noted that Set 1 (triple science group) had 40% of students who reported having books, whilst Set 2 (combined science group) had 20%. This shows a clear difference in class ability set. This may explain their attitude toward their scientific work and, hence, their attainment. Their teachers seem to think so.

“The school has made online digital resources available for all the students to access from home. The COVID-19 pandemic gave us no choice but to do so. Over half of them, especially in sets 2 and 3, never logged in. I think it's attitude towards learning that is the biggest barrier by a mile, not resources”, **CS (male, science teacher)**

When some teachers were asked what they thought was a barrier to students' science learning, some responses were.

“Hm, that is a loaded question. Attitude to school, attendance, class set, science background, connection with teacher, family support, I can go on and on”, **DO (female, science teacher)**

“I feel there are lots of barriers facing our students. The main one is themselves. They do not put in the effort required at all. I teach set 2, and it is like pulling teeth to get them to do any extra work from home. It's the attitude to learning”, **NS (male, science teacher)**

Slavin *et al* (2009) seem to think direct teaching or game-based learning yields better dividends than textbooks. He asserts that students prefer game-based learning to textbooks, particularly for subjects they would rather not take. Since science is a compulsory subject and students have no choice but to study it, can this be the reason for the apathy? This will be explored further in Chapter Six-School factors (section 6.4).

Today, most students are digital natives who, from an early age, engage with technology with ease, especially when it is readily available. Technology, digital text, and gadgets are more readily available to them than hard-copied text. Farha (2009) suggested more digital engagement in science than physical textbooks. In a correlational study, he observed a strong association between

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physical text form and student engagement among secondary-aged students. He recommends that teachers provide more online engagement and resources for home study and homework than hard-copy texts or worksheets to improve students' participation and overall performance in science. My view is that most students who could not access textbooks would also be unable to access these digital resources, as Wi-Fi costs are as high as those of physical textbooks, bringing the economic dimension back to the forefront of this argument.

Another issue that arose frequently in the interviews was the masculinity of science textbooks. Studies by Good *et al.*, (2010) claim that school students in their research had a higher science comprehension after viewing counter-stereotypical images of science. In contrast, Foulds (2013) argues that images alone do not turn the tide; rather, it is when the sociocultural context matches their realities. He therefore concluded that the gender representation in books is influenced by students' culture and societal context. Some students, however, noted that there were more images of men in science than of women, and most identified this in their textbooks but did not regard it as a major barrier to their engagement with science.

“Most of the language and examples of scientists are men, so our textbook only shows Marie Curie as a scientist who is a woman, the rest are men”, **FW (male, set 1, phase 2)**

Textbooks, however, can indirectly contribute to the legitimisation of gender roles, especially in science (Brugeilles & Cromer, 2009; Nofal & Qawar, 2015). Science textbooks have typically been overrepresented, with a predominantly masculine form and content. Most scientists highlighted for scientific discoveries, as FW noted above, are male. This does not appear to accommodate the diverse interests of male and female students. However, research has not found a correlation between the masculine nature of textbooks and students' learning outcomes in science.

On the other hand, teachers did not feel the lack of textbooks was a major barrier to students' science attainment as they claimed all the students had access to digital books online. They claimed it was the lack of commitment to use available resources that was more noticeable. They further claim that a

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student's attitude primarily influences their learning and achievement. Muhlenbruck (2010) supports this in his work which highlights that the learning of science is influenced when students learn independently and their attitude towards the subject is positive. In summary, the findings suggest that the availability of resources such as textbooks can influence students' overall science attainment, irrespective of gender. The language used in some texts, however, still seemed to hinder some students, who felt they needed more help understanding certain scientific texts and topics. This brings us to another resource that few of the students interviewed had private tuition. The extent to which private tuition does or does not influence students' science attainment will be explored in the next section.

### **5.2.2 Private tuition**

There has been an increasing recognition of the prevalence of private tutoring in the United Kingdom and its potential contribution to the nation's national achievement records (Bray, 2003). Private supplementary tutoring, however, has been defined as "tutoring in an academic subject for financial gain as an addition to the provision of mainstream schooling" (Bray and Kwok 2003, pg 2).

In this section, private tutoring does not refer to this, but rather to the expanded definition that includes one-on-one tutoring sessions provided by teachers in school, siblings, peers, or parents at home. It is worth noting that private tuition originally was more of an elite concept because of the financial aspect involved, but PISA (2001) noted that it is fast catching up as a necessity amongst all social groups so schools, teachers and even siblings and parents can provide these extra learning sessions even if highly inconvenient for them.

Private tuition was another key resource that appeared to support students' engagement with science, as reported by participants in interviews. Access to additional private science tuition and out-of-school hours, especially for science, accounted for 25% of participants' engagement with the subject. This, the students claimed, had enhanced their understanding of difficult or confusing scientific concepts and helped them ask pertinent questions in class. Private tutoring was also mentioned as a confidence booster because some students commented that they had covered most of the content ahead with their private

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tutors, hence making them learn ahead of their peers. Students who had access to private tuition as an addition either after school or on weekends were more confident in their science abilities than those who did not. It was noted that these students, when asked if science was for them, answered yes and claimed they were always ahead of their peers because they had the extra support and, as such, had a more positive view of science than those who did not have the extra access to tuition. All the participants who received extra tuition were also noted to have achieved their GCSE target grades in science (see Appendix J).

One student during the interview notably claimed.

“One-on-one tuition helped me because the tutors took the time to explain to me in more detail. My science became easier, and I began to enjoy it when I could answer questions in class more effectively. I am now confident to make my GCSE grade in science”, **MK (male, set 1, phase 1)**

MK believed that his understanding of science was enhanced by the one-on-one attention he received from his private tutor each weekend. His final GCSE grades also reflect this, as he achieved two levels above his set target science grade (see Appendix J and K). This success may be attributed, in part, to the extra tuition. This is not conclusive, but based on the available data, his private tutoring may have helped him become more confident and build his science capital.

Another student said,

“My Mom made me go to Saturday tuition every week so I can get better at my science. I did not like the tuition at first, but it helped”, **DB (female, set 1, phase 1)**

Again, DB’s final GCSE grades demonstrated good attainment, as she exceeded her target grade in science. In this research, there seems to be an emerging pattern between science grades and extra tuition. This was, however, outside the scope of this research, but is worth exploring further, as the data shows that 100% of all of the participants who claimed to have received extra private tuition exceeded their target grades for science, compared to 38% of students who did not receive extra tuition and yet achieved their target grades.

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The available data indicate a positive effect of additional private tuition on academic achievement in science. It can, however, be said that access to private science tuition was a confidence booster for many students who had the opportunity to receive it.

Working-class students typically would not be classified as those that would be having extra private tuition because of the extra financial cost implications involved (Smyth, 2009). However, the slight change in character shows a shift in the priorities of these working-class families toward schooling and their children's academic progress. Data show that 75% of participants did not have access to any paid-for extra science tuition. This was understandable, as the socio-economic status of these students' families would not typically be able to afford the additional burden of tuition costs. One participant, however, reported that her older sister served as her science tutor at home, which provided remarkable support. This provided ZS with cost-free tuition from a family member in areas she would otherwise have struggled with.

“My sisters helped me by teaching me difficult topics. That was very useful, especially with my physics, which I am not great at”,  
**ZS (female, set 1, phase 1)**

In a similar case, SR (male, set 1) also reported receiving occasional tutoring from his father, who worked at a school primarily on weekends. Other participants agreed that access to additional one-on-one tutoring would have improved their engagement with science, understanding, and subsequent science outcomes. However, a few participants were confident that their teachers had adequately prepared them in school to achieve their grades regardless.

In England, there are noticeable differences in students' science outcomes following additional private tuition (Ireson, 2004; Bray, 2006). Well-off families who can afford additional tuition fees often create a safety net for their children at risk of low achievement or falling behind. According to Bray (2006), their children spend approximately seven hours per week on additional lessons outside school, thereby increasing their overall science capital. Only 7% of high-achieving disadvantaged pupils receive one-on-one tuition in science

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compared to 15% from the most advantageous socio-economic backgrounds (Jerrim, 2017).

The Sutton Trust (2018), in their report, similarly highlights that the use of private tutors and access to additional instruction out of school hours are increasing educational inequalities and limiting social mobility across the UK. It can also be observed that students who receive homework help at home are typically from the most advantaged backgrounds. This ability to access additional private tutoring in a study showed a notable attainment gap between students who had tutoring and those who did not (NPD, 2016) However, the research data contradict these claims, as some students may receive help from their siblings, friends, and classmates regardless of their socio-economic background. Additionally, schools often offer additional revision sessions, which most students in the study reported attending; these should be considered in the judgment. However, Jerrim (2017) cautions that students' metacognitive abilities and scientific reasoning must also be considered in assessing the extent to which extra tuition would affect students' science outcomes. So far, no research has contradicted this position. Therefore, students' science efficacy is a factor in the analysis of the overall effect of tuition on achievement.

Using Bourdieu's lens to understand the importance of resources, i.e., books, private tuition, etc., in educational outcomes, he describes it as a form of economic capital that can yield an advantage to some students whose families have the good fortune to accrue this and therefore use it to the benefit of their children. Having books and other resources, therefore, gives students access to this form of economic capital and a head start in achieving higher science grades. This is viewed as a form of privilege, which Bourdieu described as 'creating social inequality' among groups with different economic potentials (Bourdieu, 1972). The analysis and literature both demonstrate that economic capital influences science outcomes; there was also a positive correlation between IDACI scores (an index of poverty) and science outcomes. There may be some advantages of having access to private tutoring that is not academic. Bloom (1994) and Gerbert (2001) noted that students who received tutoring in school spent more time studying and developed a more positive outlook toward

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learning. It has also been found to reduce test anxiety and improve school attendance. MK alluded to this (male, set 1), who claimed he felt more relaxed and confident in science classes since he started tuition. Although tutoring can have beneficial effects on students' achievement, self-concept, and attendance, these effects are not guaranteed. Research on this has been inconsistent and it remains controversial. Elbaum *et al* (2000) and Baker *et al* (2001) further point out that private tuition does not provide any added advantage to highly able students, as high-ability students already can interpret information by themselves and might not need a tutor. Interestingly, all the participants who received private tutoring were high-ability students with high target grades in the set 1 ability group. This leaves more questions if the tutoring made a difference or not. However, the data seems to show that a few students (3 out of 5) who received private tuition exceeded their target grades. It is also important to recognize that all the students who received extra tuition had a positive view of the influence the tutoring had on their self-confidence, science understanding, and subsequent GCSE outcomes. Another index of a student's home practices is the kind of science places that may increase a student's curiosity for the sciences or build their capital. This is discussed in the subsequent section.

### **5.2.3 Science Day trips in school and clubs**

Science places refer to a range of diverse science-based activities that take place outside the classroom. Such activities may take place on school grounds, in parks, in local open spaces, or at zoos or museum centres. These institutes have great potential to engage with communities and change perceptions of science. Science trips and places were also a subtheme mentioned by some participants as a means of kindling their interest in science. Archer, Dewitt, and Wong (2013) suggested that participation in science-related activities outside of school over the long term may shape students' science aspirations. Runnymede Trust (2000) observed a similar effect among students in an area where science courses are embedded and taught in settings such as laboratories, science clubs, and science museums. These students had a more positive approach than a negative approach to their science classes. These

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science day trips have also been shown to have positive effects on students' science engagement and outcomes. Science clubs in schools have been seen by most scholars as an effective means for students from low-SES backgrounds to increase their science capital (Yeoman, 2019; Aspires, 2013). Several educational approaches, clubs, and interventions have been developed to support the progression, engagement, and attainment of low-SES students in science in schools. Some students interviewed alluded to the claim and said extracurricular science activities did help them in their science progress.

A few comments from some participants touched on this.

“I used to attend the STEM club before the quarantine due to Covid, which helped me. It made me engage with a lot of the science concepts and even why we used certain equipment”, **ZS (female set 1, phase 2)**

ZS appeared to be more attuned to the operation of scientific equipment and to scientific methods through her regular engagement in the STEM club. It was great to see how small things, such as equipment, were important to ZS and helped her develop a better understanding, as she used this equipment more readily in her club. She may have transferred this knowledge to her work in class during practical experiments, which increased her confidence.

SR in another note about his involvement with science activities commented.

“Teachers have been engaging me in extracurricular programs and trips in science, which is exciting. My Dad also made me attend every science trip available and join STEM and DT clubs”  
**SR (male, set 1, phase 2).**

SR is getting a lot of encouragement from both his teachers and father. This gives him more social capital than most of his working-class peers. He may also rate the value of these activities as important, as he acknowledges, when probed further, that they're exciting and have broadened his view of areas in science he can engage with.

DS and PO offer a more academic angle on their engagement with the STEM club.

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“Yeah, I remember the stem club used to make us think about how science really works. It was great at making us figure things out by ourselves,” **DZ (male, set 1, phase 2)**

“Science trips in year 7 used to make science really interesting. Like the museum activities and the treasure hunt were really good”  
**PO (female, set 2, focus group, phase 2)**

Researcher: Can you elaborate why these were interesting?

PO: “Seeing these scientific discoveries, like dinosaur bones or even the various inventions, makes science so real, and how most of the things we have today were a result of years of trials.”

DZ: I agree with PO, that's why I feel science is so important.

A similar account was seen in the previous focus group in phase one where most students alluded to trips and their connection with understanding science better.

**GB (focus group, phase 1):** “I loved going to Kew Gardens for ecology study. It was initially boring, but later I could connect what my teacher was discussing in class.”

**CO (focus group, phase 1):** “The visit to the Natural History Museum in year 8 made it for me. The history section on drug development came to life, from powder to even soap-form medicines.”

Several other factors have been identified as contributing to the participant's engagement with science activities. A few are parental or family encouragement, their view and interest in science, and the fun factor. The motivation to partake in these extra-curricular science activities is as a direct result of family members being a part of science themselves when they were in school. This demonstrates a form of social reproduction, as posited by Bourdieu (1977), who argues that parental educational experiences constitute cultural capital and can reproduce inequalities or advantages. In this case, an advantage for them is having family members who have experienced schooling and are familiar with how the educational system works. If more students had encouragement from a family member to participate in extracurricular science activities, the likelihood of attaining their science GCSE target grades might be

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higher, as all participants who engaged in such activities in the study achieved their target grades.

It is also worth noting that creative play or activity may be a contributing factor in this attainment. One of the participants, PO, said she enjoyed participating in these extracurricular activities in science. She further claimed that it made science interesting and worthwhile to her. The “Play” aspect of science can make science more appealing to many often-disengaged students.

This is in line with Woolmough & Allsop (1985) pg. 49 who suggest that “extracurricular science activities that are embedded in some sort of fun or play build a feel for the phenomenon and an interest in the area”.

It was also seen to create imaginary scenarios where their ideas of science can be acted out or challenged. It, however, can only be effective if parents support their wards to attend such places or activities.

My data showed that only 30% of the students interviewed were regularly engaged in science activities. Most participants were from the triple science class sets. However, teachers held a different view of how students engaged with extracurricular science activities organised by the school. A few examples of such comments were:

They are often disengaged about science trips, even when it is free,” **NS (male, Science teacher, Asian)**

“We need to encourage their parents to encourage their children to partake in these activities provided by the school”, **MK (male, History teacher, White British)**

“Our WCWBS does not take up most sponsored trips to such places. Parents must do more and meet us halfway with these children when opportunities are available”, **SC (male, Science teacher, White British)**

The teachers’ positions appear to span other subject areas and science. The History teacher appears to believe that parents need to get involved in building social capital by supporting school trips and activities. For school-aged children, someone must advocate, arrange, or provide consent for these students to participate in extracurricular science activities. Their parents or other family

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members typically grant this approval. This means that if parents are not on board, most students will not be able to benefit from these opportunities, which often involve costs. This may account for the low uptake of these students in such trips and opportunities, as their families may not prioritise them.

Kowalczyk *et al.*, (2015) suggest that working-class students' experiences are a bit different because of their economic constraints and choices, unlike middle and upper-class families, who do not have such pressures. Working-class parents may be less likely to recognise the long-term value of their children's engagement in extracurricular science activities, particularly when these activities carry financial implications (Gottfriend & Williams, 2013).

Some teachers interviewed, however, claimed that it was not solely about the cost of these activities but rather about the value placed on these ventures by the families who needed to provide consent for the trips. One teacher further stated that most WCWBS would not attend trips even when they were free because they felt they were not important.

One student participant, however, stated that the science day trips were often "boring and not exciting", **LC (set 1, phase 2)**.

Working-class families were also argued to be less likely to invest in out-of-school science activities with their children, nor to encourage it (Rickson *et al.*, 2004). Akenhead (1996, 2001) conceptualized that learning science in the context of the student's life culture is more beneficial in encouraging science aspirations in science that may be in discordance with the students' cultural backgrounds. Other scholars view that diversity brings some awe and relatability to scientific information and discoveries (Carole *et al.*, 2008). The implications are that these extra-cultural activities are meant to open up the world of science in a more practical, engaging way than the academic side often experienced in the classroom. However, Mosatche *et al.* (2013) suggest that STEM programs with socio-cultural emphasis are more effective in influencing outcomes as they help to break down any perceived barriers students have towards science and close the disadvantage gap SES and background might have caused. This may explain why most WCWB students were disengaged from science-related activities and opportunities presented to

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them. It is reasoned that a sociocultural emphasis will make them feel more connected to and benefit from it.

It was intriguing to find that some WCWBS participants were not taking advantage of opportunities to build their science capital by participating in science programs, trips, and clubs that were open to them, a concern raised by their teachers.

This view was confirmed earlier by **LC (female, set 1 phase 2)** when she referred to school trips as “boring and not exciting” and also **FW (male, set 1)**, who said he had no interest in science trips and described them as “not his thing”.

Drawing on Bourdieu’s perspective, it would suggest that some individuals excluded themselves from opportunities because of a perception of not belonging. Bourdieu’s concept of habitus enables us to have a ‘sense of one’s place’ which leads one to exclude oneself from places in which one is included (Bourdieu, 1984: p. 471). This cultural arbitrariness is useful for highlighting why some of these WCWBS participants, even when empowered by these opportunities, exclude themselves from the transfer of social capital. This results in social inequality and shows class differences. Bourdieu, therefore, argues that cultural capital, shaped by parental class structures and educational attainment, can influence children’s educational attainment (Bourdieu & Passeron, 1977). In a similar study, informal learning experiences contributed to an increase in test scores amongst Hispanic working-class students who qualified for school lunches (Whitesell, 2016) Tim (2014) and Apata (2014) also observed this increase in studies. Informal learning was also found to increase students’ interest in the subject and to enable students to develop a meaningful understanding of science concepts (Kelly, 2000; Burker, 2004).

#### **5.2.4 Homework**

Homework was also a subtheme that emerged from participants’ interview responses. Most participants gave varied responses, which, on the one hand, reflected their family commitments to their academic success, but, more importantly, highlighted the values placed on such endeavours.

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When asked, who helps you with your science homework, **KA (female, set 1, phase 1)** said.

“I often complete my homework alone, as I am the eldest of 7 children and Mom doesn’t know much science, so I figure it out by myself”.

Similarly, **TB (male, set 2, phase 1)** said,

"Oh, I do mine myself. I also have to help my younger ones complete theirs, too, as no one is home to help. My parents are at work, and I’m the eldest."

“On the contrary, other participants said, " My older brother took triple science in school, so I get help from him when I am stuck”  
**LA (female, set 1)**

“My Mom helps me whenever I need help with any homework, especially science.” **DB (female, set 1, phase 1)**

“Sometimes, my mom helps me. She is not great at science, but she makes me do the work and figure it out” **LC (female, set 1, phase 1)**

“I get a lot of help from my siblings when I want it, which is a bonus” **CM (female, set 2, phase 2)**

Participants' views across both phases were mixed regarding how homework was handled in these homes. From most responses, I conclude that having a knowledgeable and available assistant was important for providing the homework support students required. Educated parents or siblings are more likely to help pupils with homework because they can interpret academic material better than less educated ones. This educational advantage enhances their human capital by leveraging their skills. They are also more likely to pose questions and employ a broader range of suggestions and vocabulary (Egalite, 2016).

Most teachers interviewed acknowledged that children whose parents assist with their homework produce higher-quality work, even when the parents are not very literate. They reasoned that parental moral support is crucial, as it often motivates students to pay closer attention and add important information and value to their homework.

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“Most of our WCWB students do not do homework up to standard because they get no support at home with the work given” **SC (male, science teacher, White British)**

“A big issue that affects our local area is the lack of home literacy. How can these parents help when they have this as a personal barrier themselves?” **JZ (female, English teacher)**

The positions of the above teachers were opposed by another teacher, who concluded that the problem was engagement with parents rather than their literacy levels. Another teacher supported the engagement explanation, noting that other ethnic minority parents whose English is not their first language may not be literate, but can encourage and supervise their children to complete all assigned schoolwork. This was because these parents prioritised schoolwork. Another teacher concluded. Their families do not encourage them the same way as other minority families do.

“ Although when you have a lot of family issues, it can be difficult for parents to prioritise education,” **OO (female, Maths teacher, Black British).**

This inequality, which often leads to a lack of opportunities for students from low-SES backgrounds, can be understood through Bourdieu's theory of reproduction. This often widens achievement gaps among those who have received additional support from their parents' economic means or academic status. Although these forms of capital can be transferred, certain habitus are products of social conditioning: some individuals become entrenched in their ways and withdraw, physically and mentally, from the notion of success, and thus do not try. This outcome can be explained using Bourdieu's concept of reproduction, and also a similar finding by Jeynes (2010), who, in his work, explains that the involvement of both parents in a child's education is more beneficial in outcomes than that of a single parent. This is because it is more difficult for one parent to provide the children with the support and interactions required to achieve their potential. This is also consistent with Hara (1998), who asserts that increased parental involvement is key to improving children's academic outcomes across all ages. One can therefore argue that most of the qualities that make a parent sufficiently supportive to influence outcomes are associated with high SES. Highly educated parents often hold their children to

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higher academic standards, serving as role models of what is possible. They also offer to help with academic tasks and related activities. They are also more likely to provide resources and expose their children to obtaining some form of science capital (extra tuition and resources, computers, etc.) which is an added advantage from their economic leverage. 40% of the participants had a parent or guardian who helped them with homework, the results are not remarkable in this research, but these particular students all achieved their target science grades, which shows some level of connected outcome (Paschal *et al.* 1984). Paschal asserted that students given homework regularly and engaging with it generally improve achievement. This was also echoed by Trautwein *et al.* (2009) and Epstein (1986), who both affirm that parental supervision of homework is a key promoter of students' school-related outcomes, such as achievement and well-being. It is clear from the data that most WCWBS lack the luxury of parental support with science homework if they have not been educated themselves, and even those who have been educated might feel inadequate to support them fully. This can be seen as a disadvantage facing these students' science outcomes as highlighted often by Bourdieu (1987). However, a few students leveraged family support from older siblings, and this was reflected in their overall GCSE science outcomes. SR, MK, DZ, SH, ZS, LA, and DB all had some form of support from a parent or an older sibling. They were grouped as having high science capital, and all achieved their predicted target grades in science (see Appendix R).

### **5.3 Parental involvement**

The prior section elaborated on the influence parental support had on homework supervision and related science outcomes. Drawing on literature in the areas of parents' involvement in education, many authors agree that it is an essential determinant of children's immediate outcomes and future success (Hays, 1996; Lareau and Weninger, 2003).

It is worth noting that none of the students interviewed attributed their parents or a lack of parental supervision as a barrier to their attainment in science. However, some teachers interviewed cited parents as a missing critical factor in the success of working-class students in attaining proficiency in science.

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“Their parents are passive about schooling, which is a problem. They do not attend academic review meetings, parents' evenings, etc., so why should the children bother or do anything different?”  
**EB (female, Science teacher)**

“Also, another teacher commented. No engagement from home with school. Parental involvement is a key issue in raising attainment in schools,” **MT (male, Science teacher)**

This discourse by teachers strongly advocates parental support for schoolwork. However, it ultimately comes down to the same issues. Parents are unable to help because they do not know how or do not want to. Most students reported that their parents were not very good at science and, therefore, were not very helpful in supporting them. On the other hand, parents who were themselves proficient in science in school could help and support their children with schoolwork. This made them either confident to engage with school or not. These barriers that parents faced were thus replicated in their children, as Bourdieu would explain. Gordon *et al.* (2009) found that parents involved in their children's education were more positively favoured by their teachers, and their expectations of academic success. Similarly, a report from NSTA (2010) claims that when parents participate in their children's learning, this often leads to improved classroom participation and positive educational outcomes. Similarly, Henderson *et al.* (2002) argue that when parents play an active role, children achieve greater success regardless of socio-economic circumstances or racial backgrounds. The present research findings support the argument that parental commitment and engagement with their children's school activities, such as parents' evenings, meetings, and other social events, are strongly influenced by families' socio-economic status and social capital, or their lack thereof. Shanae (2010) further explains that parents tend to avoid contact with the school when they believe they cannot help their child succeed. (See figure 5.1 below) Figure 5 shows that parental involvement decreased in schools with lower levels of parental education. This may explain the low engagement of most working-class students and their limited participation in school activities, particularly volunteering and chaperoning, which are more closely tied to direct supervision of students. However, a child's ethnicity has also been suggested to be associated with different kinds of parental involvement in their STEM

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achievement, which has not been factored in this research. This is often due to the high value these cultures or persons from certain communities place on STEM-related futures for their children (Yan & Lin, 2005).

### **5.3.1 Parental Engagement with School**

Parental engagement with school here refers to parents' participation in supporting their child's learning. This can be done at home, at school, or through wider community involvement (Harris & Goodall, 2007). Students who were interviewed and asked why their parents did or did not attend school functions attributed non-attendance to their inability to take time away from work or to care for younger children, and, as such, to their being less able to afford to take time off work than some middle-class parents. This can indirectly reflect on how these parents are perceived by schools in not supporting their children's learning, especially in science, which is often regarded as an elitist subject. This claim is supported by the PISA (2015) parents survey data, which suggests that inflexible work schedules of working-class parents' jobs and childcare problems are attributed to working-class parents having 'low participation in school activities.

When participants were asked if any family member attends school functions and meetings, about 60% responded negatively, whilst 30% responded positively, mostly being their mothers and reasons varied but mostly around availability to attend, whilst 10% said their older siblings will attend in place of their parents because of work commitments or other family factors (like younger children or sickness). It is therefore fair to say that most working-class parents have valid reasons to miss most school activities, which are usually around working hours, and these families may not have the luxury of taking time off work, as most skilled jobs are paid by the hour, which is important in providing security for the family. It therefore also sheds light on how schools can better meet working-class parents halfway, enabling them to engage without sacrificing their role in their children's academic development. See Figure 5.1 below.

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## The value of school reports, parents' evenings and homework

How useful, if at all, do you think the following are?

Child's school reports



**90%**

useful

Parents' evenings



**87%**

useful

The homework my child receives



**70%**

useful

Sample: 5,490 parents in England (3,012), Scotland (1,313), Wales (862) and Northern Ireland (305) who have at least one child aged 4-18 in school  
Base: All UK respondents, weighted

Figure 5.1 Parental involvement in schools, UK

Crozier *et al.* (2005) concluded in their study that middle- and upper-class families are more engaged with school because their educational background gives them more confidence to deal with school authorities who have similar worldviews to them, unlike WC families, who are less assertive but rather have a conflictual approach towards school authorities. This view was not reflected in the interview data with the students or teachers. It is, however, generally believed by scholars that parents with higher levels of education are more willing to engage in school activities and programs, and that their children subsequently have better academic performance and behaviour (Haurin *et al.*, 2002). This claim is supported by interview data from some teachers indicating that parents' involvement can positively influence students' academic outcomes and attitudes toward learning.

“Supportive families who support school activities are key to the progress of White British students. They often would do better and have a more settled outlook” **SC (male, Science teacher)**

Another teacher says.

“Parents need to be involved in school and be role models themselves. These kids need more support from home” **MKT (male, History teacher)**

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MKT, in his opinion, went on to explain that parents who cared about their children's performances would usually turn up regularly for scheduled activities in school. He maintained that White British parents are lagging in that aspect and are unlikely to attend rewarding events for their children. He further suggested that the school should continue to fill the void and encourage students from such families to succeed. Most students surveyed also reported their mothers attended school functions more frequently than their fathers. This gendered nature of parental involvement in school activities was also noted by Caputo (2007) and Lareau, (2002) who suggested that amongst working-class and middle-class families, mothers are the ones who would usually respond to school complaints, activities, meetings, and provide emotional and educational support to the children because they were often the ones available at home whilst their husbands were working. This emphasises the roles educated mothers play in the educational success of their children. This low engagement with school is observed among WCWB parents, highlighting what Bourdieu views as "a gap between the classes," since school is often seen to inhabit a middle-class habitus that differs from the working-class habitus. Therefore, this difference helps explain why engaging with school may seem difficult and not a high priority for working-class families.

Another school of thought suggests that not all parental involvement, such as class volunteerism, parents' teacher conferences, etc., seems to influence children's learning. Some researchers have determined that parental involvement can lead to positive social benefits but does not always translate into attainment (Schmid *et al.* , 2021; Teuber *et al.* , 2022). On the contrary, I believe that parental involvement in activities such as providing necessary resources, facilitating discussions, and offering support for out-of-school learning positively affects attainment. This is because parents' presence in schools can stimulate children's interest and send a positive message that education is important to them and valued. This also increases students' self-esteem and motivation (Epstein, 2009; OECD, 2017; Pate & Henderson, 2001).

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### 5.3.2 Type of Parental Housing

Researchers often overlook the impact of where a child lives, the type of family housing, and their influence on students' academic performance. School-aged children, on average, spend more time at home than at school, according to Haurin *et al.* (2002). Also, studies by (Cauley *et al.*, 2007; Schimmack, 2010) both suggest that the type of housing can have a positive effect on the academic engagement of students, especially at lower school. It demonstrates that it is important for children to feel safe and have a designated study area. The findings in this research reiterate the claim that most students with good housing indices performed markedly better than those with poor housing indices or poorer housing. It was noted that there was a positive relationship between GCSE grades, gender, and housing categories. This implies that as the intersection of gender and housing categories improves, students' performance increases noticeably (See Table 4.3). Similarly, interview data from teachers reflect how the home environment affects students' coping with academic workload.

“These students are affected by what is going on around them, the family environment is very important” **DO (female, science teacher)**

DO emphasised that the type of homes the children come from affects their attitude to studies and overall well-being. She further implied that the stability of students' housing environments seems to be important in moulding students' behaviour and ability to study independently, as we are products of our environment. Another teacher was of a similar view, insisting that there is a negative effect of the poor housing environment on the students' academic outputs.

“I think one of the things that is a barrier is the family environment”  
**MKT (male, History teacher)**

MKT believes that parents who provide a conducive, enabling environment for home learning encourage their children to study. He further explains that over the years, he has heard of students who said they could not do their homework because their home environment was not conducive enough, or they had to help with chores instead, and as such, could not complete homework. He also

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explained that the issues included noise from younger siblings, having to address other family members, and the absence of a private study area. The data shows that 50% of the student participants lived in low-income terraced houses or blocks of flats in struggling estates. This may pose a problem for these students if the number of siblings per household appears crowded. WHO (1989) suggests that poor housing provisions can cause stress, depression, and poor academic outcomes for students and termed it an environmental stressor that plays a major role in the psychological well-being of students.

However, the results of the research showed a range of siblings from 2 to 7 per family, which may help explain some of the participants' claims. Table 4.4 presents a noteworthy correlation between students' IDACI (deprivation factor) scores and their GCSE grades. IDACI scores are defined as the proportion of children under 15 living in income-deprived families (Ministry of Housing, Communities and Local Government, 2022). Ranges from 0 to 1, where 0 is the most deprived and 1 is the least deprived.

The results indicate that the level of deprivation, as reflected in participants' IDACI scores, has a discernible impact on students' academic achievement in science. It shows that lower IDACI scores are associated with poorer GCSE outcomes. Additionally, according to DFE (2006) data, a higher percentage of students with higher IDACI scores achieved 5 A\*-C at GCSE than their more deprived peers. This shows that deprivation harms attainment for these student participants.

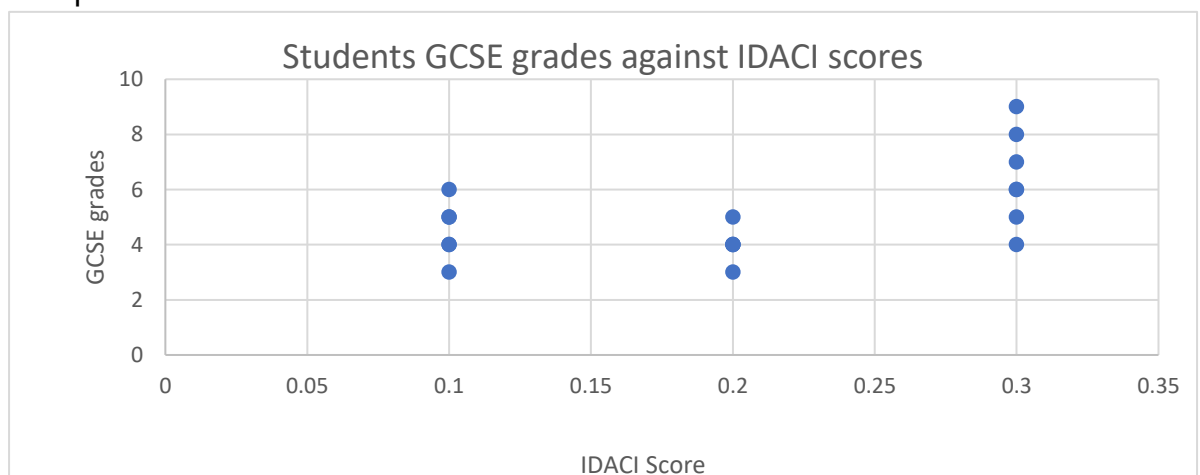


Figure 5.2 Students grades against IDACI scores

The highest GCSE grade obtained, as shown in Figure 5.2, is a grade 9, which reflects the IDACI score of 0.3 against the lowest GCSE grades at Grade 5, with an IDACI score of 0.2. This shows the higher the IDACI scores, the higher the grades.

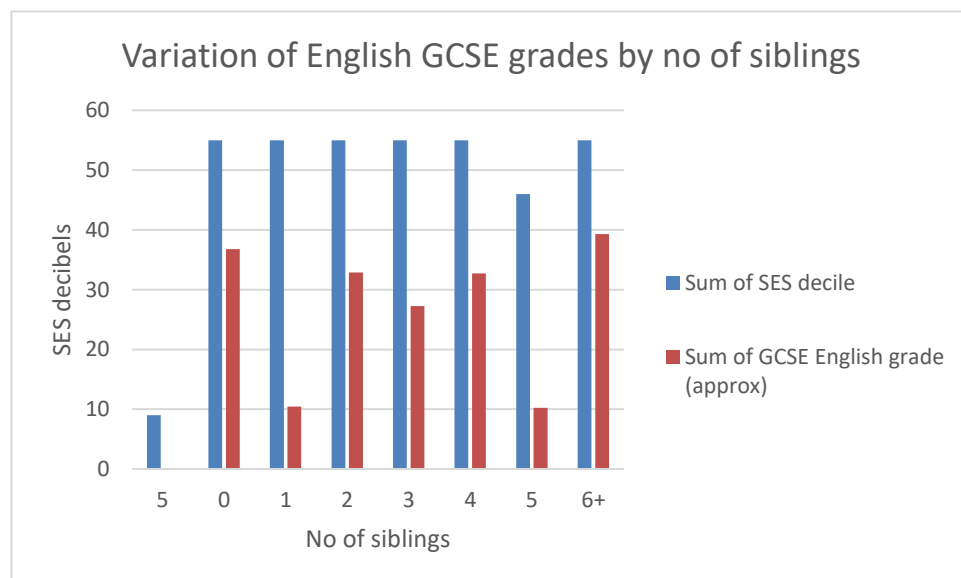


Figure 5.3 Variation of English GCSE grades by no of siblings

<https://www.cambridge.org/core/journals/evolutionary-human-sciences/article/when-does-family-size-matter-sibship-size-socio-economic-status-and-education-in-england>

Figure 5.3 above is consistent with the findings of this study, which show that the level of deprivation, as reflected in housing type and overcrowding due to multiple occupants, is associated with students' academic performance.

Students with low IDACI scores, such as BG, FW, and LC, had lower GCSE grades than LA, ZS, and SR, who had higher IDACI scores, indicating safer upscaling of housing (See Appendix K). Rudolf (2003), in his study, found a similar trend among children living in poor neighbourhoods, who showed marked improvements in academic achievement after moving to a higher socio-economic neighbourhood. This is because poorer neighbourhoods face a range of challenges that can impact their education. This may include poor

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extracurricular facilities, which hinder intellectual and social development, stress, trauma, increased crime rates, and exposure to harm. On the other hand, a supportive, stimulating learning environment encourages positive educational outcomes for students. Additionally, having positive peer groups that support learning, character development, and capacity building helps improve attitudes toward school (Kosterman *et al.*, 2000) Similarly, Alio (1995) and NOS (2019), in their works observed that family background has a positive implication for education as shown in Figure 5.2 above. The size of the family often determines to a large extent the relative amount of physical attention and time each child in a household is given by parents or caregivers. Children from large family backgrounds may suffer poverty and lack parental encouragement and structures as other salient issues may become a distraction. On the other hand, parents in smaller families can give the children the required attention and support that may improve outcomes. Family size has also been linked to academic achievement (Majoribank, 1996) Majoribank work stressed that students with fewer siblings are likely to receive more parental attention with schoolwork, homework, and resources.

