Gender Balance in Computing: Options evenings and booklets

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THE
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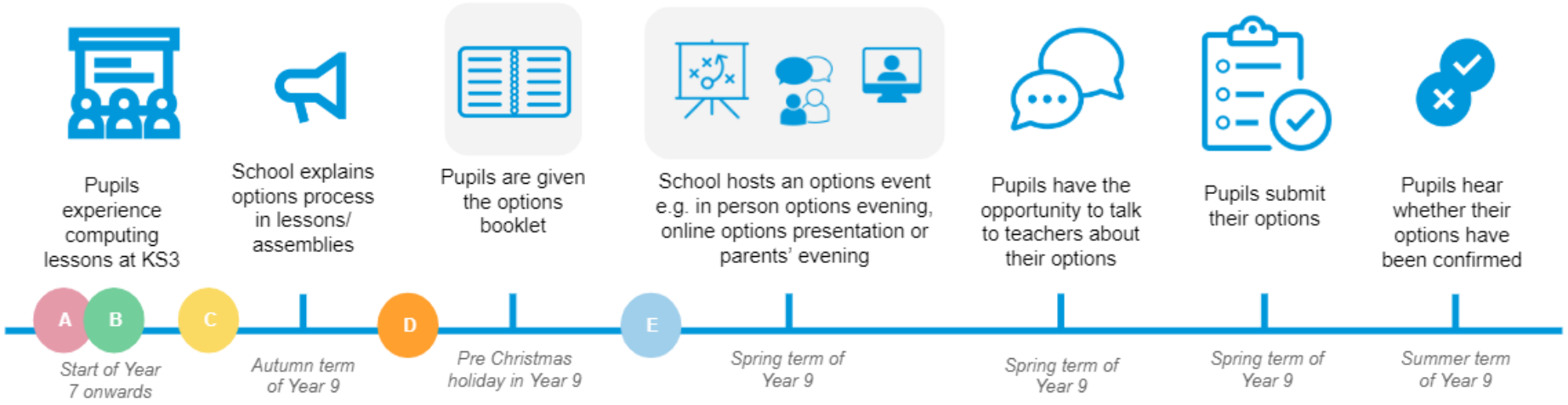
Contents

List of tables and figures

Tables

Figures

Figure 1: The GCSE options process (indicative timeline for a Year 9 options process) showing recommendations



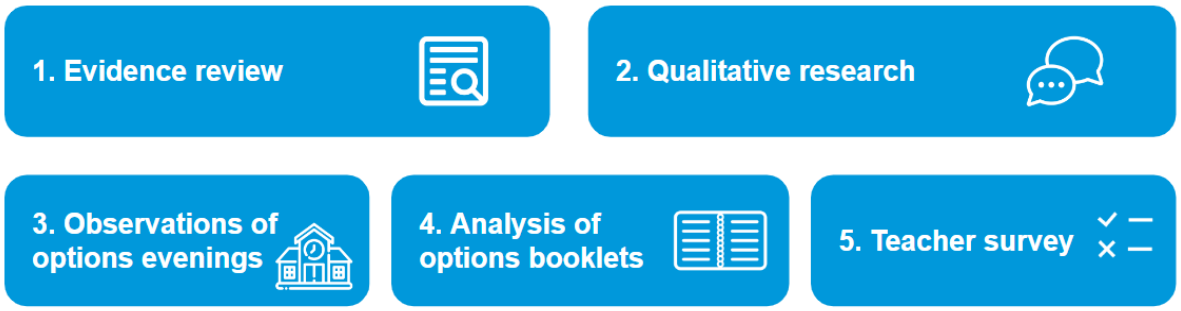
A	Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE
B	CS subject training for non CS teachers
C	Parental messaging interventions
D	Letters to parents / pupils inviting pupils to take CS
E	Checklist of what a good options booklet and options evening look like

1. Executive summary

There are currently four boys for every one girl choosing Computer Science (CS) at GCSE. More girls taking the subject would help to equip more young people with the digital skills they will need to contribute to the future workforce. This review focuses on two elements of the GCSE options process - options evenings and options booklets - with the view that it is important to understand girls' experience of the options process because it represents a period during which girls self-select out of the computing pipeline and is an opportunity to intervene. Figure 1 sets out an illustration of what the options process looks like in most schools.

Methods

We used five different approaches to explore the research question: **how is Computer Science (CS) presented in options booklets and options evenings, and could these be adapted to encourage more girls to choose it?**



Findings

We identified three categories of barriers currently affecting girls' decisions to take CS.

Capability	Motivation	Opportunity
CS is **not well understood** by parents and pupils Some non CS teachers are **unable to provide information** about CS GCSE Pupils are unaware of the **range of careers** CS is related to	CS descriptions use **unfamiliar** and **male language - *we found that Computer Science subject descriptions are significantly more male than Geography*** CS is presented as a '**hard**' option that requires **advanced maths** Girls' **previous experience** of CS are often negative or off putting Concern that a pupil will be the **only girl taking CS** **Role models** are lacking	Girls might have **structural constraints** around the options they can pick Some senior leadership teams are **not prioritising CS** as an option

How should Computer Science be presented in options evenings and options booklets?

We found that descriptions of CS that emphasise prosocial goals and social careers, use gender neutral language (where possible) and frame requirements in terms of behaviour instead of traits or innate abilities may change how pupils, parents and teachers perceive the subject and encourage girls to consider it.

Recommendations

We recommend that DfE prioritises sharing a checklist of what a good options evening / booklet looks like, to support teachers in presenting Computer Science in a way which is appealing to girls (Idea D in Figure 1). This checklist would include:

❑	Use familiar, non-technical language	❑	Reframe the maths criteria for pupil eligibility
❑	Include female role models (in quotes and in person)	❑	Present a range of social and creative career options
❑	Present CS as an enjoyable challenge, not a 'hard' subject	❑	Frame requirements in terms of behaviours, not fixed traits

Alongside using this checklist, we have suggested three other '**light-touch**' recommendations which would be relatively low cost strategies that schools could employ. These are:

- Provide subject training about CS to non CS teachers to equip them to better support their pupils' decision making (Idea B in Figure 1)
- Send letters to pupils / parents inviting target pupils to take CS (Idea D in Figure 1)
- Implement parental messages that aim to improve parental perceptions of CS (Idea C in Figure 1)

In addition to our 'light-touch' recommendations, we have suggested '**system-level**' recommendations which are designed to encourage greater prioritisation of CS GCSE at the school level, rather than focusing on take-up at the individual pupil level. Schools may be unlikely to invest in presenting computer science in a more appealing way unless they are prioritising the take-up of CS GCSE. The system-level recommendation that we would prioritise is to update the structure of the EBacc to incentivise the prioritisation of CS.

Ideally, a bundle of recommendations would be combined to a) incentivise schools to prioritise CS GCSE and b) equip teachers and school leaders with ideas to encourage more girls to choose it.

2. Introduction

2.1 Structure of the report

This report documents our research to investigate the research question: **how is Computer Science (CS) presented in options booklets and options evenings, and could these be adapted to encourage more girls to choose it?**

This **Introduction** sets out the problem and provides an overview of the GCSE options process and existing evidence. Next, the **Methods** section describes the five approaches used to gather data to answer our research question. The **Findings** section collates evidence from all five research approaches to highlight themes relevant to our research questions. Using the findings, we propose nine possible ideas and policy changes in the **Recommendations** section. We end with our **Priorities** and **Conclusions**.

2.2 The problem

In the UK, boys outnumber girls in choosing CS GCSE 4 to 1.[1] This gender difference, first apparent at GCSE (with girls making up 21% of the cohort)[2] persists to A level (with girls making up around 14% of the cohort)[3] and continues at university level where female applicants make up 19% of the CS cohort.[4]

Alongside this gender imbalance in computing, we are facing a digital skills gap: we need to equip young people who will be joining the labour market with the skills required for a digital workforce.[5] Therefore encouraging more girls to study CS could tackle both the current gender inequality, and reduce this digital skills gap.