### **5.3.3 Parents educational background**

Data from the research show that participants whose parents were graduates performed notably better than those with one parent who was a graduate or none (see Table 4.4). SR and LA both had parents who were graduates. They all achieved their target grades whilst others did not. This is either an anomaly or there is an advantage of having both parents as graduates. According to SR, his father always helped him with homework in science and LA also says both her parents helped when they could with any difficult schoolwork. This can be viewed as high cultural capital that has been accumulated and passed down to these students (Bourdieu, 1989). However, a student's background can also have a correlational effect on their attitude toward school, academic progress, and resilience (Murovile, 2000). This correlative effect can be further separated into groups based on several determinants. The main variables include parental earnings, educational level, and marital status. When the aforementioned factors are separated, it presents a clearer picture of how much effect these

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parameters have on influencing science achievement. Gonback (2005) asserts that most intellectual and personal skills are developed at home, so family background gives some people an added advantage over others. Although most scholars define a class in terms of occupation, educational status is more relevant here, as it will determine whether this variable notably influences the GCSE science outcomes of their children. This was observed mostly with SR, whose father worked in a school. He attributed his focus on his parents and the centrality of his doing well in school to his upbringing.

“My parents kept reminding me that my GCSEs are essential” **SR**  
**(male set 1, phase 1)**

Since our primary outcome of interest is GCSE science attainment, it is reasonable to define it as the key factor in this study. Similarly, Andres (2009) has used parents' educational status to indicate cultural capital. Thus, parents who are not science literate may struggle to support their children with homework. Bourdieu's (1997) standpoint is that families of different social classes will exhibit different cultural capital, ultimately determining their children's academic achievement. He also sees parental educational level as a variable that correlates with the student's social position and familiarity with the school system, which he believes is middle-class. Drawing on my analysis of the interview data with teachers, the research findings overall support the claim that family educational background influence on students' science achievement. All teachers interviewed identified this factor as a determinant of the level of students' science attainment.

Some teachers' responses when asked about the value of parental support for students suggested.

“I think parental education levels, self-motivation, and acting as role models are key to WCWBS success” **JZ (female, English teacher)**

JZ said students whose parents are educated often receive academic support to improve their performance. She further explained that parents would prioritise and make sacrifices to provide their children with the basic tools needed to support their schoolwork. She also noted that having role models around promotes self-belief and motivates students to do better. This will be

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discussed in detail in chapter eight. She believes that if more WCWB families had role models such as older siblings or a close relative who serves as an educational role model, it would encourage children to take their schoolwork more seriously. She went on to contrast WCWB with other ethnic minority or migrant families, most of which had at least one role model whom the children looked up to, a pattern that appears to underpin their higher aspirations and subsequent attainment.

Another teacher supported this by saying.

“Students from educated families seem to act differently towards their work. They seem more interested and concerned about the quality of their work. Presently, most of them do not seem to care and calling home often does not yield a lot of return” **AG (female, teacher)**

AG also noted that students whose parents are educated appeared to value the messages and notes teachers send home regarding their academic progress. This is because students realise that their parents will more closely monitor and scrutinise their progress. On the other hand, some WCWBS whose parents have low levels of education do not appear to engage with or encourage their children to take their schoolwork seriously. This notion is supported by Riberto (2018), who found that parental education was positively associated with children’s attitudes, aspirations, and academic achievement. The study also reveals that this change in attitudes and behaviour is formed primarily because educated parents once successful students themselves understand the prerequisite requirements needed for successful outcomes and as such can pass on this social capital to their children.

However, OO another teacher feels that the influence from these parents can go either way depending on the parents’ value for the educational outcomes of their children. She explains that some parents who want their children to perform well or better than themselves will support anything that will get their children across the hurdles and barriers that they may face, acknowledging all the setbacks from where they come from, while others simply don’t see the need to ‘stress’ their children to get good grades because they did not do well, and they seem okay.

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“Maybe it is something they inherited from their parents that keeps them either working hard or giving up, who knows, it can go both ways” **OO (teacher)**

However, the data shows the academic performances of students from families with only one parent as a graduate, as shown in Table 4.3, indicates no difference compared with others from families whose parents are not graduates, but of particular interest is the data that reveals that there were differences in GCSE outcomes amongst students whom both parents were graduates. This was noticed with some of the participants like DZ, MK, SR and LA who all had similar housing types from owner occupied to educational families in terraces (See table 4.3). It was noted they all achieved or exceeded their GCSE target grades. Bourdieu’s standpoint accounts for the educational advantage passed on to participants who have both parents as graduates (as supported by the data in Table 4.3). He attributes this to the accruing of social capital which he says is important in acquiring an education (Bourdieu, 1979). This research has noted that participants with both parents as graduates will possibly have combined economic and social capital to explore opportunities and resources to support the high attainment of their wards since capital can be built up and transferred from one form to another (Bourdieu in Harker, 2000: pg.843). In this case, it is the transformation of economic and social capital into scientific capital, as reflected in students’ GCSE science outcomes.

### **1.1 Family worldview**

A family’s worldview is the fundamental orientation, set of beliefs, and mental mode of reality that influences the way people perceive, think, know, and act in the world. It is often influenced primarily by a person’s educational level and exposure to external influences (Runco, 2014). It was difficult to provide a single view of the WCWB community’s education for this group. However, it can be influenced by several factors and nuanced opinions.

The issue of the family’s view or perception was mentioned in interview transcripts from a few teachers. Some examples were.

“They don’t want to be different from their families” **FL (female, Language teacher, White European)**

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FL claims that most WCWB families operate small-scale, family-run businesses and trades and are comfortable inheriting or serving in the business in the future. She further explains that some students tell her they intend to continue the family business upon completing secondary education and have no ambition to pursue anything else. She sees this as a major barrier and a reason for their lack of interest in academic attainment.

“Some say I’m not interested in science because I don’t see how we will use it in the future” **DO (female, teacher)**

DO further stated that some students cannot envision science in their futures, families, or communities. This is not to encourage students who are already struggling with the subject. DO further argues that working-class individuals may view vocational education as a more feasible option than the traditional academic routes most schools currently offer. A similar claim was also recorded by another teacher who, when asked what he thought was a barrier to WCWB students’ interest in engaging with science, said:

“I would put it down to the family; some do not encourage their children. One parent once told me my son will not do well because neither his dad nor I did well in school” **NS (male, Science teacher, Asian)**

All teachers cited family background as a factor influencing students’ engagement with science and school. They emphasised that students whose parents were positive about school and shared the school’s core values and standards regarding their children’s potential often worked harder and persevered more. A teacher attributed the lacklustre behaviour of some WCWB students towards their studies to poor work ethic and accountability. Another teacher supported that argument by comparing the passive nature of parents’ responses to complaints about their children’s homework and academic reports with the children’s engagement with schoolwork. She said this reflects how children respond to schoolwork.

“They’re not performing well as the other students are purely down to poor work ethics” **OO (female, Maths teacher, Black British)**

*Another teacher supported this view.*

“Their parents are passive, why should they do it?” **EB (female, Science teacher, White European)**

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A 2013 survey by the ASPIRES project found that working-class adults were more likely than their wealthier peers to see the value of vocational and skills-based educational pathways for their children. 63% of them believed vocational pathways were a more effective way to prepare their children for a future career than an academic pathway. Scrutinising the interview data suggests a relationship between students' GCSE science performance and their parents' marital status. The data shows students with both parents performed better than those with single parents (See Table 4.4) Berger *et al.* (2012) and Kaili (2018) work support the trend that when both parents are present, they often have shared responsibility and support each other in the supervision of children's schoolwork a lot better than in a single-parent household. This may cause students to have a more supportive home environment and a higher combined resource, which aids students in their academic performance. Bourdieu (1997) argues that family structure is a pivotal asset in the transmission of cultural capital. In particular, Bourdieu's theory is similar to Berger *et al.*, (2012) that two-parent families have access to more cultural and economic capital than single-family households. Berger similarly in his work claims that this gives students a wider range of cultural capital and opportunities which can help them develop skills and knowledge needed to succeed in education. Bourdieu further claims that this habitus is subtly passed on from parent to child and, as such, children will share a similar worldview to their parents. Working-class students, in his view, however, lack this familiarity with the dominant culture and, as such, are not positioned suitably within the field. He sums this up as access to different forms of capital through social positioning is a determinant of advantage (Bourdieu, 1996) However, Pinxten (2015) suggests that parental influence in transmitting their worldview is gradually losing its grip due to integration and the rise of peer influence among young people. This is where positive role models would be important and is explored in the upcoming section.

#### **5.3.4 Family Role Models**

Role models and encouragement from family have been noted to greatly increase students' science capital, perseverance, and final GCSE science

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performance (Igiri *et al* , 2015) My interview data suggests that both teachers and student participants agree that role models within the family supported science engagement. Most of the participants mentioned a family member to be their source of encouragement in pursuing their study of science. They claimed that these family role models gave them the additional belief that they were capable of achieving success in science if they persevered. Examples of such are:

“My role model is my second-oldest sister; she does Radiography and Oncology. I look up to her when I have problems”, **ZS (female, set 1, phase 1)**.

“My Aunt is a nurse, and my cousin is a dentist. They want me to be a dentist, so they help me whenever I need their support” **DB (female, set 1, phase 1)**.

“My cousin is a science technician in a local school. He says science is easy if you put your mind to it” **KM (male, set 2, phase 1)**.

Having role models near home appears to have positively influenced the student participants' values regarding education and hard work. Siblings as role models have also played a role in academic influence as in the case of ZS who values the perspectives and support from her sisters. However, one of the teachers interviewed cautioned that role models need to be similar in race, culture, and ethnicity to be effective.

“There is a need to highlight WCWB figures with which they can identify. They need role models, mainly from family. Sadly, most lack these role models.” **JZ (female, English teacher, White American)**

The works of Carrington *et al* ., (2003), however, counter this view about role models and advocate for more nuanced approaches to address broader systemic inequalities for disadvantaged groups.

It is evident from the interviews that most of the role models appear to be race-, class-, and gender-matched to the participants. This is a positive sign, as a study of young adolescents found that students who reported having a role model who was race- and gender-matched performed better than those with

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role models from opposite genders or different races (Habermas & Bluck, 2000). They further revealed that the availability of race- and gender-matched role models increase uptake in certain areas of academia (including science) as young people become increasingly aware of how they fit within the broader social context. Such role models can provide invaluable information to address misconceptions and concerns, without making students feel like outsiders. This sense of belonging is a key factor in enhancing students' confidence and sense of identity in science (Fordham, 1998; Ogbu, 1991). These authors further argued that these role models positively influence young people's self-concept and their ability to achieve set goals.

Among the student participants, those with role models were all gender-matched, which may suggest, from a theoretical perspective, that these were suitable to them and helped raise their confidence. However, this was not a considered factor influencing scientific outcomes; it can be added as a privilege that enhanced these students' science capital (See Appendix R) Similarly, Bourdieu's theory offers insight into why various social relationships (in this case, role models) are important resources that can foster the development of human capital when nurtured over time, particularly for underprivileged individuals (Bourdieu, 1979). He argues that family endowments are necessary for educational success and are transmitted intergenerationally as capital. This becomes more experiential as students learn, through observation and proximity, to embody values from their family members and to explore them. Bucher (1997) similarly asserts that models are one of the most important pedagogical agents in the history of education, as young people imitate the values and behaviour of adults close to them or whom they admire. This was evident among participants with siblings, parents, or other family members in science-related careers, who had acquired higher science capital than those without such connections and, as such, showed greater perseverance with science and its challenges than others. Crenshaw's view is also useful for explaining the impact that these role models have on the science experiences of the different participants. Her theory asserts that the combination of race, ethnicity, and class can subject individuals to behavioural attitudes that are often subtly self-imposed and suppressive (Crenshaw, 1995). Different races

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and classes perceive themselves differently across societies and, as such, place priority on different things (Gilborn, 2016). This intersectionality of race, ethnicity, and social class is exemplified when Asian and African parents in the aforementioned category demonstrate high expectations and provide support for science careers through their social networks to their children as they see these as tools to gain access to status, stability, and income. On the other hand, WCWB students have barriers to finding suitable role models with the right combination of gender and class as an added layer of disadvantage. Through Crenshaw's view, those different layers of advantage or disadvantage affect the way groups perceive themselves and act. This is not the stance of most WCWB parents, who might not see science and educational attainment as the only route to their children's success but rather prioritise skills, the ability to earn a living, and hard work over academics (Platt, 2007).

### **5.3.5 Girls, science, and cultural norms**

“My parents believe science is important for everyone, not just boys. However, they would not want me to study something like engineering because they feel it is an area for men”, **LA (female set 1, phase 1)**.

LA's parents believe certain science courses are too masculine for her to pursue. This can remarkably influence how seriously LA feels science is for her and, therefore, how much she invests in it. Research by Bucks *et al.*, (2008) supports this influence in their survey of young adults who perceived science to be masculine because of the kind of information they receive from the media, family members, and other organizations. In this case, it was LA's father who felt that engineering was too masculine for his daughter and not girly enough, somehow convincing her it was not for girls.

There are cultural barriers in some communities around girls' participation in science or some areas of science. In some communities, typically, men participate in anything seen as hard work and women participate in domestic work (Adkins, 1999, 2000). These societal norms and values around gender roles aided the argument that science is for boys/men. Often, these gender roles can limit what a person can or cannot do, reducing a person's life and

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desire to conform to society's rules (Newman, 2021). Many societies that have these norms further help to reinforce the notion that science is a male domain (Miller *et al.*, 2015). These cultural norms may influence the notion of male superiority in mathematics and science, causing teachers to overrate boys' ability in the subject. Women and girls are still seen in traditional homely roles, and science is seen as a dangerous career choice that is more suited for men (Steel, 2010). In addition, media representations of the scientist as male do not help in dispelling this narrative (Brandel *et al.*, 2008).

Those traditionally institutionalized science-related subjects have also set the dominant cultural norms and narratives in those fields. These are primarily male, white, western, and wealthy, according to some researchers (CAISE, 2013). This information is mainly passed on through interactions with others, observing what those around us do and say to form those beliefs. These misconceptions and views are invariably passed to the next generation, and the cycle continues and builds up to become a norm. This passed-on perception of science exemplifies how Bourdieu (1997) believes social reproduction happens amongst families and communities to become a norm. These norms influence science, notably at home and in schools, are understood, applied, and conveyed to others and invariably passed on and reproduced. In consonance with Bourdieu's (1986) concept of capital and habitus, the dominant culture creates the narratives that control the thinking of the individuals within the field. This is seen within the narratives of the students who accept the perceptions of science from family members as fact without questioning, as Bourdieu suggests. This, therefore, seems to suggest that an individual's environment and dominant beliefs uphold their forms and shape their perceptions even when they are presented with new information.

Some of the participants in this study, when asked about their views on gender and science, posited that there was a gender bias against girls that pointed towards societal cultural norms.

“Most people expect that only boys should be good at science because that is what they know about scientists. Our books only show male scientists “, **NS (male, set 2, phase 1)** .

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JA added:

“From when we were little, we were told science was a boy’s business. However, I like science, though I would not want to be a doctor or anything like that “, **JA (female, set 2, phase 1)** .

These different views from NS, LA, and JA suggest that cultural norms do influence how different persons perceive science and who should get involved in science or not. Similarly, another respondent commented that people tend to be comfortable sticking to what they know. Like JA, who said she was told science was for boys, though she likes science, would not have a career in it. Some teachers, however, believe that these views of science masculinity have been given credence in schools mainly by the science curriculum, which highlights more masculine views of science than necessary.

“Science discoveries all highlight male figures, which seems to say it’s a man-thing”, **NS (male, Science teacher)**.

This view is supported by Kelly’s early works (1985) in her study of the construction of ‘the masculinity of science’, which are referred to as key pointers in forming science identities. They are those who study science, those who teach science, and those who are recognised as scientists. The implication that the curriculum does not support or encourage girls’ participation in the subject, nor challenge its misconceptions around science being gendered as masculine, leaves a grey area for open assumptions.

Bourdieu (1990) also claims that societal standards are not just a reflection of reality or the natural order but are created and maintained by dominating groups. These dominant groups use their cultural capital to define and uphold cultural standards while marginalizing or excluding others who do not follow them. As a consequence, I argue that this process strengthens social inequality and power structures that already exist, especially among men. It is therefore important to note the influence of persons around certain domains of power and associations. In schools, teachers, non-teaching staff, and peers play different roles in solidifying these norms and contributing to making up these cultural values that students uphold. Even when individual ideas remain the same, these institutions can alter how people perceive societal norms, which has been

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demonstrated to guide some of the thoughts and behaviours of working-class students (Tankard and Paluck, 2017).

#### **5.4 Summary**

The study shows that participants' family backgrounds influence students' educational outcomes, whether the influence is positive or negative. The combined data generated, however, show that some aspects of family life remarkably shape the educational outcomes of children positively. Key factors such as the educational levels of both parents, family worldview, availability of resources and parental involvement with schoolwork show differences in the GCSE science outcomes of the participants.

The more these factors were available, the stronger the commitment from the participants was, both in class when science was being taught and at home during the holidays and weekends through private tutors or a day out to visit some science-based center, e.g., museum, aquarium, zoo, etc. It showed higher science attainment amongst these students than amongst those who did not have these opportunities.

The academic performances of students from families with high IDACI scores (least deprived), having the highest level of GCSE science achievement, and, on the contrary, those from families with low IDACI scores (most deprived), having the lowest GCSE science outcome, show that housing type can increase a student's social capital, which can influence attainment. It was noticed that even though they were WCWBS, some of the participants, like DZ, MK, SR and LA, who all had similar housing types from owner-occupied to educational families in terraces (See table 4.3). It was noted they all achieved or exceeded their GCSE target grades. Also, the educational status of family members and in-house role models are privileges that some students have subtly gained from their families. Therefore, this indicates that the social capital transmitted through parents' educational attainment can positively influence students' academic performance. This social capital acquired from their families gives them some advantage over the others as posited by Bourdieu's theory of reproduction. DeWitt *et al.* (2011) similarly found that parents considerably

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influenced how students participated and engaged in science activities. Bourdieu's concept of educational inequality or advantage being reproduced in families of different socio-economic classes by enhancing social capital is evident in the findings of this study (Bourdieu, 1986). Precisely what constitutes valued cultural capital is a product of the values and decisions of the dominant group. Since the nature of cultural capital is subtle and concealed in nature and appearance, it is often difficult to measure or regulate its role in forming these social strata. This goes unnoticed in most circumstances. Overall, the results of this present study support Bourdieu's claim and demonstrate how family background and students' outcomes closely resemble their present family situations rather than their class of origin. Similarly, Family background plays a key role in which gender expressions are accepted or valued. Cultural, religious, and class norms all affect how people show femininity and masculinity, showing that gender depends on context, not biology. Family background shapes how people express their gender because parents and relatives are the first to show children what is considered right for boys and girls. They influence this through choices like toys, chores, clothes, and how they expect children to show their feelings. Children often follow these examples. Family income, education, culture, and background also play a role, leading to different ideas about gender in different families and communities. Families that are more open or different from the usual can help make more types of gender expression accepted and encourage people to question common rules. Family practices offer strong evidence for gender performativity theory. They show that gender is created, repeated, and maintained in daily life, not just something people are born with (Barton *et al.* , 2013; Johnson *et al.* , 2011).

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## Chapter 6: School-based factors

### 6.1 Introduction

Schools, much like families, as proposed in the previous chapter, play a crucial role in instilling distinct values, ethos, attitudes, and behaviours in students. These factors inevitably shape their attitude toward learning and determine how they interact with various stakeholders (Bennett *et al.*, 2013). To understand the obstacles WCWBS faces in science, it is essential to examine the various facets of school life that shape the dynamics of the working relationship. This chapter discusses various school-based factors identified through interviews with student participants and teachers. Most of the school's policies and practices discussed during the interviews included ability groupings, a comprehensive science curriculum, key stages, students' attendance rates, teachers' pedagogies, in-school activities, and various support programs.

This chapter will utilize Bourdieu's theory of social reproduction (1973, 1997) to analyse the data collected. Bourdieu, in his work, claims that schools and other educational institutions operate the culture of the upper or middle class, which they pass on to students within the school, including those from the working class. This makes working-class students feel awkward about school because it is assumed to embody characteristics of a different culture from that to which they are accustomed. However, students must have the ability to adapt to and fit into this culture to be successful. Students often rely on the type of cultural capital and habitus passed down from their families (as discussed in the previous chapter on family background), although some can acquire different forms of capital through regular exposure to opportunities from the dominant culture. These cultural values influence and motivate aspirations for the future (Machin, 2006). This study argues that numerous school-related factors have the potential to either exacerbate or mitigate the disparities in academic achievement between students from different socio-economic backgrounds. Familiarising oneself with these factors can facilitate the advancement and optimisation of each student's potential, regardless of social status. Consequently, those from less privileged backgrounds must overcome several obstacles that I will explicate in this chapter to excel in the science domain

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typically associated with the upper and middle classes. This chapter begins by addressing the topic of ability grouping, specifically regarding science sets, and the adverse impact it has on the science efficacy and outcomes of these students. Subsequently, the ensuing section scrutinises the distinct facets of the science curriculum and its disassociation from the authentic experiences of these students, influencing their choices, engagement, and actions about science. The following two sections explore the pedagogical approach adopted in secondary schools in England regarding science education. This includes a breakdown of the science subjects into biology, chemistry, and physics, and an organization of the phases of science into key stages. The variances in these subjects' appeal, engagement, and perception of difficulties will also be explored. Additionally, the importance of science at the various key stages will be examined to delineate plausible trends and patterns observed by WCWBS.

Gender equity is critical to advancing science education. This equity begins within schools where teachers, peers, and other factors enhance engagement and development (NSTA, 2021). This chapter will also highlight how gender biases can often be deeply embedded within school culture and can influence students in several ways (Smith, 2012). This is also predicated on a lot of school-based factors where students spend most of their time. School culture is often complex and has an unwritten framework for every educational interaction (Xiaojing Gu, 2021).

The concluding portion of this chapter shall delve into the manner by which the selective practices of schools and the pedagogies employed by teachers have an impact on the limitation or enhancement of students' achievement in the field of science. An exhaustive scrutiny of the science GCSE results of the participants, and the data gathered from interviews, with various school-based factors, shall bring to the fore which among these factors bear significance in the promotion of superior science outcomes.

## **6.2 Science ability groups in class**

This is the first school factor that emerged from the findings of the interviews with both the student participants and the teachers. In the research school,

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science is taught in set groups according to the students' academic ability and sometimes based on students' prior attainment. These abilities set groups are the triple science group (often called set 1), which is for selected high-ability students who will subsequently take three separate science subjects at GCSEs and the other ability group is the combined science group (set 2 or 3) for selected students who are considered average or low ability or have low science interest and as such are offered a double honours award across the three science subjects (Archer *et al.* , 2015). The setting of students in this ability group is mainly because science is one of the main core subjects that are compulsory for all students to offer as a GCSE subject at age 16. The setting of students often poses a dilemma to schools to figure out which students will benefit more from the uptake of the three science subjects, and which ones will achieve better with less science content and fewer examination subjects. Students placed in these high ability sets nicknamed triple science tend to benefit from being given more advanced science content, instructions, and accelerated pace in class and would often have more experienced teachers involved in their learning process. On the other hand, the lower ability set (combined science) is interestingly characterized by lower-paced teaching, reduced science content, and subsequently lower expectations and attainment (Ireson *et al.* 2005). Study participants were selected from both groups.

Participants were asked, "What affects your science experience the most?"

A few of the students alluded that being in a triple science class was challenging for them. Some of the students' responses included.

"There is too much work in triple science. I did not even choose it as one of my options. I was just told I had to do it", **FW (male, set 1, phase 2)**.

FW's comments clearly demonstrate that he had no choice in the science class he was placed in because the school had removed the subject as an option choice, and rather, teachers selected students into these classes based on their prior attainments or results in science the previous academic term. This, sadly, has become common practice in most schools as it improves ratings on league tables to have three science grades instead of two. FW further states that he

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had wished to be placed in the combined science class with less science coursework, as he had no intentions of pursuing science in the future and did not require the subject for his future career choice.

One teacher later explained how students were placed into these ability sets since it was not by their choice.

The teachers who worked with the students made recommendations backed by the in-class test and exam data for the recommended students. Also, teachers' assessments are taken into consideration during the subject setting.

“This ensures only ‘capable’ students are offered triple science as it affects the school's league table results”, **EB (Science teacher)**.

To improve their academic success, schools serving underprivileged areas prioritise securing good exam scores and, as a result, adopt performance-driven decisions such as using selective settings. (Lupton & Hempel-Jurgensen, 2012). This frequently worsens socio-economic inequality, which I do not agree with, as all students should be given the same opportunities regardless of class, socio-economic background, or ethnicity. This study shows that most students were not offered the choice but were selectively placed in sets. Archer *et al.* (2012) describe ability setting as a form of symbolic violence against working-class students, as it segregates them and makes them feel science is for special people. This symbolic violence describes subtle, covert actions by the upper class against persons of the lower class in their use of authority, often perpetuated with tactical consent, and leaves one powerless to challenge. In this case, the students involved had no say over which ability sets they would be placed in science, which adds to the insecurities students feel about their science efficacies. Bourdieu's (1990) concept of field further describes the school as a primary place of cultural production, interaction, and exchange of goods, services, knowledge, and status, which is controlled by middle-class players. These middle-class players are, by Bourdieu's explanation, the teachers and other school staff. His concept is helpful in understanding that if schools operate a middle-class culture that is embedded in the expectations of teachers and staff, the working-class students will find themselves as outsiders to this middle-class field of play, where there is a gap

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between these two cultures, their values, and expectations. That being said, KH and LC, two top-set students in the triple science set, also felt extremely overwhelmed and stressed by being in the triple science class. A few examples are.

“I get overwhelmed with all the revision classes, exams, and tests involved in the science triple set. I would be less stressed in a combined science class”, **KH (set 1, phase 2)**

“Triple science is hard. My sister warned me it is not fun”, **LC (set 1, phase 2)**

Family habits about triple science do not help LC, as she refers to her sister, who also had difficulty with triple science in school. Whilst LC and KH (both in triple set 1) struggled with the various difficulties they encountered in the triple science ability group, they, however, acknowledged that being in a competitive class made them pay more attention to science than they would normally have been, mainly because they did not want to appear ‘Dumb’ to their peers. This also may constitute the labelling of some students as clever and others as dumb, as suggested by KH.

“I will try my best to pass any science test, or you will stand out as dumb”, **KH (set 1, phase 2)**

“You will look stupid if you keep failing your science test; yes, there is pressure to do well”, **LC (set 1, phase 2)**

In contrast, FW, who is also in triple science set one, says he feels he would do well in science regardless of the set. However, he was not ready to face the challenges of belonging to a higher set.

“ I just did whatever I could under the circumstances, good or bad, and I could not force anything. I would do well anyhow, even in a lower set”, **FW (set 1, phase 2)**

When these students (FW, LC, and KH) were probed further about why they did not change their options to the combined science group, they responded that it was no longer an option. As such, it was based on their previous grades (prior attainment) that they were selected into the set. FW, amongst others, seemed to be unhappy about not being given the right to choose the science ability set or pathway to take. This can be considered a structural barrier as alluded to by

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Perry & Francis (2010). If this is considered a structural barrier, it acts as a further constraint for WCWBS to overcome, regardless of how they feel about it or how much effort they seem to make. Some other students in the triple science group admitted the same plight, but they had adjusted to the idea of being in that higher set, and they felt happy, though, at the same time, they felt pressured to live up to the expectations of the teachers and others. They also acknowledged that there was a lot to do and get through in the higher ability set regarding workload and content in the triple set compared to their combined set colleagues. These findings align with Fairbrother & Dillon (2008) and DCSF (2008), which affirm that the triple science route was introduced as an entitlement for higher-attaining students to enable them to study science in greater depth and breadth than the combined science route.

On the other hand, most of the other participants in the combined science group had different experiences from the triple science (set 1) group. Most students were accepting and happy about their placement in the combined science class. A few of them did not consider themselves triple science material and felt they would achieve better with less science workload and instructions. Only a few complained about the inability to have the chance at the triple science group. Some said.

“I was not even given a choice. I wanted to have that option as I like science a lot” **JN (male, set 2, focus group, phase 2)**

Though it seems reasonable to place the more able students into the triple science set, the process fails to consider students’ future career choices and requirements associated with the type of science students offer. I suggest that teachers and policymakers consider this error when selecting students.

“I would have loved to have been offered triple science because I would like to choose science as an A-level option, but combined science does not help me, and you have a lot of extra lessons and practical classes” **JA (set 2, focus group, phase 2)**

This was a common thread of desire from the three combined students interviewed. Also mentioned was the need to have as many practical sessions as the triple science students. Other than those few complaints, overall, most of these students seemed to be pleased and content with their science sets and

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experiences, similarly admitting that science was not an easy subject for them.

Some of these responses included:

“Science is a nice subject; I enjoy the practical a lot”, **PE (female, set 2, phase 2)**

“Combined science is not as hard as triple science. It is all right since I do not really need science, but I enjoy the practical”, **KM (male, set 2, phase 1)**

“I like science; it is an interesting subject.” The practical experiments are the best part”, **CM (female, set 2, phase 1)**

These findings suggest that the above combined science (set 2) students, PE, KM, and CM, have favourable science experiences, all linked to the practical classes involved. This corresponds with the survey data, which shows that 80% of the students enjoyed their chemistry experiments, and over 72% enjoyed science. Despite the above comments from PE, KM, and CM, the GCSE science final grade outcomes for these combined science students paint quite a different picture. These students (PE, KM and CM), even while enjoying science practical sessions, were not enough for them to achieve their predicted target grades in science.

Final GCSE results show that most of the students in the higher ability (triple science) group achieved their target grades (70%) in science, whilst only 38% of the students in the combined science group attained their predicted target grades. This, however, does not account for those students who were in the higher set, like JB, LC, and KA, who were not as successful. This outcome, therefore, suggests a weak link between ability group and attainment in science. Literature suggests that the attainment and progression data of students in the triple science classes tend to be better than those in the combined science classes DFE, 2012; Archer *et al.*, 2017. This is not unusual considering the selective intake pattern and students’ self-efficacy in these higher-ability groups. It is expected that the students will achieve the desired outcomes. On the other hand, the teachers can be said to be justified in placing the combined students in the lower set, considering only 38% met their target grades, even with less science content. This outcome is supported by Bourdieu’s assertion of symbolic violence against the working class, as these

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students do not seem to have been set up to be successful, but rather reproduce a disengagement from science, as was predicted.

The teachers were also asked about their experiences teaching WCWBS in the different science ability groups. Some of the responses often referred to the students' ability group as a principal factor.

“It depends on what class it is, really, triple set one or combined set two.” In the triple science classes, students are more engaged and ready to be challenged, whilst the combined students are a bit more laid back and unengaged most of the time.” **NS (teacher)**

Similarly, another science teacher said,

“The students who get offered triple science seem to be more purposeful in lessons and, as such, more pleasant to teach.” In the combined science set, most of the students are not interested in science, and so it requires a lot of extra planning to get their attention or involvement”, **SC (teacher)**

When asked to explain further, SC admitted the students responded better only when there was a practical session, whichever group it was, triple or combined science. He, however, said you cannot have a practical for every lesson taught. He further explained that the students regarded the practical sessions as fun and sometimes just messed around with whatever was given without relating it to the lesson objective. He said this attitude, displayed by students in the lower ability group, made them miss much vital learning.

“Science is not for everyone; it is just a compulsory subject, so students have no option but to do it. I guess that does not help because it is not helpful when students do not want to be there”, **EB (Science teacher)**, one teacher interviewed, commented.

She said she believed this inability of some of the students to engage in science was not surprising, as they show a lukewarm attitude towards the subject. Another science teacher (DO) argued that grouping students into ability sets made the teaching of these WCWBS easier because you knew exactly what to expect and, as such, prepared adequately. She also surprisingly revealed that some of the brightest WCWBS in the triple set classes were not doing well because they had low self-belief not only in science but across other core subjects. Apart from the above teacher, the majority of the other science

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teachers felt their experiences of teaching WCWBS were no different from teaching other disadvantaged groups across the school in those ability sets.

So why do these WCWBS, even though some of these students have high academic ability, having been selected into the higher ability classes (set1), still feel science is difficult and something out of their reach? Bourdieu (2015) aptly describes this attitude as “Working class pupils having an in-built barrier to learning”. This barrier often hinders some of these WBWC students from focusing on their abilities. It, therefore, refocuses their attention on the failures and struggles their immediate families faced around science, as expressed earlier by LC. This hindering mindset would need to change drastically if they are to meet the expectations of success in this middle-class field. It was also noted that students’ proposed choices of science routes after GCSE had also been influenced by their respective levels of cultural capital.

MK and DZ, who are both WCWBS, are examples of parents playing a major role in supporting and influencing their children's educational trajectories, as both students mentioned their parents’ influence, views of science, and investments (private tuition) that played a role in their being worthy of being selected for the triple science class because their science grades improved over time. Therefore, the placement of students in these streams of classes can indirectly reproduce inequality among students and create an uncanny mindset of unworthiness or cleverness amongst certain groups of students over others (DFE, 2012; Archer, 2017). Another area of concern that stemmed from the data seems to be the science *et al.* curriculum. The curriculum designers, when reviewing the science curriculum, intended for it to be accessible to all students to understand science irrespective of ability or class (DFES, 2015). The reality, however, for most students is different. The nature of the science curriculum and what alienates these students are unpicked in the next section.

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### 6.3 Science curriculum

The science curriculum of a society is supposed to reflect the knowledge and abilities that are seen to be the most valuable in that society and incorporate international trends and innovations (OECD, 2020). For a curriculum to be effective, it must be translated properly into classroom practices that produce desired outcomes. A considerable amount of literature highlights the science curriculum as overloaded, not relatable, or irrelevant to most students' lives (Fullan, 2015).

This wide nature of the science curriculum was noted as a recurring code among students and teacher participants. Science is one of the very few subjects that is made up of many distinct parts. These are Biology, Chemistry, and Physics. The volume of the materials studied and how demanding the content is for each of these subjects determines which certificate a student is awarded at the end of the GCSE course. A student enrolled in the triple science option has covered a larger volume of science content in each of the individual sciences than a student who studies for the combined science option. This was elaborated in detail in the introduction section of this thesis.

When students were asked, “What are the major barriers to your learning of science”?

An overwhelming majority referred to the science curriculum. This was similarly echoed by teachers who also felt that the curriculum was too wide for the students to cover in school within the teaching time allocated for it. As such, more of the breadth teaching was done (to cover the curriculum before exams) rather than depth. Some of the responses received included.

“Science is too broad, and most of the topics, especially in physics, I feel, are irrelevant”, **JB (set 1, phase 1, focus group)**

“The science curriculum is too broad. Triple Science has six exams. It is too much. It is like taking History, Sociology, and Geography all in one” **SH (set 1, phase 1)**

“The content they need to learn may be a problem for most of the students. Some cannot keep up with everything they must learn before the exams. A lot of pressure is placed on these students”, **EB (teacher)**

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Students and teachers complained about the vast nature of the science curriculum. Whilst JB felt most of what was taught in science was irrelevant to his life, SH was more concerned about the enormity of content to be covered, and rightly so, as acknowledged by various educational committees (DFE, 2017, 2020). Some participants also claimed that some content at various stages was unbalanced. There seemed to be a consensus amongst participants that there was more content to cover in the upper classes (Key Stage 4) than in the lower classes (Key Stage 3) in science, which put pressure on the subject in later years.

“We did not do a lot of science in years 7 & 8 (key stage 3), but now there is just so much to do, I cannot keep up” **LC (set 1, phase 1)**

“Maybe if we learned more in key stage three, we would not be this stressed out”, **JA (set 2, focus group, phase 1)**.

The teachers, on the other hand, stated that they were following the government-set curriculum and felt the 3-year key stage three curriculum was a waste. They would have preferred a 2-year key stage three to give more teaching time to the upper classes at key stage 4. When asked why they chose to continue with the curriculum when they knew it was not improving students' subject knowledge, they responded that OFSTED and most regulators recommended it.

“If we do something different from other schools, OFSTED will pull us down, so it is a losing battle here”, **SC (male, Science teacher)**

SC makes a point that they have no choice in the matter and that the government must make a shift in its policy and inspection measures to make the teaching of science more flexible and bespoke to different schools. This view was similarly voiced by different science groups and scientific researchers who have been calling for a review of the science curriculum in the UK for a while now, EISER (2014), ASE (2013), AAAS Project (2002), Wellcome Trust (2013), Banner *et al.* (2010). The recent Francis Curriculum Review (2024), however, proposes several key changes to the science curriculum, focused on improving access, relevance, and coherence. The most notable

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recommendation is the introduction of an entitlement for all students to study Triple Science (separate Biology, Chemistry, and Physics) at GCSE level, to address the current disparity in access for disadvantaged students, including our participants, and to promote progression into STEM fields. Additionally, the review calls for an increased focus on practical science experiences, explicitly into the curriculum, and reviewing the overall volume of content in GCSE science to reduce repetition and allow for a deeper understanding of key scientific concepts. This review represents a welcome change in science and aims to bridge the attainment gap among students across socio-economic classes.

Another complaint about the science curriculum voiced by 80% of the participants was about the curriculum content. A few students felt the contents of the curriculum for science were irrelevant to their lives and obsolete, as mentioned earlier by JB and SH. Others were overwhelmed by having to study three subjects (Biology, Chemistry, and Physics) in one, each of which was quite different from the other and sometimes left the students feeling disconnected. Teachers' views about the science curriculum similarly mirrored the concerns of the students. A few examples include.

“The curriculum content right now is exceedingly difficult for our students to connect with. It is hard to make it seem relevant, modern, and interesting”, **DO (teacher)**

“The mandatory text and specialist vocabulary required doesn't help in the study of this subject; it's quite daunting, and a lot hasn't changed from when I was in school, and the world has changed a bit”, **JZ (teacher)**

“The science curriculum really affects our students as it requires an elevated level of interest to connect with the subjects. Most students find a lot of the content boring or indeed over their heads”, **SC (teacher)**

The data obtained shows a definite call for a reduced curriculum that is flexible and relevant. If students are to enjoy the subject and perform well, I agree there should be a level of connection to everyday life and enough freedom for the teachers to teach in-depth in areas they feel are beneficial for the students they teach. Studies by Williams *et al.* (2013) support this view and similarly

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observed that the science content was perceived as less favourable than other subjects by most students they surveyed because they felt the content was not useful to them outside school. Bourdieu's view about social capital can be used to explain the disconnect between the science curriculum content and the WCWBS lives. Most of the behaviour, norms, and values associated with certain social strata will help one make meaning of certain things. This will influence choices, actions, and issues one considers relevant and important to them (Bourdieu, 1997). This is seen in the interactions between the WCWBS and the content of the present science curriculum, which is tailored to the middle to upper-class strata. Teachers acknowledge this difficulty when they say

“The science curriculum is disconnected from our WCWBS students.”

This highlights working-class students' disadvantage in learning science because of their low science capital and literacy. Kirsch *et al.* 2002 posit,

“School has an academic language which is the dominant barrier to comprehension of the science of most students.”

In a similar tone, Osborne & Collins, when critiquing the science curriculum for not being inclusive, berated,

“There seems to be a deliberate choice to offer a curriculum overladen with information” (Osborne & Collins, 2001, 450)

That being said, PISA (2000) also claims that students' engagement with academic material and their literacy level can influence academic success. A similar report by Speirs (2021) on “The Hidden Curriculum” suggests the present GCSE curriculum does not serve the interests of working-class students. He argues that working-class students cannot connect with the contents because the curriculum was written to suit those with school habitus, which are middle- and upper-class students. This does not serve as an equitable learning experience for all students. Another criticism of the present science curriculum is that it may not provide enough depth on certain topics (DFE, 2014) Similarly, the Scottish Department for Education (2018), in its review of the science curriculum, called for major changes to prepare students for the modern world, as it found the curriculum did not integrate a fair amount

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of modern everyday life into its content. This could be the disconnect the science curriculum has with its present-day students and requires a change in itself to bring everyone, despite their various backgrounds, to understanding and appreciating the modern world of science. Brown (2006) and Lemke (1990) both argued that there is a certain way of talking about science that is privileged over others. This might be in the language or symbolism that may be foreign to certain groups, thus eliminating or preventing them from accessing the knowledge given. Although none of the participants talked directly about the language of science, a few did mention that science has a lot of terminology. Bourdieu's theory offers a useful thinking tool in explaining this advantage. He addresses this as a form of cultural capital that understanding the language of science or science literacy offers. How distant and difficult the science curriculum is another feature raised in the interviews above. From the type of specialist vocabulary to the abstract content, it does seem to be a disadvantage to WCWBS. Bourdieu's view about schools operating a middle-class habitus that is not suitable or considerate of WCS supports this. Another salient point raised was the issue of the type of science taught at the different key stages of learning, which, for some of the participants, was not very balanced. The science at different key stages will be discussed in more detail in the next section.

### **6.3.1 Key stages**

In England, science is taught segmentally according to key stages. They are key stage 2 (primary school), key stage 3 (lower secondary), and key stage 4 (upper secondary) and key stage 5 (Advanced level or sixth form). This subcode of key stages was noted to be recurrent in the responses of student and teacher interviews alike. Most students claimed that science was more interesting in the lower school than in the upper secondary school. They further explained that there was more relevant and interesting content taught at the lower school. Also, they claimed they had access to more engaging science activities and practical work. Some students expressed disappointment with their science experiences at key stage 4 (upper secondary). Some of the issues mentioned included difficulty, abstract content, and a reduced frequency of

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practical experiments. Some examples of how students expressed their worries are as follows:

“Year 7 was the best; it was fun, the lessons were more relevant and enjoyable”, **SH (set 1, phase 1)**

“Yeah, all the experiments just went with the years. From year 10 we had fewer practical classes, and definitely enjoyed science in key stage 3”, **ZS (set 1, phase 1)**

“Key stage 3 was better. I understood a lot then, but now I am just a bit overwhelmed with the amount of work”, **KM (set 2, phase 1)**

Similar studies by Bennett *et al.* (2013) and Shirazi (2016) support the students' views. In their work, both authors suggested that more exciting science content at the lower key stages and teacher delivery remarkably contribute to the enjoyment of science by the students at that level. However, it was not conclusive whether this enjoyment translated into better attainment in the subject at that key stage.

Some teachers in their responses also claimed that they observed that students were more engaged in science lessons in the lower school, and they also enjoyed it. This difference was speculated to be attributed to the content of the science curriculum at the higher key stage, which had a bit more difficult abstract content compared to the lower key stages. Examples of responses from the interviewed teachers about science at the various key stages were.

“The topics are easier at key stage 3, so students can engage with them better. Also, the practical equipment for illustrations at this key stage is readily available, so you can do more interactive things in class” **DO (Science teacher)**

“There is more work in key stage 4, more content to cover in a short time, so it will be more challenging and less interesting for the students”, **EB (Science teacher)**

“I think key stage 3 is where they progress the most and performance is much better as the science at key stage 3 is still very basic and easy compared to what is obtainable at key stage 4”, **SC (Science teacher)**

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Undoubtedly, the information from both students and teachers would seem to suggest that the difficulty of science content increased with increasing key stages. The data seems to suggest that the lower the key stage, the more engaged students were with science, and the more progress was made. This finding is supported by the position of The National Curriculum Review (2012), which submits that the key stage at which science is taught is an influential factor that shapes the pattern of science participation of students in future stages.

The language used to teach science is drastically changed with more specialist terms as the key stages progress. As a result, students are not keeping up with the word bank and the difficulty of the content taught as it progresses through the various key stages. This view comes through, especially in the focus group interviews, where the majority of the participants felt the science taught at the upper key stage (KS4) was abstract and often irrelevant to them.

Cultural capital is important in acquiring a robust education in science. At the lower key stage, the language was still very simple. This might appear in the form of language, information, and resources. This lack of science capital may also be responsible for the perceived difficulty of science at the higher key stages, whilst the embedded practical activities at key stage 3 kept them engaged at that level.

It is unclear in this research if attainment was better at KS3 for the students, as it was beyond the scope of this work. Nevertheless, the data from DFE England (2020) shows that science attainment at KS4 was 82% compared to 68% at KS3. This suggests that students make more progress between KS3 and KS4. However, it is worth noting that students on FSM tend to achieve 10-20% lower than their peers. So, what else can be hindering the science progress of WCWBS at Key Stage 4? Another code worth looking at closely was the type of science subject students had to engage with. Interview data shows that students could relate to some subjects better than others. There may be some factual basis for this that will be explored in the next section.

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## 6.4 Science subjects

This section explains how science is separated into different subject areas and how this can potentially contribute to affecting the engagement and attainment of WCWBS at key stage four (GCSE) Science at the GCSE level is taught separately into three subjects: biology, chemistry, and physics. The key issues that emerged from this theme were based on the students' perceptions of the difficulty of these different science subjects. A large majority of the participants viewed the subject of biology as very relatable. A summary of the student survey data (Appendix B) shows that 92% of the participants say they enjoy biology compared to other science subjects. A similar view was echoed in interviews when most students spoke positively about biology. A few examples were.

“Biology is about everyday life. I like the subject, and I understand it better than the other subjects because I can connect with it”, **ZS (set 1, phase 2)**

“I guess Biology would be my best science subject because I can relate to it and it is easier than physics or chemistry”, **LE (set 2, focus group, phase 2)**

“Biology is just straightforward. It is also very everyday stuff”, **JA (set 2, focus group, phase 2)**

These were typical responses from both boys and girls interviewed. However, a few boys said biology was stressful because “it involved a lot of writing and reading and copying notes,” which they did not enjoy. Singh (2020) suggests that boys' separation from biology is a factor limiting their participation in the subject. Understanding this interplay between gender preferences can help us support and nurture their interests in fields such as biology, often perceived as feminine, and physics, often perceived as masculine. Most of the students, however, who found biology easy were those inclined to be interested in nature and in how living things operate, and they did not seem to view biology as feminine; rather, they viewed it as relatable. The boys' complaints about writing and copying notes can be read as performative acts that can distance them from activities that are culturally coded as feminine, thereby aligning themselves with a male stance (Reilly *et al* , 2018) The boys who reject biology

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demands can be seen as performing a masculinity that identifies literacy with girls. Gender performativity helps explain why biology has a more feminine posture. When students discuss biology, they talk about care, nature, nurture, bodies, and related terms, and they often reiterate a broader discourse that associates it with women, whilst difficulty and abstraction were associated with masculinity (Gentile, D. *et al.* , 2013; Nosek *et al.* , 2015)

When students were asked about subjects, they felt it was difficult. Physics was top of the list for most participants. The students said this was because of the abstract nature of the subject, irrespective of gender, whilst some mentioned the difficult calculations involved with physics. It was further gathered that physics was perceived to be strongly associated with maths, as most kept referring to their poor maths skills affecting their grades in physics. This is a commonly held view of why Physics is perceived as a particularly challenging science subject (Gray, 2008; Gire & Jones, 2009). Some participants' views on physics are included.

“Physics is full of maths calculations and formulas, and I am not great at Maths”, **FW (set 1, phase 2)**

“Physics has too much maths in it, it makes it tedious and boring. It really does my head in “, **TB (set 2, phase 2, focus group)**

There was a recurring mention of physics having unrelatable abstract content, which did not help them engage with the subject, as they could not understand some topics. These results are supported by the findings of Wellcome Trust (2009) and Sutton Trust (2010), who similarly surveyed a group of 16-year-old students who listed physics as one of their most difficult GCSE science subjects. They also attributed its difficulty to the complex equations and the lengthy, disjointed syllabus. Contrary to the above, some participants liked physics for the same reason others disliked it.

“Physics is easy.” You need to know the formulas”, **SR (set 1, Phase 2)**

“I like physics, just calculations. You do not have to read much stuff”, **MK (set 1, phase 2)**

“Physics is easy to pass, just know the formulas, and that is it”, **LA set 1, phase 2)**

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Mathematics plays a critical role in scientific calculations in physics. Physics shared a notable crossover with maths in different areas. Thus, the data shows that having a good grasp of maths enhances your physics engagement and attainment (Safritri *et al* , 2017). This perception was similarly noted in a study by Doug (2011), where students felt physics was difficult because of the algebraic content involved, while others felt intimidated by the level of critical thought required. The summary of the survey data, however, does not reflect the apathy for physics. Seventy-six per cent of participants reported enjoying physics as a subject. This, however, surprisingly, did not manifest in poor grades in their final science results, which shows otherwise. The final GCSE results obtained by the students showed that students had better GCSE grades in physics and chemistry than in biology, which does not provide evidence for the difficulties the students talked about earlier regarding physics. This was not reflective of the national context, which showed better results in biology and chemistry than physics (DFE, 2020) See Table 6.1, Final GCSE grades according to subject.

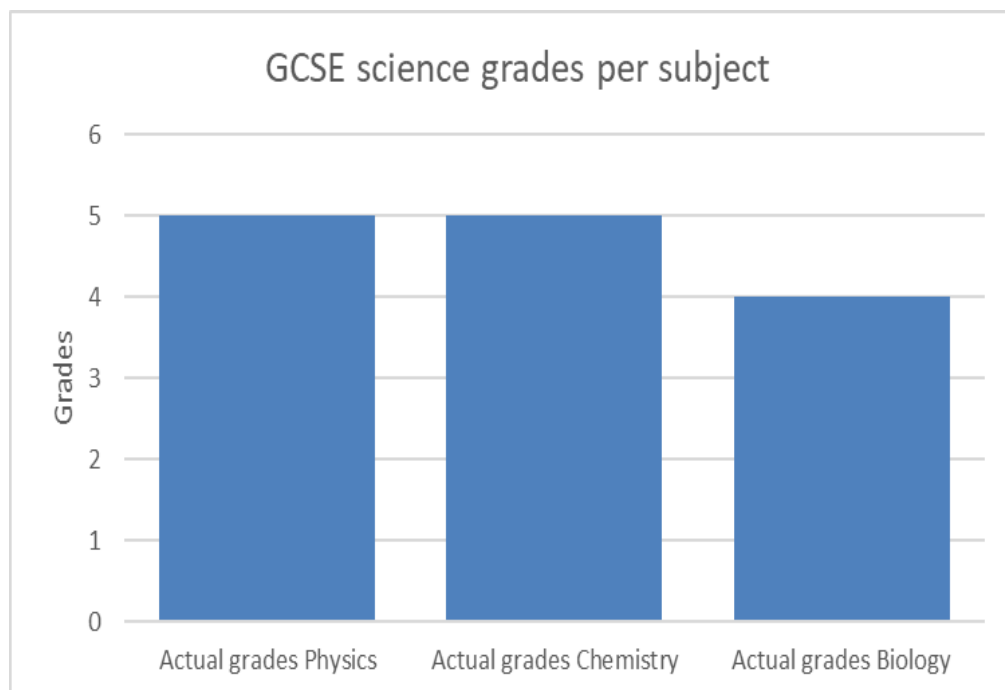


Figure 6.1 GCE grades per science subject

Bourdieu's perspective helps explain why the results did not align with the participants' perceptions or fears about the difficulty of physics. Bourdieu refers to the 'habitus' as a subjective system of expectations and predispositions

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acquired through several past experiences, in this case, the difficulty of the physics course, as evidenced by tests and exams in the past. The participants, therefore, to be successful, have unconsciously adapted their habitus, acknowledged its difficulty, and worked harder at the subject to compete in this particular field (Bourdieu, 1984).

Chemistry, on the other hand, was perceived to be a middle-ground science subject. All students agreed that chemistry was enjoyable and involved many practical experiments, which they enjoyed.

“Chemistry is fun and easy because it has a lot of practicalities, and it helps you understand the subject better”, **KH (set 1, phase 2)**

“Chemistry is 50/50: Sometimes, it is hard, and other times, it is okay. I am in between it”, **DZ (set 1, phase 2)**

“I prefer chemistry except for the bit of the balancing equation; it is all right. Definitely better than physics for sure”, **PE (set 2, focus group, phase 1)**

The data generated suggests that most participants engaged more with biology as a science subject than chemistry and physics. However, my findings call into question whether the appeal of biology as a preferred science subject could be because of its relatability to nature and everyday existence, or maybe because of its simplicity. The students’ mock results and GCSE results do not show or explain why the students’ results do not reflect this, as they show comparable results for chemistry and physics, as seen earlier in Table 6.1.

However, the survey data show that only 61% of the students, against 39%, agreed that biology was easy for them. It is possible to hypothesise that the participants may not have been very candid in their initial survey responses, even though it was anonymous. It could also be due to unpreparedness in view of taking biology for granted, thus not preparing well for it. (See Appendix B, students' survey data) Overall, research may explain the poor performance of biology compared to other acclaimed, difficult science subjects. A few scholars suggest biology requires large memorisation to be successful compared to other science subjects and can be deceitful at first glance to be tagged easily

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because it is relatable (Ormerod & Duckworth, 1975; Osborne & Collins, 2003).

An earlier science survey by Osborne & Collins (2000) in twenty schools in England found similar outcomes. More girls were keen on selecting biology than other science subjects because they were taught familiar concepts and participated in coursework. Similarly, other researchers claim that girls tend to perform better than boys in writing-intensive subjects, such as biology (Gurian & Ballew, 2003; Murphy, 1991). There may be a gender stereotype among the students regarding science subjects, as all the girls claimed that biology was the easiest during the interview sessions, whereas some boys disagreed. The opposite occurred in physics, where the majority of boys reported that physics was their easiest science subject, whilst the majority of girls reported that physics was the most difficult for them. Again, this shows a gender difference in preference. Physics and biology are the two most gendered science subjects, according to the OECD Report 2000 and Tiffany *et al.* (2004), who examined gender disparities in science. A longitudinal study of young people in England (2019) found a similar gender split in science subject preferences among students. Physics had 70% male and 30% female. Biology had the most pronounced gender distribution, with 60% female and 40% male. Chemistry was the most gender-balanced, with 51% male and 49% female.

Additionally, based on my years of experience, Physics has consistently been identified as the least engaging subject for students due to its mathematical content. It is therefore not surprising that the data reflect this prevailing trend. Although a few girls reported enjoying physics, this may largely reflect that they also reported being good at mathematics. It shows these few girls leveraged their maths skills to improve and navigate the difficult calculations in their physics. The results also resonate with the work of Osborne & Collins (2000), whose study found that students did not find physics meaningful. The exception was those who enjoyed mathematics and could relate to abstract concepts of relativity. Using Bourdieu's theory (1997) to scrutinize the collected data, it can be argued that the way some students perceive a science subject can encourage or discourage them from fully immersing themselves in the subject

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and relying on their capabilities. This suggests that there are many inequalities produced by the interaction of different habitus in the broad field of education, and only those who have the right habitus to fit in or have built up enough social capital can be successful in the field (Bourdieu, 1997). This might be the case with some students building upon their mathematics advantage and, as such, thriving in physics, whilst others who were not very competent could not do so. Bourdieu also argues that there is a narrow perception of what is possible for certain groups or social classes. Bourdieu posits that students' feelings or thoughts that they are not good at certain subjects may be self-inflicted and a perception of who they think they are rather than what they are capable of achieving (Bourdieu, 1993). The Aspires 2020 report similarly notes that WCWBS disengaged with science mainly because they have low science capital and do not express STEM-related future aspirations. Overall, the data reveal that students respond differently to the different science subjects and are mainly influenced by their interests, acquired skills, relatability, and future career interests.

#### **6.4.1 Gendered science subjects**

Science, technology, engineering, and mathematics (STEM) subjects have traditionally been perceived by students as masculine, whereas art (Languages, English, performing arts, etc.) courses have traditionally been perceived as feminine (Archer *et al.*, 2000). The various facets of science are not exempt from gender bias in different disciplines. In England, secondary science classes are often separated into physics, chemistry, and biology. According to studies, certain genders are more drawn to particular subjects than others (UCAS report 2018). A-level test participation, university course admissions, and overall subject interest are indicators of this (Archer *et al.*, 2000; Hoofman, 2002).

The participants were probed to explain why they felt there was a stereotype with science, and a few issues around pedagogy, curriculum, and subject profiles were mentioned. Some examples of these were.

“I think boys respond better to physics than girls do, while girls are better at chemistry or biology. I am not sure why, but that is a general pattern I have noticed.” **DO (female teacher)**

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Another respondent mentioned,

“Biology, however, is better for girls as it's more with living things than construction.” **FW (phase 2, male, set 1)**

This reinforced information has proven to shape the direction the students feel they can fit in with the various science disciplines. Farenga (1999) in their study of subject preferences of young people (9–16 year old students) found a strong effect of boys preferring physics over chemistry, biology, and technology. However, this interest declined gradually with the age of the participants involved (Hoffman *et al* , 2002). He reported that the older the participants, the less interested they were in the subject. He also claimed that this was a result of the physical nature of the subject, which seemed to discourage girls.

An analysis of participants' GCSE science results showed no difference in physics grades in achieving a pass. However, looking into more detail regarding achieving the upper grades, 40% of the boys attained higher grades in physics than the girls (see Figure 5). This also reflects the results obtained from the questionnaire data summary, which shows a 50% split between boys and girls when asked if they enjoyed physics as a subject, but this was not a very true picture. Other studies show that girls enrol more for biology courses than chemistry and physics combined (DFE, 2010; Calvert, 2003). The GCSE results of the participants also show girls performed better in biology, scoring an average of 50% pass rate, than boys with 40% pass rate. This result is also supported by the ROSE study (2005), which found that girls' interest was more focused on health, life sciences, medicine, wellbeing, and the mind, and outperformed boys in biology (Murphy & Whitelegg, 2006). The biggest difference between boys' and girls' science interest and achievements has been found with regard to the subjects of biology and physics (Kelly, 1978; Tamir, 1988; Mullis *et al* ., 2000; Spall *et al* ., 2003) Numerous studies have shown that biology interests girls more than boys (Osborne & Collins, 2001).

Summary of questionnaire data on favourite science subjects also showed 76% of girls responded that biology was their favourite subject against 54% of boys. Also, 85% of girls responded that biology was easy for them, whilst 70% of boys did (Appendix O) 80% of the girls, unsurprisingly, also achieved their

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projected grades in biology, compared to 40% of the boys. The participant's science results when taking gender into account are consistent with earlier studies (Mullis *et al.* , 2000; Whitelegg, 2006) (Appendix P). However, the research data shows girls performed better than boys in all three science subjects at GCSE - Biology 50%, Chemistry 70%, and Physics 70%, while boys had 40% in all three subjects. All the data collected and analysed show that girls attained more top grades in biology than in any other science subject. This was in line with previous researchers who argued that biology was carved out as a feminine niche amongst science subjects because of performance data of female students (Osborne & Collins; Mullis *et al.* , 2000). As regards chemistry, there has not been a gender bias seen in the subject, but physics has. The RSC report (2019) and the Institute of Physics (2020) flag unconscious bias as the main reason, and also a lack of female mentors in the field acting as role models to encourage participation. In secondary schools in the UK, a similar trend is being noticed. The Joint Council for Qualifications (JCQ), 2021 reports that there were 41% of A-level student entries amongst female students against 59% of male students.

It is also worth noting that there was not a high degree of complaint about the difficulty or abstract nature of chemistry by the participants, unlike physics. Typically, the physical sciences like earth science, mechanics and physics are said to be more drawn towards boys while the life sciences like human biology and chemistry are more appealing to the girls (Shemesh,1990). Physics has typically been stereotyped as a male monopolized subject although the research data shows otherwise with girls having 70% pass grades while boys have 40%. The researchers Howe (1989), Shemesh (1990), and Rose (2005) all propose that early development of reasoning skills in boys pushed them towards these physical sciences, which are more mathematically oriented subjects, though it is still an inconclusive topic. International studies by Syberg (2005) have also indicated that boys were more drawn towards the dramatic aspects of chemistry, physics, and technology, whilst girls were more favourably disposed to biology, which involved the body and medicine, as observed in the study.

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Nevertheless, among the participants, girls have outperformed boys in all the science subjects at GCSE level, which is supported by the observations of many other scholars (Hartley, 2013; Dweck, 2017; JQC, 2021). The findings suggest, and I argue, that gender does affect girls' preference for science subjects, but does not affect the attainment of girls in these subjects at GCSE. These may be linked to their future career preferences that might not include some science subjects (Godec, 2017).

## 6.5 School attendance

Apart from the appeal of various science subjects, literature on the subject of academic achievement consistently emphasises the importance of school attendance. According to DFE (2013), there was a link between students' absence and attainment in Key Stages 3 & 4. Students with no absences were 1.5 times more likely to obtain their set target grades at GCSE than those who had high absence records. Students' school attendance records were also a theme that was coded for in the interview analysis. Student participants, however, did not identify attendance as a barrier to their learning or success in science. In contrast, the teachers interviewed did. Most teachers highlighted poor attendance as a factor or barrier to WCWBS achievement. They linked it to gaps in knowledge, behaviour issues, lost study time, and subsequent underachievement amongst the WCWBS. Some comments among teachers were.

“Many WCWB students have very poor attendance, which will ultimately affect their attainment because they will lose valuable lesson time”, **JZ (teacher)**

“Another key factor is attendance. When students' attendance is 75% or less, they are not likely to achieve”, **OO (teacher)**

“Attendance is a massive concern amongst these groups of students; it affects the outcomes of even the brightest”, **FZ (teacher)**.

The teachers seem to suggest that poor attendance is a major problem amongst working-class white British students. They assert that this creates a gap in the overall learning of these students and should be

a serious concern. Kuo et al . (2014) support the teacher’s stance that regular attendance was positively associated with higher academic achievement across multiple disciplines, including science. Kuo’s study suggests that students who attended classes regularly were more likely to be more engaged in the subject, which was used as a strong predictor of academic success. Similarly, Lemos et al . (2012) also emphasized attendance as a factor in attainment in science, where they found attendance was notable and correlated with higher science attainment and students demonstrating greater motivation and interest in the subject.

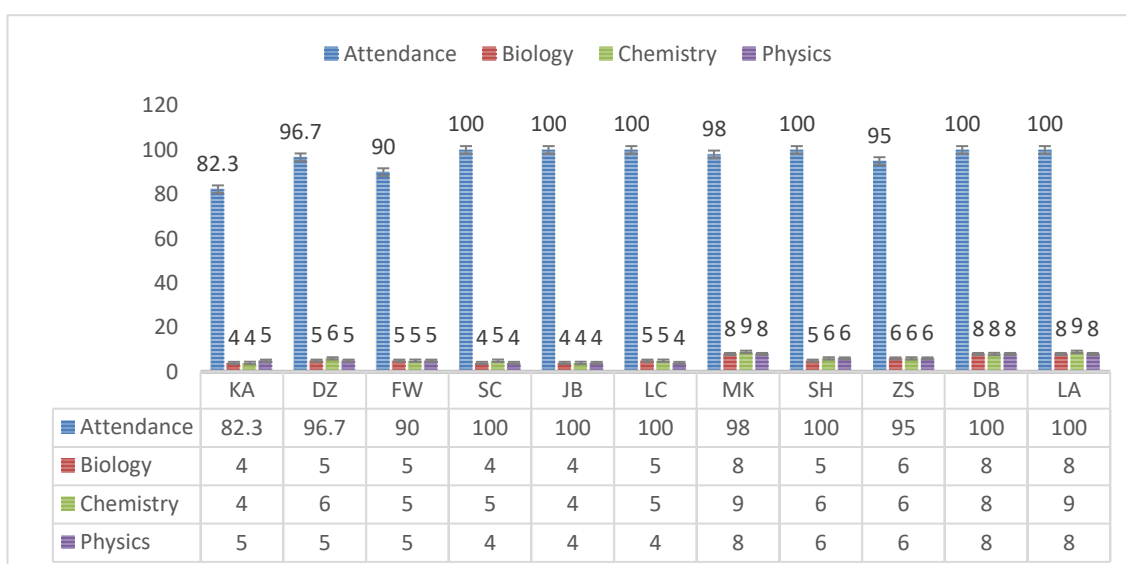


Figure 6.2 Students attendance against their GCSE science grades , class set 1 only

However, the analysis of the participating student’s attendance data against GCSE science results did not show any correlation as students who had high attendance still had comparatively low grades examples, SC, JB and LC all had 100% attendance but did not achieve their target grades. (See Figure 6.2).

There is, therefore, no compelling evidence in this study to link attendance with the science outcomes of this research group. On the contrary, researchers have suggested that pupils from low-income households or working-class backgrounds see a larger negative effect from each day of school absence

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(Wang *et al.* , 2012; Cox, 2000; DFE, 2006). Poor school attendance records for working-class students have long been a concern for most schools (DFE, 2006). This has often been associated with parental variables such as socio-economic status, neglect, level of education, and family conflict (Cox, 2000; Desforges & Abouchaar, 2003). Studies have also shown that students from working-class backgrounds have poorer attendance records due to several factors, including bullying, physical illness, socio-economic hardship, and a lack of value for school. Good school attendance is viewed as a crucial tool for working-class individuals competing against their peers and succeeding in school (Cox, 2000b).

Using Bourdieu's theory of reproduction to contextualise the teachers' views, it is possible to argue that one's habitus, which fits into a particular field, becomes active and makes them successful in that field

“Habitus, as the product of social conditioning, and thus of history , is endlessly transformed”(Bourdieu, 1990b, 116).

When a habitus (one's disposition encounters a social world that is not reflective of its own, the results are often unease and a struggle to fit in, which can lead to disadvantage. The school (field) is predominantly middle-class, and these students come from a working-class home (field), thereby creating tension and a rift between the two. According to the cultural reproductive theory, this poor attendance habit is most likely passed on from their parents or family members, who also had a negative habitus-field experience in school. This has formed a pattern of negative streaks that the teachers have associated with WCWB students. This may explain the teachers' views despite the statistical outcomes.

It may also be possible that the long closure of schools due to COVID-19 is likely to perpetuate some inequalities in the school attendance effects. Estimates by the Educational Endowment Foundation (2020) suggest that the attainment gap between students from advantaged and disadvantaged backgrounds as a result of Covid-19 closure will increase by about 35% where there was home schooling, online learning and resources are at play, students from more economically well off families had extra online tuition and access to

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books and study materials whilst those from disadvantaged backgrounds had to struggle with network or WIFI issues, no laptops to join online school lessons etc. Another hypothesis is that there was no effect on these students' attendance during the COVID-19 lockdown because instruction was delivered remotely, and attendance was virtual rather than in person, so the results may not be as accurate. This is because, according to some teachers, when students log in in the morning, the school records them as present for the entire day, regardless of whether they stayed logged in or experienced connectivity problems thereafter, which can explain the high attendance percentage during lockdown. This was explained by one of the teachers interviewed, who also reiterated that the school provided students on FSM with laptops, WIFI dongles, and subject textbooks to help fill the gaps in home learning. One of the teachers expressed this.

“We did not fail our students; we knew those who would struggle to access basic resources during the lockdown, and we provided laptops, books, and, in some cases, Wi-Fi dongles for their use”,  
**SC (Teacher)**

Although other researchers and EEF have reported similar conclusions regarding the widening attainment gap due to school attendance during the lockdown across social groups (Andrew *et al* ., 2020; Guveli, 2020; Bayrakdar, 2020), this factor cannot be considered conclusive in the context of the research school. The results indicated that student outcomes were not notably affected by the COVID-19 closure, as they were comparable to those of previous years across all measures. This can be attributed to the implementation of targeted one-on-one tuition and robust support for students' learning and mental health during this period by the school, putting in place a bank of online resources and classes for students to stay on top of studying during the COVID lockdown. These strategies aligned with the recommendations from the Education Endowment Foundation (EEF) guidance for helping students catch up. However, teachers' pedagogy was frequently mentioned as a major discouraging factor during the lockdown in many of the responses of the participant students. Teachers' pedagogy will be explained in more detail in section 6.6 ( pg178).

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### 6.5.1 Gendered science participation

Gender can refer to the behaviours, attitudes, and expectations a society considers appropriate for individuals based on the biological sexes assigned to them at birth (Rennine, 1988). Traditionally, many societies have operated on this binary definition of gender involving male and female. However, this binary definition does not encompass the full spectrum of gender, which is much more fluid and multifaceted. It is socially constructed by cultural, social, and individual factors that can change at any time (Westbrook, 2014). The individuals who make up the various societies in which they live construct this socially. The postmodern application of gender, as described by Butler (1994), is characterised as 'performance' produced through continuous social interaction. Butler describes gender as a continuous performance that produces men and women. She argues that a person might seem to have the same identity willingly because they repeat actions that maintain the status quo, thus being gendered by the societies we exist in (Butler, 2006). Overall, gender can be said to be more nuanced; people can construct their own gender identities that go beyond the male-female binary, which relates more to cultural or attitudinal characteristics.

Historically, science was highly restricted to elite persons, which often excluded many females, as science was purported to be more masculine (Brickhouse, 2001). Therefore, science seemed to feel over time to be a male-dominated field of endeavour. This is often noticed mainly in the underrepresentation of women in various scientific areas, especially in technology, engineering, and physics (UNESCO Science Report, 2021). The gender composition in science is often, but not exclusively, linked to the fact that science is a very heterogeneous subject comprising life science, physical science, mathematics, and computing. These areas are filled with very different gender compositions. It has also been observed that girls and young women often avoid mathematics-intensive fields like engineering in favour of those more human-centred (HESA, 2013). Most of the female students in my study claimed to like science, but very few of them (45%) envisioned a career in science, compared to 60% of the boys. This reflects a prevalent national pattern, showing that

more girls do not feel a future career in science is for them. This trend corresponds to the low uptake of women in science-related careers, as noted by OECD countries (2018) in Figure 6.3.



Figure 6.3 Gender participation in science careers OECD (2018).

The chart (Figure 6.3) shows twice the number of boys interested in becoming science and engineering professionals, ICT, and associate professionals than girls. This was from a selection of top students, leaving one to assume something other than ability was hindering the girls from participating. This fact is highly discouraging and can account for why women do not have the visibility men do in science professions. Also, in terms of careers in science, Engineering is still the most gendered science career, consisting mostly of 75% males, which is often a result of cultural biases and stereotypes of what an engineer should look like (UNESCO, 2005). Many preconceived ideas about how women should be viewed in science often depend on cultural norms, upbringing, or societal stereotypes. These preconceptions may influence how people view and treat women in these disciplines and may contribute to the underrepresentation of women in science-related fields (UNESCO Science Report: Towards 2030). Males are believed to be strong and, as such, deal with traditionally tough, difficult, energy-intensive tasks or careers like engineering, whilst females are often associated with the easier, non-physical tasks (Etzkowitz *et al.* , 2000).

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Gender identities in science are often formed through formal and informal processes such as education, families, peer pressure, and cultures (Archer, 2022). Young people are often expected to fit into certain pre-conceived identities and behaviours depending on their gender. These should often conform to the socially acceptable norms of the community or groups in which these students find themselves to gain acceptance or approval from them (Dalgety & Coll, 2004). A study by Baker & Leary (2003) supports these science identity formations through various societal factors, learning environment, and childhood peer relations have been reported to be very influential in forming gender identities, especially in working-class girls.

In my study, students' science identity influences were unpicked when answering the questions during the focus group interviews. "Do you think science is for everyone? Is there a stereotype in science? Most of the students answered no! When asked to elaborate, some explained that people's competencies and their performance in science alienate them from being described as a science person. Participants argued that a scientist's identity is more masculine than feminine. A few examples include.

"Most people feel science is more suited to boys than girls" **DZ (male, set 1)**,

Another student said,

"I want to believe there is some gender bias." This may have to be a result of how science has been presented over the years. The science curriculum is very masculine, too. Everything is about the male scientist and discoveries, so natural science would be more associated with boys" **SR (male, set 1, phase 2)**

Another student said,

"Yes, I think there is a stereotype in science. Most people believe science is for boys. All the scientists we learn about are men, although I know there are some female ones out there", **KH (female, set 1, phase 2)**

JB's view was a bit different.

"My parents say science is not a girl's subject, at least not in their days, I'm kind of with them on this" **JB (female, set 2, phase 2)**

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The inference from the students suggests that they understood science to be geared towards boys more than girls, based on what their environment tells them. In summary, my view is that science is not for everyone. Often, these informal structures, like family and friends around us, help to form and shape our various identities, which we then replicate and pass on (Passeron *et al.*, 1990). These views often put pressure on one to conform to certain ways of thinking and behaving, and invariably accept these identities, just like JB, SR, and DZ. Kim *et al.* (2010) support this view in their work, which argues that social perception around young people influences who they identify certain subjects with. Most people assume science to be masculine because of hearsay conversations they have heard passed down to them over time, just like KH and SR above, Buck *et al.* (2008).

However, on another level, how we perceive the dominant beliefs and experiences also supports or undermines these identities. Mks thinks that boys are more likely than girls to be linked with science because of how science is taught, particularly the textbooks utilised.

“I believe science is very masculine and biased, our textbooks never mention female scientists, it is always men, except maybe Marie Curie”, **MK (male, set 1, phase 2)**

TB shares MK’s view and associates science with the male gender because of what he has seen and heard all his life.