This report focuses on pupils' decisions about GCSE subjects: the first stage at which CS is optional. It is likely that, were more girls to choose CE GCSE, those girls would then be more likely to go on to take CS A level or study CS (or related subjects) at university. Whilst the overall number of pupils taking CS has increased over the past two years, in the same time frame, the total number of girls choosing GCSE CS has dropped - from 17,158 in 2019 to 16,549 in 2021.[6]

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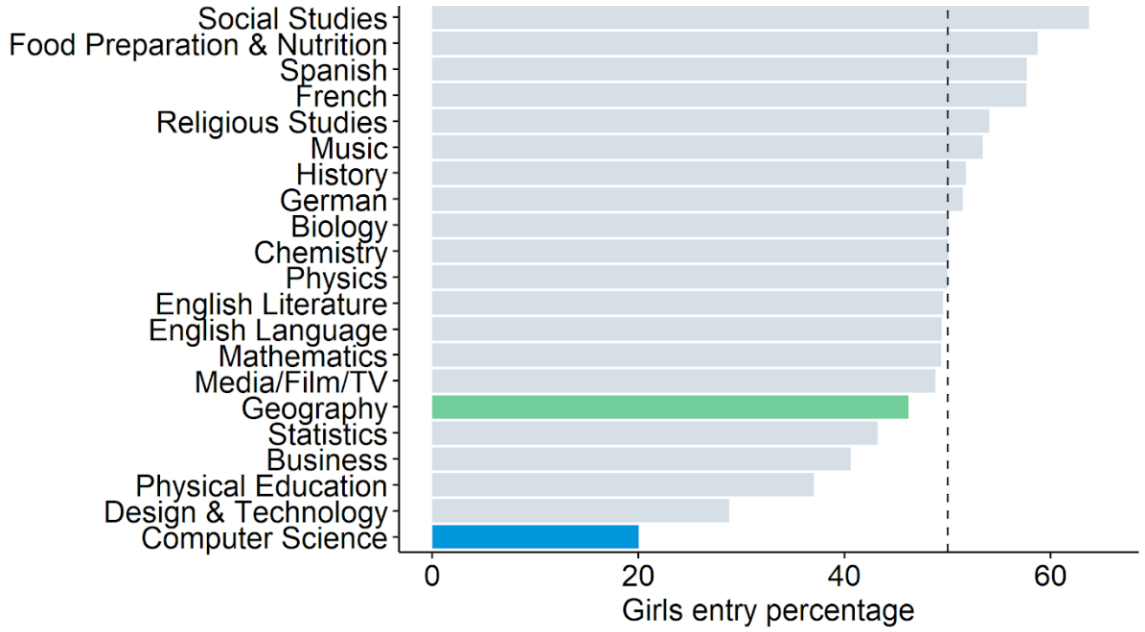
[1] Joint Council for Qualifications. (2021). *GCSE (Full Course) Results Summer 2021 - Outcomes for key grades for UK, England, Northern Ireland & Wales, including UK age breakdowns.*
[2] ibid
[3] The Chartered Institute for IT. (2022). *BCS landscape review: Computing qualifications in the UK.*
[4] ibid
[5] OKdo. (2021). *Computer Science in the classroom report: 2021 results update.*
[6] Joint Council for Qualifications. (2021). *GCSE (Full Course) Results Summer 2021 - Outcomes for key grades for UK, England, Northern Ireland & Wales, including UK age breakdowns.*

Figure 2 shows the percentage of female entrants for 21 GCSE options. Within this range of options, CS is the subject with the smallest percentage of girls taking it for GCSE. Geography is highlighted in green we use it as a comparison subject later in this report.

Figure 2: Gender gap by subject



There have been two major policy changes in recent years which are relevant to the number of pupils choosing CS GCSE.

The first is the introduction of the English Baccalaureate ('EBacc'), announced in the *Importance of Teaching* White Paper under the coalition government in 2010.[7] The subjects in the EBacc are English, maths, science (either double or triple, including CS), a humanity (history or geography) and a modern foreign language. The government's current ambition is for 90% of GCSE pupils to take the EBacc by 2025.[8] Whilst CS GCSE is listed within the 'Science' category, this may not be a significant incentive for pupils to take CS GCSE. Whether or not pupils take CS might rarely be the deciding factor in determining if a pupil's subject choices meet the EBacc criteria. This is because if pupils take either combined science or triple science (biology, chemistry and physics), they have already met the 'science' criteria for the EBacc. Taking CS would only be necessary to meet the criteria if a pupil was taking single sciences but only taking two out of biology, chemistry and physics. Therefore the scope of the current EBacc to incentivise schools to encourage CS (and pupils to choose CS) may be limited.

The second major policy development has been the transformation of the GCSE computing curriculum.[9] Following heavy criticism of the ICT GCSE as outdated, a new CS GCSE was introduced in 2014, with a greater focus on algorithmic problem solving and programming.

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[7] Department for Education. (2010). *The Importance of Teaching The Schools: White Paper 2010.*
[8] Department for Education. (2019). *Guidance: English Baccalaureate (EBacc).*
[9] In line with the Roehampton Annual Computing Education Report, we define 'computing' as the umbrella category containing both Computer Science and ICT.

ICT was a more gender balanced subject at GCSE than CS: 38% of ICT GCSE takers in 2017 were girls, compared to 20% for CS. Therefore, one impact of this change has been an increase in the gender imbalance in computing education in Key Stage 4 overall.[10]

Data also suggests that the relatively new CS GCSE is one of the hardest GCSEs on offer. On average, pupils achieve half a grade lower in CS than in their other subjects. There is a small gender gap in attainment, with girls taking the GCSE scoring slightly higher on average than boys.[11]

2.2.1 Research Question

Given the current gender imbalance in pupils choosing CS GCSE, our core research question for the report is: **how is Computer Science presented in option booklets and options evenings, and could these be adapted to encourage more girls to choose it?**

2.3 Project context

The Gender Balance in Computing Project (GBIC) aims to tackle a number of known and well-researched barriers to female pupils engaging with computing, including a disconnect between extra-curricular computing activities and subject choice; a lack of encouragement to study computing; a lack of familial and other role models in computing and a perceived lack of relevance of computing to pupils. These barriers are addressed in the five intervention strands that comprise GBIC, with the common goal of increasing the number of female pupils who study GCSE and A Level computer science. This project explores the presentation of CS as a GCSE option, through schools' options evenings and options booklets, and how this presentation relates to female pupils' GCSE options decision making.

This report follows previous research into the relationship between schools' GCSE options systems and subject choice, with a focus on CS GCSE.[12] In that report, the Behavioural Insights Team (BIT) suggested further exploratory research, focusing on how CS GCSE is presented in options evenings and options booklets. The current report documents that research.

The exploratory hypothesis guiding our work is that the way CS GCSE is presented as a GCSE option may influence pupils' choices, and that some ways of presenting CS GCSE could lead to fewer girls choosing to study it at GCSE.