“You can associate science with everyone, but mostly I would say boys. When people talk about a scientist, you first think of a man”, **TB (male, set 2, phase 2)**

Often, students would band together in school and form their mutual identities from the people they surround themselves with, who have similar habitus embodied through several social dispositions such as accents, posture, mannerisms, and conversations (Attridge, 2021). Comments from MK and TB above are opinions they have formed over time and will pass them on to other people around them who are of the same habitus. Since science has been constructed as an ‘elite’ subject and masculine, these students come from working-class communities; therefore, having people with female science identities would often be rare in their circles (Archer, 2020). Overall, from the

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research, science identities are mainly formed around experiences with peers, teachers, and family members. This informs how individuals, especially girls, place themselves and engage with science.

In summary, I argue that gendered barriers affect girls' science participation more than boys. These barriers include cultural norms, stereotypes about careers for women, family orientation, media connotations, and science role models (Sarseke, 2018; Sutton Trust, 2019). These biases, which start at an early age, are reinforced at every stage to build a sense of masculinity around science that makes it uncomfortable for girls to participate (Aspires, 2020).

## **6.6 Teachers' pedagogy**

Teachers' teaching styles or methods, often referred to as pedagogy, were another theme that emerged from the interview data. A recurrent theme with both teachers' and students' interviews was a sense amongst participants that teachers played a key role in the science experiences of students.

During the interviews, students were asked, "Who is the biggest influence in your study of science?" Most students mentioned their science teachers. Some of the responses included.

"My science teacher just makes it fun and interesting", **MK (set 1, phase 1)**

"Teachers help you when you are struggling and keep you behind to complete your work", **TB (set 2, phase 1)**

"One participant commented, "There is a lot to learn in science, but my teachers are quite motivating", **DB (set 1, phase 1)**

MK and DB seemed to believe their teacher made the lessons fun and motivating, whilst TB felt highly supportive in his class, thereby enhancing the quality of learning. The enthusiasm expressed by DB about her science teacher was clear, as she admired her teacher's teaching style and admitted it played a big role in her engaging positively with the subject. The different teaching styles and approaches to teaching science can notably impact students' learning outcomes. It can shape the classroom environment, as mentioned by some of

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the students, and keep them on track when they fall behind, like TB earlier mentioned.

A similar light-hearted response was echoed when students were asked to talk about their science experiences. A few of the students mentioned their teachers' teaching style as influential in their understanding and engagement with science, positively or negatively. Some commented about the passion their teachers exuded whilst teaching, which encouraged them, for example, one student said.

” You can never be bored with Mr S' class; he is really enthusiastic and gets you sucked into his class. Also, there is lots of banter with him”, **LE (set 2, phase 2)**

“I enjoy my science class because of Miss. She is full of life and makes the class interesting even with very boring topics”, **SC (set 1, phase 2)**

A few others had negative reviews about their science teachers in terms of their teaching styles and the effects it had on their science experiences.

“I have not had a particularly good experience with my science classes. The few teachers I have had since year 9 have been really boring and make the lessons really difficult to follow, unlike some other classes that have more fun lessons”, **NS (set 2, phase 2)**

Another student said,

“I like science, but my teacher, well, one of them just makes us do a lot of book work and copying notes and does not explain much”, **LC (set 1, phase 2)**

The negative science experiences of these few students did not vary from set. This may be due to teachers and students having conflicting learning versus teaching styles that are not compatible, thus students not engaging with the subject. This suggests that teachers who use an engaging, upbeat, and supportive teaching style that accommodates students' learning styles can notably increase students' engagement, self-efficacy, and their ability to succeed. Marzano (2007) supports this view, positing a student-centred approach as a framework for effective instruction to enhance engagement and motivation towards the subject. If students take to the teacher, it becomes

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easier for them to engage, learn, and persevere as a form of payback to the teacher. The two students surprisingly did not achieve their target grades in science. This apathy for science and subsequent underachievement could be hypothesised to be a result of the teaching approaches of their teachers. This was similarly observed in the studies by Hattie *et al.* (2013) and Darling-Hammond (2005), who both propose that when students disengage with their teachers' teaching methods or style, they often do not do well in the subject and lack interest. On the other hand, if students connect with their teachers, it increases efficiency and self-confidence and a keen desire to do well. A similar correlation was reported by Chen *et al.* (2018), who claimed that teachers often teach the way they learn; as such, unconsciously, their backgrounds shape their teaching styles and also the way they engage with their students. This was why some students engaged and formed rapport with certain teachers more than others. This, in their study, proved that positive teacher pedagogy can lead to students' engagement and subsequent attainment. Bourdieu's theory also often describes the school as a field of relational construct (Bourdieu & Wacquant, 1998). The type of rapport formed between students and teachers can affect how students engage in class. The results of the research suggest that a teacher's approach, style, and engagement techniques, which can have positive educational outcomes (Burrige, 2014) can affect students' achievement. This finding is also supported. There can also be a combination of several other school-based factors that, in tandem with those mentioned earlier, can affect the attainment of the students. Some of these, as alluded to by participants, can be grouped as in-school support programmes and activities, which will be explored in the next section.

### **6.6.1 Peer pressure at school**

Several studies on peer influence have considered it a notable factor in shaping adolescent outcomes. Often, peers influence youth with poor self-regulation more to value reinforcement of these values. These influences can be positive or negative, and girls are reported to be more influenced by each other than boys (Olasehinde, 2014; Siege, 2006). A peer is a person who has equal standing with another (Siege, 2006).

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Peers were found not to have any remarkable impact on the participants' choices, attitudes, or attainment in science, according to the data from the research interviews. One student acknowledged a friend as having influenced her decision to pursue a science-related course.

“What, in your opinion, is preventing students from achieving in science?”

Her response was simple.

“Friends”!

When probed further, she explains.

“If I have friends who like science, then I would like science. If I have friends in Triple Science, I will want to be a triple student to be with them. I would not want to be away doing something else. If no girls are there, then I might not feel very comfortable like Geography”, **LC (female, set 1)**

There is no doubt that LC, who is in the higher ability set, was impacted by her peers, even though studies have shown that the students' aptitude affects how much peer influence they experience. According to Burke *et al.* (2008), peer influence is less pronounced when an individual has greater competence. Despite being in the high ability set (set 1), LC still makes judgments that affect her view of science that are influenced by peer pressure. Undoubtedly, peer pressure was not notably influential in the science engagement of the other participants in this study. This was at variance with studies by Raabe *et al.* (2019), who posit that peers contributed to the decline in science grades and the uptake of science courses among adolescent girls. Also, working-class students tend to have high peer influence because it increases the similarity between friends and reduces social risks and dissimilarity (Mora *et al.*, 2020). This, however, was not the case observed in the study. Other school factors, like the type of science subject, may serve as a barrier to girls' science attainment.

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## 6.7 In school support

Various schools' support systems and programmes also contributed to the science experiences of the participants. These include Gifted and talented programs, extracurricular events, competitions, trips, and in-class mentoring and assistance. These programs allow students to increase their science capital through new connections, role models, and positive educational experiences (Casey, 2022). These programmes are also geared towards encouraging learning in these subject areas or the uptake of these subjects where it is applicable. Several students mentioned these programmes as part of their science experiences in the school.

### 6.7.1 Gifted and Talented Program

Students identified as Gifted and talented students (G&T) who make up about 5% of their year group cohort in terms of academic attainment often benefit from a range of interventions in schools, including higher ability setting, accelerated learning projects, summer schools, specialized assemblies, master classes and extracurricular trips (Cross *et al* , 2014). However, the identification of gifted learners often excludes WCWB students who enter secondary schools with low prior attainments from primary school, thus are unlikely to be identified as such, and therefore many WCWBS are often missed out during identification, selection, or excluded from the provisions available to these groups of students. It is also reported that 15 930 students are not identified each year from this group due to the non-robust identification systems that are used. (DCSF, 2008).

“Children from families of modest means constituted 9% of those accepted into the national Gifted and Talented program  
“(Campbell *et al* , 2007b).

The student interview data analysed suggest a slight impact, as some students in the higher set mentioned being involved in various extracurricular opportunities in science based on being identified as Gifted and talented students. Amongst the student participants, only 35% were identified as Gifted

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and Talented and participated in the various school programmes. It is interesting to note that all the students in the research identified as G&T achieved their target grades in science.

When asked, "What is your biggest encouragement in studying science?" Some responses from the set one respondent were as follows.

"School is my biggest support as I get to go on a lot of G&T trips, especially in science. I still remember my first trip to Oxford University, which encouraged me to pay more attention to science and rethink my future career goals", **MK (male, set 1, phase 1)**.

Another student also said,

"School is my biggest encouragement. I am fortunate to have attended numerous science-related programs since Year 7. I guess it is one of the benefits of G&T, as there is always something going on. I especially like being part of the brilliant club", **SH (female, set 1, phase 1)**

Other students also attributed their positive experiences to school competitions, such as Debate Mate and the Faraday Challenge, among others, and various school trips. A few teachers interviewed also mentioned the difference in attitude of the students being selected as G&T. They acknowledged experiencing a more committed attitude from these students to science lessons, and a general cheerful outlook to learning. One science teacher commented on his experiences teaching WCWB students.

"The WCWB students who are gifted and talented are a bit different. Perhaps giving them the title of Gifted and Talented provides them with an ego boost. They seem more invested in the lessons and work more, knowing there is a lot expected of them. On the other hand, most of the others are often not notably bothered by their science results", **NS (male, teacher)**

Another said,

"It depends on the class you teach. The top set students, often those with high abilities or Gifted and Talented, are inquisitive and fun, whether they are WCWB. Others not so much as they are difficult to convince that they can achieve in science", **SC (male, teacher)**

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The above agrees with the findings of Mazzoni (2014), who aptly remarks that labelling working-class students as 'gifted' gives them a sense of belonging and encourages achievement.

On the contrary, one science teacher's experiences were a bit different as he identified the majority of the WCWB students he taught as disengaged with science despite their ability, set and G & T identification. One of the teachers elaborated about this.

"My experience with WCWB students has been similar since I started teaching science. They have much self-doubt, often disengaged, surprisingly, some of the brightest of them would try",  
**EB (female teacher)**

Campbell *et al.* (2009) provide a helpful reflection, noting that working-class students have a different notion of their giftedness and may view it as a means of escaping from irrelevance rather than an opportunity if not effectively managed by people they trust. This may explain why some gifted students, as one teacher noted, often remain disengaged and experience self-doubt about their abilities.

Bourdieu's (1997) theory often stresses that schools are the kind of institutions that reproduce social inequalities by disenfranchising low SES students; however, this does not seem to hold true in this case. On the contrary, most teachers found that most WCWBS who were identified as Gifted students excelled and met their target grades in science, and the data from these studies confirm that. This gave them a new identity, breaking that stereotype mould in which their families were cast. From the research, 45% (9 out of 20) were identified as Gifted and Talented, and 88% (8 out of 9) achieved their target grades in science, which supports the above submission by the teachers. Only one student identified as Gifted and Talented did not achieve her targeted grade. This may be one of those students with self-doubt of their abilities and often disengaged with learning, that EB (science teacher) referred to.

The Gifted and Talented or more able students' programmes in schools have been noted to be associated with promoting students' science engagement and higher academic attainment over the years (Birdwell *et al.*, 2015), as it

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systematically helps to build up their science capital through the various interventions and extracurricular engagements, as seen with the participants in the Gifted and Talented programmes. According to Sutton Trust (2013), these in-school support programmes are selective and may not be available to many pupils from working-class backgrounds. Karaduman (2020) and Siegle (2022) also cite emotional and social difficulties that contribute to the underachievement of gifted working-class students.

### **6.7.2 Other Extra-Curricular Science Activities**

Findings from previous research suggest that extracurricular activities are important in producing positive outcomes in students (OECD, 2015). In the research school, STEM club, Science club, Brilliant club, and Faraday Challenge were among the science-based after-school activities that impacted some students. A few of them allowed to participate in these extracurricular activities can often be influenced by the gendered nature of the activities, which may appeal to one gender over another. For example, a flower hunt or a kayaking trip. These programmes are similarly structured and depend on schools to arrange for select students who will attend. Examples of this thinking include.

“I used to attend the STEM club before the lockdown, it made me understand a lot in science”, **DZ (male, set 1, Phase 1)**

“Teachers have been engaging me in different extracurricular programmes like STEM and the Brilliant Club. It has motivated me”, **SR (male, set 1, phase 1)**

Another commented.

“The Faraday Challenge was so cool. It inspired me to start looking into Forensic science”, **SH (female, set 1, phase 1)**

Teachers interviewed also agreed to the above claim but were worried about the low level of participation of the WCWB cohort of students. They claimed they were not engaged with most science-related trips or activities. One teacher remarked.

“Our WCWB students are so disengaged about participating in science-related trips and activities, even when it is free and often

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targeted to them. When they do not engage or take up places, we must open it up to other groups to participate”, **SC (male, teacher)**

Another said.

“Few of our White British students enrol in the STEM club or want to participate in competitions. You virtually have to hand-twist them to join”, **DO (female, teacher)**

Studies show that students who partake in extracurricular activities that involve science regularly tend to have higher grades and enjoy a more positive outlook towards science (Munroe, 2014). For various reasons, many young people engage in extracurricular activities in school. In addition to making students more at ease with the subject, it allows them to study more outside the classroom about their particular areas of interest. These additional educational opportunities can foster perseverance, self-worth, and a firm sense of direction. Some scholars have linked extracurricular activity participation to better grades and results (Siegler, 2006).

Data from the study show that an equal number of children attended STEM club as an extracurricular activity involving science. They also admitted that it was a great resource for better understanding science applications (Appendix Q).

“The STEM club was excellent in raising my interest in science.”  
LA (female, set 1)

It was worth noting that although there was no difference in participation in one area of extracurricular activity, school trips had more boys in attendance than girls. The following dialogue during the focus group with some girls interviewed ensued around why girls did not like to go on science trips.

**Student:** “Sometimes, teachers always pick the boys for engineering trips or projects.” **Researcher:** “Do any of you girls volunteer for it? Do you complain?”

**Student:** No, I guess we do not really, it is boring anyway!

**Researcher:** “How do you know it is boring when you do not go?”

**Student:** Miss, which is what people say, so yes.

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The interaction with the focus group of students mentioned above revealed that most of them withdrew from these outings because of rumours of boredom by their peers, which I found strange for students to miss an opportunity to have a day away from school.

The views of the one science teacher were explored around students' trips in science.

**Researcher:** “Why do you have more boys than girls on your trips?”

**SC, science teacher:** “Girls are often disengaged about science trips.”

**Researcher:** “Why so?”

**SC, science teacher:** “My guess is their friends are usually not on the trip or do not feel it is beneficial.”

**Researcher:** “How about the cost of the trips?” “

**SC, science teacher:** “Oh no, most trips are free or highly subsidised for students on FSM.”

This dialogue shows an inertia around the girls and how they are losing out on opportunities to build up science capital through these extracurricular activities. The idea of trips as a tool for building science interest is supported by the work of Sheldrake (2018), who recommended extra-curricular science opportunities to help encourage students from disadvantaged backgrounds to build self-confidence and science career aspirations. Most of the girls, however, seemed unable to benefit from the social capital that the trips provided because of their negative attitudes towards science trips. This gave the boys an advantage over the girls in building up more science capital for themselves.

The Educational Endowment Fund & The Royal Society (2017) also reported that a lack of opportunities to gain experience notably lowered students' achievement in science amongst working-class students. This view supports the teachers' view that the girls are not ready to take advantage of opportunities like science-based trips as the boys were. If this trend is recurring, then the gap in science capital between the boys and girls may widen. Also, extra revision

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classes showed a low uptake by girls. Teachers claimed girls had the lowest uptake in this out-of-hours opportunity.

**NS, male science teacher:**

“Most of our young working-class girls will not attend extra revision classes. In the mornings, they say it is too early, and they have to pick up their younger siblings after school. So, we cannot win.”

This shows an apathy amongst the students, especially the WCWB girls, to affect their build-up of science capital that they otherwise would have acquired. This would have equated middle-class students whose parents could afford private tutors at home. Similar studies by Yeoman (2019) on the non-participation of working-class students at the A-level of science posit that they self-exclude themselves from out-of-hours engagement in science, which they feel is not for them.

The important finding here is that the extracurricular activities have a positive overall impact on students' science experiences for the students who attend. It is also worth noting that a high participation gap is noticed amongst the different socio-economic classes of students in the school in this regard. In a similar study by PISA (2015), working-class students were noted to have the lowest uptake rate in after-school activities due to socio-economic hardship and low self-efficacy. It cannot be certain if the aforementioned applies to this research, as insufficient evidence was available to make such a deduction. However, it may be possible to suggest that outside-of-school-hours activities have been shown to engage students in the study of science. It can also be put forward that the extracurricular activities made a positive impact, as claimed by all the participants in the research. This implies that these activities do have a positive impact on students' engagement or interest in science. This is in line with Mahoney *et al.* (2003), who claim that consistent participation in structured extracurricular activities has the potential to enhance students' educational motivation.

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## 6.8 Summary

Overall, the school factors mentioned affected the students' engagement with science differently. Although most of these factors did not directly impact the science outcomes of the students, we can argue that factors such as the science curriculum and the type of science subject did influence the perceptions and attitudes of the participants towards the subject in general. The science curriculum has been debated and is widely accepted as not serving or helping working-class students attain their goals (Spears, 2021; DFE, 2019; OFSTED, 2000). On the other hand, schools are at a crossroads because they cannot offer an alternative curriculum due to accountability frameworks and, therefore, must work with the existing science curriculum (DFE, 2014). From the students' reflections, it can be said that the broad science curriculum contributed to the students' challenging experience with science. Regrettably, most of those features were not the target of the research and were left inconclusive.

Drawing on the theorisation of Bourdieu (2002) and school as a field, Bourdieu suggested that "education was foremost in producing differences between groups and social classes and in the reproduction of those differences". Regarding ability, classes in science where students did not have a choice of science route but were steered and channelled by their teachers to accept placements. It can be said that this falls into the narrative of Bourdieu because it reproduces inequality amongst students and functions as a reinforcement of 'cleverness,' or 'science not for me' tendencies amongst the different students. In school support programmes like Gifted and Talented, STEM club, school science trips, and challenges clearly showed their positive contribution and impact on the engagement and attainment of students in science. This could be said to have increased the participating students' science capital, and as a result, their attainments were positively influenced.

It can also be suggested from the data analysis that teachers' pedagogies positively affect students' engagement with science and possibly their overall relationship with the teacher. Teachers who had promising relational pedagogies had more students engaged with the subject. Studies by Tobin *et al.* (1994), who contend that teachers who used relational pedagogies rather

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than instructional ones frequently had pupils learn more and be more dedicated to the teachings, corroborate this claim. It is also conceivable to argue that pupils notice teachers' attitudes towards what they are taught, as they continually interact with them (Van Manes, 1999).

Schools likewise offer strong support for gender performativity theory because they are places where gender is produced, regulated, and normalised through daily routines. Uniform policies, classroom interactions, subject choices, behaviour rules, and peer groups all shape how students act out gender. Schools reward some gender behaviours and discourage others. Students learn to “do” masculinity or femininity in ways that are accepted. Over time, these repeated actions start to seem natural and unchangeable. Teachers' expectations, the way the curriculum is presented, and how students are assessed often also reinforce gender norms. For example, confidence and assertiveness in science are valued more than caution. These practices shape how students perform gender in school. Overall, schools demonstrate that gender is not merely a personal trait but a social achievement, continually re-created through school routines. This directly supports the main ideas of gender performativity theory.

Although the Curriculum and Assessment Review is underway (Francis, 2025), the UK science curriculum still poses problems for teachers and schools because it contains too much content. Almost three-quarters of science teachers believe the curriculum is overwhelming and fails to inspire genuine scientific curiosity. Because of high-stakes tests, teachers often focus on exam preparation, and hands-on science activities have become much less common. These issues are exacerbated by ongoing teacher shortages, especially in physics, limited involvement of classroom teachers in the review process, and a sense that the curriculum does not cover important topics such as climate change. With final reforms not expected in classrooms until 2028, teachers and students are left waiting for real change (RSC/IOP Science Teaching Survey 2024, DFE, 2024). The next chapter will discuss in greater detail the factors that enabled some students to become excited about science as a subject, as well

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as the perceptions and motivational factors that led them to take up and engage with science.

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## Chapter 7: Students' science perceptions and motivations

### 7.1 Introduction

Many studies have shown that self-perception is closely related to a variety of school-triggered variables, as was discussed in the previous chapter. Other salient factors that have been associated with students' learning of science have also included how students perceive themselves concerning the subject, how much motivation they have received from notably others, or their academic efficacy towards the subject. This also enhances the socio-emotional well-being of the students generally towards school (Goodenow, 1993; Faulk *et al* , 2007). This chapter contends that students' perception of themselves with regard to science affects their attainment in the subject. The first section will elaborate on self-perception as it relates to resilience within science. This will highlight why students' level of belief in their capabilities affects their aspirations, attitude to studies, level of interest, and subsequent attainment. Self-perception in many studies has been seen to be a positive predictor of academic resilience and achievement (Moulton *et al* , 1991; Schunk *et al* , 2013). It will also highlight the specific efficacy girls have in their experiences with the different science subjects, and also their future engagements with science.

Next, I will unpick various links to students' motivation as was coded for in the data, which include ability grouping, future careers, family affiliations, teachers' pedagogy, and subject influences. A student's level of motivation, as posited by Skinner & Belmont (1993), can often be reflected in their engagement and attitude towards a subject, as was seen with several of the participants in this study. The final part of the chapter then will look at what value the participants have towards science and how this contributed to their experiences and attainment in the subject. The scale of this value can be seen to be motivating or demotivating students to do well in science.

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## 7.2 Self-perception

The term self-perception will be defined here as “one’s confidence in their own ability.” The way children think of their capabilities and how they respond to this is said to affect their later academic achievements. This notion is a general explanation for academic achievement about children’s views in specific subjects or domains (Susperneguy, 2017). On the other hand, some scholars refer to self-perception as a person’s self-image (Davis–Kean, 2008). I am of the view of Susperneguy (2017), as it is more suitable to the context of working-class students’ perception of themselves in relation to science only. The way students perceive their abilities in different subjects may variably contribute to how much effort they put into the subject, which will, eventually, affect attainment.

One of the questions the participants were asked was “Do you think science is for you?” A few responded negatively. Examples of such negative responses were:

“No, I am not sure science is really for me. Most times I find a lot of topics difficult, and I do not get a lot of it straight away. I need to keep going over it to remember”, BG (set 2, phase 2).

Similarly, another said.

“No, science is not for me. I am very weak in maths, physics, and chemistry. Biology is okay, but the rest-no!”, PE (set 2, focus group, phase 2).

Another respondent said.

“Science is not for everyone; some people are better at other things. Not everyone can do calculations or memorise stuff like that. I try though, not quite sure.”, SC (set 1, phase 2).

This negative perception of one’s ability may be the reason for BG and PE not engaging or applying themselves fully in their science lessons, as alluded to in some studies that students will achieve better when they take a positive view of the subject (Marsh & Martin, 2011). Similarly, Watts *et al.* (2015) reported that the students’ own beliefs regarding their abilities resulted in variance in the relationship with attainment outcomes among the students they studied. This often reduces resilience when things become difficult and promotes

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discouraging views about science. The GCSE results confirmed their doubts, as neither BG nor PE achieved their set target grades in science. SC, however, was in a dilemma about whether science was for her, and she postulated that people were good at different things, and that while one was bad at science, they could excel in another subject. SC also narrowly missed achieving her target grades in science. On the other hand, the participants who thought positively about their abilities in science seemed to engage better in class and were more certain and confident about their science abilities. This was articulated by some participants:

“Science is for me. I have always been good with science since primary school, and it is not as difficult if you like it. I know my biology is not as strong as chemistry and physics, but I try my best not to do too poorly”, SR (male, set 1, phase 1).

On another note, another respondent said.

“I know if I study more, I can do very well. Sometimes I do not prepare well enough for a test as I should, and then revise at the last minute. It's stressful to do that but I know I must pass so I push on”, KH (female, set 1, phase 1).

These statements highlight how these students' self-perception influences their attitude towards science or vice versa. SR attributes his high perception of success in science to his love for the subject, whilst KH places hers on the good grades she continues to attain and commit to in science. Not surprisingly, SR and KH achieved their target GCSE grades. These positive participants have different reasons for feeling science is for them. However, the commonality is that they both demonstrate resilience when facing difficulties in the subject and possess a can-do attitude towards it. It can be argued that fostering a positive self-perception can be crucial to increasing resilience since it can help us cope with handling failures, barriers, or obstacles in life. We can build the confidence and resilience required to navigate life's obstacles more easily by cultivating a belief in our capabilities and qualities, as supported by Dweck (2006). SR and KH both have shown these attributes of resilience, which are clearly demonstrated by their drive to be successful amidst all the challenges and unpreparedness they sometimes feel. Mastan (2018) notes that individuals with a positive self-perception are typically more driven, hopeful, and

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confident, and are more often better suited to coping with problems and developing resilience. On the contrary, those who have a negative self-perception are the opposite; they are not driven and easily give up on the task. However, some researchers on the link between students' self-perception and their ability to do well have made mixed reviews. Some researchers believe there is a positive correlation, but this is seen only when the ability and attainment are also high in other subjects (Huang, 2011; Guay, 2003).

BG and PE might have barriers that SR and KH do not have, which makes them have a certain image of their science abilities that is different. Data shows BG and PE to belong to science class set 2, which has less science content and is termed a low ability class, while SR and KH belong to class set 1, which is termed the higher ability class. It can be postulated that the class setting may also reinforce the positive or negative self-perceptions they have of themselves. Francis et al . 2020 support this by workers who claim there is a self-confidence gap between students placed in the top sets and those in the lower sets and this affects attainment in these groups. Recent work by Davis–Kean (2017) in her research investigating the link between self-perception of abilities and academic achievement argues that this hypothesis works in all levels of achievement, and it is not age dependent. Davis asserts that even students in the bottom 10th percentile of achievement performed better. This offers a useful insight into the power that self-perception can invariably arm students with to become successful at something. This line of thinking, however, does not explain why SC, who is also in set 1 (higher ability class), did not achieve her target grade in science.

It was interesting to note that most students who claimed they were good at science also seemed to be good at maths, and it showed when analysing their GCSE grades. 85% of those who said they were good at science achieved their target grades. There seemed to be a link between their confidence in science and math. Examples were seen when calculations in chemistry or physics were mentioned. A few confessed that their maths did affect how they performed in science.

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“I’m not very good at physics, it’s the calculations and formulae bit and I’m not good at maths either”, TB (male, set 2, phase 1).

Similarly, another respondent said.

“Science is not for me. I get confused with balancing equations and any calculations at all”, BG (male, set 2, phase 1).

Tommy and Ben's view of their science abilities was linked to what they believed they failed at, which was the mathematical aspects of science. When further probed about their view of biology they said it was their better science subject but said they still thought they were “rubbish” at it. Another set of participants felt science was easy because of their maths prowess.

“Physics is great because it’s just maths and my maths are really good” (LA, set 1, phase 1).

“Yes, I feel science is for me. It is logical like maths, it has to make sense” (MC, focus group, phase 1).

It may be possible that, to comprehend and conduct scientific research, a strong mathematical foundation may be required. The ability to use these mathematical tools is crucial for making sense of scientific data and developing scientific ideas because many scientific notions are stated using mathematical equations and models (Liu *et al* , 2020). Students who could meet these self-requirements of being good at maths were also seen to feel they could achieve better in science.

### **7.2.1 Teachers' view of students' ability**

The way teachers perceive students' abilities seems to affect what the students think of themselves. This was evident in the data, as in JA, DZ, and SH.

“My science teacher says I am doing great and that if I continue, I will surpass my predicted grade. I am more confident I will get my grades in science now”, JA (set 2, phase 2).

Another respondent's view was.

“I get good feedback from my teachers in all my science classes, so yeah I hope to achieve my target grades or surpass them even”, DZ (set 1, phase 2).

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While SH (set 1, phase 2) said, “I am not sure, but my teacher thinks I will achieve my predicted grade. I have been working hard though.”

These responses can be said to be a result of positive reinforcements by their teachers, which in turn boosted their self-perceptions. This external validation of students’ abilities encourages and often pushes students beyond their perceived sense of self (Hofkens *et al* , 2019; Linn, 2021). This seems to suggest that when teachers provide positive feedback to students, they are more inclined to believe and feel more positive about their capabilities and emphasise their strong points. Hoffman (2010) similarly reports that a positive sense of self-perception enables learners to view different tasks with a view to overcoming them. Moreover, Bandura (1995) also hypothesised that persuasion or encouragement from others is an influential factor in raising self-efficacy among students. This heightened sense of ability might raise or enhance their resilience, which may encourage the students to engage more in science. Newman’s (2004) review also suggests that strong social support or relationships help students develop coping strategies and increase self-belief. Other scholars believe that when students have a belief in their abilities or are encouraged by their teachers, it fundamentally improves attainment and ambition (Goodman & Greggs, 2010).

Another interesting finding was that the views expressed by some science teachers during the interviews provided a useful insight. They claimed that the majority of the WCWB students they taught over the years perceived themselves as non-academic and therefore not fit for science. The teachers also inferred that most students required constant reassurance of their abilities and self-worth. They said this showed up in their attitude, efforts, and what they affirmed constantly about themselves. It was also noted from the interview that this view was similar amongst all other subject teachers interviewed. Some reiterated that the students lacked self-confidence and belief in themselves, especially when they perceived a subject or task as difficult. Examples were:

“The lack of self-confidence that they can do it. This is a major problem with these students. I wish they could give themselves a bit more credit”, **NS (teacher)**.

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Another teacher said,

“What is missing among these students is self-belief and confidence that they can do it.” They give up too easily. That is an area that has to be addressed, but where do you start with that?”,  
**JZ (teacher).**

There seemed to be a recurring opinion amongst these teachers interviewed that the students needed to believe in their abilities and build a sense of determination in science to do well. It was also mentioned that most of the teachers affirmed that the limitations they felt these WCWBS posed had nothing to do with intelligence or academic ability but just self-doubt for most students. This may suggest that a lot needs to be done to remove barriers that might make these WCWBS feel less confident in their own abilities, and it might be useful if there were more teacher affirmations to help build that confidence.

On asking students, “Do you think you will achieve your target grade in science?”

All of the students who affirmed that they were good at science were also very confident they would achieve their target grades in science and vice versa. Such an example was.

“I know I will achieve my predicted grade in science because I have been working hard, and I enjoy the work I do in science. I am sure I will get the top grades”, **SR (set 1, phase 2)**

This high self-confidence seen by SR can be linked to the behavioural domain of science engagement, which has to do with involvement in academic tasks and having a positive conduct and attitude, which often translates into achievement during teacher assessment (Fredrick *et al* , 2004) Mori and Chow (2012) can also see this link between self-perception and science attainment in similar works. Bourdieu’s (1987) posture on habitus can be used to determine why some students have developed this negative concept of themselves, which the teachers talked about. He claims that the negative predisposition towards their abilities, which results in self-elimination, is based on their habitus generated unconsciously by their families, who probably had people who thought and felt the same way. Bourdieu’s standpoint supports these views that habitus determines the actions and perceptions of the members of the class and is simply reproducing itself in these students. This notion is reflected in the

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interview data with some students whose responses may suggest that family can pass on these perceived negative traits.

NS said, “None of my parents were any good at science, neither was my brother”, **NS (male, set 2, phase 1)**

Another respondent claimed. “Science is definitely not my thing. I will pass in Arts but not in Science. Both my sister and I are creative people”, **CM (female, set 2)**

The data shows CM and NS are reproducing their home habitus which says they are not very good in science. This predetermination of failure is subconsciously embedded in the thoughts of these students and creates a conflicting stance with school which expects them to do well. This negative self-perception seems to form a barrier for these working-class students. Bourdieu calls this phenomenon ‘working class habitus,’ which predetermines the actions and self-efficacy of members of the class. He goes on to explain:

“This negative predisposition must be understood as anticipation based upon unconscious estimation of the objective probability of success possessed by the whole category of persons “(Bourdieu, 1997, p. 495).

### **7.2.2 Self-perception of different science subjects**

It appears that low self-perception among some participants was limited to science. This was observed when they were asked whether they expected to achieve their target grades in other subjects. Some students responded positively and very enthusiastically; some examples were.

“I know I will get my grades in Art, drama and PE for sure” (**LE, set2, phase 2**) When probed further, he said, “ Because I am good at those subjects. I am just terrible at science. Another said.

“I will pass my History, French, English, Sociology, ICT and maybe Math if I am lucky. The rest, I am not sure right now”, **CO (set 2, focus group, phase 2)**.

These students’ low self-efficacy was mainly in the domain of science. They seem to be very confident in their abilities to achieve their target grades in other subjects just not in science. This can be due to repeated failures as one respondent advocates.

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” I used to like science, but I never seem to be able to pass well in any test for years now. It is not my strength, maybe”, **KA (set 1, phase 1)**.

Yendork *et al.* 2015) asserted that low expectations discourage one from overcoming failures and trying again but instead develop low self-esteem and give up on a project, endeavour, or a goal. This can be seen to be applied here as the students seemed convinced that they would not achieve a good science grade. This attitude supports Bourdieu's argument that habitus can be shaped by past events and structures that condition perceptions of oneself. He also posits that this habitus is transferred mainly within the home setting and passed on to the individuals, which supports the above claims by the students (Bourdieu, 1994). These sets of dispositions or inclinations can often be expressed in the form of a low sense of self or ability (Dumais, 2002). The OECD Report (2009) similarly corroborates this idea of Bourdieu and found that SES was the most influential on students' self-perception and subsequent subject choices. This, however, fails to consider other competing factors such as individual personality traits, cultural beliefs, and previous experiences of success or failure. Nevertheless, self-perception has been shown from the aforementioned data to affect, in some way, students' experiences and attainment in science.

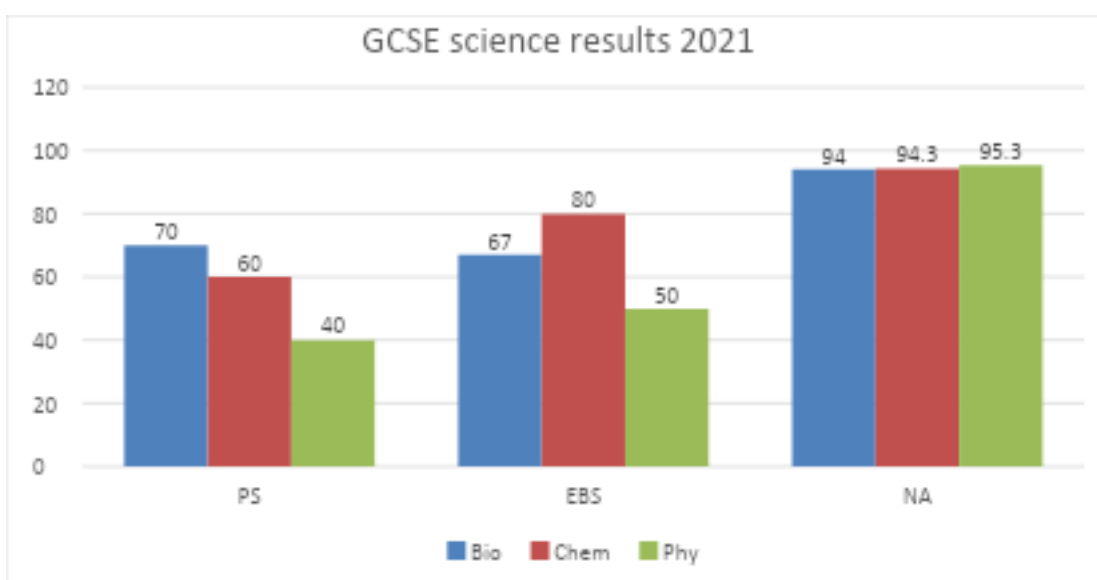


Figure 7.1 Participants' GCSE results compared against the trial school and the national average in England

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In Figure 7.1 above, PS denotes participants, EBS denotes the trial school, and NA denotes the national average. The 2021 GCSE science results indicate a clear achievement gap across the groups. Results improve from PS to EBS and then national average. In Biology, Chemistry, and Physics, students in PS have the lowest pass rates. EBS students perform slightly better, but their scores remain substantially below the national average. National pass rates are very high in all three sciences, about 94 to 95 per cent, probably because teacher-assessed grades were used during the COVID-19 pandemic. Even with these more flexible assessments, PS and EBS students still perform less well. This suggests that long-standing inequalities in science education are not just about how exams are given.

Physics has the largest gap in results, with much lower pass rates in PS and EBS than in Biology or Chemistry, even though Physics has the highest national pass rate. This suggests that Physics results are strongly affected by factors such as having specialist teachers, the time spent on the subject, and the expectations placed on students. The data show that differences in science achievement are primarily attributable to unequal access to resources and opportunities, rather than to differences in student ability or self-perceptions. This indicates that the education system requires broader changes, not merely adjustments to how students are assessed. Another notable influence on students' perceptions of science is their motivational drive, which warrants in-depth examination in the forthcoming section.

### **7.2.3 Girls' science efficacy**

Science efficacy is one's belief in being successful in completing science tasks (Robnett *et al* , 2015; Britner, 2008). The level of scientific efficacy can predict academic achievement and behaviours in science (Honicke & Broadbent, 2016; Tuan *et al* ., 2005). The higher the science efficacy, the more willing students are to participate, engage, and complete tasks, especially when there are difficulties (Baldwin *et al* , 1999; Pajares, 2006). However, there seem to be a few factors that can influence students' perceived science efficacies. These factors include socio-economic background and cultural messages and beliefs.

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It is often presumed that those from less affluent socio-economic origins have less access to opportunities and resources that could hinder their scientific progress. (Demie et al , 2009). This suggests that students' SES backgrounds often affect students' educational outcomes and self-efficacy by controlling students' mindsets about their abilities (Destin et al , 2019; Yeager et al. , 2016). This is often reflected in poor educational outcomes due to little resilience, witnessing less success, and apathy towards challenges. However, students from higher SES are more resilient, likely to witness family members being promoted, having opportunities to advance careers, etc, which gives them an air of importance and capability (Wong et al. , 2019). Working-class white British students in this study fall within the boundaries of this disadvantage because of their socio-economic backgrounds. Also, cultural messages about who is deemed a scientist and what they should look like work against them, fostering a true sense of themselves as scientists. This implies that the general factors discussed above may influence the participants' aptitude in science at different stages of their development, making them feel inferior because of their social class status (Marks, 2020). Nevertheless, some students in the study have proven to go against the norms and have developed resilience and a sense of ownership about their abilities and identities in science. Example:

“I feel science is not very difficult if you put your mind to it, although some people feel it is”, **KH (female, set 1, phase 2)**.

KH has high science efficacy. She believes she is good at science and acknowledges that certain people cannot cope with the difficulty of science. Girls have been shown to exhibit higher science efficacies than boys in middle school. However, it is noted to dwindle off in higher school, as reported by Chan (2022) and Weisgram & Bigler (2006). It can be said, however, that most of the girls interviewed were very confident in their science abilities and sounded determined to achieve their target grades in science. This showed that their self-efficacy in the subject was generally high. Furthermore, the participants' GCSE results show that girls match the boys' attainment. 40% of girls in the study achieved their target grades against 40% of boys (See Figure 7.2), which also tells the story of high science efficacy amongst some girls. The chart

shows the participants' GCSE grades, and gender shows no gender barrier toward students' GCSE performances in science, as girls had more top grades than boys in the study. However, when proposing the question, how many of you see science in your future? Five out of the eleven girls asked said they saw science in their futures, which makes only 25% of the participants. In the UK, girls have traditionally matched boys in attainment in science GCSE but do not proceed to match them in admissions into science-based careers, especially engineering and physical sciences. However, the results do not account specifically for working-class students (Sutton Trust 2019; UCAS, 2015). This gap between GCSE and further education seems to be where boys overtake girls in science, and it is not due to their lack of ability in science but their outlook or perceptions of themselves in science (Archer *et al.* , 2015, 2017).

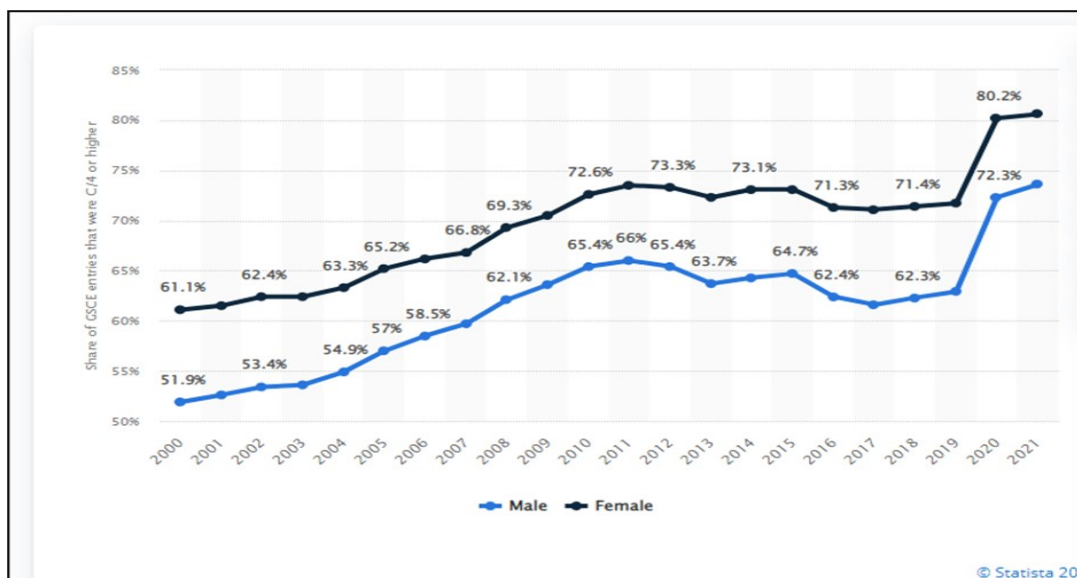


Figure 7.2 GCSE results between males and females in UK(2000-2021).

Cultural messaging about girls' science efficacy can be detrimental to science outcomes for girls. This messaging can also be found in schools and classrooms, as the research suggests, through peers and teachers alike indirectly portraying boys as more suited to science than girls (Bian *et al.* , 2017; Miller *et al.* , 2014). An example of such messaging was found in some responses when asked, "Are boys better at science than girls?"

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The response was.

“I think the boys are better at science than the girls, just because they are more resilient”, DO (**female, Science teacher**).

Another student's response was,

“I think boys answer more questions, so maybe yes, they are better”, TB (**male, set 2**).

TB's view was that he saw more engagement from the boys, which to him meant more understanding of the subject, thus reflecting his opinion, while the teacher did feel boys had the required resilience to be more successful in science than girls. Both views are different forms of messaging that ultimately come together to construct science as masculine; as such, girls might not be as successful in the subject. This view is supported by the research from Bian et al. (2017) and Markova (2015), who both argue that girls often do not like to rate themselves as smart as boys would and come off as shy, introverted, or slow, but this is not often the case. They are also better at hiding their efficacies and downplaying their abilities publicly, often showing their true abilities in examinations (Halpern, 2007).

Despite the scientific efficacy of most girls in some communities, girls are still often portrayed as fragile, unskilled, and a poor fit for tackling anything within the field of science. This may discourage girls from wanting to participate and prove themselves to be a right fit in a male-dominated field (Science News, 2015). The good educational outcomes for the girls in the study add to the mystery behind the unequal participation of girls in science compared to boys. Perhaps having more role models and highlighting women's achievements in science may change perceptions of male dominance in science.

### **7.3 Motivation**

The notion of motivation encompasses a robust inclination to participate in a specific endeavour. It is the process that drives, selects, and directs goals and behaviours (Dweck et al. , 2023). In the context of this inquiry, the emphasis was placed on evaluating the extent of enthusiasm exhibited by pupils towards the discipline of science, to elucidate the underlying causes for the inadequate

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academic performance of select WCWBS in this field. It was found that some working-class individuals had many barriers that were not fostering motivation in education generally. The average working-class student can face a wide range of problems that can be obstacles, potentially having a knock-on effect on their motivation in school. These problems may range from lack of educational resources, financial insecurity, lack of role models, and housing type as deduced from the study. Most working-class students facing the above issues find it difficult to stay motivated for long as one problem after another keeps weighing them down (Richman et al. , 2020).

This theme clearly captured what the teacher's opinions were regarding what they felt WCWB students lacked the most. Motivation was what some teachers believed affected students' effort, zeal, and a thirst for knowledge. Some of the teachers believed ability was not in question for some of the WCWBS but rather the absence of interest and motivation. This lack of motivation, however, was reportedly more prominent among boys than girls. Martin et al. (2004) study, however, reports that there is no difference in achievement amongst the genders, even though girls seem to express more motivation than boys. Some of the comments teachers made that led to the adoption are.

“Some of the WCWBS are very bright but do not make an effort, especially the boys”, SC (male, science teacher).

“They often need that constant reassurance to complete work, so highly demotivated but the girls seem to be better than the boys”, NS (male, science teacher).

Some girls interviewed subtly confirmed this by stating that their teachers encouraged them to complete work even when they were not particularly motivated to do so but they obliged. Others claimed that fear of reappraisals, such as detentions, motivated them to continue with their science tasks even when they had no interest in doing so. This motivation by fear is disputed by the works of Jackson (2017) who posits that these working-class students are not demotivated but are rather trying to protect themselves against ridicule in the school system that only recognises formal achievements. In another view, Pomerantz et al. (2002) propose that females from working-class backgrounds often set higher motivational goals for themselves, which is often associated

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with the desire to please adults, such as parents and teachers. Boys, on the other hand, were often less motivated to succeed without more material interest or incentives. Data show that a majority of these students, who claimed to be less motivated in science, also had poor overall GCSE science grades. (i.e., BG, NS, SC, and LC. See table 2). This is supported by Steele (1997), who observed that identity and motivation can shape academic performance amongst students from disadvantaged backgrounds. However, Yosso et al . (2009) caution that the motivation of working-class students is multi-layered, and no one factor can be said to have an influence on it.

This lack of motivation can also be expressed as a lazy attitude toward schoolwork, as noted by several teachers interviewed. A few examples are.

“I don’t see a thirst for knowledge in the White British students that I have come across”, OO (teacher).

Another claimed, “They do not want to do any extra work, no zeal” AG (teacher).

These comments show a combination of a lack of effort as a barrier responsible for the students’ unsatisfactory performances, as similarly reported in a study by Hidi & Harackiewicz (2000). This view was also supported by Galloway et al. (1998) and Martin et al. (2000), who have all established that motivation in a subject is often associated with students’ engagement, effort, and subsequent positive academic performance and vice versa. Whether students in this research are motivated or not, it is clear from previous studies that motivation is a key part of what is an essential requirement for academic success among students (Martin et al ., 2000). The next subsections will outline the various factors that participants noted as influencing their motivation in studying science.

### **7.3.1 Motivation and ability**

Ryan & Deci (2000) argue that successful academic performance increases motivation in that subject area or endeavour. Being good at something gives students confidence to engage in the subject and also raises interest in the area. When students perform well, it also gives them the perseverance needed

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when they face a challenge. If they feel their ability is in question, they tend to become demotivated. This notion is supported by the work of Garon-Carrier et al . (2015), who evaluated this idea on elementary students and their motivation in mathematics, finding that students who felt they were able were more motivated than those who questioned their ability in the subject. In response to “Do you feel you are doing well in science?” Some of the students’ responses reflected mainly their perceived abilities in the subject.

**LA (female, set 1, phase 2)** responded:

”I am doing well. I have not had bad grades. Science is very interesting, and it is one of those subjects I have good grades in.”

Similarly, **MK (male, set 1, phase 2)** responded:

” For sure, I know I am doing well because I have improved in my biology to a grade 8 and now, I am very secure in all my target grades”.

On the other hand, some students who were not as motivated with science said:

“No, miss, Science is very difficult for me. I am afraid I will not achieve my target grade. I just do not get most of the stuff straight away, so I get bored”, BG (set 2, phase 2)

These responses show that ability is a vital component that can aid motivation. If a student maintains a belief that their learning capacity is limited or feels unlikely to achieve success, their academic motivation will be negatively impacted (Pintrich, 2004). Motivation matters because the way students think of their capabilities to learn can influence how motivated or interested they are towards a subject (Barry, 2007; Murray, 2011). Motivation can be extrinsic or intrinsic, both types of motivation whether intrinsic or extrinsic can be effective in driving student success, but intrinsic motivation is claimed to be more long-term because it is directly linked to how much a student wants to succeed in a particular thing and the inward determination to overcome obstacles (Deil-Amen et al. , 2002). Although intrinsic abilities may contribute to one's aptitude for science, effort and hard work are frequently the most crucial elements in finding success in the area. The data also suggest that these students already feel a sense of defeat with science and so lack the zeal to try. BG claims he gets

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bored and gives up, unlike LA and MK, who sound confident and motivated about science because of their continued good grades, which in a way reflects their ability in the subject. Wigfield et al . (2000) in their research suggest you can accomplish a positive science aptitude in a number of ways, including through reading, attending lectures, working through practice issues, running experiments, and taking part in research projects. Overall, ability tends to increase with motivation. Higher degrees of motivation are typically linked to higher levels of ability since the two variables have a positive correlation (Locke et al , 2002). The relationship between the two variables does, however, exhibit some individual variation as some persons may have high ability levels without high levels of drive, or vice versa. The relationship between motivation and ability can also be affected by other factors, such as outside resources and support, which can tip the motivational scale either way (Ryan et al , 2000).

Ability grouping has the potential to offer notably motivational benefits for students by recognizing and nurturing their academic strengths within specific groups. The data highlights a clear opportunity for improvement: 54 percent of working-class students in higher ability groups successfully achieved their target grades, while only 29 percent of those in lower sets did the same. This suggests that thoughtful placement can greatly enhance students' engagement, confidence, and overall performance. Research by Ireson et al . (2002) sheds light on the importance of these dynamics. They note that students placed in lower sets often internalise negative perceptions about their academic potential, which can diminish their self-belief and motivation. This can create a cycle where their views of their abilities become self-fulfilling. Conversely, students in higher sets experience a positive reinforcement effect; being assigned to a top group typically boosts their motivation, fosters a strong academic identity, and promotes persistence. While ability grouping can effectively support student performance particularly for those already excelling or benefiting from the prestige of top-set placement it's essential to recognize that these advantages are not universally accessed. Students who struggle to meet their target grades or find themselves in lower sets may benefit from additional support, targeted interventions, and adaptable teaching strategies. By adopting a more responsive approach that acknowledges and addresses these diverse needs,

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schools can strike a balance between the benefits of ability grouping and a commitment to equity and inclusive practices. This way, we can create an environment where all students have the opportunity to thrive. Other factors, therefore, may be responsible for the poor results, which would be explored in the next section.

### **7.3.2 Subject structure and motivation**

All students, regardless of socio-economic status, need to find the science curriculum to be relevant to them. Regardless of the students' future job objectives, the curriculum should offer a variety of scientific topics and abilities and skills that are crucial for them to master. However, literature on the science curriculum structure in regard to working-class students has been hypothesised to be one of the barriers in decreasing students' subject motivation in the Elton Report (1989). This was further supported by the DFE (2003) and Charlton et al. (2004), who all argue that the streamlining of the national curriculum will further have a deleterious effect on pupils' view of schooling and might have a far-reaching negative effect on working-class students. This argument is consistent with that put forward by Vulliamy & Webb (2003) and Morris (1996) that the introduction of the new National curriculum increased the perceived irrelevance of school for many students and decreased motivation, especially amongst working-class students. This may be attributed to the fact that working-class students often prefer more vocational and skilled subjects that seem inclusive and relevant to them than the traditional academic-based route, which is not readily available for them in most schools (Herbault, 2022, Aschbacher *et al* 2010 ). This view supported the students' interview data. The majority of the students were demotivated, especially by the physics curriculum, which they found difficult and quite abstract. Most felt that they could not connect with the subject.

“Some topics, I just do not understand why we are learning them, especially in physics. Fleming's left-hand rule, for example, what is that? And it is so much”, DZ (male, set 1, phase 2).

Another student said,

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“Physics just spoils everything. We have six units to learn in one subject. It is so confusing and boring”, BG (male, set 2, phase 2).

. Unrelated physics topics were demotivating for BG and DZ. Similar complaints regarding the abstract character of physics concepts and their applicability to real-world situations were also made by most students in the focus groups. This may have an impact on how students feel about their education overall, and how motivated they are to learn in the subject. In a similar study, Nash (2002) advocates that subject content should be tailored to the relatable life experiences of students to boost motivation. However, Young (2018), on the contrary, claims this will limit subjects and will not help students open their minds to broader horizons and opinions. He further asserted that lived experiences are not always going to be relevant for most science topics, but the students may gain other skills, like problem solving, indirectly. Chemistry also had a few negative complaints and questions on relevance from the students. They claimed the abstract chemistry topics, as expressed by CA and JB, were by far out of date and scope.

“Chemistry is long and all the ionic stuff in every unit is unbearable. I cannot get the point sometimes”, CA (**set 2, focus group, phase 2**)

**JB (set 1, phase 2)** said:

“I would say chemistry is the deal breaker for me. All the equations and formulas, then the history of every scientist, is not easy to remember or interesting.”

Others made favourable or neutral remarks regarding chemistry. Obviously, this view and level of engagement with the subject were shaped by its practical aspect. Chemistry may allegedly be taught in a practical and engaging manner by employing experiments and demonstrations that highlight chemical reactions and phenomena in the real world which might serve as an attraction for some students. It is also possible that others may link the role of chemistry in routine tasks like cooking, cleaning, and medicine using this approach. On the positive side, students enjoyed the biology curriculum. Most students claimed they felt biology was the most relevant science subject of the three.

“I can relate with biology topics because it’s about nature and living systems and how it all works”, **CO (focus group 2, phase 2)**

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“I think biology is the one that I can understand, no matter how wide it is, I can read it and understand”, **GB (focus group 1, phase 2)**

CM and GB, amongst others, felt biology was more relatable because it dealt with the study of life and living things, including humans. Biology is frequently thought to be more approachable for pupils (Salmi, 2018). It may be possible that this relatability with living processes enabled them to connect and understand better how they work, making the subject of biology interesting.

The three science subjects show varied responses and affinity. Data reveals a higher engagement and motivation to do well in biology than in chemistry or physics. This may be the abstract nature of its content (i.e., chemistry and physics), while biology is more relatable. Although Bourdieu’s work did not directly talk about the relationships the various science subjects had on motivation, it was clear to ascribe his thought on science being a “loci for competitive struggle” (Bourdieu, 1975, p19) for the working-class student because it operates a culture opposite to their interest, language, and future career ambitions.

### **7.3.3 Motivation and future careers**

A student's motivation is a critical aspect in determining their academic achievement and can have a big impact on their chances for a successful career. Students who are motivated, especially intrinsically, are more likely to persevere in school and be successful. Also, they are more likely to participate in extracurricular activities, internships, and other forms of experiential learning that can aid them in developing knowledge and experience pertinent to their future careers (National Bureau of Economic Research, 2009). It was believed that inspiring pupils to learn and persevere in courses like science, which were perceived to be challenging, depended on their perception of the utilization of the knowledge at the end of the qualifications (Pajares, 1996). The research showed some students that seemed to have high motivations related this to prospective future science careers they had envisioned for themselves. Statements like the following showed high motivation linked to future career prospects from some participants:

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“I know science is difficult sometimes especially for me, physics but I need physics to get into engineering apprenticeship”, **SC, (female, set 1, phase 1).**

Similarly, another student said,

“I see science in my future, and I want to do my best to become a forensic scientist”, **KH (female, set 1, phase 1).**

This is consistent with the findings of Anderman & Maehr (1994), who assert that motivation influences students' decisions about their future educational and professional aspirations. In the case of SC, who appeared to struggle with physics but was motivated to overcome the fear of it because she recognized that she required physics to reach her engineering objective, this motivation, tied to a purpose, seems to be the reason some students persevered until the finish line. A striking statement from another respondent on her interest and motivation in science said:

“Oh yes, I feel science is important because it changes the world. The doctors working to save lives during this pandemic are all science, and I want to one day be part of that. I want to be a person who one day treats cancer”, **BL (female, focus group, phase 1).**

Another said:

“Scientists are paid well and respected. I do not mind working hard and having a good job, though in the end”, **JT (male, focus group, phase 1).**

These two students are convinced that science plays an important role in society and in their prospective futures. This has encouraged commitment, engagement, and motivation to succeed in the subject from them, despite admitting earlier the difficulties of science. Unpacking the motivation of these students is important in discussing their science experiences. The above discourse shows that the students' perception of their future career choices regulates their science motivations and expectations of themselves (Bourdieu and Wacquant, 2007). Justin and Beloved seem to link their motivations to be committed to science to its importance to their future ambitions. They are clear about science being a part of their future and their readiness to work hard to achieve it. This claim is supported by Stahl (2013), who claims that the future

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value placed on an educational pathway will determine the level of motivation and commitment from someone towards it. This further goes to confirm that a student's future career choice, like in the case of BL or JT, which is linked to science, does have a role to play in motivating the student to work towards achieving good grades in science. Kohn (2017), however, challenges this view that motivation improves academic performance and rather advocates self-motivation and determination exclusive of external influences. Students who lack motivation can miss out on various opportunities and limit themselves to enjoying a well-rounded education and potential for a future job in any scientific area. Bourdieu (1997) claims we are part of our environment and that our attitude towards life, motivations, and norms will often be created around it and will be passed on to those around us. The importance of family background and how this relates to regulating students' motivation is discussed in the next section.

#### **7.3.4 Motivation and family background**

A student's family environment can have a big impact on how motivated they are as individuals. Most of what we deem important or not is inherent in our family values and norms. Students' motivations therefore can also possibly be impacted by a variety of home variables, including their parents' educational background, socio-economic status, parenting style, and family dynamics as these are more likely to be external drivers that propel academic success (DFE, 2015). The educational level parents possess has been confirmed to have a big impact on how motivated and successful their children are in school, according to research that has been done repeatedly (Sutton Trust, 2019). This is because they have a higher propensity to help their children's education by offering materials and encouragement that can improve learning and a greater level of expectation. Bourdieu's theory alludes to this as built-up capital that can be passed on to their children to possess.

The interview data demonstrate how these WCWB students believe they fit into the school or scientific field through a number of favourable or unfavourable contacts and experiences of people who are close to them and have had an effect on their lives (Cheung et al , 2012).

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ZS (**Female, set 1, phase 1**) said:

“My sisters all encourage me in science. They all are studying one science or another.”

“Likewise, SR (**male, set 1, phase 1**) who said:” My father works in science, so science has always been around my family”.

There were also others whose circumstances were probably a demotivating factor towards science, such as TB (**male, set 2, phase 1**), who said:

“Nobody in my family has done well in science. My parents say science was difficult for them and they never liked it. My brothers, too.”

Unlike TB’s situation above, ZS and SR appear to have been inspired by a successful family member who had already endured the rigours of studying science and has thus provided them with some encouragement and a road map for success. In TB’s case, though, both his parents and siblings believe they were not very good at science; consequently, he believes it is not surprising that he has simply become like them. This has a negative impact on his motivation to succeed in this scientific sector.

According to Bourdieu (1990), the idea of reproduction refers to this part of culture or experiences that are passed down via families to provide some groups or individuals an advantage or a disadvantage. This theory can be said to be applied in the above case with these students. I similarly concur with Hill et al. (2007) that students perform better if they receive a lot of encouragement about their scientific aptitude from their families. It also demonstrates how interactions with family members or personal experiences of some family members can have a beneficial or negative impact on students’ motivation. Their socio-economic background can also notably impact a student’s motivation and academic success, according to research that has been conducted repeatedly. NFER (2017), EEF (2018), and OECD (2017) show that students from higher socio-economic backgrounds have more cultural and science capital to achieve better than those from lower backgrounds. This is suggested to contribute to better performance and motivation. Academic progress of students from low SES communities is often adversely affected by a range of hurdles and challenges in school that their well-off peers do not

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experience. These multi-layered factors also inversely affect their motivation and zeal for learning. All of the participants from the data come from homes with low IDACI scores and are on FSM, showing a lack of basic resources that might be a hindrance to their academic outputs. Also, paid trip opportunities in schools might be missed because of financial reasons, which continues to build a cycle of inequality amongst these groups of children. Moving away from family background and looking at a more extrinsic factor that has been recurring in the data is teachers' input on motivation. The next section will unpick teachers' pedagogy and how it impacts students' motivation towards science.

### **7.3.5 Motivation and teachers' pedagogy**

Teachers, as one would suggest, play important roles in the lives of the students they teach. Kipris (2011) agrees and argues that teachers are more important than family background in fostering students' motivation, partly because students spend a great amount of time in school. This means having more time to engage with students and building positive, secure learning environments. Students who experience close relationships with teachers and peers within a supportive school community are said to report more positive feelings about school or the subject. This safe base may motivate students to engage in activities relating to the subject the teacher teaches (Hughes and Kwok, 2007) Some comments from the participants that alluded to the claim include one from ZS and ML.

“My understanding of science really depends on the teacher. Some teachers explain things very well and you understand straight away, others make it difficult and sometimes even more complicated. So, the teacher affects how I understand science”,  
**ZS (female, set 1, phase 1)**

Another said:” I was not fondest of science. But this particular year of having a good teacher changed that”, **ML (male, focus group, phase 1).**

ML when probed further added:” I do not know, just the way she explained stuff made it look so easy and interesting, now I enjoy science.” **ML (male, focus group, phase 1).**

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ZS and ML both link their motivation in science with their teacher's style of teaching. They claim that the enthusiastic way their science teacher teaches, and the illustrations given in lessons make the lessons very inspiring and motivate them to do better. These interactions between teacher and students are suggested to help in building students' motivation, as was noticed in the study with the relationship ZS and ML had with their science teachers. Indeed, studies have shown that students' relationship with teachers is strongly associated with academic motivation and positive self-concept (Skinner & Belmont, 1993; Watson & Baltistich, 2006) Ozek & Cortore (2012) support the idea that teachers' effectiveness in classrooms can have a positive or detrimental effect on students' motivation in science. Other participants also mentioned their teachers as their science motivation.

MK (**male, set 1, phase 2**) commented about his science experience as: "I think I have had a great relationship with both my science teachers, which is great because if I did not, I probably would not be in triple science. They have kept me focused and encouraged me to be better."

"Also, another student claimed. "My science teachers have always kept me very encouraged and always supportive", **SL (female, focus group, phase 2)**.

SL and MK's experiences show they have a good relationship with their science teachers and depend on their trusted feedback to keep them focused on the course. This view is further supported by Caballero (2010), who posits that students who have a good rapport with their teachers usually show a higher participation level with the subject.

The COVID-19 lockdown period, when schools were closed, however, had a negative effect on some students who missed having physical face-to-face lessons with their teachers. Some of these anxieties were expressed by GB, JB, and SB below:

"The lockdown period was difficult to study, I have come to respect and value my teachers more now", **GB (female, focus group, phase 2)**

JB recounted:

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“Remote learning from home was harder. I preferred having my teachers there to encourage and keep me focused. There was too much distraction at home, and my mom could not help me either”, **JB (male, set 1, phase 2)**

Likewise, SH said, “I actually missed my teacher’s banter, I did feel the difference of studying remotely”, **SH (set 1, phase 2)**.

These students’ remarks demonstrated the heavy reliance on teachers that the majority of participants had, as well as how the Covid-19 lockdown period affected the student-teacher connection because of the students’ distant learning requirements during the period of isolation. This clearly shows that teachers can have an effect on students’ motivation, resilience, and participation in a subject. However, on the contrary, a minority of students have discovered that the adaptability and independence of distance learning can actually boost their desire to learn. A few examples were:

**DB (female, set 1, phase 2)** describes her experience.

“I enjoyed studying on my own. I did a lot of research and mind mapping the way I usually like it and there was no rush.

“Similarly, **KM (male, set 2, phase 2)** said, “I preferred remote learning. I had time to work at my pace and not feel stressed.”

These two students did not seem to be affected by not having their teachers physically in classrooms. This shows some form of intrinsic motivation that kept them focused on their study of science.

The effect of the COVID-19 lockdowns on students’ motivation to learn varied based on their unique personal circumstances, such as home conditions, learning styles, among other things. The pandemic has undoubtedly disturbed conventional schooling and relationships that were formed. It has effectively made it evident that fresh methods of teaching and learning are required to keep students’ motivation high if there is a similar recurrence in the future (DFE, 2021).

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## 7.4 Students' value of science

In this study the priority that the participants accorded to science as a subject would hereby represent the value of science. Value is described as the degree of significance to a person or that an item or task has importance (Eccles & Wigfield, 2002). The data from the study shows most of the participants felt very positive about science and revealed that science was integral in most inventions, innovations, and modern-day living styles. They also acknowledged that science was valuable to society and life in general. However, there were mixed feelings about individual subjects, such as physics, which the majority of the participants felt they could not connect with, mainly because of its abstract nature and how it barely connects with their present lives. Due to this, some participants felt that the science curriculum needed to be adapted to be reflective of society, real-life applications, and, as such, attract more interest and engagement in the subject.

When participants were asked, "What is your view of science"? Here are a few responses:

"Science has a very interesting combination. I think science is a very radical subject. Science is really not only important but also really fun and relevant", **LA (female, set 1, phase 2)**.

"I think science is important. I just feel physics as a subject is not", **FW (male, set 1, phase 2)**.

Another student said, "The science curriculum is very boring and not interesting even though it has important stuff. Most physics, however, is irrelevant to me. I hope it can be modified in future", **DZ (male, set 1, phase 2)**.

LA, FW, and DZ all feel science is important, but some aspects are not very relevant to them. DZ earlier had complained about physics and how some aspects he felt were boring and abstract. He was not alone in thinking this way as a few others had the same disaffection for physics as an abstract science as mentioned in earlier chapters. The nature of the different science subjects overwhelmingly had a lot to do with the students' view of science. Most students responded positively to biology being the easiest science subject, whilst chemistry and physics were viewed a bit more negatively.

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” Biology is just straightforward”, **JA (female, focus group, phase 1)**, And another said: “Yes, miss, Biology is about life, and we can relate to that easily”, **PT (male, focus group, phase 1)**.

The conversations around the value they placed on science touched mainly about what the students could relate with. Most believed science was important but ‘school science’ was more about what the school wanted students to learn.

“I think they want us to learn certain things about how stuff was made and all, but I feel they should keep it fun and at a minimum because not everyone wants to be a scientist”, **LE (male, focus group, phase 1)**.

On the other hand, most students found physics difficult because they associated it with mathematics which some of them claimed they already struggled with.

“Physics involves a lot of calculations which I am not good at”, **DA (female, focus group, phase 1)**.

Chemistry was the middle ground for most students who found only the practical parts interesting. The data, therefore, seems to suggest that most students engaged more with biology than any other science subject. This was similarly echoed amongst both boys and girls and supports the data from the science questionnaires. This finding is supported by the works of Sheldrake et al. (2014) and the TIMMS report (2015), who found that most students, regardless of their backgrounds, liked science, but their confidence in certain aspects, like physics, was the lowest amongst the three science subjects studied. A possible explanation for the disparity in science value and subsequent affiliation can, as mentioned earlier, be linked mainly to the student’s future science career. All students who had a positive view of science wanted a career in the future with science. Others seem to want to chart another career path, hence their disinterest. Various studies have established that career choice has a positive correlation with students’ value of science (Galloway et al. , 1998; Martin et al. , 2000; and Wigfield, 2002). On the contrary, Hidi & Harackiewicz (2000) in their work propose otherwise and judge that the lack of ability and attitude is the biggest factor that influences students’ value of science. Most participants had a positive attitude to science, as such expressed in their science experiences. The study, hence, is at variance with

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Hidi et al. (2000) There may be several other things suggested that might shape one's science experience; people's experiences are very different, and the outcomes will determine one's attitude and response to the subject. A belief that science may help solve practical issues and enhance people's lives is a common source of positive attitudes towards science. Individuals with a positive attitude towards science may also be curious about learning new things, exploring scientific concepts, and conducting experiments, as observed in this study. On the other hand, many unfavourable views of science, as seen in the research, stem from a lack of interest and the perceived irrelevance of the taught science to the students' immediate lives. This measure of relevance and importance within the respondent's sphere of operation seems to scale their value of science. Cultural perspectives on science might also influence an individual's mindset. For instance, some cultures could place great importance on conventional wisdom and beliefs, which can lead people to believe that science is at odds with these ideals (Maltese & Tai, 2011). However, this view did not seem to be reflected in the study.

#### **7.4.1 Girls, science and intersectionality effect**

Intersectionality is the concept that all forms of disadvantage are interlinked to cause disadvantage to an individual (Crenshaw, 1991). This includes the interconnected nature of several social categorizations, such as race, gender, disability, class, age, or ethnicity. Intersectionality also highlights the ways in which several factors interact with other social identities to give certain people different privileges, experiences, and oppressions while others benefit (Rogers et al., 2021).

Gender and intersectionality seem to be closely related factors that contribute to diverse social stratification and inequality in society (McCall, 2005). Over the years, it has generated debates on how it affects women, particularly girls, in different sectors. Crenshaw (1989) recognized the intersectional nature of these social identities in her work. She argued that understanding the various layers

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of intersectionality will help in policy initiatives and discrimination from those groups marginalized.

Science identity has predominantly been viewed as male throughout history, and therefore, this bias keeps the female students at a disadvantaged starting position (Staats, 2016). The working-class girl studying science can be viewed as disadvantaged, as the societal norms in which they exist and live mostly prefer male figures instead of females engaging with science, particularly in physical science careers (Godec, 2018). Working-class girls face various interlocking systems of power in their lives that shape their scientific constructs. Their backgrounds, abilities, science stereotypes, schools, science subjects, teachers, and peers shape the unique science participation of these working-class girls, as these variables often influence their science aspirations. In the research, several of these factors were identified as affecting WCWB girls' science achievements. These included social class, ability groups, science subjects, and career choices.

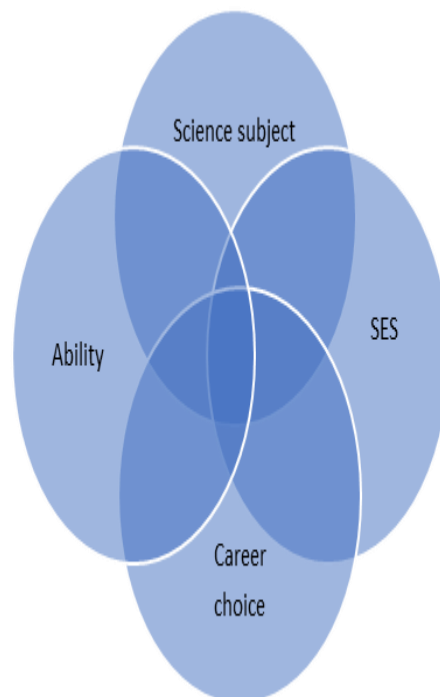


Figure 7.3 Intersecting factors affecting WCWB girls in science

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These factors (See figure 7.3) overlap and create disadvantages that can affect each student differently and cumulatively harm the girls' engagement, perceptions, and attainment more than the boys. This is because more of the aforementioned factors are discriminatory towards girls, as such, not encouraging science participation, while it is creating the opposite effect for the boys. One specific location on the interface can determine one's experience in science (Gross et al. , 2016). These intersections include science subject, ability group, social class, and career choice, which will be addressed in more depth in the next sections.

The type of science subjects was the first intersectional layer of disadvantage observed that affected girls in the study. Data from the research shows biology was preferred by girls, whilst physics was more sought after by boys. This means any girl favourably inclined to be interested in physics as a career choice might feel marginalised or in the minority, which might make them uncomfortable, lose interest, or may finally drop out. All female participants preferred biology to physics and reported that physics was more abstract, more difficult, less relevant, and more masculine. However, some students like Shannon, Lena and Kelsey all said they could still have good grades in physics. This incompatibility with physical science for girls may not be a matter of ability, but rather a mindset or social problem. This is supported by the work of Francis (2000), who posits that girls are more averse to physics but more favourable to biology. In the study, most girls said they would rather choose biology than physics because they deemed physics more masculine. This is supported by Moote et al. , who found that only 23% of girls surveyed in the ASPIRES 2 ( 2020) project would take up A-level physics; others who met the course criteria dropped physics because they felt it was masculine, not because it was difficult. A similar pattern of girls aligning more with biology was noted amongst the participants. According to Ayalom (1995) and Osborne et al. (2001), Biology and other life sciences have slowly emerged over time as a feminine niche in science, thereby slowly eliminating or restricting females from physical sciences like engineering involving chemistry and physics. This apathy for physics can affect their overall attainment in the subject or aspirations for a future career in that area of science.

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In some secondary schools, students are designated into teaching groups according to their ability, often using their key stage 2 results (DFE, 2019). These teaching groups ultimately determine the tier level of GCSE a student would be entered for during the final examinations. A high-ability group student (usually set 1) would have the opportunity to take a higher-tier paper in science, having the advantage of achieving a level 5 to 9 grade at GCSE (equivalent to the old B-A\*). On the other hand, a lower ability set (typically sets 2 & 3) students can only take a foundation paper, limiting their achievement to a level 5 pass grade as the highest achievement (old C grade). This invariably means students' grades from these various groups are already capped according to their ability groups.

Often, the child's best interest is supposed to be considered in determining which tier would give the student the most benefit. This call is left at the discretion of teachers, which is subject to bias if checks are not properly placed to counter this by schools (Baird *et al.* , 2001; Ofqual, 2017). This liberty makes students from disadvantaged communities vulnerable to being marginalised or discriminated against as they may be seen as lacking the prerequisite resources to be selected (Dewitt, 2015).

In this study, more boys than girls were in the high ability set 1; therefore, the girls have another layer of academic disadvantage against them. This means girls in set 2 (lower ability class) would be eliminated from pursuing a science career because their grades would be limited to a particular grade, even before they attempt the examinations. Elwood & Lundry (2010) suggest that these tiering restrictions for exams for particular students can hurt their self-confidence. They also found that their teachers disproportionately placed girls into the foundation tier for Maths and STEM subjects due to a lack of confidence. Also, Strand (2007) found a similar trend for exam entries for certain ethnicities, mainly placed in lower foundation sets.