[10] Kemp, P.E.J., Berry, M.G. & Wong, B. (2018). *The Roehampton Annual Computing Education Report: Data from 2017*.
[11] ibid
[12] Behavioural Insights Team. (2020). *Gender Balance in Computing: Subject Choice Exploratory Research.*

2.4 The GCSE options process

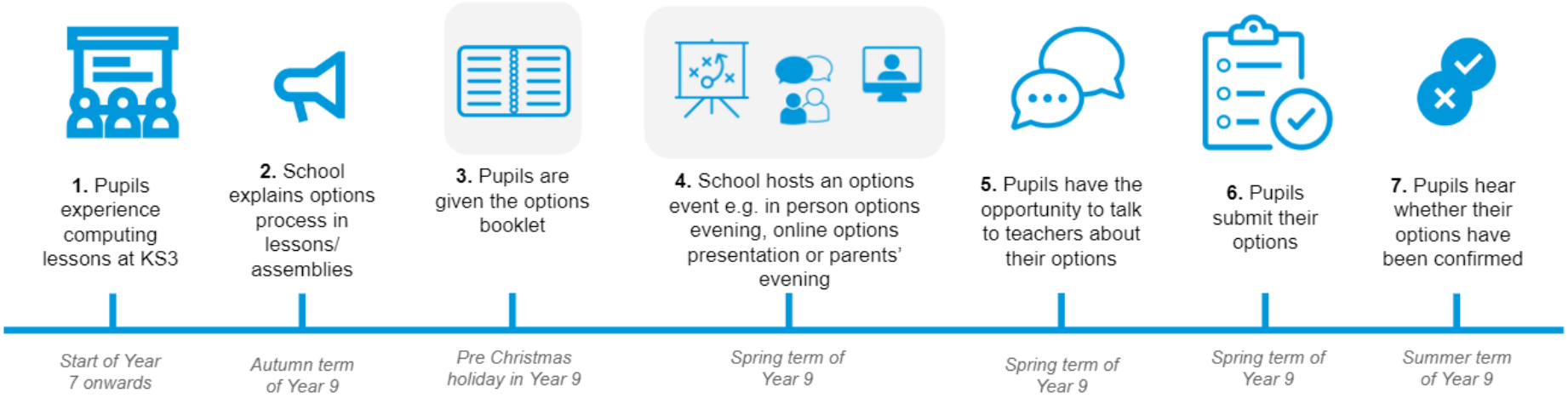
The GCSE options process is the set of steps through which schools set out the GCSE subject options and pupils make their selection. All schools require pupils to take a 'core curriculum' (usually English language, English literature, maths and science). In addition, pupils can typically choose two to four optional subjects, depending on their school.

Generally, schools ask pupils to make the GCSE options decision in either Year 8 or Year 9. In 2019, 56% of schools required pupils to choose in Year 8, creating a three-year window for pupils to be working on their GCSEs (from Year 9 to Year 11) and 40% of schools required pupils to choose in Year 9, leaving two years to spend on their GCSE courses (Year 10 to Year 11).[13] It is possible that since 2019, the proportion of schools in which pupils choose their GCSEs in Year 9 has increased, as some schools have decided they are more able to provide a 'broad and rich curriculum' (from the 2019 School Inspection Handbook)[14] with a three-year Key Stage 3. These schools have made the decision to have the GCSE options process in Year 9, so that pupils can complete the whole three years of Key Stage 3 studying the full curriculum, before starting the narrower range of subjects they are taking for GCSE.[15]

There is wide variation between schools in the precise timing of the options process, and the subject combination decisions that are available to pupils. This is in part because some schools offer a fixed block system, in which pupils pick one optional GCSE subject per block from a series of blocks; some schools offer a free choice system, in which pupils choose any combination of optional subjects they wish from a list; and other schools offer a mixed system which incorporates elements of both systems. Whilst the exact structure of school options processes varies, Figure 3 illustrates what a 'typical' options process might look like for a school that runs the options process in Year 9.

[13] Education Endowment Foundation. (2020). *What works at Key Stage 4, two or three years of study?*
[14] Ofsted. (2019). *School Inspection Handbook.*
[15] Ofsted. (2020, Jan). *Making curriculum decisions in the best interests of children.* [Blog post]

Figure 3: The GCSE options process (indicative timeline for a Year 9 options process)



Within the options process, two main points at which schools share information about the GCSE subject courses with pupils and parents are the sharing of the **options booklet**, and through an **options evening** (either online or in-person). These sections are highlighted in grey in Figure 3. This research project focuses on these two aspects of the options process, as they provide scope to explore how CS is presented as a GCSE option, and how that presentation might be linked to pupil decision making.

Options booklets tend to be fairly long documents that are shared with pupils and parents and contain information about the system for making subject choices (and the constraints on those choices) as well as subject descriptions for all subjects. Typically, each subject description is 1-2 pages long. See Figure 4 for an example of the CS section of a GCSE options booklet.

OPTIONAL EXAMINATION SUBJECTS

COMPUTER SCIENCE

OCR EXAMINING BOARD (GCSE 9 – 1)

CONTENT

The new OCR GCSE Computer Science specification has taken the best elements from the extremely successful GCSE Computing specification and modernised and reformed it. The Computer Science qualification will, above all else, be relevant to the modern and changing world of technology. Computer Science is a practical subject where learners can apply the knowledge and skills learned in the classroom to real world problems. It is a creative subject that involves invention and excitement. This qualification will value computational thinking, helping learners to develop the skills to solve problems and design systems that do so.

These skills will be the best preparation for learners who want to go on to study Computer Science at A Level and beyond. The qualification will also provide a good grounding for other subject areas that require problem solving and analytical skills, subjects such as Engineering and Science. Computational thinking is, in essence, the ability to think about any problem logically, compare to previous experience and develop a solution; it is not simply instructions and actions. Computational thinkers are able to see algorithms, processes and data and know how to then implement them in their chosen language.

Component 1 – Computer Systems	Component 2 – Computational Thinking, Algorithms and Programming
The first component is an exam focused on computer systems covering the physical elements of computer science and the associated theory.	**This component is focused on the core theory of computer science and the application of computer science principles.**
• Systems Architecture • Memory and storage • Computer networks, connections and protocols • System software • Network security • Ethical, legal, cultural and environmental impacts of digital technology	• Algorithms • Programming fundementals • Producing robust programs • Boolean logic • Programing launguages and Integrated Developmental Environment.

Almost every career in the future will have an element of computing involved, whether it is digital doctors or GPS farmers. The more knowledge you have, the more control you will have and the more jobs will be available to you at higher salaries.

Assessment	
Component 1	**Component 2**
1 ½ hour paper Mix of long and short answer questions 80 marks 50% overall GCSE	**1 ½ hour paper Mix of long and short answer questions 80 marks 50% overall GCSE**

OTHER INFORMATION

A minimum of grade 4 in Mathematics and/or Computing at the end of KS3 is required because there is a strong link between Mathematics and computational thinking.

Students will be given time to carry out a reasonable programming project during the course of study.

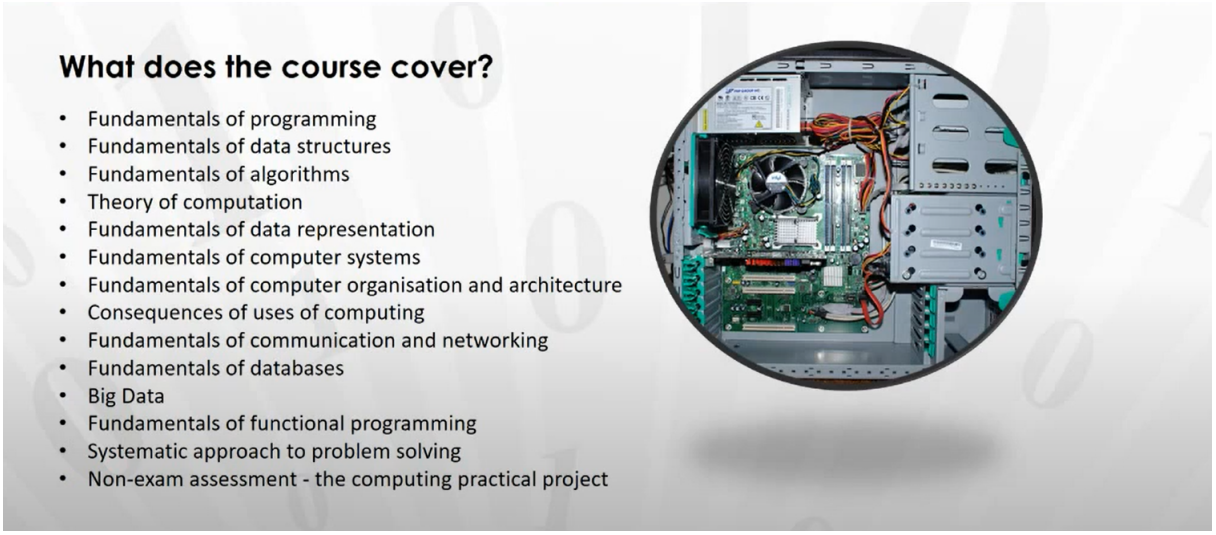
A keen interest in Computing and Technology and some interest in or experience of programming would be beneficial.

Figure 4: Example of a Computer Science options booklet description

Options evenings vary in structure and can be held either online or in-person. Generally, they include a summary presentation which introduces the options system (and school constraints / encouragements) to pupils, followed by information about each of the subjects, either through presentations or pupils having the opportunity to visit a subject space.

In some schools, instead of having a separate parents' evening and options evening in the Spring term of Year 8 or 9, they have a parents' evening that has a particular focus on options. Within this parents' evening, parents and pupils would be able to discuss with the child's current teachers the possibility of them taking that subject for GCSE, and there would be some slots available for parents and pupils to book in discussion with potential teachers of GCSE subjects that the child is considering.

Figure 5: Example of a slide from a Computer Science options presentation



The impact of COVID-19 has changed the GCSE options process over the last two school years: most schools were not able to run an in-person options evening in 2020-2021, and a large number of schools either decided against running an in-person options evening in 2021-2022, or were forced to cancel their planned event because of the COVID-19 context. This meant that in 2020-2021, 'options evenings' moved online, and many schools are now using a hybrid of online and in-person events to share information about subjects with pupils and parents. Because of this change, we will use the term 'options evenings' broadly, referring to any event (in-person or online) run by the school, which aims to share information about GCSE subject options with pupils and parents.

2.5 Overview of the evidence

Women are underrepresented in technical and computing careers, and the gender imbalance is the largest of the STEM fields.[16] This imbalance starts early in girls' educational journeys as they self-select out of computing over time. A study examining all pupils in Years 7 to 13

[16] Cheryan, S., Ziegler, S.A., Montoya, A.K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143*(1), 1-35.

found that interest in CS dropped off sharply after Year 7 (when pupils were first exposed to the subject) - and this decrease was greater for girls.[17]

2.5.1 What factors influence girls' decision to take Computer Science in school?

The evidence suggests that individual and social factors, as well as broader cultural and structural factors influence pupil choice and contribute to the gender imbalance in CS.

Interest and enjoyment. The literature consistently reports that pupils select their subjects based on how interesting and enjoyable they find them.[18] Evidence from the UK, US, and Australia finds that interest is a major reason for taking (or avoiding) CS.[19] There is evidence of an "interest gap" as girls on average find computing less interesting and enjoyable than boys do.[20] Qualitative research suggests that after Year 7, pupils overall find CS less interesting (and creative), but this decrease is larger for girls (i.e., by Year 9, 65% of boys found CS interesting, compared to 32% of girls).[21]

At least some of this may be due to the type of tasks and quality of teaching in these first experiences. Research suggests that girls do engage in computing outside of school but the types of activities they engage in (e.g., creative pursuits, role playing games) are typically not the focus of the CS curriculum.[22] For many girls, this will be their first experience with coding (a key component of CS GCSE) and some may find the task boring and repetitive, which can deter girls from selecting CS.[23]

Perceived usefulness. Perceived usefulness for the future is an important reason why pupils select particular subjects.[24] Part of the reason why girls do not go into computing at the

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[17] Wellcome Trust. (2020). Young people's views on science education: *Science education tracker 2019*.
[18] Happe, L., Buhnova, B., Koziolek, A., & Wagner, I. (2021). Effective measures to foster girls' interest in secondary computer science education. *Educational and Information Technologies, 26*, 2811-2829.; Jin, W., Muriel, A., Sibieta, L., & Institute for Fiscal Studies. (2011). *Subject and course choices at ages 14 and 16 amongst young people in England: insights from behavioural economics.* Research report DFE-RR160. Department for Education.; Cuff, B.M.P. (2017). Perceptions of subject difficulty and subject choices: Are the two linked, and if so, how? *Ofqual.*; Tripney, J., Newman, M., Bangpan, M., Niza, C., MacKintosh, M., & Sinclair, J. (2011). *Factors influencing young people (aged 14-19) in education about STEM subject choices: A systematic review of the UK literature.* EPPI-Centre.
[19] Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008). 'Because it's boring, irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education, 50*, 1304-1318.; Denner, J. (2011). What predicts middle school girls' interest in computing? *International Journal of Gender, Science and Technology, 3*(1), 54e69.; Palmer, T., Burke, P.F., & Aubusson, P. (2017). Why school students choose and reject science: A study of the factors that students consider when selecting subjects. *International Journal of Science Education, 39*(6), 645-662.
[20] Happe, L., et al. (2021). Effective measures to foster girls' interest in secondary computer science education. *Educational and Information Technologies, 26*, 2811-2829.
[21] Wellcome Trust. (2020). Young people's views on science education: *Science education tracker 2019*.
[22] Anderson, N., et al. (2008). 'Because it's boring, irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education, 50,* 1304-1318.
[23] Lasen, M. (2010). Education and career pathways in Information Communication Technology: What are schoolgirls saying? *Computers & Education, 54*, 1117-1126.
[24] Anderson, N., et al. (2008). 'Because it's boring, irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects. *Computers & Education*, *50*, 1304-1318.; Jin, W., et al. (2010). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.; Cuff, B.M.P. (2017). Perceptions of subject difficulty and subject choices: Are the two linked, and if so, how? *Ofqual.*

same rates as boys is their understanding and expectations of computing-related careers.[25] First, girls may not be aware of the types of careers that are available, and may not have parents or teachers that can tell them more.[26] Beliefs that computing primarily involves solitary work consisting of programming tasks may be less appealing to girls, who more often cite a desire to work in social environments or with people.[27] In addition, perceived usefulness of computing itself may contribute to girls' interest. A US study of middle school girls enrolled in an after school IT program found that when girls thought computing was useful with real-world applications, they reported more interest in the subject.[28]

Perceived difficulty. How difficult a subject is thought to be is one of the main reasons why pupils select classes.[29] A 2010 systematic review found that for pupils who avoided maths or science, perceived difficulty was their primary reason for not taking it.[30] CS is a challenging subject and the belief that it is "difficult" is widespread among both boys and girls, although girls may be disproportionately discouraged by this belief.[31] As girls may be less confident in their abilities and have less prior experience with programming to draw on,[32] they might view CS as too difficult and avoid it. Pupils also considered how they would be assessed (e.g., at which tier they would take the final exam) when judging how hard a subject would be and deciding whether to take it.[33]

Confidence and self-efficacy. The beliefs pupils hold about themselves affect which subjects they choose to take; and in particular, beliefs about their ability to succeed (confidence and self-efficacy[34]). Confidence and self-efficacy appear to play a role in girls' decision to take CS, as girls tend to rate their abilities and skills lower than boys in CS.[35] These beliefs persists even when girls are of equal ability and performance to boys, and among girls who are interested in, and have even pursued CS.[36]