On another note, most working-class students often do not see being clever in school or “geek” as being fashionable or much valued by their peers and family, and as such do not give much to counter the narrative (Moote *et al.* , 2020). When asked if they were good at science, most of the girls answered

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negatively, even though some were in a higher-ability science class and had good science grades. An example of such a response was from Lena.

“I am not sure, miss, maybe not fantastic” LA (set 1).

This suggests that LA sees herself as not as brilliant as others in her class, even though data shows she had top grades in science with grades 8,9, 8 (old A, A\*, A, see table 3) in biology, chemistry, and physics, respectively. This notion of not wanting to appear brilliant might have been acquired early. She mentioned in a previous interview that her parents did not want her to become an engineer because they felt it was for men. This might have to do with the notion of gendered brilliance as supported by the works of Bain et al. (2017) and Schunk (2002), in which certain students from affluent backgrounds and genders are supposed to be intelligent, whilst others are not, because their background does not support it.

Science efficacy, therefore, is important in developing students' choices, interest, persistence, and subject attainment, especially girls, as it affects how they assert their full potential in the area if they are not determined. This unconscious self-elimination is another layer of barrier that the working-class girl will face in her pursuit of attainment in science. The stereotype of associating boys but not girls with brilliance, genius, or ability may account for girls veering away from subjects that society has associated as being masculine (Meyer et al. , 2015).

Coming from a working-class background often comes with its perceptions of gender roles and limitations for the white working-class girl who is typically expected to engage in subjects that are family-oriented or 'girly' (Godec 2018; Gupta 2006) .Archer et al. (2015) have argued that science is perceived by most of the working-class community as not girly, sexy, or glamorous, which they often associate with girls. This, coupled with the label of geek, has made science undesirable for most girls.

Often, most students assign themselves roles that are reflected by family, friends, and their cultures or communities (Blakemore, 2003). They also tend to have lower science capital, making it further challenging to view science as

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something for “people like them” to pursue (Brickhouse et al , 2000) Identification with science has been argued to be additionally complicated by ethnicity, which presents an added barrier for most working-class girls in science (Godec, 2017). Research has also shown that working-class girls might struggle with the discourse of femininity, which excludes science (Archer, 2013).

Only two of the girls interviewed had a person in their families who had any science in their background, which also created another disadvantage for girls, as they lost out on science capital that could be accrued from family members. On the other hand, working-class boys who come from similar backgrounds had the advantage of several external influences that helped them to build up their science capital because they saw themselves represented in textbooks, in the media as great scientists, coupled with teacher support, which, over time, cancels out the social class barriers for them. This subsequently improved the science capital of most boys and their involvement in science compared to their female counterparts. This shows the intersectionality effect on girls more than on boys. Studies by Campbell (2015) and Archer et al. (2012) made similar observations that boys have more societal norms, values, and expectations that support their relationship with science than girls. This was noted to be conveyed through text, media, and readily available male role models.

Science careers can affect students' science attainment. Career expectations often reflect perceived barriers, opportunities, social stereotypes, and gender-specific ability perceptions (Sax et al ., 2013; Thomas, 2015). These perceptions may often not be a true reflection of ability but more of what the student feels is acceptable or suitable to their cultures or communities. It also depends on other challenges like school socialization processes and culture (O'Brien et al. , 2015) Although socialization experiences influence both genders, it is presumed to have a greater effect on girls than boys because it tends to restrict their options and academic pursuits more than boys (Kong et al. 2023; Wang et al. 2013). The research reflected most of the common underlying factors that seem to influence most girls' science choices. Also, girls are more likely to have role models in traditionally female occupations, such as

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education, nursing, or social work, than in engineering and computer science. (“Gender and Careers Development Research”). This was previously deliberated fully in section 6.5.1.

Finally, the extent to which some girls are endeared to their communities’ norms will affect students’ biases towards different science career choices. This was seen in the research participants who felt specific STEM courses were unsuitable for them but could not fully explain why they thought so. The boys, however, did not have the same pressures in determining what type of science careers they could aspire to study, as societal and cultural norms gave them a greater sense of possibility. Some scholars, however, did acknowledge that intersectionality can affect boys, especially around factors like race, ethnicity, and disability (Kaur et al. , 2019; Villegas et al. , 2017).

The research acknowledges that the working-class girls inhabit multiple social identities with intersectional layers of disadvantage for them. This has impacted their future career prospects in science and, in some cases, their science attainment. Using the intersectionality lens (Crenshaw, 2019) to analyse this data shows four main intersecting factors of gender, ability group, future career, social class, and science subject may contribute to affecting the output from girls compared to boys.

CM, one of the participants, for instance, is a girl from a working-class background and has no relatives who have had a science-related career; she is in a lower science ability set, which hinders her from obtaining a high GCSE grade and so is already excluded from pursuing a science-related career that might require higher pass grades for admission. She also does not feel confident about pursuing a career in science as she only likes biology (not chemistry and physics) She also does not have much encouragement from home, likely sees more male role models in science than female, did not attend STEM club and science-related trips, and so has low science capital. This is a typical example that shows how intersectionality affects female working-class students more than boys, who are more favoured by teachers to be in a high ability group, thus have a higher chance of having a top grade required to pursue a science career, may not have relatives in science careers but observe

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male scientists through media, school, and books. Also, boys are more likely to attend STEM clubs and science trips and build up science capital through these sources.

The perceived gender inequality in science seems to stem from multiple interlinked influences in students' circumstances and future outlooks regarding science. These are often invisible barriers embedded within self-concept, social norms, media perceptions, stereotypes, career choices, and school factors like ability groups and teacher effects, among others. These social constraints were acknowledged as suppressing factors on some of the girls' science potential and attainment. It was also noticed that the most profound difference between boys' and girls' science interests and achievements was found in biology and physics. This dichotomy between biology and physics was noticed in the present research. This dichotomy was found to be common but mostly prevalent amongst working-class students in other studies (Mullis et al. , 2000; Guenaga et al. , 2022).

Also, I argue that students' identities in science were influenced by their gender and self-perceptions, as shown in several instances in the study. Multiple dimensions of gender stereotypes often showed a wide range of effects on girls and how they view themselves within the field, more than on boys. This impacted their identities, self-efficacy, career aspirations, and other science-related opportunities like science trips, interventions, and extra revision sessions (Aki, 2012). For instance, societal expectations and gender roles may deter girls from pursuing science-related careers, diminishing their confidence and enthusiasm in these disciplines.

On the other hand, Rodriquez *et al.* . (2015), in their studies, conclude that these stereotypes are often misleading and can make boys feel overconfident and inclined to feel a sense of entitlement to science careers and jobs because of their perception of science as inherently masculine. The boys can also be self-persuaded to attempt careers in the field even when they lack the skills and qualifications to do so (Rueben et al ., 2014).

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The study also conveys a message of subtle teacher bias towards girls in science as some girls felt they were incapable of making much progress in science. These impacts are often not uniform, so some students will experience the effects more than others, as is revealed in the cases of working-class white British girls in the study compared to the boys. Working-class girls' extensional and intersectional impact and anti-science approach that has formed and has been passed down to them unwittingly can account for their inertia in science. Science identity for girls, therefore, needs to be resolved as a personal matter and needs to be negotiated as such in order for most girls to break the barriers to be successful (Hazari et al. , 2013; Avraamidou, 2020).

It is also important to note that, despite the overlapping barriers, the research data show that girls performed better overall in science GCSE than boys. Nonetheless, girls perceived science as more complex than boys did, again suggesting an air of inferiority. There was, therefore, a disconnect between their results and their self-efficacies. This may be due to the multiple invisible intersecting layers of barriers that they face, which makes them feel inadequate, therefore professing non-science identities for themselves when they genuinely can be successful in science.

## **7.5 Summary**

Students' self-perception of themselves attaining in science seems to give insight into why some participants are confident in engaging with science, whilst others are not. This self-judgment reflects on how they participate, persevere, and show their interest in science. This can also be a result of a lack of support from family, which Bourdieu often argues that we are shaped by conditioned perceptions of our families' habitus. He further reiterates that this habitus is often fixed and, until certain life events occur to provide an opportunity for it to shift, it remains in opposition to the dominant group.

Data from the study also shows that motivational factors like relationships with teachers, future career aspirations, and family backgrounds can greatly increase the level of motivation and perseverance towards science. Surprisingly, the students all had a positive view of science and overwhelmingly

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agreed it was important, but some concluded that the physics aspect was very abstract and difficult for them to connect with. In summary, the participants all had different factors that influenced their motivations, engagement, and value of science. These were mainly dependent on their outlooks on life regarding the subject and on how they considered it relevant to their present and future lives.

The data also indicate that the experiences and scientific achievements of working-class white British girls in science are not solely due to gender or class but are often influenced by how these various identities interact (Boyle et al ., 2023; Archer et al ., 2024).

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## Chapter 8: Influencers

### 8.1 Introduction

This chapter examines the categories of individuals who have notably shaped the participants' scientific perspectives in the investigation. The chapter's overarching theme, labelled "Influencers," explores how these diverse influences shape and direct the pathways through which working-class pupils navigate their involvement with science and subsequent achievement in the field. The majority of these students appear to have encountered a multifaceted blend of academic influences and role model typologies. These influences were frequently socially mediated through the associations these students fostered, primarily within their homes and educational institutions. Pierre Bourdieu (1997), who refers to these relationships and affiliations as social capital, posits that they serve as reservoirs of resources that enable students to develop a particular habitus, a desirable prerequisite for achieving successful outcomes within the academic context.

The present chapter begins by justifying the use of the terminology "influencers" or "role models" to categorize the various factors coded in the data related to motivating students in scientific pursuits. Subsequently, a thorough analysis of these factors was conducted to ascertain the extent to which family, teachers, and career choices have influenced students' scientific values and attainment. These deliberations will be approached from the perspective of Bourdieu's theory of reproduction (2006, 1992, 1997).

The final portion of this chapter shall culminate in a comprehensive summary of the contributions brought forth by these influencers, particularly as it pertains to the advancement of student learning, active participation, and outlook in science. This study contends that the social capital and habitus transmitted by these influencers had a positive impact on the participants' engagement in science and their level of achievement.

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## 8.2 Influencers or role models

In selecting the term "influencers" for this chapter, careful consideration was given to the title to effectively convey any notable changes in students' perceptions of science or factors that maintained their focus on achieving in the field. While various influences were observed in this study, not all could be classified as role models. For instance, future career aspirations were a motivator but did not fully align with the definition of a "role model." Therefore, this chapter will examine both influencers and role models in parallel. That being said, role models are frequently viewed as encouragers, motivators, or as people who have achieved success in a particular field, career, or line of work or passion. This is mainly because of what they seem to have accomplished in their own life that can be imitated or reproduced, which encourages most people to establish similar ambitious goals for themselves Verheul *et al* , 2012) Ibarra & Petriglieri (2008) similarly defined role models as individuals who are successful in a particular career and emulated by those striving to fill a comparable professional role.

During one of the focus group interview sessions, participants were asked, "Do you have any particular role models that have encouraged your science studies over the years"?

There was a bag of mixed responses that seemed important enough to warrant further consideration. A few that stood out seemed to border on how much trust these individuals had in their persons of influence. These were.

"My Mom for sure, she thinks scientists are paid well and are in high demand", **DZ (male, set 1, phase 1)**

Additionally, another student said:

"I think listening to my teachers go on about how important science is and, in the news, makes me want to be a part of that. I do not know, but it is important", **LN (female, set 1, phase 1)**

People they respect or consider reliable sources of information have influenced both of these students. It demonstrates how a collective push for information, whether genuine or false, can influence young people at this developmental period to steer them down a certain path. In these instances, these nods and

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encouragements were positive, indicating that some may also negatively lead people.

The research also shows that other participants mentioned a family member, like ZS and DB, as their influence, whilst MK 's influence was a celebrity he admires and follows online.

” I like the way Brian Cox teaches physics. He has made physics enjoyable for me. I follow him on Instagram and YouTube for a lot of fun stuff”, **MK (male, set 1)**

In MK's case, his role model was a TV personality who made science enjoyable for him. He has seen science through the eyes of Brian Cox as fun! There may be a danger here when science becomes difficult and tedious, as mentioned in the focus group, where key stage 3 (lower-level science) was found to be fun, but key stage 4 (higher-level science) was perceived as boring and difficult. Some students who claim they no longer enjoy science in key stage 4 justify their claims by explaining that it has become too serious and no longer fun. They preferred the lower-key Stage 3 science that involved a lot of science experiments. Being attracted to science for the wrong reasons can also become a disadvantage if not looked at holistically. This fulfils Bandura's (1996) notion of role modelling, which is driven by motivation. The notion of perceived success that we use to choose our role models is widely shared. We tend to view someone as having admirable and valuable qualities that we would like to emulate when they have accomplished something that we deem successful (Haslam, 2004). Affiliation with specific influencers or role models gives behaviour meaning and purpose and increases the drive to emulate or alter their realities (O'Reilly, 1986). These findings align with many of the elements that have either encouraged participants to engage in science and related activities or discouraged them from seeing science as part of their lives, which have been identified as key influencers on the participants' interactions with science. This viewpoint is also backed by the work of Lockwood (2006), who contends that role models may be distant persons not really known to the individual but can change through time so long as they continue to offer a replicable model of success that benefits some disadvantaged groups of individuals. These role models can be relatives, instructors, peers, or even total

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strangers. It is likely that, whether consciously or unconsciously, people, particularly adolescents who look to role models, first observe what these individuals do before attempting to mimic their actions. These role models serve as vital inspiration for what some individuals, often from the working class, believe is truly attainable. Working-class pupils often have extrinsic drive, making them heavily dependent on picturing successful individuals, firstly among their own type, before they buy into the concept of success in the area (Zirkel, 2002).

Role models can also provide people with indirect connections to networks and opportunities that would otherwise be inaccessible or difficult to attain, which helps them build their social capital. This is seen in the case of DB, whose role model is her aunt, who is a dentist. She claims her aunt invites her to work as a volunteer during the holidays, which has exposed her to dental practice.

“My Aunt lets me work with her in her dental practice; it’s helped me understand more about being a dentist”, **DB (female, set 1)**.

Role models are depicted here as conduits for passing on social capital in specific domains. These role models are suggested to give not only knowledge but support, opportunities, and connections that can enhance the social capital of individuals like DB mentioned above. These exclusive access to certain social institutions, connections, and privileges are a few domineering ways in which social capital is expressed (Putnam, 2000).

People can also gain an understanding of social norms and expectations through role models who exhibit particular attitudes and behaviours. This can help them navigate social settings and find acceptance in particular contexts (Coleman, 1988). But it is also possible for the transmission and acquisition of social capital through role models to perpetuate current social inequality trends. It would often appear that students who have access to these social connections have a higher chance of meeting with people who may be good role models for them, just like the case of DB above. This can have the effect of making people with more social capital better positioned to gain additional social capital through their networks and contacts, which is known as the "rich get richer" effect (Lin, 2001). It is possible that Bourdieu's concept of social

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reproduction is pertinent, as it emphasizes how social inequality can be maintained through the intergenerational transmission of social and cultural capital within a particular closed group. In summary, role models can be crucial in this process, either by presenting opportunities for upward mobility to those who have access to them or by highlighting the societal advantages and disadvantages that already exist for others (Bourdieu, 1988). In the next section, we will examine how families can pass on these advantages through social capital networks.

### **8.2.1 Family Members as influencers/role models**

The findings of this research have revealed a multitude of factors that impacted the academic pursuits and scientific engagements of the participants.

Specifically, family members have played a crucial role in shaping the ideas and rationales behind the learning behaviours of these students' concerning science. Reliable adults, such as parents, educators, and mentors, have a notable influence on the growth of teenagers, as evidenced by this study's identification of numerous factors that affect academic pursuits and scientific engagement. In particular, parents serve as natural role models for children, as they are the first adults that children encounter who exhibit certain behaviours (Notaro, 2002). Previous research has demonstrated a correlation between children's aspirations and goals and the expectations of their parents or family members (Helwig, 1998).

Studies have also shown that family members can influence students' affinity for science or spark their interest in the field through casual family outings and visits to various places. These include visiting science museums, aquariums, and technology centres during days out or family trips, which are very commonplace for most middle-class families (NSF, 2016; Sutton Trust, 2020). Several museums offer fascinating, entertaining, and interactive displays and activities that enable visitors to learn about science while having a fun family day out. Most WCWBS, however, are not exposed to this luxury, and it may be unlikely that they would have these opportunities except for the occasional school trips, as noted when the issue was raised in the interviews. When the participants were asked whether they had experienced any of the

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aforementioned activities with their families, only three individuals (equivalent to 15%) responded affirmatively to having visited one of these science establishments with a family member. On the other hand, 50% confirmed having gone on a school-based trip to such a location, while 35% responded negatively to having ever visited a science-related venue. These results indicate that a relatively small number of participants had the opportunity to cultivate their scientific knowledge through family outings. Such outcomes also underscore the significance of these experiences to families. Interestingly, a substantial 50% of the students acquired scientific knowledge through school-sponsored excursions to these scientific establishments, which reduced the degree of inequality between upper- and middle-class students whose parents took them on such visits, thereby building science capital among the working class, who may not have been as privileged.

Another area that was noted is that families can have an influence on a child's interest in science. Viewing science documentaries and shows on television with family members can be a good method to educate students about various scientific subjects and increase their interest. There are a lot of interesting and educational science-based documentaries and shows on streaming services like Netflix, Amazon Prime, and Disney+. Again, only a few students interviewed during the study engaged with these services because most of them required paid subscriptions, which further alienated most working-class families. Despite the above, family members did influence how WCWBS engaged with science in a few other ways.

It was noted that siblings and the wider family members often can have either a positive or negative impact on young people by the experiences of success in science that they share. In analysing the WCWB students' understanding of their influences, we attempted to do this by finding out who they felt was responsible for their relationship with science. When participants answered the question, "Who has had the most impact on your study of science? Some of the comments alluded to various family members. An example is ZS.

"My role model is my second-oldest sister, who studied radiography and oncology. My other sisters were also very good at

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science and would always remind me to do well on science tests. Yes, they are my inspirations”, **ZS (female, set 1, phase 2)**.

Using Bourdieu’s principle to review this statement, it becomes evident that ZS’s attitude towards science was part of what Bourdieu (1996) referred to as “the constant endeavour to reproduce success,” as she has observed success in her older sisters with science; thus, she is attempting to do the same. This also aligns with Bandura’s (1986) concept of social learning. ZS looks up to and receives a lot of support from her older sisters, as evidenced by her affectionate, admiring, and enthusiastic descriptions of them. She also gave credit to her sister for helping her persevere through her science challenges. To stay focused and interact positively with science, she acknowledged the need for the support structure her sisters had built, which served as a source of inspiration that role models often exude. This is also supported by Coleman’s (1988) research, which suggests that sharing intellectual resources within families promotes the development of social capital and the co-creation of interests among family members in a specific field. ZS was fortunate to have older sisters who served as role models and a strong support network for her to benefit from, despite her seeming working-class background. This network of sisters, who had achieved academic success, especially in the fields of science, enhanced her scientific and social capital. This is an example of how social capital can be transferred and gradually built up. ZS, in this instance, has accumulated enough social capital to elevate her reasoning and outlook to that of a middle-class individual due to the experiences and support she received from her sisters. It was also heartening to revisit remarks from DB, who also benefited from the influence of a family member.

“My main role model is my aunt, who is a dentist. However, I also receive support from my cousin, who is a nurse. Yes, those are my role models. They are my go-to in science matters, and they both are doing well. I want to do well in science too and maybe become a Dentist”, **DB (female, set 1)**

DB’s aunt and cousin were her motivating force when it came to science. DB says her family members have been a great influence on her determination to succeed in science. She reflects on how they have positively encouraged her to pursue a career in science and have also helped her become very focused and

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resilient. Additionally, she claims that watching her aunt work at her Dental practice has contributed immensely to motivating her. Having these two successful scientists close to her made science a possibility for her. DB also claims that it played a part in her decision to pursue the triple science option in Year 9, as opposed to the combined science option in school, because the former can lead her to obtain the required grades for pursuing her desired course in the future. This supports the previous research of Dabney et al . (2013) and Chakraverty (2013), who both claim that family members can influence a person's interest in science through their scientific work, occupations, lifestyle, and hobbies. They also assert that parents and family members with specific occupational backgrounds would discuss their experiences with science with their children or wards in different ways, either to motivate them or, sometimes, unwittingly, influence them. Similarly, Zirkel (2002) argues that young people are more inclined to look upon role models who share their race and ethnicity. In this case, a family member gives them an idea of what is possible. This is supported by the work of Dasgupta (2011), who, in his report, noticed that the more similar the role models are to the individuals, the better they relate and have more positive outcomes. In these cases, ZS and DB saw family members whom they could relate to who had been successful in their engagements with science, and so they saw a future for themselves within the subject. These social relationships and representations serve as resources that support Bourdieu's concept of building human capital as essential in bridging the gap of specific socio-economic barriers and limitations, especially among the working class. These students (ZS and DB), though from a working-class background, do not see themselves as limited because they have family members that have been successful, from the same race and socio-economic backgrounds as such they feel the successes can be replicated and do not see any science aspirations to be out of their reach unlike someone who has not seen or known anyone around them that has been successful in science. It is also worth noting that both ZS and DB achieved their GCSE target grades in science, exceeding two grade levels previously predicted. It would not be out of place to say that the positive build-up of science capital from their different families gave them an advantage to be successful in science.

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Role models of this nature promote self-belief and drive tenacity in students' scientific pursuits. Bourdieu's notion of capital, specifically science capital, encompasses a broad spectrum of expertise, information, and experiences in the industry. These students believe they can succeed in science because they have outstanding role models who are also of the same sex and so have received this built-up capital from family members.

The myth that science is only for boys is untrue in this instance when students have examples of female role models close to them. Nonetheless, this may imply that attaining in science can be influenced by having the correct role models. Role models give people, especially those from lower SES groups, examples of what is possible and achievable. They often help people to form habits or behaviours to replicate (Bourdieu 1997). These habits are usually easily copied from people of similar SES backgrounds because one can readily have access to these persons. Most high-profile role models would often come from affluent backgrounds, leaving those from lower SES backgrounds lacking direct access to copy or learn from because they do not operate in the same circles as Chowdry et al. 2009 noted. This is because they lack the social capital needed to access those persons. Studies have also shown that giving more women visible and motivating role models who have achieved success in STEM disciplines is a productive method to encourage them to enter into and stay in these fields (Sales et al. , 2019; Jackson et al. , 2017).

I similarly argue that effective role models are often those from the same gender or race. This makes the possibility of successful duplication even more desirable and believable, as with ZS and DB. This notion is supported by Zirkel (2002), who argued that young people tend to gravitate towards similar people, especially in terms of gender and race, which makes them comfortable interacting with them. While same-sex role models can be a source of inspiration and motivation, Schiebinger et al. (2018) caution that they cannot solve every problem experienced by underrepresented groups in STEM. Other variables are crucial to explore to boost involvement and retention in STEM disciplines, such as access to resources and welcoming surroundings. Indeed, female role models from working-class backgrounds can make science more

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approachable and friendly to a larger spectrum of people while also assisting in the dismantling of prejudices and biases against women (Calas et al ., 2006).

Some teachers mentioned this need in the interview data.

“There is a need to highlight WCWB figures that they can identify with and encourage them to work hard to achieve in Science,” **JZ (teacher)**.

JZ believes that role models can, overall, play a crucial part in promoting engagement in science by offering motivation, mentoring, representation, and networking possibilities. These role models can promote a more diverse and inclusive scientific community by openly discussing their failures and victories. Other areas that may be effective in influencing girls' science attainment are several school factors that will be elaborated upon in the next unit.

On a similar note, another respondent said:

“My cousin is a science technician at a local school. He supports me when I need help with any science homework. I can depend on his help and support anytime I am stuck with my science assignments”, **KM (male, set 2, phase 2)**.

DB, ZS, and KM all share several key issues. First, it is worth noting that a relative who pursued a career in science inspired them. Secondly, they all believed that if their relations could be successful, then there was a high chance of their succeeding. Finally, they all attributed their perseverance in science to their family role models. This kind of support is critical for young people as it is at this age that they are trying to discover their identity, what is possible for them to achieve, and their role in the space or societies they find themselves in. The idea that someone close to them is successful might be responsible for their positive self-efficacy and forward-looking view towards science, which other participants seemed to lack.

The above examples very clearly showed the positive effects these family role models had on the participants. On the other hand, there may be a likely negative effect that these family members can have on students who look up to them for guidance, as shown in early studies by Eccles et al . (1996).

Thankfully, in this study, only a small minority of participants had family role

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models who were not supportive or encouraging of their science aspirations. Some examples were JB and NS. When asked about their views on Science, they responded.

“My older brother studied triple science and found it very difficult. He told me physics is not for everyone. He is smarter than I, and even he struggled with this subject, so I knew it was just not for me”, **JB (male, set 1, phase 2)**.

Another said:

“Oh, miss, I have a cousin who dropped science at A level because she said it was very difficult. Nobody in my family is good at science, so yes, I am not alone on this one, it is not just my thing”, **NS (male, set 2, phase 2)**.

Both JB and NS come from families where members have had bad experiences with science and have passed these bad experiences on to them. This has had a negative impact on their commitment to science and further dashed any potential scientific ambitions that would have been nurtured. When explaining further, they both admitted that they do not see science as a career path for them in the future and are only continuing with the subject to the GCSE level because it is a compulsory subject at school. This raises the question of whether the outcomes for these two students would have been different if their family role models in their school days had favourable experiences themselves. It is possible to convey the thinking of these students using Bourdieu's (1977) theory of reproduction. Bourdieu, in his view, contends that the repetition and emphasis on the difficulty of science over time served to instil these characteristics and negative inhibitions in others. Bourdieu's theory of social reproduction, if applicable here, is likely reproducing the negative science experiences of these family members in these students. For James and Nathan, the effects were highly negative. They could not see themselves as successful because they had nobody around them with a successful science blueprint, and so they eliminated themselves from success in this area; this science disengagement was socially reproduced according to Bourdieu (1977). Additionally, the data suggest that these replications of social capital are advantageous to people who possess them. Social capital practices were evident at play with DB and ZS, both of whom had family members who had

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good science experiences and were more positive in their science engagements, as such could see science in their futures and persevere more. There was an air of possibility and a sense of successful outcomes with them because they had successful family members. Overall, family members can play a notable role (positive or negative) in the science attainment of these WCWBS through the social reproduction of shared values, traits, failures, and achievements. Those who may want to pursue science may be deterred by social prejudices about others who do so. Stereotypes and prejudices about scientists can also be detrimental, deterring people from pursuing scientific careers. Most often, children do not want to be seen as different from their peers or perceived as awkward, as scientists are often depicted (Calhoun, 1993; Swartz, 1997).

Another point to note is that most of the role models mentioned in the study came from comparable backgrounds and genders, whether they were siblings or friends. This may be because these students can see parallels between the role models and themselves. These like-for-like role model influences are often a stronger and more powerful influence, showing one what is possible (Dasgupta, 2011). Similarly, Zirkel (2002) found a similar result in a report, stating that people are more likely to pay attention to role models they perceive as similar to themselves because they are more relatable. It is therefore crucial for family members to be aware of these prejudices and stereotypes and to attempt to dispel them if they are unfavourable. Family members can support their loved ones in achieving their objectives and finding success in science-related occupations and hobbies by addressing these prejudices and stereotypes and encouraging them to pursue their scientific interests (Brown et al., 2013). It was also important to note that most of the students mentioned Family role models of the same gender, only a few mentioned those who were not.

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### 8.2.2 Teachers as influencers/role models

There is often a common rapport between teachers and students. This relationship can often develop into forming trusting bonds around academic identities and influences. This study reveals how some of those relationships have unfolded and have affected the trajectories of students in their views and value of science.

A teacher can be considered a person who trains others in new skills or disperses new knowledge. This definition seems to imply that teachers have the ability, considering the nature of expertise they offer, to add credibility or to add some form of endorsement to the subjects they teach. In light of this, the mentor-mentee-like relationship seems to be produced (Buttner, 2021). In schools or other formal educational institutions, the role of a teacher is often one that is official, respected, and ongoing. Some of the most important stages of a student's development in life are often observed by their teachers due to the large amount of time spent together. Students often spend more time in school than at home during weekdays, especially in schools that offer after-school activities. Teachers, therefore, tend to be poised to be the primary adults interacting with and influencing the lives of the students they constantly come into contact with, due to the reinforcement of knowledge and academic assessment roles that their jobs entail. Bearing in mind that school is a second home to some students, close daily association means teachers can unconsciously influence students positively or negatively.

“Who has been the biggest influence in your study of science?” Participants were asked. Some students, unsurprisingly, pointed to their teachers.

“My science teacher encourages me to excel in science and pursue a career as an engineer; it's definitely my science teacher”,  
**SC (female, set 1, phase 2)**

Likewise, KH said:

“I would say my science teacher because she believes I would do well in any science career. I want to be a veterinarian because I love animals and biology, and she encourages me in this direction”, **KH (female, set 1, phase 2)**

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Also, another student, JB, commented:

“I have always liked science, and I have had great science teachers since year 7. They all have said I can be a great scientist one day, and I especially want to study some form of science in the future”, **JB (female, focus group, set 2, phase 2)**

Teachers acting as an encouraging voice is supported by the works of Lunenberg (2006), who submitted that teachers are influential in encouraging career aspirations in the students they teach. They are also responsible for providing a good foundation for students to self-access and also measure how they view their abilities in different subjects, as mentioned by KH earlier. Thus, teachers' evaluation of students' abilities may count to either encourage or discourage students' self-efficacy in a subject. This was evident in the various responses from study participants. This demonstrates that teachers' influence on student attainment in science is additive and can, over time, be cumulative (Ozerk, 2012). The data show that these teachers, over time, have fostered a science interest in JB, SC, and KH by establishing a strong, caring relationship that has grown and developed over time. JB claims if her science teachers had not encouraged her since her early school days of year seven, she might not have the sustained interest she has today in science.

**KH** (set 1), in a show of solidarity, went on to say: “I have good teachers, and I don't want to let them down”.

This was almost a heavy commitment from her to herself and the teacher, which suggests how influential this teacher was in her sustained interest and perseverance in science. A common notion observed in studies by Rosser (1990), Ingram (2009) and Wang (2017), who both claim teachers can unknowingly pressure students or make them feel a sense of guilt in pursuing a STEM subject when students' abilities are not in question. Although KH was not pressured, she seemed to have it as a goal to keep her grades up and impress her science teacher. This similarly may suggest that her teachers made a big impression on her and captured her interest, which warranted such a huge commitment.

However, Munro (2000) claims that teachers only endorse students' preconceived decisions about their views of their science ability rather than

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inspire or direct their thoughts. He claimed students will make up their own minds about the subject but will need their teachers to validate their fears or aspirations. This validation in itself is powerful to influence the student's views. On another note, Jackson (2017) advocates that teachers have the biggest influence over student's academic resilience. He further explains that because they work daily with these students and access them in some way academically, therefore the students can look upon them to be the best predictors of their academic success. Jackson's(2017) view was noted in the study when some students mentioned the inspirations they received from some of their teachers which influenced their choice of persevering in science when it started becoming difficult. Some examples *were*.

“I never would have coped with science if it were not for my science teacher who has been brilliant. Every time I feel I will give up, he just has a way of making me work harder and believe in myself. My grades just got better”, **AD (focus group, set 1, phase 2)**

Similarly, some teachers' efforts to make Science relatable have also influenced positive science experiences for some students. Examples are SA and EL.

“My science teacher has really influenced my liking of science. She makes it easy to relate to and breaks it down so you can follow easily”, **SA (female, focus group, phase 2)**

“Yes, my teacher is quite good. She gives you a lot to think about. I am not sure I would get it if I had a different teacher, as she is quirky and fun”, **EE (focus group, phase 2)**

Teachers who strategically use methods like scaffolding, case studies and connection to real life in order to deliver purposeful lessons often can engage the students better and as a result have a higher chance of producing better academic results or progress from students (Schwartz, 2009). This was implied in the case of SA and EE who liked their teachers' teaching style in science. Students seemed to be motivated to learn better in a pleasant environment by teachers who are enthusiastic about the science they teach. Teachers who are enthusiastic about science might pique students' curiosity and enthusiasm. These teachers seemed to have been able to demonstrate their passion for

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science by presenting amusing anecdotes and information about the subject in a straightforward manner, conducting experiments and demonstrations with enthusiasm, and inspiring students to share their scientific interests and questions (Barak et al ., 2009). On a similar note, Maltese et al ., (2011) also stressed the importance of highlighting the role of different aspects of science to daily life to keep students intrigued and engaged. These types of teachers often serve as positive role models for students.

Ultimately, it is essential for us to acknowledge that teachers who foster a mindset of scientific inquiry that does not feel judged or pressured can help students develop self-confidence, improve critical thinking skills, and cultivate a greater interest in science. Asking open-ended questions, promoting practical experimentation, and enabling pupils to pursue their scientific interests are all ways that teachers can stimulate scientific inquiry, as previously alluded to by Maltese et al . (2011).

On the other hand, students were also asked if their teachers had discouraged them from pursuing science, and only one student responded affirmatively.

“Yes, one teacher in my Year 8 class had told me that he saw me more as a lawyer than a science person. Another told me I would be better off choosing combined science in Year 9, which was more straightforward, but that did not mean much because many people had told me that before, and I knew for sure I was not good at science at all”, **CM (female, set 2)**.

Although CM thinks her teachers were not much of an encouragement, she also thinks they were right about their assessment of her ability in science. Surprisingly, CM was not perturbed by her teacher’s assessment of her science ability, as she had often been told that science was not her strongest subject. This sadly only went to validate her view that she was not a science person. This demonstrates how easily teachers can have an influence on students’ educational outcomes, acting either as a pillar of support or as an opposing voice to attainment. From a Bourdieusian perspective, CM already felt out of place, acknowledging her habitus, which suggested that science was not for her. CM’s self-limitation to what she feels she can achieve differs from KH’s, who finds science difficult but has developed the habitus to be resilient, which

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has enabled her to achieve success. However, Bourdieu does not acknowledge that the school's educational system has the potential to reengineer a person's habitus. In the case of KH and several others, it is possible to change a person's habitus by using teachers to gain social capital. This view is also supported by the work of Goldthorpe (2007) and Hart (2013), who argue that habitus is not fixed and can be changed if exposed to adequate capital and positive experiences.

On another note, the teachers interviewed held different and varied opinions about their roles in encouraging students' science attainment. Most of them pointed to the fact that working-class science representation in and around the school was the missing key in influencing attainment among these groups of students.

“There is a need to highlight WCWBS figures that they can identify with in lessons. This will encourage them to engage with the subject better and not just see the subject as an elitist thing”,  
**JZ (female teacher)**

Whilst another teacher said:

“I do not think there is much working-class representation around the school, even in the science department. Students must see others like themselves in the subject. I think this will help greatly since most of them do not have many family members in science-related fields around them”, **FL (female teacher)**

In a similar note, another teacher mentioned:

“I wish our WCWBS would see their successful peers from the same backgrounds as role models and believe in themselves more”, **SC (male teacher)**

Teachers tend to display unintentional behaviour and attitudes in the classroom that frequently reflect the norms and values of their cultures and institutional beliefs since they are products of those communities (Blazar, 2017). Teachers' actions to either challenge gender biases or reinforce them are crucial to forming lasting impressions on the students they teach. The demand on teachers in schools, which are high-stress environments, can be exacerbated by pressures that often expose one's implicit biases. As Staats (2016) points out,

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“In education, the real-life implications of implicit biases can create invisible barriers to opportunity and achievement for some students” (p. 33)

These biases, however subtle they are expressed, can lead to discouragement among certain groups, usually girls, against science (Andre et al ,1999). Research has also shown that girls internalize these biases and prefer places and areas where they are accepted (Steffens et al , 2010). Therefore, teacher encouragement is vital in improving girls' educational outcomes in science. Higher-level science courses cannot be considered without having success first at GCSE. Therefore, if the number of women in STEM-related subjects is to improve, attainment in GCSE is the starting point. It has been observed that working-class students, particularly girls, are among those unrepresented in A-level and universities in STEM-related subjects in the UK (Yeoman, 2025). These also include people of colour from Black African and Caribbean ethnicities (Francis, 2000; Demie,2014).

According to the interview data, 85% of students surveyed say their teachers encourage, assist, and help them positively engage in their pursuit of science. In comparison, 10% say their teachers were unhelpful to their goals. The other 5% attributed their science encouragement to siblings and parents (family). There was also a subtle assertion from participants that can be ascribed to the teachers' preference for boys in science class. Here is a conversation with **CM (female, set 2)** during the focus group interview session with a group of girls.

**Researcher:** “Do you experience any gender bias in Science lessons?”

**CM:** “Not really, but my teachers seem to like the boys’ answers to girls’ ”.

**Researcher:** “How so?”

**CM:** They get praised for great answers while we do not!”

**Researcher:** “Can it be that the boys’ answers are more detailed?”

**Student:** “Maybe, but we try, but still.” (Echoed another student)

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**CM:** “Miss, I will not mention names, but they are not that clever; they just treat the boys better”.

**“Researcher:** “How does that make you approach science differently from your other subjects?”.

**CM:** “Yes, it is almost like girls are not good enough for science. Well, at least that is what I feel.”

CM and most of her group (they were agreeing and heckling in the background) often felt marginalized during their science lessons when they gave answers to questions. It can be hypothesized that this poor treatment of these girls has in some way contributed to the students’ disenfranchisement with science (Terrier, 2020). Also, more evidence needs to be generated to draw a conclusion outside this research’s scope. However, the above statement by the students helps examine the impact of specific acts on students’ interest in a subject.

Teachers interviewed, however, had conflicting opinions about how they felt gender affected science.

**(Researcher)**

“Do you think students’ gender is a barrier for girls in science?”

“No, definitely not! It is more science than gender. We encourage as many girls as possible to pursue a career in science, especially if we know they are capable”, **SC (male, teacher)**

Another teacher hesitated and then said.

“Hmm, in a way. I understand if some students feel some aspect of science is masculine, like physics, but on the whole, no”, **EB (female, teacher)**

The teachers seem to believe that gender does not affect the science attainment of girls, even though one teacher admitted that physics was deemed masculine. This now leads us to review the link between peers as another school-based factor that might hinder girls’ science attainment.

All the teachers mentioned above believed that the students needed role models they could identify with and see what was possible for them through these people. What also came through in the discussions with the interviewed

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teachers was that students needed to see WCWBS representations that looked like them (same race, ethnicity) to encourage them to persevere and view science as a possible career prospect. This supports the work of Bryant and Zimmerman (2003), and Zirkel (2002), who suggest that ethnic and gender-matched role models are associated with more positive academic outcomes than non-matched role models, especially for working-class individuals.

It was, however, refreshing to see that the study affirmed the teachers knew some students looked up to them for encouragement and support. One teacher claimed that sometimes all the students needed was teachers' validation of their ability, and they would begin to believe in themselves. However, one teacher mentioned that a few students needed more creative imagination to inspire them to aspire to be successful in science. The role of teachers as role models or influencers is undoubtedly pertinent in raising the science engagement of the students they teach; however, students' habitus can often be a limiting factor, as seen in this study.

On another note, regarding school-related impacts, it was interesting to observe that none of the student participants blamed or attributed their peers for their decisions or engagement in science, nor did they attribute their motivation to pursue those options or describe the experiences they had that were favourable or negative. This is unquestionably in opposition to the works of Hanushek *et al.* (2003), Robertson *et al.* (2003), and McEwen, P. (2003), who all reasoned that schoolmates or peers have a substantial influence on success, especially of working-class pupils. These studies further claimed that students of different abilities however respond differently to these influences from teachers. They suggested lower attaining students are the most affected by teacher influence whilst higher attaining groups of students were the least influenced mainly because they had higher self-efficacy levels. However, there are other influences that can affect how students respond and navigate their science experiences as is shown in the next section.

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### 8.2.3 Future career choice as an influencer

The research revealed that the choice of future career pathways notably influences the science engagement of the student participants. Most interview data reflect students commenting on what science means to them. During the interviews, most students made it clear where they stood with science and if it was something that had a place in their futures. Students expressed this in individual interviews and focus groups. That is how career choice was flagged and deemed noteworthy to be listed as a type of influence in this study.

When the participants were asked the question, "Is science important to you?" Some of the answers were below.

"Oh yes, because I want to become a forensic photographer, so I need biology. Yes, science is important to me. If I do not do well in science, then I will not be able to pursue my course", **ZS (female, set 1, phase 1)**

Another student said:

"My science is very important." All of it. I want to become a general practitioner. That is my dream, and I cannot achieve that without science", **SR (male, set 1, phase 1)**

Additionally, she responded:

"Yes, science is very important to me because I want to become a dentist", **DB (female, set 1, phase 1)**

Now, these students see science as integral to their future job pathways. DB, SR, and ZS all place a high importance on it. Their increased attention and involvement in their science have been attributed to this factor. Additionally, it has strengthened their drive and resolve to tackle the numerous challenges in specific scientific fields by helping them become more resilient in their approach. Due to their drive and focus, they have also developed a genuine interest in the subject. DB said she found physics difficult but has grown to deal with it and likes it, as she knows it is key to her reaching her goal of becoming a dentist. She would not let her aversion to the subject interfere with her attainment in science. This affinity for science by the participants is supported by the findings of Renniger (2007), who claims that exposure to opportunities can also spark interest and motivation to perform well in a particular area or

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subject that prints out a desirable future outcome and incentive, as in the cases of DB who spends time with her cousin who is a dentist and Samuel who wants to be a doctor and thus takes his science seriously. The kind of impact a future job choice can have on a student's appreciation of science, however, also appears to have a flip side. Several other survey participants, however, had a casual attitude towards science, as they believed they did not need it to succeed in their future career paths or to perform well in the subject. Some of the following responses provide context for this.

“Nah, I don't need science, so I just coast. I do not need science. I know it is not for me, miss. I want to be a businessperson”, **TB (male, set 2, phase 1)**

Additionally, another student commented,

“No, science is not that important to me. I want to study Visual Arts”, **LE (male, set 2, focus group)**

These findings raised questions about how students rated their various subjects against their future careers. TB and LE did not view science as a valuable aspect of their futures; therefore, they did not make a remarkable effort to engage positively with science in class, as it was not a priority for them. It is no surprise, therefore, that neither TB nor LE achieved their target grades in science.

Bourdieu emphasizes that “a person’s habitus is internalized and converted into dispositions that generate practices and perceptions” (Bourdieu 1979, 170)

This lack of enthusiasm for the subject may have led to a decrease in attention given to science before the exams, which is why TB and LE experienced the outcomes they did. The choice of a career will influence any future ambitions or career routes students might want to navigate. The GCSE and A-level subjects a student chooses to study will affect these career plans. Since most jobs require a variety of educational backgrounds and subject specialisations, it is best to make this decision early in life. As they advance in their academic careers, the subject combination becomes more pertinent for students to engage with. Students can eventually develop interest and resilience in science, as they can in any other topic, due to their diverse future career

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intentions in science (Dewey, 1979) It is also noted that the career path of most WCWBS can often be influenced by some extrinsic factors. These include parents, peers, teachers, relatives, school factors, learning opportunities and other role models (Pummel,2008). These students have all evaluated the importance of science in different ways based on how it relates to their intended future careers. The students' opinions of science therefore can be divided into two categories according to the data collected as such: how effective they thought science was and how they planned to use it soon. A few teachers interviewed concurred that a student's future career choice notably affects how engaged they are in science classes. Two of these opinions were given in response to the question of what they thought prevented students from learning science:

“So maybe their career choice for the future has an influence on performance. If they need it for their future, they will work hard for it. It often seems to be a matter of priority”, **MKT (male, teacher)**

Another teacher mentioned. “I would say, future career ambitions. This is a great drive for our students towards being steadfast in science. If they see science as a career option, they will take the subject seriously”, **DO (female, teacher)**.

These beliefs, however, go against the assertion made by Hewitt-Taylor (2002) that most WCWBS frequently select the same professional pathways as their parents or family members because they believe and perceive this to be a real option. On the contrary, the research data did not match this assertion as reference to this did not come up in any of the response's students alluded to for their science participation.

“I like science a lot. I like how it tells us how things are made and how the body works. It is very interesting. I am torn, though, between nursing and psychology, but something with biology in it”, **JB (female, set 2, phase 1)**.

JB, one of the participants, was unsure of the science career she would like to pursue, but what she was sure of was that it had to be biology-centred. Gender role beliefs often predict one's educational and occupational aspirations and choices for some students at an early age (Eccles et al., 1993; Schoon &

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Parsons, 2002). Entrenched gender differences can still persist in terms of science attainment, in the choice of career pathways of girls, especially in the areas of physical sciences, where girls remain noticeably underrepresented (Smith, 2010; Libertore *et al* , 2020). Family influence is also positively correlated with students' career choice and is strongest at the high school level (Alansari, 2011). Working class students usually have very strong family ties and often would not typically have science workers in their families; as such, they are not likely to be advised to follow STEM-related careers (Duffy *et al* , 2016).

Rather, the study noted that more girls than boys preferred science careers. When asked the question, do you see science in your future? Although some girls were unsure of specific science careers they wanted to pursue, most responses centred on people and care goals associated with them. Of the 10 girls in the interview sample, three expressed science career aspirations, two expressed related science aspirations, whilst the others expressed aspirations for a future career unrelated to science i.e. 45%. For instance, Shannon sees science in her future, although she is not very sure about a specific area she would like to pursue. She knows it will centre around children as she feels she is good with them.

“I see a bit of science in my future, although right now I do not know exactly what it is. I know it will be centred around children as I am good with them and would like to do some child-related course”, **SH (female, set 1, phase 1)**.

On the other hand, ZS, DB, and SC were quite clear about the direction they wanted to take as regards their future career choices. ZS wants to be a forensic photographer, combining her love of science investigations with photography. Donna was clear about wanting to become a dentist like her cousin, while SC likes to build things and believes she can become a civil engineer. Their future career choices did not reflect that they considered gender a hindrance to achieving their goals.

“Yes, I see science in my future. I have been looking at forensic photography, and it is very interesting. Not CSI but helping to solve cases using science is fun”, **ZS (female, set 1, phase 1)**.

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SC:” I want to become a civil engineer. I like to build stuff and figure out how things are made. I also like the body but physics more. “When asked why she chose engineering, she attributed her love of physics to her liking of maths.’ Physics is not complicated, just formulas, and I am good at maths most times.”, **SC (female, set 1, phase 1)**.

Likewise, DB wants to be a dentist like her aunt.

“For sure, I want to become a Dentist like my aunt. I know it will not be easy, especially with chemistry, but my biology and physics are great, so I could do well. I also get much inspiration seeing my aunt at work as a dentist, plus there is a lot of money when you are a dentist”, **DB (female set 1, phase 1)**.

Various scholars believe that the gender gap in STEM may be due to the difference in career preferences between boys and girls (Murphy, 2000). Studies show girls rate communal goals more important than men do and so prefer occupations that allow them to interact and help people more (Konrad et al , 2000). This often leads them to focus on and choose more people-oriented careers than abstract technical ones. This notion may be applicable here, as all the science-oriented girls, except SC and KH, had people-oriented science career choices.

Lacey, however, one of the non-science career girls, said she has had no interest in science mainly because of the difficulty in physics. She says it was too difficult, and she could not relate to its abstract nature.

“Physics is such a drain, and sometimes I do not get the point in it. No, I have no interest in having a science career, it is way too hard for me. I prefer arts”, **LC (female, set 1, phase 1)**.

Most students did not echo the gender constructs of science as masculine, but only the difficulty. Overall, all the students acknowledged that society perceives it as masculine.

The teachers, however, argued that students’ choice of future careers did influence their science engagement and subsequent attainment in science, in spite of gender. A few of the comments were.

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“I do feel that if they see science in their future outside school, they will work for it, but most of them don’t see science as a career choice”, **EB (teacher)**.

Another science teacher said:

“I think a bit more guidance on what science can offer as a career they hope to pursue would increase interest” **NS (teacher)**.

These teacher comments also suggest that these students need to see science a lot differently than just a subject they need to learn in school but link it to a profitable future that includes them. This would mean that these WCWBS need to see science in their future or are open to the possibility of science in their future to engage and succeed. This argument is supported by Dewitt *et al.* (2015), who link students’ aspirations in science to cultural capital, gender, parental influence, among others, and also advocate for more career-related information in lessons by science teachers or career advisors early in junior years in secondary schools.

Bourdieu (1997), however, in his work posits that those societal structures and socio-cultural norms shape people’s lives, thinking, ambitions, and future opportunities in society, and so will affect the future career chances and choices of these WCWBS. However, gender did not seem to notably affect the career choices of the girls in this study as most of them aspired to pursue science careers. I can therefore argue that science careers can influence the science attainment of WCWBG.

The majority of participants were primarily motivated by a passion for the topic or by external role models. Only one of the responders, Samuel, had a parent who was actively working in the scientific field. The others relied on other family members, role models, or potential job routes to foster their understanding and belief in themselves to interact with science positively. The findings in this study clearly suggest that career pathways also had an influence on some of the participants science experiences.

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### 8.3 Summary

This chapter explored the various influences that have shaped the participants' science experiences. These included a variety of family members, teachers, and potential future career ambitions related to science. The degree to which a person can influence one's choices is often dependent on how much trust and regard that person places on them. A majority of the participants demonstrated this in the nature of their fond descriptions of various role models or influencers. This demonstrated how these role models can have a beneficial effect, as seen in the case of ZS, or a negative effect, as observed in the case of CM, on the participation of these students in science. Needless to say, one needs to have some personal stake or motivation in a subject before one chooses it as a career for the future, but having a role model in the domain can also serve as a booster. This motivation can lead individuals to be more initiative-taking; they may be more inclined to enrol in additional classes, take advantage of opportunities with their teachers, and participate in activities that enhance their knowledge and expertise in science.

The chapter also links students' value to science to their future career plans. This was a key construct that influenced the students' engagement with the subject and subsequently their pursuit of science attainment. It can also be said that continuous encouragement by teachers and family members can help to mature the interest in science into a deeper kind of knowledge (Bell *et al* , 2009; Baron *et al* , 2009). It was also acknowledged that working-class students may face more challenges than their peers in pursuing a career in science due to a lack of resources and support networks. However, they can still work around those challenges if they have a positive view of the subject and leverage the role models around them to build up enough science capital, which can then be passed on to other family members, reproducing transferable and reproducible capital for the future. Furthermore, a career in science may offer working-class students better employment opportunities and financial prospects than a career in a different subject, due to the strong demand for jobs in various scientific fields, thereby helping to bridge the inequality gap. O'Brien *et al* . (2015) similarly suggest that this may help students from working-class communities

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build social capital and thus reduce the level of inequality. The most obvious finding to emerge from this theme is that students did not attribute their engagement or lack of engagement in science to their peers. This was contrary to the literature, which describes peers as an influence on students' academic attainment, especially among students from low socio-economic backgrounds (McEwen, 2003; Hanushek, 2003). It can therefore be concluded that role models of any form have some positive impact on the science perceptions and subsequent engagement and attainment of working-class white British students in science.

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## Chapter 9: Conclusion and recommendations

### 9.1 Introduction

This final chapter presents the main findings derived from the information and data generated and analysed throughout this research. The study explored the science experiences of twenty working-class white British students (WCWBS) for two years. This was in response to declining GCSE science results observed over time in the research school and, similarly, across similar schools and boroughs with a high percentage of working-class white British students (Demie, 2008; Elias et al., 2009; Wong, 2012; Godec, 2017; Yeomans, 2019). The underachievement trend has also led to low participation and uptake of science courses in higher education and universities across the UK amongst these groups (Sutton Trust, 2018).

The first part of this chapter will focus on the research outcomes. This study addressed three main research questions to explore the science experiences of working-class white British students at the secondary GCSE level. The first question explored if social class affected the achievement of working-class white British (WCWBS) students in science at GCSE. The second question focused on the relative value these WCWB students placed on science as a subject and was analysed using Bourdieu's theory of reproduction. The third research question asked if gender was a barrier to the science attainment of these working-class white British girls using the intersectionality theory (Crenshaw, 1989) to frame the analysis in addition to Bourdieu's theory of reproduction (1987).

In the second part, the results were analysed and discussed using prevalent themes that emerged from the data to draw on key issues to make conclusions and recommendations for all stakeholders and probable areas of future research that would be beneficial as a follow-up to this research.

The final part of the chapter discusses the original contributions to knowledge that the research offers and the limitations of the study. Both serve to highlight the various impacts the research would have on teaching working-class white

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British students and also improve the intake of science subjects by this group of students. It then concludes with some suggestions of direction for future research and recommendations for policy and practice in education.

## **9.2 Research findings**

Several broad themes emerged, suggesting that social class was strongly associated with participants' science experiences and subsequent attainment among WCWB students. These themes included students' family backgrounds, school factors, perceptions, motivation, students' influencers in science, and their future career pathways.

Family background was a theme that affected most students, mainly because they did not have the required resources to help them have independent learning facilities at home like their peers. These resources included textbooks, computers, and WIFI access to connect to school platforms for homework. Often, they were found not available or too expensive (details in chapter five). These findings were supported by the works of Betancur *et al.* (2018) who posit that books and home computers are linked to children's development of analytical and critical thinking skills, an essential tool needed to excel in science. Other socio-economic variables that appeared to influence the lack of adequate science capital were primarily measured by factors such as the ability to afford private tuition and the availability of science role models within the family structure. These factors, when available, helped students accrue science capital that equipped them to meet the demands of science education (Von *et al.* 2022, Ayon,2008). In this study, however, it was observed that some WCWB students were able to utilise these resources to benefit themselves and improve their attainments in science. On the other hand, other students leveraged programs the school implemented to acquire the science capital they otherwise would not have obtained due to their social class backgrounds. This view of the importance of family background and support to ensure academic success in science was also supported by the work of Kaushal *et al.* (2011, 2019), who observed similar patterns in their research.

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This acquisition of science capital was normally traditionally associated with middle-class or upper-class students (Smyth, 2009). This possession of high science capital by a few students in the study shows working class students can leverage social capital from various sources as previously reported by Yeoman (2019). This social capital advantage is seen reflected in their overall engagement and subsequent positive science attainment. Bourdieu's (1997) theory of capital was seen here as being used as a 'convertible resource' that can yield measurable results may account for this outcome as seen with SR, MK, ZS, and DZ. These students had measurable science capital from their siblings, relations and some parents, which gave them an edge over other participants even though they came from the same working-class backgrounds. A few other students utilised resources available to them through the school, such as LA and SH, and these students also performed well in their science GCSEs, citing these out-of-school-hour resources as notably useful to their science engagement and attainment. Other students used their older siblings as tutors to gain science capital, while some others gained theirs from attending STEM clubs, after-school, and extra science classes held after school. The findings from this study also posit that within certain environments, working-class students can take on board enough of the characteristics of the middle class to enable them to obtain a pass grade in science without accumulating the necessary broader cultural capital that is central to Bourdieu's reproduction theories. This acquired capital was noticeable through various school-run extra-curricular activities embedded within the school's framework. These activities were identified as instrumental in nurturing some students to change their perception of science and see a future in the subject which gave them a greater sense of determination and boost to succeed in subjects like MK, PB and SH. It can be argued that these interventions helped them acquire enough social capital to change their mindset and outlook toward science. Whilst accruing science capital may be the basis for some explanations of social class difference, others did not completely follow Bourdieu's premise which most of the discussions for analysis were based on (Kapfer, 2014). For example, it does not explain why SC and BG, who also had access to the same school inputs, went on the same trips and attended the same STEM club, yet had very poor GCSE results compared to the others. Some scholars have explained that the

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convertibility of some forms of capital may be personal or community-unique, with little or no exchange value in the dominant society (Skeggs, 2004; Carter, 2003). However, further research into these outliers in attainment is needed to explain this exception to the phenomenon.

On another note, students' social class often affects the type of interactions they would typically have and the types of people they would naturally associate or come in contact with. These included family role models who have science careers. These role models' presence or absence was considered central to changing the students' perception of science and their science futures. ZS, for example, had sisters who were all science majors studying in universities, and DB had a cousin who was a Nurse and an aunt who was a Dentist. These family role models gave these two girls the blueprint of what was possible and encouraged them to achieve it. Most of the others with no family members involved in science had different views and perceptions of themselves in relation to science. Igiri *et al.* (2015) support this observation and argue that role models and encouragement from family members have been noted to notably increase students' science capital, perseverance, and final GCSE science performance. It is therefore not surprising that all the participants who claimed to have science role models obtained their targeted GCSE grades. It, however, cannot be concluded that it was the result of having these persons alone in their lives that made the difference to their science outcomes; other factors may have also contributed. It is my conclusion however that it did contribute to their science attainment.

Teacher expectations and school culture shape educators' perceptions of the abilities of working-class white British students. These beliefs can influence teaching methods and the distribution of resources in the classroom. These biases often lead to lower expectations, which can limit academic opportunities and make it harder for these students to get interested in or build skills in science. The issue gets worse in some STEM fields that value natural talent over effort. This can discourage students from less privileged backgrounds who may not see themselves as naturally gifted (Low, 2024). When working-class white British people are not shown in STEM careers or learning materials,

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students may struggle to imagine themselves in these fields (Essex et al ., 2024). Without role models they can relate to, students may feel that STEM is not for them, which reduces their motivation. Schools and families sometimes see subject engagement differently. When schools do not fully understand these differences, they may attribute low engagement in science to parental factors rather than to broader issues. School expectations are often shaped by middle-class norms, which can unintentionally exclude working-class parents. This was evident in data indicating that many participants felt science was not for them because either the tests were too difficult or the specific subjects, such as physics, were too abstract and unrelatable. Some of the teachers attributed the students' poor engagement in science to discouragement from home and laziness.

The theme of self-perception, as discussed in chapter seven, revealed how these working-class students placed themselves in the world of science, and what they perceived as required to be successfully engaged with Science was crucial in answering these research questions. It was observed that many of the students felt a need to align with what was acceptable to their families' thoughts and perceptions of science. These perceptions of science were noted during the interviews to often mirror the views of a close family member or persons within their social circles. Interestingly, they generally viewed science as something that was not for everyone. Some scholars have noted this perception that science is often viewed as a "middle-class "subject and profession (Parker & Rennie, 2002). This thought process made science achievement seem unattainable for working-class students who do not see a lot of working-class people involved in science careers and hence eliminate themselves from the prospect of it. This anti-science perception of themselves was expressed and found to affect some of the students' motivation, engagement, and attainment in science. This was seen to be all self-afflicted and avoidable. Overall, this low self-evaluation was linked to the student's subtle acknowledgement of their working-class status with expressions like:

"No, I do not think science is for me. That is because I find stuff hard, and I do not get a lot of it straight away like other people. I need to keep going over stuff to remember, especially in science",  
**BG (set 2, phase 2).**

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Also, **TB (set 2, phase 1)** said:

“Nobody in my family has done well in science. My parents say science was difficult for them and they never liked it. My brothers, too.”

These statements from BG and TB show that these WCWB students experience a cultural deficit of science as perceived by their families which is important for attainment (Runnymede Trust, 2009). TB even reflected on the fact that his parents had also found science difficult, and as such, not an aberration. BG, on the other hand, felt that certain people understand science concepts right away, but not him; science is not for him. Some other students, nonetheless, leveraged on the social capital their siblings extended to them through their own experiences and successes, which helped students like ZS and KH to persevere and achieve more successful outcomes, knowing their siblings had achieved similar successful feats. This replication of habits and perceptions positive or negative brings alive Bourdieu’s theory of social reproduction (1977) which infers that families would reproduce successes or failures of their various groups because they have access to cultural capital that gives them a boost of confidence and a leverage of advantage and in the case of ZS and KH the success of their siblings was the blueprint for their success while BG and TB families poor history with science put them on a disadvantage.

In another situation, some school-based factors, such as science ability groups, choice of science subject, and teacher pedagogy, all played a role in how much value these students placed on science. However, most students echoed the importance of science either by feeling good about science and seeing how it played a role in their future or feeling left out and not being a part of the science community because of their poor grades or understanding of the subject.

According to Rokeach (1973), this served as an instrumental value- means to an end. This means the students will only give their best effort when they see that it will enhance or fulfil their future purpose. Dewitt et al. 2015 also noted this in a similar study who sampled secondary students who aspired to a science career and found only those with good grades aspired to have a future in science. Likewise, it was also observed through the interviews that most students placed in the higher science ability groups, otherwise named “triple

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science,” felt science was valuable to them. This was mainly because it was a vital requirement for their future career prospects, unlike those in the lower combined science group. To this end, most of the combined science students did not place much value on science, nor cared much about their grades in science, mainly because it did not affect their prospects for the future. The American sociologist Herbert Hyman's (1967) theory explains that the value system of most lower-class individuals is terminal values, which create a self-imposed barrier to an improved position, even when it seems futuristic. This notion explains why most non-triple science working-class white British students felt their science was unimportant to them, as it was not instrumental to being a part of their future selves.

It was also worth noting that the data showed teachers' influence had both a positive and negative impact on how students engaged with science and how much value they subsequently placed on it. This came down mainly to the teachers' different teaching styles and pedagogies for delivering the science content. These findings provided strong confirmatory evidence about the influence of teachers as role models, influencers, and great determinants of how students regarded themselves in school science. The study also revealed the importance of teachers' views about how students performed in their subjects. This caused a few of the participants to be encouraged by their teacher's positive feedback that they had a future in science and could beat whatever odds, whilst others who received negative feedback from their teachers felt discouraged and had a low view of themselves regarding their potential in science or pursuing a career in science. This may have also contributed to the inconsistent way students rated how important science was to them. The research observations are supported by the views of Tyler-Wood *et al.* (2019) and Schillings *et al.* (2017), who both contend in their respective studies that science teachers play a crucial role in inspiring students and offer subtle embedded mentoring to students in encouraging them to pursue STEM fields and raising or in some cases, lowering their self-efficacies in STEM subjects. That being said, the student's value of science is posited to be a mixture of several factors within different circumstances. These include mainly perception of science, teachers' influence, and future career prospects. Most of

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the responses seem to reflect the students' thought processes and how they perceive science to fit into their lives presently or in the future. In summary, 40% of the WCWBS valued science as a subject, whilst 60% did not place a premium value on science, mainly because they did not feel science was for them, nor was it relevant to their future endeavours.

Lastly, the question of gender was explored in relation to how it affected the female participants. Gender, on its own, did not seem to play a notable role in influencing girls' GCSE attainment in this study. All genders performed at the same percentage pass rate at GCSE. However, when it was intersected with other factors such as particular science subjects, girls performed better in biology, whilst boys performed better in physics and chemistry. This was also reflected in the interview data, where girls were more inclined to like biology, which had more life and human-related topics than physics. This may be due to several factors, such as girls being drawn to the social aspects of biology, which can be beneficial in studying biology, and also, it may be perceived as being more applicable to their future goals (Jenkins *et al* , 2005). Utilising the intersectionality lens (Crenshaw, 1992) on this aspect of the research enabled me to examine the overlapping identities that might affect the science participation and attainment of the WCWB girls. The theory also helped me to put into perspective how some individuals' experiences of multiple identities informed their social interactions, science engagements, and subsequent attainment. The primary overlapping variables notably impacting the girls' attainment were ability groups, science subjects, career choice, and societal expectations. Girls in the study were observed to be at a lower ranking in terms of ability sets in science. More boys than girls were offered a place in triple science classes. This meant boys could achieve more top GCSE grades than girls in science. This was because triple science allowed students to enter for a higher exam paper, which led to top grades. Science teachers interviewed similarly admitted that this may be so, claiming that boys, overall, showed more interest and often pursued higher science programs, i.e., A levels, than girls, and as such were often given this priority. However, PISA Reports (2019, 2020) have shown no remarkable difference between boys' and girls' science abilities. On the contrary, it shows that all genders can succeed in the subject. It

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therefore leaves the poor uptake by the girls down to cultural values and other external influences about their choices to exclude science.

Several other disadvantages the girls faced could serve as barriers to their attainment in science. The choice of science subjects was the first noticeable intersectional layer of disadvantage for girls relative to boys. According to Ayalom (1995) and Osborne *et al.* (2001), Biology and other life sciences have slowly emerged as a feminine niche in science, thereby slowly eliminating or restricting females from physical sciences like engineering involving chemistry and physics. This supports participants' views on the various science subjects, which showed that biology was most preferred by girls, whilst physics was most sought after by boys. An intersectional approach is important for understanding how different aspects of social identity combine to create complex advantages and disadvantages, forming a matrix of inequalities that shape students' science aspirations (Wong, 2015). This calls for a careful look at how schools and society may unintentionally continue these inequalities, especially for working-class white British students.

Gender performativity theory and intersectionality reveal that gender can be a subtle barrier for working-class white British girls in GCSE science. However, this barrier is shaped by overlapping class and cultural factors. Therefore, this suggests that any girl favourably inclined to pursue physics as a career might feel out of place, in the minority, and therefore may be highly discouraged. Physics was therefore seen as masculine, and all the participants in the research agreed with this assertion. The girls also acknowledged that physics is a gendered subject, having a masculine image ascribed by several researchers (Keller, 1985; Watts & Bentley, 1993; Harding & Parker, 1995; Rennie, 2002). This choice of biology over physics may explain better why most girls' choice of future science career was unsurprisingly around the life sciences. Studies showed that girls rate communal goals more important than boys and prefer occupations that allow them to interact with and help people more (Konrad *et al.*, 2000). This often leads them to focus on and choose more people-oriented careers than technical ones. These layers of factors do not help encourage girls to pursue science goals. Often, students feel comfortable engaging with

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science because of their personal experiences, family, and cultural practices. These all cumulatively communicate how this group of students constructed and perceived science. These subtle communications from school and home play an important role in disrupting or perpetuating the dominant cultural norms that have, over time, been embedded in their communities' view of science as masculine. The visualisations in school textbooks, data, and media reflect a lingering bias and cultural orientation against female students playing notably roles in science.

All sampled students agreed that science is important to society and that they learned interesting things in science. They also believed that scientists do valuable work and are beneficial to society, which has made life more modern and easier. However, it was noted that very few WCWBS were willing to pursue careers in science or achieve top grades in science. This was also seen as a measure of their regard for science, or their disregard or apathy toward it. It is also possible that the value these students place on science might depend on how science fits into or around their lives. Several studies have investigated this phenomenon, and most have revealed that no single factor can account for it; instead, it is complex and multidimensional. A few of these factors are capital-related inequalities, educational practices, and social representations of science (Archer, 2020). Smith (2018) describes disadvantage as cumulative. Working-class students are not disadvantaged once; they experience layered constraints. The research shows how this layering begins early in secondary schooling through setting practices, Curriculum pacing, reduced science identity formation, and lower perceived belonging. By GCSE, the gap is not merely academic; it is relational and aspirational. I can, therefore, conclude the following findings in summary: Social class did affect the science attainment of working-class white British students through lack of resources, low science capital, and low self-perception, which showed in their overall GCSE outputs. Also, the science value of these students was linked mainly to their future career prospects. However, gender was noted to hinder only the uptake and interest of WCWB girls in science participation, but not in their science attainment, as final GCSE results showed an equal percentage of passes in science between the girls and boys.

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### 9.3 Limitations of the study

The study sought to explore the science views of WCWBS and understand why these students have underachieved at GCSE science. This empirical data was obtained from student participants and teachers over a two-year period. The study, however, has a few limitations that will be mentioned for the record.

Firstly, the study had a small sample size of student participants, primarily due to the unavailability of most students who volunteered, either because they did not meet the research criteria or withdrew from the study. Most students were very reluctant to participate and commit to the two years required for the study. The research sample size given had to be reduced. This had an overall implication for data analysis and assumptions. Had the samples been more extensive, these statistical assumptions for the analysis would have been met. This was remedied by using some supporting quantitative data to corroborate the findings.

Secondly, I had to describe social class using a generic school's proxy, 'Free school meals,' which identifies a social stratum of students of disadvantage, but does not completely capture everyone that is socially disadvantaged, as not all FSM students are socially disadvantaged. Although widely used by researchers and educators to date, very little is known about the validity of this measure as a proxy for socio-economic status (Taylor, 2018); however, it is still a useful tool in identifying working-class students.

Also, it would have been ideal to have a study with more schools to make it easier to generalise for a wider area or demography. However, as a teacher researcher and working full time, I was limited in this regard. Therefore, I conducted my research within my teaching school as a longitudinal cohort study since the phenomenon investigated also existed there.

Finally, a slight limitation of using Bourdieu's theory as an investigative lens was also noted regarding its not addressing gender, ethnicity, and how they intersect with social class. To mitigate this shortcoming, I drew on gender performativity theory (Butler, 2002) and Crenshaw's (1991) intersectionality

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theory to analyse their GCSE successes and failures in relation to gender and other contributing factors (Archer, 2010; Ingram, 2011).

Despite these limitations, this research offers several original contributions that have implications for policy, practice, and research regarding working-class white British students and science attainment. These can be useful for future research and policy implementations in education.

#### **9.4 Contributions of this study**

This thesis contributes unique and underexplored perspectives to the field of science education and educational inequality. The research provides empirical data about working-class white British students' science attainment at GCSE, which has been unreported, and little literature is available on this issue. Examining subject-specific barriers (science) rather than generic underachievement, filling a gap in both educational and sociological literature. White British students generally can be considered above average in science GCSE compared to other ethnicities. However, very little information is available for working-class white British students (WCWBS) specifically in science. This dearth of studies on WCWBS academic attainment in science may be because most available studies have been conducted on the wider white British population generally, which includes all classes, and not particularly on the working class (those on FSM). Furthermore, most data from relevant stakeholders use ethnicity, not social class, to analyse and evaluate attainment. This can explain why the underachievement of subgroups, in this case, the white working class, can be missed or go unreported if the larger parent group is doing well (OFSTED Unseen children's report, 2013). The gap in academic achievement has widened between white British students and students from other ethnicities, especially at KS4 (GCSE). There was a gap of 16% (2012) to 26% in attainment in 2020 (DFE, 2012, 2022). Whilst other ethnicities have narrowed the gaps over time, white British students on FSM continue to widen and remain among the lowest-achieving groups (Strand, 2015; Education Select Committee Report, 2014, 2021). This study adds to the scarce literature on the attainment of working-class white British students,

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specifically in science GCSE, and will be useful in addressing these gaps by further understanding their particular issues and barriers to studying science.

This study also provides a theoretical contribution to science education. The conceptual tool of Crenshaw (1989, 1991) was employed as an exploratory lens in the context of working-class girls and science education. Crenshaw's conceptual tools are usually used to analyse covert discrimination and marginalisation of black women in different sectors. I have contributed to science education by applying Crenshaw's intersectionality theory to examine how working-class white British girls face greater barriers to multiple identities in their science achievement than their male counterparts. In doing so, it applies and potentially extends Crenshaw's theory of intersectionality frameworks to a specific and complex social group. I have added to the theoretical weight, ascertaining that working-class white British girls do not have an ability problem. Instead, I argue that they have several interwoven layers of disadvantages working against them in achieving in science. My research examines the covert layers of practices that further discourage or alienate this group from pursuing science (Archer et al ., 2018; Francis et al ., 2019). This intersectional approach also shows how the social-historical position of working-class white British girls makes them particularly vulnerable to all the flaws in the educational system. Working-class girls interested in science must deal with various interconnected challenges that obstruct their progress in science and negatively influence their engagement. This study explains how such elements as gender, culture, ability set, science subjects, etc, interact to prevent them from succeeding in science as much as the boys. It helps us seize opportunities to remove inequalities and make learning accessible for all working-class students to be successful, regardless of gender.

This thesis also adds data to the debate around working-class white British girls' low engagement with science courses and careers (Archer, 2011). Contributing to national conversations about educational equity, levelling up, and STEM participation. This thesis will highlight the complexities involved with this group and GCSE science. Working-class women are often underrepresented in higher-level STEM-related degree courses and careers,

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even when statistics show they outperform their male counterparts at GCSE, an essential foundational stage for higher academic pursuit (ONS, 2019; DFE, 2021). A few working-class white British cultural values conflict with the scientific structures and systems operated in schools, often positioning these students as outsiders from scientific endeavours (Bonal *et al* , 2016). These are pragmatism, preferring hands-on knowledge gained through experience rather than theory, focus on immediate survival versus long-term goals, scepticism of change, and distrust of authorities (Pellizzoni, 2011). This thesis unpicks these conflicts and highlights differences in cultural operations that often seem to be expressed as disengagement. This thesis corroborates this and adds data on working-class white British girls' attainment at GCSE science.

This study finally contributes to the literature on how science capital shapes working-class white British students' science focus at GCSE. Students from higher socio-economic classes typically have more access to resources like advanced scientific books and software, well-equipped science labs, private tutoring, and private enrichment activities that may involve visits to science (museums, aquariums, planetariums), thus building science capital for them. These factors may offer students an advantage in their study of science and eventually improve their chances of pursuing careers in the field of science. In contrast, access to these resources may be restricted for students from poorer social strata. For example, students from lower social classes often attend fewer effective schools with fewer resources to fund science experiments, trips, and extracurricular activities that benefit improving and building students' science capital (Graham, 2016). They also might not have access to qualified science teachers or science role models to encourage their science experiences. Furthermore, they might not have healthy peer competition or encouragement because of the general apathy or preconceived notion of science amongst the majority in this WCWBS group (Yeoman, & Wilson 2016). This might often lead to fewer of these students engaging with science and planning future career choices around the subject.

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## 9.5 Recommendation – policy and science education

This thesis acknowledges that several factors combine to influence the science experiences and achievements of WCWBS. These are mainly cultural and structural disadvantages, which require shifts in educational and scientific culture to make science relevant for these students, even if it is not needed for their immediate career goals. My recommendations for improvement are below.