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[25] Lasen, M. (2010). Education and career pathways in Information Communication Technology: What are schoolgirls saying? *Computers & Education, 54*, 1117-1126.
[26] Hunter, A., & Boersen, R. (2016). Attracting girls to a career in programming: A New Zealand investigation. *International Journal of Gender, Science and Technology, 8*(3), 338-359.
[27] ibid
[28] Denner, J. (2011). What predicts middle school girls' interest in computing? *International Journal of Gender, Science and Technology, 3*(1), 54e69.
[29] Brown, M., Brown, P., & Bibby, T. (2008). 'I would rather die': Reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3-18.; Jin,W., et al. (2010). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.; Palmer, T., et al. (2017). Why school students choose and reject science: A study of the factors that students consider when selecting subjects. *International Journal of Science Education, 3*9(6), 645-662.
[30] Tripney, J., et al. (2010). *Factors influencing young people (aged 14-19) in education about STEM subject choices: A systematic review of the UK literature.* EPPI-Centre.
[31] Cuff, B.M.P. (2017). Perceptions of subject difficulty and subject choices: Are the two linked, and if so, how? *Ofqual.*
[32] Gerson, S.A., Morey, R.D., & van Schaik, J.E. (2022). Coding in the cot? Factors influencing 0–17s' experiences with technology and coding in the United Kingdom. *Computers & Education, 178*, 104400.
[33] Barrance, R., & Elwood, J. (2018). Young people's views on choice and fairness through their experiences of curriculum as examination specifications at GCSE. *Oxford Review of Education, 44*(1), 19-36.
[34] Brown, M.,et al. (2008). 'I would rather die': Reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3-18.
[35] Wilson, D., Bates, R., Scott, E.P., Painter, S.M., & Shaffer, J. (2015). Differences in self-efficacy among women and minorities in STEM. *Journal of Women and Minorities in Science and Engineering, 21*, 27-45.
[36] Förtsch, S., Gärtig-Daugs, A., Buchholz, S., & Schmid, U. (2018). "Keep it going, girl!" An empirical analysis of gender differences and inequalities in Computer Sciences. International Journal of Gender, Science and Technology, 10(2), 265-286.; Grimalt-Alvaro, C., Couso, D., Boixadera-Planas, E., & Godec, S. (2022). "I see

Perceived lack of ability can also be impacted by prior classroom experiences, including the amount of IT use at school.[37] A recent UK survey showed that boys are more likely to have previous experience with coding, which may improve their classroom experiences.[38] On average, girls have less experience with coding outside of the classroom, which may contribute to lower perceived ability and confidence when encountering these tasks for the first time in lessons.

Pupils' beliefs about their abilities also interact with other factors that influence GCSE decisions (i.e., interest, perceived usefulness, perceived difficulty, and expectations for success). For example, a longitudinal study that examined pupils' interest in science and maths as they transitioned to middle and high school found that self-efficacy was the most important predictor of changes in interest over time. And in many cases, these factors are mutually reinforcing. For instance, when pupils have positive experiences with a subject, their perceived ability can increase, affecting both enjoyment and interest.[39] In turn, when pupils are interested in a subject they tend to do better.[40]

Influence of peers, parents, and teachers. The people around pupils also influence their choices, although this may be less important than individual factors like interest and enjoyment.[41] There is also some evidence that support from parents, teachers, and peers can increase girls' interest in computing.[42]

Parents, siblings, and friends serve as informal sources of information and advice for pupils going through the options process.[43] Teachers also support the options process by providing information, guidance, and encouragement. Multiple studies suggest that parents have the largest degree of influence into pupils' subject choices, with the findings more mixed on the relative influence of peers and teachers.[44] Having access to people that can provide information about computing is important for the options process, as some studies have

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myself as a STEM person": Exploring high school students' self-identification with STEM. *Journal of Research in Science Teaching, 59*(5), 720-745.

[37] Downes, T., & Looker, D. (2011). Factors that influence students' plans to take computing and information technology subjects in senior secondary school. *Computer Science Education, 21*(2), 175-199.; Tripney, J., et al. (2010). *Factors influencing young people (aged 14-19) in education about STEM subject choices: A systematic review of the UK literature.* EPPI-Centre.

[38] Gerson, S.A., et al. (2022). Coding in the cot? Factors influencing 0–17s' experiences with technology and coding in the United Kingdom. *Computers & Education, 178*, 104400.

[39] Jin, W., et al. (2011). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.

[40] Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research, 95*(6), 323-332.

[41] Jin, W., et al. (2011). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.

[42] Denner, J. (2011). What predicts middle school girls' interest in computing? *International Journal of Gender, Science and Technology, 3*(1), 54e69.

[43] Jin, W., et al. (2011). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.

[44] Denner, J. (2011). What predicts middle school girls' interest in computing? *International Journal of Gender, Science and Technology, 3*(1), 54e69.; Ikonen, K., Leinonen, R., Asikainen, M.A., & Hirvonen, P.E. (2017). The influence of parents, teachers, and friends on ninth graders' educational and career choices. *International Journal of Gender, Science and Technology, 9*(3), 316-338.; Jin, W., et al. (2011). *Subject and course choices at ages 14 and 16 amongst young people in England: Insights from behavioural economics.* Research report DFE-RR160. Department for Education.

found that many girls do not know where to get information about careers in computing or programming, and parents and teachers are not always able to provide adequate information.[45]

Pupils' experiences with CS in the past and the quality of teaching also appear to contribute to pupils' decisions. A systematic review of factors that contribute to pupils' STEM subject choices in the UK found that one reason pupils avoided STEM subjects was their previous classroom experiences.[46] The quality of teaching could also undermine efforts to increase the number of girls in computing if teachers do not have subject matter expertise and/or are ill-equipped to provide high quality learning experiences. For example, an Australian program to increase junior and middle school girls' interest in computing courses and careers significantly increased girls' confidence after four years, but had no effect on future aspirations.[47] A follow up evaluation suggested that the program was unsuccessful in part because teachers were not confident with the material which contributed to a lack of efficacy. A different study identified that instruction by teachers with limited computing expertise was a barrier to girls selecting advanced ICT options.[48]

Social and cultural landscape. CS is a male-dominated field and technology itself is seen as a 'masculine' domain.[49] There is considerable evidence that women tend to be less attracted to fields that are dominated by men,[50] which may be a major reason why girls do not take CS as they do not expect to pursue careers in computing. The lack of women in computing may deter girls from these fields because they anticipate less support, and more hostility and challenges due to their gender.[51] This is consistent with research that among high school girls interested in pursuing STEM, the amount of anticipated support and belonging in each field (and relative to the others) influences which subjects they will take (e.g., girls may choose biology over CS or physics because they anticipate more women in the field).[52] The presence of same-gender role models is important for girls considering male-dominated fields[53] and interacting with role models has been shown to have positive

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[45] Hunter, A., & Boersen, R. (2016). Attracting girls to a career in programming: A New Zealand investigation. *International Journal of Gender, Science and Technology, 8*(3), 338-359.
[46] Tripney et al. (2010). *Factors influencing young people (aged 14-19) in education about STEM subject choices: A systematic review of the UK literature.* EPPI-Centre.
[47] Lang, C., Fisher, J., Craig, A., & Forgasz, H. (2015). Outreach programmes to attract girls into computing: how the best laid plans can sometimes fail. *Computer Science Education, 25*(3), 257-275.
[48] Lasen, M. (2010). Education and career pathways in Information Communication Technology: What are schoolgirls saying? *Computers & Education, 54*, 1117-1126.
[49] Abbiss, J. (2011). Boys and machines: Gendered computer identities, regulation and resistance. *Gender and Education, 23*(5), 601-617.; Pechtelidis, Y., Kosma, Y., & Chronaki, A. (2015). Between a rock and a hard place: women and computer technology. *Gender and Education, 27*(2), 164-182.
[50] Cheryan, S., et al. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143*, 1-35.
[51] Tellhed, U., Bäckström, M., & Björklund, F. (2017). Will I fit in and do well? The importance of social belongingness and self-efficacy for explaining gender differences in interest in STEM and HEED majors. *Sex Roles, 77*, 86-96.
[52] Veldman, J., Van Laar, C., Thoman, D.B., & Van Soom, C. (2021). "Where will I belong more?": The role of belonging comparisons between STEM fields in high school girls' STEM interest. *Social Psychology of Education, 24*(5), 1363-1387.
[53] Lockwood, P. (2006). "Someone like me can be successful": Do college students need same-gender role models? *Psychology of Women Quarterly, 30*, 36-46.

effects on girls' achievement and expectations towards maths as well as aspirations for STEM more generally.[54]

Cognitive factors. People have limited cognitive capacity or "mental bandwidth" which can be taken up by planning, remembering, worrying, or other mental processes. When these resources are strained, it can impact how we make decisions (e.g., which information we pay attention to) and the quality of those decisions.[55] For example, in a laboratory setting, people often make more impatient and random choices when performing memory tasks that strain their cognitive capacity.[56] Pupils are asked to consider a lot of information during the options process and how this is presented may influence what subjects they select. An experiment that looked at how information was presented in booklets about university courses found that when pupils were asked to read and reflect on each piece of information in the booklet, they made poorer quality decisions (i.e., selected courses with worse ratings) and were less able to perceive differences in the quality of courses than pupils who were given the booklet without any instruction.[57] This may have implications for how much information is presented in booklets and how students are instructed to use them.

Structural factors. Narrowing in on the options process specifically, several additional factors appear to influence choice. Education policies that explicitly value some subject choices over others (e.g., the EBacc) and institutional support for CS can affect girls' subject choices. At the institutional level, limited resources may create timetabling concerns (e.g., fixed block system), contribute to a lack of support for teachers, or prevent some schools from offering CS GCSE. In addition, due to the nature of the qualifications, many girls have limited or very few open subjects in their schedule and CS may be competing with subjects that are seen as more enjoyable, more useful, or less work.[58] A qualitative study with pupils in Northern Ireland and Wales, countries with similar systems, reported that pupils felt they had limited choices and were concerned about making such an important decision under these conditions. Pupils' choices were limited both by the aspects of the selection process and more actively through guidance and perceived pressure for high and low achieving students to take specific subjects.[59]

2.5.2 What is the role of gendered language in influencing girls' decisions?

The use of gendered language (i.e., words seen as 'masculine' and 'feminine') has been shown to influence how people make decisions and behave in a number of arenas, such as

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[54] González-Pérez, S., de Cabo, R.M., & Sáinz, M. (2020). Girls in STEM: Is it a female role-model thing? *Frontiers in Psychology, 11*, 2204.
[55] Fiske, S.T. & Taylor, S.E. (1991). *Social Cognition* (2nd ed.). McGraw-Hill.
[56] Deck, C., & Salar, J. (2015). The effect of cognitive load on economic decision making: A survey and new experiments. *European Economic Review, 78*, 97–119.
[57] Wilson, T.D., & Schooler, J.W. (1991). Thinking too much: Introspection can reduce the quality of preferences and decisions. *Journal of Personality and Social Psychology, 60*(2), 181-192.
[58] Anders, J., Henderson, M., Moulton, V., & Sullivan, A. (2018). The role of schools in explaining individuals' subject choice at age 14. *Oxford Review of Education, 44*(1), 75-93.
[59] Barrance, R., & Elwood, J. (2018). Young people's views on choice and fairness through their experiences of curriculum as examination specifications at GCSE. *Oxford Review of Education, 44(*1), 19-36.

education, business, and performance on cognitive tasks.[60] In particular, there is considerable evidence on the impact of gendered language in workplaces and in job advertisements on women's behaviour.

A series of experiments looking at the effects of explicitly gendering a job description (i.e., using he / him) found that when descriptions used masculine pronouns women anticipated feeling excluded and were less interested in the position.[61] This was true both when the description was read and listened to, which suggests that how CS is described outside of booklets (e.g., at options evenings or in lessons) may be just as important in shaping girls' impressions of the subject.

However, language does not have to be explicitly gendered to carry stereotypically masculine or feminine connotations. For example, a series of experiments showed that when job ads included more masculine words, people perceived those occupations to have fewer women (i.e., as "male-dominated" fields) and for women, these jobs were significantly less appealing.[62] Language may subtly emphasise gender stereotypes; for instance, language that references innate ability, talent, brilliance or genius may be seen as masculine due to the stereotype that men are naturally good at STEM while women have to work at it. In fact, evidence suggests that job descriptions that emphasise innate ability (e.g., "sharp, penetrating mind", "at ease with complex, abstract ideas") are less appealing to women than those that reference dedication (e.g., "great focus and determination") as they viewed themselves as less suitable for the position and less likely to belong.[63] This may be particularly relevant for CS as there are stereotypes around "the computer genius" and many prominent figures in computing are talked about in these terms.[64] For job ads that reference personality traits that may be associated with gender stereotypes[65] (e.g., the statement "you are calm" with the stereotype that women are more emotional), the way these are framed can change how women respond.[66] Two Belgian experiments showed that changing such language from trait-like adjectives ("you are calm") to behaviour-like verbs ("remaining calm during stressful situations") increased women's intent to apply for the job.

There is less evidence on how the language in subject descriptions affects pupil's decisions, but it is likely to be similar. A German study comparing descriptions of coding (CS) courses found that high school girls were more interested when the description emphasised a

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[60] For example: Balachandra, L., Fischer, K., & Brush, C. (2021). Do (women's) words matter? The influence of gendered language in entrepreneurial pitching. *Journal of Business Venturing Insights, 15*, e00224.; Kricheli-Katz, T., & Regev, T. (2021). The effect of language on performance: Do gendered languages fail women in maths? *npj Science of Learning, 6*, Article 9.; Kollmayer, M., Pfaffel, A., Schober, B., & Brandt, L. (2018). Breaking away from the male stereotype of a specialist: Gendered language affects performance in a thinking task. *Frontiers in Psychology, 9,* Article 985.

[61] Stout, J. G., & Dasgupta, N. (2011). When he doesn't mean you: Gender-exclusive language as ostracism. *Journal of Personality and Social Psychology*, *37*(6), 757-769.

[62] Gaucher, D., Friesen, J., & Kay, A.C. (2011). Evidence that gendered wording in job advertisements exists and sustains gender inequality. *Journal of Personality and Social Psychology, 101*(1), 109-128.

[63] Bian, L., Leslie, S. J., Murphy, M. C., & Cimpian, A. (2018). Messages about brilliance undermine women's interest in educational and professional opportunities. *Journal of Experimental Social Psychology, 76*, 404-420.

[64] Perez, C.C. (2019). *Invisible women: Data bias in a world designed for men*. Abrams Press.

[65] The study tested meta-stereotypes, which are beliefs about what out-group members think of in-group members, such as stereotypes that girls may believe others hold about them.

[66] Wille, L., & Derous, E. (2018). When job ads turn you down: How requirements in job ads may stop instead of attract highly qualified women. *Sex Roles, 79*, 464-475.

communal goal (i.e., helping the elderly) rather than an instrumental one.[67] This is consistent with other research which has found that the more girls and young women associate STEM fields with helping others, the greater their intent to pursue STEM careers[68] and the more STEM courses they take (i.e., the gender disparity decreases).[69] Booklet descriptions that emphasise prosocial uses of CS and highlight careers with a social element may increase the appeal for girls.