### *1. Restructuring of the science curriculum:*

The present science curriculum needs to be more engaging and relevant to young people within the age brackets being taught. This view was heralded throughout the investigation by students who described it as dull, full of abstract theory, and irrelevant to their lives. Teachers who suggested a review of the science curriculum to increase engagement and be more inclusive similarly concurred with this view. This would subsequently increase interest in the subject, ultimately improving the output of Science results across all groups (RSC/ IOP Teaching Survey 2024). Teachers and students feel the curriculum does not reflect student interests in topics such as sustainability and climate change, leaving them disengaged and not encouraged to explore the subject. If mounting obstacles like relatability are improved, WCWBS may find it easier to navigate the science curriculum and be successful. A multifaceted approach to address these issues may also be necessary, one that includes extending access to educational opportunities outside of the classroom, encouraging diversity and inclusion in STEM professions, and adding resources and support to schools in underserved areas. The Francis (2025) curriculum review, however, will encourage more working-class students to see themselves as legitimate participants in science by highlighting science from various backgrounds, races and social standings, which challenges who a scientist is and giving hands-on experiences to students' lives and cultures.

### *2. Increase science capital within schools:*

Secondary schools should adopt programmes that increase the overall science capital of all students. These include STEM clubs, science clubs, and other

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educationally targeted scientific programmes and opportunities to attract more interest from working-class students and fill gaps in science capital lacking amongst minority groups at an early stage. This should be sustained from key stage three (lower school) to key stage four (upper secondary) to build upon more students engaging in science throughout the secondary phase and removing the stop point of lack of interest after key stage three. In general, extracurricular activities and programmes that support students' engagement and interest in science will, overall, increase their social and science capital, which is important in helping them increase confidence, efficacy, and skills required to become successful in developing an ambition to pursue science-related careers in the future.

### *3. Improved science teachers' pedagogies and styles:*

Teachers' pedagogies and teaching styles should also be more upbeat and inclusive to address and attract all levels of students. Most students engage and enjoy science when their teachers show enthusiasm for the subject they teach. This inspires students to persevere with the subject and follow through on science concepts more quickly. Teachers should also compulsorily embed career opportunities in their science teaching to widen the science and future opportunities for students. The preferred tool for this engagement was regular practical experiments included in teachers' teaching approaches to science. Successful educators, therefore, need to take a deliberate approach to their craft and work to foster a positive learning environment that is relatable and supports their students' achievement.

### *4. Make the science workload even amongst key stages*

It was agreed by students and teachers alike that there was a heavy workload for students at key stage four (i.e., years 10-11). This was considered a major concern to most participants and an excuse for why they did not do well or were unsuccessful in science. Most students confessed to engaging better with science at the lower class of key stage three but were overloaded by the enormity of material to cover at key stage four. I therefore propose to curriculum managers to have an even spread of the science schemes of work throughout

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the different science phases to avoid overload at key stage four. An early introduction to GCSE concepts in year nine would reduce the amount of work required for GCSE in key stage 4 and thus reducing fear and stress for students and allowing teachers to be flexible and creative to teach concepts at key stage four instead of rushing to cover content.

#### *5. All students should have access to triple science*

All students, regardless of ability, should be given the choice to take on triple science as an optional subject and should not be limited to the recommendations or assessment of teachers only. This selection or recommendation by teachers creates a group of students (often working-class students) who feel science is not for them or are marginalized, thus disengaging from committing to science. They are often restricted to taking up combined science instead, which is also detrimental as it is limited in the amount of science output you can achieve and the subject's depth. This has created a subset of students who are stigmatized to feel they are not clever enough to engage and produce top marks in science. Therefore, this thesis calls for replacing dual science streams of triple science and combining science with a single science award for everyone to encourage full participation, engagement, and progression for all.

#### *6. Future science career goals:*

Having an early future career goal focused on science has been seen in the study to keep students interested in science. Teaching science by integrating ways that students can see where science can fit into their futures helps increase engagement with the subject. Cleaves (2005) argues that the limited image of scientists is a factor in students not engaging thoroughly with science, as they do not see themselves as such. Therefore, more career-focused guidance should be embedded into science teaching daily to keep students' interest in the subject high.

#### *7. White working-class role models in science:*

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More teachers from working-class white British backgrounds should serve as role models for these students. This might help encourage participation and build self-confidence in students like them to engage in science. Overall, by offering motivation, mentoring, representation, and networking possibilities, these role models can play a crucial part in promoting science engagement among these groups of students. These role models can also contribute to the development of a more diverse and inclusive growing science community by sharing their experiences and accomplishments within their communities.

#### *8. Working-class parents' engagement in schools:*

Schools should encourage parents to be more involved with school programmes, especially STEM-related activities happening inside and outside of school. Proper enlightenment outreaches to parents will help build the bridge of interest in science amongst their wards and probable future science-related career goals. Working-class parents can promote their children's interest in science and cultivate a lifelong love of learning by giving resources, fostering a science-friendly environment, fostering their interests, establishing connections with the school, and highlighting the importance of science. However, schools must intentionally have programmes that allow them to interphase more regularly with school and science-related activities in an inclusive, friendly, and less intimidating way.

#### **9.6 Final remarks.**

In my introduction, I highlighted the issues concerning the attainment of working-class white British students at GCSE, particularly in STEM subjects. In this respect, the current study has sought to contribute to a small but growing understanding of the unique experiences that working-class white British students face in studying GCSE science. Through longitudinal interviews with participants, supported by some quantitative data, this thesis has demonstrated the complexities and gendered ideas surrounding working-class white British students' perceptions of science, values, and barriers.

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The recommendations suggest several ways to help WCWBS overcome the barriers they face in learning science, which may help narrow the attainment gap. Although these measures are not conclusive given the small sample size, they provide useful starting points for further elaboration and discussion. Some of the solutions proposed here address only what educational authorities and schools can do. These include strong leadership and favourable policies toward WCWBS, effective links with families to encourage aspirations, equal opportunities for in-school support, and an inclusive curriculum that fosters positive engagement and motivation.

In summary, the absence of a national comparative data bank on social-class achievement in England may hinder monitoring and highlighting working-class attainment. It will help highlight early detection and narrow their attainment in a broader range of subjects currently available for English and mathematics. Overall, I am satisfied with the outcomes of my study and optimistic about its potential to enhance pedagogical practices and teaching for white British working-class students, thereby increasing their prospects of success in science GCSE.

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## Appendices

### Appendix A: Letter of approval from headteacher



*Together we learn*

17/2/2019

Eno,

I give my permission and really look forward to seeing the outcome of this research. It is so relevant. Do I have your permission to forward this email to the senior team so that they can see the work you are doing in this area?

Thank you

Paul

***Paul Frith, Headteacher***

***Eastbrook School***

***Dagenham Road***

***RM10 7UR***

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**Appendix B: Students Survey: Students' views on science**

Name:	Gender:
Name:	Gender:
Name:	Gender:
Name:	Gender:

***My gratitude to you for completing this questionnaire, which should take about 5 minutes of your time. I am interested only in your science views. There are no right or wrong answers, so please be honest. Only I will see your answers. When you have finished, put it in the envelope that your form tutor has, and it will be sealed and sent to me. Many thanks, Mrs Anwana***

How much do you agree with these statements? Please tick one answer only per question.	Strongly agree	Agree	Disagree	Strongly disagree
1. Boys find written science work more difficult than girls				
2. Girls perform better than boys in science tests				
3. Science lessons are easy for me				
4. Science is my favourite subject				
5. Boys answer more questions than girls in science				
6. Science lessons make me happy				
7. Science lessons are easier for girls than for boys				

<b>How much do you agree with these statements? Please tick one answer only per question.</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
8. My friends say I am good at science				
9. Girls find science calculations more difficult than boys				
10. I look forward to science lessons				
11. My teacher believes I can do well in science				
12. Boys like jobs that involve science unlike girls				
13. I enjoy learning science				
14. Girls enjoy field work in science more than boys				
15. Science lessons make me nervous				
16. Boys are better than girls in science experiments				
17. My science lessons are fun				
18. Girls put a lot of effort in science lessons than boys				
19. I am good at working out difficult science problems				
20. Science lessons are boring				
21. Boys are more curious than girls about discoveries in science				
22. My parents believe science is relevant to my future				

23. What can be done to help you to perform better in science lessons?

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*Thank you for taking time to complete this questionnaire.*

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## Appendix C: Ethics approval letter from Lancaster University

Educational  
Research

Lancaster  
University



1<sup>st</sup> December 2019

Dear Eno Anwana,

Thank you for submitting your ethics application and additional information for 'Barriers to achievement in GCSE science amongst White British Students'. The information you provided has been reviewed by Professor Carolyn Jackson and I can confirm that approval has been granted for this project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress) to the Research Ethics Officer (Dr Murat Oztok or Dr Natasa Lackovic).
- submitting details of proposed substantive amendments to the protocol to Professor Carolyn Jackson (spvr) for approval.

Please do not hesitate to contact your supervisor if you require further information about this.

Kind regards,

Alison Sedgwick

Programme Administrator  
Doctoral Programme in Educational Research

Head of Department  
Professor Paul Ashwin, BA, MSc, PhD  
Professors  
Carolyn Jackson, BSc, PhD  
Don Passey, BSc, MA, PhD  
Murray Saunders, BA, MA, PhD  
Malcolm Tight, BSc, PhD  
Paul Trowler, BA, MA, Cert Ed., PhD

<http://www.lancaster.ac.uk/fass/edres/>

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## Appendix D: Information sheet and consent letter



### **Research Project on Barriers to achievements in GCSE Science amongst White British Students.**

I invite you to take part in an important study that I am conducting for my PhD research at Lancaster University. Before you decide whether to take part it's important to understand why the research is being conducted and what it would involve for you. Please take time to read the following information and ask if there is anything that is not clear or if you would like more information (contact details below).

#### ***What's the purpose of the study?***

This is a longitudinal study to explore barriers to achievement amongst White British students in school science. I am particularly interested in finding out if social class, gender or their values impact on their achievement in science.

#### ***Why have you been invited?***

I want to get a variety of perspectives on the ways in which the different factors affect achievement of White British students. As such, I am interviewing students at different stages of secondary school as well as relevant staff.

#### ***Do I have to take part?***

No, participation is voluntary. Furthermore, if you decide to take part and then change your mind you may withdraw at any stage. If you withdraw from the study within two weeks of your interview, I will not use your data in the project; after this point, the data will remain in use. However, participants are vital to the success of the project, so I really hope you will be involved.

#### ***What will taking part involve for me?***

- Completing a questionnaire (approximately 20 minutes)
- It will also involve undertaking an individual or focus group interview of around one hour in duration at four time points over two years.
- All data - which will be used in academic, journal, publications and public presentations - will be anonymised and confidential.

#### ***What will I have to do?***

If you are willing to be interviewed, I'll liaise with you to find a time and venue that is convenient for you. In advance of the interview, I will send an outline of the areas I'll cover. The interview itself will be audio-recorded (with your permission) and later transcribed. All data will be anonymised and stored securely; only I will have access to use it.

#### ***What are the possible benefits of taking part?***

The research will enable us to develop understanding of the barriers and examples of good practice in addressing underachievement in science. Based on this knowledge I will provide students, staff and policy-makers with recommendations about how to improve student achievement and well-being, and increase uptake of science subjects after GCSEs. This is an opportunity for you to have a voice in identifying problems as well as good practice, and suggesting meaningful ways forward.

Many thanks for taking time to read this information sheet.

Eno Anwana  
Department of Educational Research  
Lancaster University  
UK  
Email: e.anwana@lancaster.ac.uk  
Tel: 07853153231

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If you have any concerns about this research, you can contact my supervisor.

Professor Carolyn Jackson

Department of Educational Research

Lancaster University

Lancaster

LA1 4YD

Tel: 01524592883

Email: [c.jackson@lancaster.ac.uk](mailto:c.jackson@lancaster.ac.uk)

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## Appendix E: Consent Form for Interviews

### Consent Form for Interviews

#### Title of Project:

“Barriers to achievement in GCSE science amongst White British students.”

Name of Researcher: Eno Anwana

#### Please initial box

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.
3. I understand that if I withdraw from the study within two weeks of my interview my data will not be used in the project; after this point the data will remain in use.
4. I consent to the interview/sessions being audio-recorded.
5. I agree to take part in the above study.


Name of Participant:

Date:

Signature:

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## **Appendix F: Students interview schedules 1& 2.**

### **Schedule 1**

#### **Welcome**

Hi! My name is Mrs. Anwana and I first want to thank you for accepting to be a part of this research I am conducting for my Doctorate programme at Lancaster University.

My topic is “Barriers to achievement in GCSE science amongst White British students.” The results will be used to put strategies and intervention in place to encourage more science achievement in the coming years. You were selected for this interview because you had very interesting views during the focus group sessions which I would like to further explore.

#### **Guidelines**

1. There are no right or wrong answers only different points of view.
2. I am audio recording to help in accurately transcribing the session.
3. Your views will be respected.
4. You are welcome to withdraw from the interview at any time.
5. You can refuse to answer any question you feel uncomfortable with.

#### **Opening Questions:**

1. Why do you think you are doing well or poorly in science?
2. What is your opinion about science? Explain further.
3. How do you think teachers can make teaching of science interesting?
4. Who is your biggest influence with the studying of science?
5. What home support do you get in matters relating to science work, trips or homework?
6. Do you see science in your future? Why or why not?
7. Are any of your parents involved in science related work? What do they do?
8. What in your opinion is preventing students to achieve in science?
9. Do you think your gender affects how well you cope with science?

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## **Schedule 2**

### **Welcome**

Hi! My name is Mrs. Anwana and I first want to thank you for accepting to be a part of this research I am conducting for my Doctorate programme at Lancaster University.

My topic is “Barriers to achievement in GCSE science amongst White British students.” The results will be used to put strategies and intervention in place to encourage more science achievement in the coming years. You were selected for this interview because you had very interesting views during the focus group sessions which I would like to further explore.

### **Guidelines**

1. There are no right or wrong answers only different points of view.
2. I am audio recording to help in accurately transcribing the session.
3. Your views will be respected.
4. You are welcome to withdraw from the interview at any time.
5. You can refuse to answer any question you feel uncomfortable with.

### **Opening Questions:**

6. Why do you think you are doing well or poorly in science?
7. What is your opinion about science? Explain further.
8. How do you think teachers can make teaching of science interesting?
9. Who is your biggest influence with the studying of science?
10. What home support do you get in matters relating to science work, trips or homework?
11. Do you see science in your future? Why or why not?
12. Are any of your parents involved in science related work? What do they do?
13. What in your opinion is preventing students to achieve in science?
14. Do you think your gender affects how well you cope with science?

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## **Appendix G: Teachers' interview schedules**

### **Welcome**

I want to thank you for accepting to be a part of this research I am conducting for my Doctorate programme at Lancaster University.

My topic is “Barriers to achievement in GCSE science amongst White British students.” The aim is to understand the main barriers to achievement and subsequently put strategies and interventions in place to encourage more science achievement in the coming years. I would like to ask you some questions about your views, some experiences you have had with these cohort of students, and your recommendations as a teacher on how to effectively remove the barriers to learning of these students.

### **Guidelines**

1. There are no right or wrong answers only different points of view.
2. I am audio recording to help in transcribing accurately.
3. Your views will be respected.
4. I will moderate just to guide the discussion.
5. You are welcome to withdraw from the interview at any time.
6. You can refuse to answer any question you feel uncomfortable with.

### **Opening questions**

7. How long have you been teaching science/ your subject?
8. How do you feel our white British students are performing at GCSE level in your subject?
9. In your opinion, does gender affect outcomes in your class test or at GCSE?
10. What barriers do you notice amongst these students?
11. What factor do you think affects their achievement the most?
12. Are there any trends you notice linked to achievement or underachievement?
13. What do you feel can be done to improve their learning outcomes?

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## **Appendix H: Focus group interview schedules 1&2.**

### **Focus group 1.**

#### **Welcome**

Hi, all my name is Mrs. Anwana and my assignment here is to moderate this discussion.

I want to thank you for accepting to be a part of this research I am conducting for my Doctorate programme at Lancaster University.

**Our topic** is “Barriers to achievement in GCSE science amongst White British students.” The results will be used to put strategies and intervention in place to encourage more science achievement in the coming years. You were selected for this focus group because most of you had very interesting views from the questionnaires which I would like to further explore.

#### **Guidelines**

1. There are no right or wrong answers only different points of view.
2. We are audio recording one person speaking at a time.
3. We need to respect the views of others.
4. My role as a moderator will be to guide the discussion.
5. You are welcome to withdraw from the interview at any time but cannot withdraw your contribution to the discussion once recording has begun.
6. You can refuse to answer any question you feel uncomfortable with.

#### **Opening questions**

7. Think back to when you chose your options. Why did you choose or not choose triple science?
8. How does your science teacher interest you in science?
9. Which science subject do you like the most why?
10. Do you think it is important to do science, why? Or what do you think of science?
11. How do you think teachers can make teaching of science interesting?
12. Who is your biggest influence to studying science?
13. Do you feel the same about all three sciences?
14. What was your attitude to science in year 7 compared to now? What has changed?

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- 
15. Do you feel your gender has encouraged or discouraged your choice of science?
  16. What home support do you get in matters relating to science work, trips or homework?
  17. Do you see science in your future? Why or why not?

## **Focus group 2.**

### **Welcome**

Hi, all my name is Mrs. Anwana and my role here is to moderate this discussion.

I want to thank you for accepting to be a part of this research I am conducting for my Doctorate programme at Lancaster University.

**Our topic** is “Barriers to achievement in GCSE science amongst White British students.” The results will be used to put strategies and intervention in place to encourage more science achievement in the coming years. You were selected for this focus group because most of you had very interesting views from the questionnaires which I would like to further explore.

### **Guidelines**

1. There are no right or wrong answers only different points of view.
2. We are audio recording one person speaking at a time.
3. We need to respect the views of others.
4. My role as a moderator will be to guide the discussion.
5. You are welcome to withdraw from the interview at any time but cannot withdraw your contribution to the discussion once recording has begun.
6. You can refuse to answer any question you feel uncomfortable with.

### **Opening questions**

7. Do you think it is important to study science? Explain further.
8. How do you think teachers can make teaching of science interesting?
9. Who is your biggest influence with the studying of science?
10. Do any of you see science in your futures? Why or why not?
11. What in your opinion is preventing students to achieve in science?

### Appendix I : Students questionnaire summary

Section	Question	%	Boys	%	Girls
Self-perception	1-5	72% 40%	They enjoy science They put a lot of effort in science	60% 55%	They enjoy science They put a lot of effort in science
Girls and science	6-10	70% 52%	Boys answer more questions than girls Girls put more effort in science	70% 60%	Boys perform better than girls Boys answer more questions in class
Boys and science	11-15	66% 62%	Boys are better than girls in experiments Boys enjoy jobs that involve science	75% 40%	Girls are better than boys in science experiments Boys find written science work difficult
Views about physics	16-19	72% 35%	They cannot remember physics formulas They enjoy learning physics	80% 35%	Not good at working out difficult calculations They enjoy physics
Views about biology	20-23	70% 55%	Biology is easy They enjoy biology classes	85% 75%	Enjoy biology classes Biology classes are easy for them
Views about chemistry	24-27	75% 63%	Enjoy experiments in chemistry Cannot balance chemistry equations	80% 50%	Enjoy experiments in chemistry Cannot balance chemistry equations
What can better science lessons	28	35% 13%	More science experiments More interactive sessions	27% 14%	More revision sessions More science experiments
Favourite science subject	29	54% 25% 21%	Biology Physics Chemistry	76% 17% 7.4%	Biology Chemistry Physics

## Appendix J: Participants school data

Student participants	KS2 Entry data	Mid Year Scores	Attendance	Class set	Predicted GCSE Grade	Actual GCSE Grade
KA	55	116/A	90.0	Triple	5-5-5	4-4-5
DZ	44	90/D	96.7	Triple	5-5-5	5-6-5
FW	44	112/A	96.6	Triple	6-5-5	5-5-5
SC	55	109/B	100	Triple	6-5-5	4-5-4
JB	44	94/C	100	Triple	4-5-5	4-4-4
LC	55	114/A	100	Triple	6-5-5	4-5-5
KM	44	99/C	100	Comb	5-5	4-4
JB	44	92/C	92.2	Comb	4-4	4-4
CM	55	4107/B	88.5	Comb	5-5	4-5
BG	44	83/D	100	Comb	5-4	3-3
NS	55	115/A	96.7	Comb	5-4	3-3
CO	64	104/B	94	Triple	8-9-8	8-8-8
KH	55	110/B	100	Triple	6-6-6	7-7-6
JA	44	87/D	66.7	Comb	5-4	4-4
SR	66	138/A	100	Triple	8-8-8	9-9-9
SH	55	124/A	100	Triple	7-6-6	6-6-5
TB	45	91/C	95	Comb	5-4	4-4
ZS	55	123/A	95	Triple	6-6-6	6-6-6
DB	44	115/B	100	Triple	8-7-7	8-8-8
LA	55	128/A	100	Triple	7-8-8	8-9-8

Where BCP stands for biology, chemistry and physics

## Appendix K: Students demographic data

Students Interviewed	Housing categories	Acorn data	Financial category	IDACI score	No of siblings	Parents Graduates
KA	Deprived	Struggling estates	Urban adversity	0.2	7	No
DZ	First time buyer	Struggling estates	Rising adversity	0.1	None	Yes, Mother
FW	Low-income terrace	Struggling estates	Urban adversity	0.1	2	No
SC	Low-income terrace	Struggling estates	Urban adversity	0.2	2	No
JB	Low-income terrace	Struggling estates	Urban adversity	0.1	3	No
LC	Low-income terrace	Struggling estates	Urban adversity	0.1	2	No
KM	Low-income terrace	Struggling estates	Urban adversity	0.2	1	No
MK	Families in right to buy	Steady neighbourhoods	Comfortable communities	0.2	3	Yes, Father
CM	Owner occupied	Steady neighbourhoods	Comfortable communities	0.3	4	No
BG	Low income	Struggling estates	Urban adversity	0.1	2	No
NS	Low income	Struggling estates	Urban adversity	0.2	3	No
CO	Educational families in terraces	Steady neighbourhoods	Comfortable communities	0.3	6	No
KH	Educational families in terraces	Steady neighbourhoods	Comfortable communities	0.3	2	No
PB	Educational families in terraces	Steady neighbourhoods	Comfortable communities	0.3	4	Yes, Father
SR	Owner occupied	Steady neighbourhoods	Comfortable communities	0.3	2	Yes, Both parents
SH	Educated young families	Steady neighbourhoods	Comfortable communities	0.3	4	Yes, mother
TB	Low income	Struggling estates	Urban adversity	0.2	6	No
ZS	Educational families in terraces	Steady neighbourhoods	Comfortable communities	0.3	3	Yes, Father
DB	Low income	Struggling estates	Urban adversity	0.2	3	Yes, Mother
LA	Owner occupied	Steady neighbourhoods	Comfortable communities	0.3	2	Yes, Both parents

### Notes

IDACI score is defined as the proportion of children under fifteen living in families that are income deprived. Ranges from 0 to 1, where 0 is the most deprived and one is the least deprived.

## Appendix L: Emerging themes from students

Theme	Subtheme	Codes	Description
<b>Capital</b>	<b>Influencers</b>	Role models	<p><i>“My role model is my second oldest sister; she does radiography and oncology.” (ZS, female, set 1)</i></p> <p><i>“My science teacher encourages me to do well in science and become an engineer” (SH, female, set 1)</i></p>
		Family members	<p><i>“My Aunt, she is a nurse, and my cousin is a dentist.” (DB, female, set 1)</i></p> <p><i>“My cousin is a science technician in a local school” (KM, male, set 1)</i></p>
	<b>Resources</b>	Books	<i>“Maybe if more resources like books were given would help” (KM, male, set 2)</i>
		Private tuition	<p><i>“One on one tuition helps you because they explain to you in more detail” (MK, female, set 1)</i></p> <p><i>“My Mom made me go to Saturday tuition so I could get better at my science” (MM, male, set 1)</i></p>
		Stem club	<p><i>“I used to attend STEM club before the quarantine” (MM, male, set 1)</i></p> <p><i>“Teachers have been engaging me in extracurricular programs in science” (SR, male, set 1)</i></p>
<b>Field</b>	<b>School factors</b>	Teachers	<i>“School, teachers help you when you’re struggling and keep you behind to complete your work” (TB, male, set2)</i>

		Ability set	<i>"I did not choose triple science, but I was told I had to do it because of my grades"</i> (FW, male, set1)
		Science subjects	<i>"I think we should be able to choose which science subject we want to do"</i> (SC, female, set1)
<b>Habitus</b>	<b>Worldview</b>	Perceptions	<i>"My older brother did triple science and found it difficult"</i> (JB, male, set 1)
		Family disposition	<i>"My family, they see core subjects as more important, subjects like English, Maths and Science so you have to do well in them"</i> (LA, female, set1)
		Value of science	<i>"My science is very important to me because I want to become a dentist"</i> (DB, female, set1)  <i>"Nah, I have no need for science so I just coast"</i> (TB, male, set2)
		Future careers	<i>"I want to become a general practionner"</i> (SR, male, set2)  <i>I want to become a forensic photographer, so I need biology"</i> (ZS, female, set1)
		Gender	

## Appendix M: Emerging themes from teachers

Teachers	Theme/Codes	Description
	<b>Family Background</b>	
<b>MK</b> (Male, History, White British)	Family environment	"I think one of the things that is a barrier is the family environment"
<b>OO</b> (Female, Maths, Black British)	Family encouragement	"Their families don't encourage them the same way as minority families do."
<b>DO</b> (Female, science, Black African)	Parents prioritising education	"Where you have a lot of family issues, it can be difficult for parents to prioritise education."
<b>EB</b> (Female, Science, White European)	Financial situation	"Maybe it's their financial situation at home."
<b>JZ</b> (Female, English, White American)	Parental educational background	"I think parental education levels, self-motivation and role models are key."
<b>JZ</b>	Home literacy	"A big issue that affects our area is a lack of home literacy."
<b>OO</b>	Work ethics	"They are not performing well as the other students purely down to work ethics."
<b>MK</b>	Support at home	"These kids need more support at home."
<b>EB</b>	Parents passive	"Their parents are passive, why should they do it?"
<b>NS</b> (Male, Science, Asian)	Family	"I would put it down to the family."
<b>DO</b>	The environment	"What's going on around them, the environment."

<b>Teachers</b>	<b>Theme/Codes</b>	<b>Description</b>
<b>FL</b> (Female, Languages, White European)	Different to their families	"They don't want to be different to their families."
<b>CC</b> (Male, Science, White British)	Parents being involved	"Parents need to be involved in school and be role models themselves."
<b>MK</b>	Engagement from home	"Maybe there is no engagement from home."
<b>FL</b>	Lack of resources	"Maybe some of them lack resources."
<b>MK</b>	Homework	"They do not do homework up to standard."
	Inherited from parents	"Maybe it's something they inherited from parents."
<b>JZ</b>	Difficult home situation	"They have attendance issues because of some really difficult home situations."

<b>Teachers</b>	<b>Theme/Codes</b>	<b>Description</b>
	<b>Motivation</b>	
<b>MK</b>	Career choice	"So maybe career choice has an influence on performance."
<b>EB</b>	No role models	"They have no role models, especially from family."
	No motivation	"There is no motivation from home from any family member."
<b>OO</b>	Thirst for knowledge	"You don't see a thirst for knowledge in the White British students that I've come across."
<b>OO</b>	Reassurances	"They often need that constant reassurance to complete work."
<b>JZ</b>	Role models	"They don't see role models around them"

<b>Teachers</b>	<b>Theme/Codes</b>	<b>Description</b>
<b>NS</b>	Do not persevere	“On the other hand, our white British students do not persevere as much. Everything is at their disposal.”
<b>DO</b>	No zeal	“They don’t want to do any extra work, no zeal.”
<b>NS</b>	Effort	Some are very bright, very able but do not try.”

<b>Teachers</b>	<b>Theme/ Codes</b>	<b>Description</b>
	<b>Self-Identity</b>	
<b>NS</b>	Assurances from peers	“The lack of self -confidence that they can do it, that science is for them”
<b>DO</b>	Not interested	“Some say I’m not interested in it because I don’t see how we’re going to use it in future.”
<b>JZ</b>	WCWB role models	“There is a need to highlight WCWB figures that they can identify with”
	Develop interest	“Developing interest is what is lacking, similarly lack of motivation”
<b>EB</b>	Self-doubt	“I would say it’s a psychological problem-self - doubt.”
<b>OO</b>	Laziness	“A lot of times its partly laziness that would just kind of hinder them from reaching their goals.”
<b>FL</b>	Representation	“I don’t think there is a lot of working-class representation around the school”
<b>NS</b>	Gifted and talented	“Giving them the label of Gifted and talented gives them some sort of boost.”

<b>Teachers</b>	<b>Theme/ Codes</b>	<b>Description</b>
<b>DO</b>	Self-perception	“Self - perception and confidence that they can do it.”

<b>Teachers</b>	<b>Theme /Codes</b>	<b>Description</b>
	<b>School Factors</b>	
<b>NS</b>	Key stage 3 better	“White British students’ progress better at Key stage 3”.
<b>CC</b>	Science curriculum	“This affects all of our students anyway right now, the science curriculum.”
<b>EB</b>	Attendance issues	“A lot of white British students have attendance issues”
<b>MK</b>	Society	“Well to a large extent, society is trying to bridge the gap through globalisation.”
<b>OO</b>	Over pampering	“A bit of over pampering I think from all sides.”
<b>OO</b>	Accept excuses	“Schools accept excuses that students give so easily.”
<b>EB</b>	Key stage 3	“I think Key stage 3 overall is the one where performance is much better “.
<b>DO</b>	Modern and interesting	“It can be difficult make it seem new and relevant, modern and interesting.”
<b>JZ</b>	Supportive families	“Supportive families are super key to supporting the progress of White British students.”
<b>MK</b>	Poor attendance	“Another key factor, where students’ attendance is 75%or 80%, they don’t achieve”.

<b>Teachers</b>	<b>Theme /Codes</b>	<b>Description</b>
<b>JZ</b>	Working class representation	"I still think there is not necessarily a great amount of working-class representation in schools."
<b>FL</b>	In school support	"I don't think the White British kids get the same fair amount of support."
<b>NS</b>	Innovative teaching	"I think one way to teach these particular groups is just being innovative."
<b>FL</b>	Personal connection with teachers	"Maybe they just don't feel connected to us."
<b>CC</b>	Relevant	"Make it seem relevant, modern and interesting"
<b>NS</b>	One class	"Maybe separating them into one class will motivate them more to do better."
<b>FL</b>	Create competition	"Create competition between the boys and girls."
<b>JZ</b>	Mandatory subjects	"Mandatory texts and subjects I think sometimes can be very difficult."
<b>DO</b>	Society views	"The society view is that science is not a rewarding subject."

<b>Teachers</b>	<b>Themes/ Codes</b>	<b>Description</b>
	<b>Science Capital</b>	
<b>CC</b>	Science terminology	"So, the science language is so complex for them to relate to."
<b>NS</b>	Role models	"Role models are key."
<b>MK</b>	Enlightening their parents	"We need to be enlightening their parents of the need to encourage their children more."

<b>Teachers</b>	<b>Themes/ Codes</b>	<b>Description</b>
<b>NS</b>	Work in science	"They never did work in science, so I'm not going to do well in science."
<b>CC</b>	Learning passively	"They are often disengaged about science trips"
<b>EB</b>	Attitude to science	"Look at the attitude and how disengaged he is in science."
<b>DO</b>	Outside the classroom	"Unless you actually do work outside of the classroom."

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## **Appendix N: Questionnaire pilot summary**

In order to ensure that the questions and scale items were clear, and the appropriate time allocated for completion, the survey was pilot tested with twenty students. This was to deal with any problems with the wordings, structure and any other issues that may come up. Upon completion of the questionnaire, the following findings were discovered.

(a) The average time each respondent needed to complete the questionnaire was between 15 to 25 minutes. They expressed that the questionnaire was too long for the time required to complete it.

(b) There was some misunderstanding of the word 'science' which the students' needed clarifications about if it was science in general or a particular science subject.

(c) The outcome of the pilot was used to improve and streamline the questionnaire for the research as follows.

i) The number of questions asked was reduced from 34 to 29 to lessen completion time.

ii) Questions were asked specific to biology, chemistry or physics for clarity.

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## Appendix O: Participants GCSE results

<b>Students</b>	<b>Mock exams BCP</b>	<b>Predicted grades average</b>	<b>Final GCSE BCP grade</b>	<b>Exam tier</b>
<b>KA</b>	5-4-4	5	4-5-5	Triple science
<b>DZ</b>	5-6-5	5	5-6-5	Triple science
<b>FW</b>	5-5-5	6	5-5-5	Triple science
<b>SC</b>	4-5-4	6	4-5-4	Triple science
<b>JB</b>	4-4-4	5	4-4-4	Triple science
<b>LC</b>	5-5-4	6	4-5-5	Triple science
<b>KM</b>	4-4	5	4-4	Combined science
<b>LD</b>	4-4	4	4-4	Combined science
<b>CM</b>	5-5	6	5-5	Combined science
<b>BG</b>	3-4	5	3-3	Combined science
<b>NS</b>	3-3	5	3-3	Combined science
<b>MK</b>	8-9-8	6	8-9-8	Triple science
<b>KH</b>	6-7-7	6	7-7-6	Triple science
<b>JP</b>	4-5	5	4-5	Combined science
<b>SR</b>	8-9-8	8	9-9-9	Triple science
<b>SH</b>	5-6-6	7	6-6-5	Triple science
<b>TB</b>	4-4	5	4-4	Combined science
<b>ZS</b>	6-6-6	6	6-6-6	Triple science
<b>DB</b>	8-8-8	6	8-8-8	Triple science
<b>LA</b>	8-8-8	7	8-9-8	Triple science

Appendix P: Major Themes from Thematic analysis from student interviews (using Bourdieu's lens)

<b>Students <i>Pseudonyms</i></b>	<b>Family Background <i>Parents graduates</i></b>	<b>School factors <i>Engagement</i></b>	<b>Self –perception <i>Science is for me</i></b>	<b>Influencers <i>Family in science</i></b>	<b>Gender <i>Boy or girl</i></b>	<b>GCSE science grade Rank</b>
KA	N	N	N	N	G	5 good
DZ	Y	Y	Y	Y	B	5 good
FW	N	N	N	N	B	5 good
SC	N	N	N	N	G	4 passes
JB	N	N	N	N	B	4 passes
LC	N	N	N	N	G	5 good
KM	N	Y	Y	Y	B	4 passes
LD	N	N	N	N	B	4 passes
CM	N	Y	Y	Y	G	5 good
BG	N	N	N	N	B	3 fails
NS	N	N	N	N	B	3 fails
MK	Y	Y	Y	Y	B	8 excellent
KH	Y	Y	Y	Y	G	7 high passes
PB	Y	Y	Y	Y	G	4 passes
SR	Y	Y	Y	Y	B	9 excellent
SH	N	Y	Y	Y	G	6 very good
TB	N	N	N	N	B	4 passes
ZS	Y	Y	Y	Y	G	6 high passes
DB	Y	Y	Y	Y	G	8 excellent
LA	Y	Y	Y	Y	G	8 excellent

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## **Appendix Q: Key terms and abbreviations**

White working-class students receive free school meals as a proxy for social class.

WCWB- Working class white British.

FSM- Free school meals

Triple science- Science class that awards one grade for each of the science subjects.

Combined science- Science class that awards two grades across the three science subjects.

GCSE- General certificate of secondary education awarded at age 16.

G&T- Term used to identify gifted talented and able students.

IDACI- English indices of deprivation

**Appendix R: Intersectionality themes from students**

Name of Boys	Power		Privilege		Demography	
	Resources	Identity	Ability group	Science capital	Acorn data	Financial category
<b>DZ</b>	Stem club	Science is for me	Set 1	Mother	Struggling estates	Rising adversity
<b>FW</b>	X	X	Set 1	X	Struggling estates	Urban adversity
<b>JB</b>	X	X	Set 1	X	Struggling estates	Urban adversity
<b>KM</b>	X	X	Set 2	Teacher	Struggling estates	Urban adversity
<b>MK</b>	Stem club TV programme	Science is for me	Set 1	Private tuition	Steady neighbourhoods	Comfortable communities
<b>BG</b>	X	X	Set 2	X	Struggling estates	Urban adversity
<b>NS</b>	Books	X	Set 2	X	Steady neighbourhoods	Comfortable communities
<b>CO</b>	X	X	Set 2	X	Steady neighbourhoods	Comfortable communities
<b>SR</b>	Stem club Books	Science is for me	Set 1	Father	Steady neighbourhoods	Comfortable communities
<b>TB</b>	X	X	Set 2	Teacher	Struggling estates	Urban adversity

*Boys table summary*

High science capital	SR, MK, DZ	30%
Medium science capital	NS	10%
Low science capital	FW, JB, KM, BS, CO, TB	70%