Language may also impact other aspects of the options process, affecting how teachers and parents view CS and provide guidance to students. There is some evidence that masculine language can change how people evaluate suitability of candidates or appropriateness for a field. For example, an experiment in which students evaluated the hireability of fictional applicants found that when the job ad used masculine language, women applicants were viewed as less suitable for the position despite having identical qualifications to the men (i.e., identical CV with different names).[70]

Descriptions of CS that emphasise prosocial goals and social careers, use gender neutral language (when possible) and frame requirements in terms of behaviour instead of traits or innate abilities may change how pupils, parents, and teachers perceive the subject and encourage girls to consider it.

[67] Neuhaus, J., & Borowski, A. (2018). Self-to-prototype similarity as a mediator between gender and students' interest in learning to code. *International Journal of Gender, Science and Technology, 10*(2), 234-252.
[68] Weisgram, E.S., & Bigler, R.S. (2006). Girls and science careers: The role of altruistic values and attitudes about scientific tasks. *Journal of Applied Developmental Psychology, 27*(4), 326-348.
[69] Yang, Y., & Barth, J.M. (2015). Gender differences in STEM undergraduates' vocational interests: People–thing orientation and goal affordances. *Journal of Vocational Behavior, 91*, 65-75.
[70] Horvath, L.K., & Sczesny, S. (2016). Reducing women's lack of fit with leadership positions? Effects of the wording of job advertisements. *European Journal of Work and Organizational Psychology, 25*(2), 316-328.

3. Methods

This section covers the research activities we conducted to address our core research question: **to understand how Computer Science is presented in options booklets and options evenings, and whether this presentation could be adapted to encourage more girls to choose it**. We first summarise our overall approach to addressing the research question, before describing the method for each of the five research activities in turn.

The diagram below summarises our overall approach to tackling this question.

Figure 6: Research methods

3.1 Evidence review

We reviewed the evidence on how pupils choose their subjects, perceptions of computing and subject choice, and the influence of gendered language on decision-making. We searched scholarly databases (e.g., EBSCO, PsycINFO, Google Scholar) for academic evidence, conducted online searches for grey literature (e.g., industry and government reports), and reviewed citations to identify additional literature. This was used to contextualise the qualitative findings and frame the report.

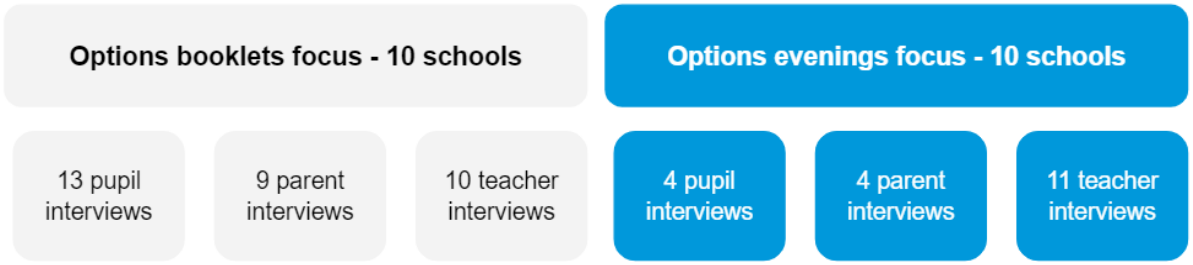
3.2 Qualitative research

3.2.1 Data collection

We conducted semi-structured interviews to explore how CS is presented in options evenings and options booklets, how pupils', parents' and teachers' perceive the subject and to understand their experiences of taking part in the options process.

Ten schools took part in interviews about options evenings and a further ten took part in interviews about options booklets. Figure 7 presents the interviews conducted for each project.

Figure 7: Overview of qualitative research participants



A convenience sampling approach was used to recruit the 20 schools in our sample. The 20 schools which took part included 17 mixed non-selective schools, two all girls non-selective schools, and one all girls selective school. We ensured that we recruited schools which differed according to pupil premium level, school type (academy vs LA maintained), and region.

To conduct the interviews, we worked flexibly with the schools, adapting whether the interviews were conducted in-person or online, jointly or individually, to suit each schools' and participants' needs. Interviews with parents and pupils were recorded and detailed notes were taken for the observations and teacher interviews.[71]

It is worth noting that the schools which were willing to take part in our research might have been schools which are particularly engaged with the options process for CS and so the teachers, parents and pupils we spoke to may not represent the full range of experience for these groups.

3.2.2 Analysis

A thematic analysis was conducted to answer the research questions as well as identify overarching themes within the data.[72] The interview data were combined across participants to form two data sets (options evenings, options booklets). Before coding, the data were first

[71] In most cases a second interviewer was present to act as an additional note-taker.
[72] This was loosely informed by the steps outlined by Braun & Clarke (2006).

reviewed and any initial observations noted. On this basis, some of the data were moved or copied over into the other set as applicable (e.g., if a pupil talked about the options evenings in the interviews about the booklets, or vice versa). Features of the data that were relevant to the research questions were used to develop initial codes, which were manually sorted into larger patterns of meaning or potential themes, and any common elements (overarching themes) documented. Two members of the project team reviewed these for internal consistency and discussed each theme until there was alignment on interpretation. Potential themes or features of the data that did not address the research questions were omitted.

3.3 Observations of options evenings

We observed options evenings across ten schools, to see how CS was presented as a subject, how that compared to the presentation of other subjects and how pupils and parents engaged with CS as an option. These observations took place either in-person or virtually - depending on whether or not the school was holding an in-person event.

The majority of the schools who volunteered to take part in this research project were holding their main options presentation online.[73] It was more challenging to observe parents' and pupils' engagement with online presentations than in-person events so we triangulated parent and teacher responses to related questions from the interviews at these schools, to build a picture of overall parental engagement.

We used an observation guide to structure the data we gathered from these options evenings. This included noting:

1) How CS was framed in school options evenings
2) The methods that were used to make subjects appealing to pupils
3) How the framing of CS compared to other subjects
4) How pupils and parents engaged with the options evening

3.4 Analysis of language in options booklets

3.4.1 Data collection

To collect the options booklets data, we used the DfE's 'Get information about schools' service[74] to randomly sample 10% of secondary schools in England - this generated a list of 304 schools. We then manually searched each school's website for their GCSE options booklet and found 179 usable descriptions of CS and 191 usable descriptions of geography.[75] This sample of booklets will be referred to as Sample A. For an additional comparison, we

[73] It is possible that online options evenings observations were over-represented in our sample, as it was less of a burden on schools to direct us to a pre-recorded or live online options evening, as opposed to hosting BIT researchers for an in-person event.
[74] https://get-information-schools.service.gov.uk/
[75] In some schools, the descriptions were not usable because they were either not shared publicly on the school website, or they were shared in a format that didn't allow for the text to be copied.

used a semi-manual digital scraping tool to gather CS and geography subject descriptions from booklets from 50 additional schools.[76] This sample will be referred to as Sample B.

Geography was used as the comparison options descriptions as geography GCSE has a fairly even gender balance with a 47% female cohort in 2021.[77] Figure 2 (in section 2.2) illustrates where Geography and CS fall in terms of gender balance within the most popular GCSE options.

3.4.2 Analysis

Gender bias

To measure the extent to which language in options booklets is 'gendered', we used a method which assigned a gender score to each word in the booklet, representing how 'male' or 'female' that word is. To calculate the score for each word, rather than using a pre-made list of 'male' or 'female' words, we used a method which uses text from over a billion webpages to find how close (in terms of how often it appears near or is used in similar contexts) words are to 'male' or 'female' terms (the GloVE model).[78] It is this 'closeness' which assigns words a gender score: a negative score indicates that the word is closer to 'female' terms and a positive score indicates that the word is closer to 'male' terms.[79] Once each word had a gender score assigned to it, overall scores for each subject description could be generated.[80]

The GloVE model

GloVe is trained on a wide range of texts which capture the gendered nature of terms as they are used more broadly in society. In this way, the data mirror how gender is constructed in society more broadly and do not represent an "objective" or neutral measure. This means that we are hopefully accounting for readers' perceptions of the terms used in our analysis.

Whilst the GloVe model could, therefore, be argued to be biased, any attempts to intentionally debias or choose an unbiased model would be counter-productive to our purposes as this would not reflect how terms are used and perceived in our current culture.

Exploring the 'crucial' and 'optional' language within booklets

To explore how gendered the language in booklets was, we manually categorised each of the words found in the CS and geography booklet descriptions into 'crucial' (words which must be used to describe a subject), 'optional' (words which could be used to describe a subject,

[76] The scraping was semi-manual. A list of school websites was created that had working webpages in the format www.schoolwebsite.com/year_9_options/ or www.schoolwebsite.com/year_8_options/. Then this list was used to manually download the subject descriptions for geography, Computer Science and drama.
[77] Department for Education. (2021). *Key stage 4 performance: Academic Year 2020/21.*
[78] Using https://nlp.stanford.edu/projects/glove/
[79] For brevity, for the rest of the report, when we refer to 'male words' or 'female words', we are referring to 'words which are closer to male terms in semantic space' and 'words which are closer to female terms in semantic space' respectively.
[80] We did this for three categories of words within the booklets: nouns, verbs and adjectives/adverbs

but it would be possible to describe the subject without them) and 'other' (words which could be found at random in any subject's booklet description). Table 1 sets out the stages of the questioning and how this corresponds to the conclusions we could draw from the analyses.

Table 1: Research Questions for the gendered booklet analysis and what this told us

What we asked		What this told us
What is the gender balance of language in CS and geography booklets when:		
	All words are included in the analysis	Whether the language used to describe CS was more male than geography, taking into account all of the words in the booklets
	'Crucial words' are excluded from the analysis	Whether the language used to describe CS was more male than geography, after the 'crucial' words are excluded.
	Both 'crucial' and 'optional' words are excluded from the analysis	Whether the language used to describe CS was more male than geography, even after all of the 'optional' and 'crucial' words were removed from the analysis.

Readability

Readability scores for each of the subject descriptions were generated using formulae designed to assess the complexity of the language used in a piece of text.

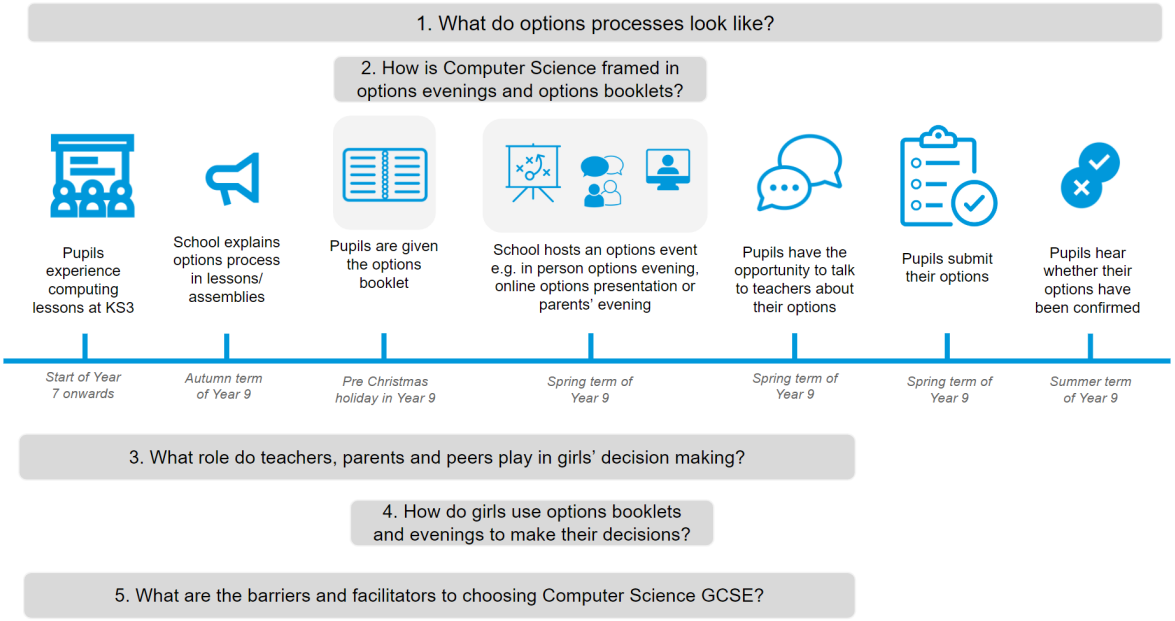
3.5 Teacher survey

Survey data from 4,150 secondary teachers and school leaders was collected via the Teacher Tapp survey app. In this app, participants are a self-selecting group of teachers who are sent three short questions each day. Teachers were asked "*To choose Computer Science as a GCSE option…which of the following criteria apply to students at your school?*" and were given a range of options describing formal or informal criteria related to maths and language attainment. While the self-selecting nature of the teachers means that this sample is not fully generalisable to the national picture, a sample of this size does represent a good range of school experience.

4. Findings

This section summarises the findings from the five research activities described in the previous section. We have divided our main research question into sub-questions, and organised this section starting with questions related to the options process and factors affecting pupils' decisions, followed by the barriers and facilitators to girls choosing CS GCSE. Figure 8 illustrates how the research questions addressed in this section relate to each stage of the options process. We combined evidence from our multiple research activities to address each question in turn.

Figure 8: Research questions covering the GCSE options process



4.1 What do options processes look like?

Options evenings are part of a longer options "process" which prepares pupils to make their decisions.

The options process varies betweens schools and includes a range of activities, with some schools viewing the options process as starting as early as Year 8 when pupils are first introduced to the timeline of the decision making process. Most teachers described the options process as information during lessons, exposure to any 'new' GCSE subjects, guidance from teachers leading up to the selection, provision of options booklets, and an options evening (or evenings). Some schools offered separate parents evenings while others

Case study 1: School A's options evening

Before the options evening
- Shared options booklet
- Gave 'taster lessons'
- Maths & CS teachers met to target pupils

During the options evening
- In person
- Presentation on the overall process
- Classroom display on CS
- Opportunity for parents and pupils to ask teacher questions
- Teacher shares handout

"We're normally inundated - there's hundreds of parents." (Teacher)

consolidated the parents evening and options evening into one event. A few schools enhanced their offerings with assemblies, trial classes, and individual feedback. Additionally, some teachers tried to enhance options evenings with demonstrations, activities, and having senior pupils speak to younger pupils: *"I think talking to someone who has taken Computer Science could really help because when the teachers say it, they always describe it really positively, but pupils you can hear the positives and negatives." (Pupil)*

Options evenings varied in how information was delivered and structured.

Options evenings typically included a presentation about the subjects or options process followed by opportunities to interact with teachers and ask questions. Less commonly, options evenings offered parents and pupils the opportunity to speak with teachers but had no formal presentations. Within presentations, there was considerable variation in the amount of information provided, both with regard to if each individual subject was discussed and the amount of detail provided.[81] The structure of options evenings also affected the ability for parents and pupils to get information. In some schools, pupils and parents chose which subject presentation to attend and in some cases were only able to attend four talks as part of a process that would see them select four options. This limitation may mean that 'marginal' or 'wildcard' subject choices, like CS perhaps, are not prioritised when parents and pupils are deciding which talks to attend, and consequently not selected. The benefit of an options evening is arguably reduced if pupils and parents can't attend a number of subject talks that is higher than their number of options.

Case study 2: School B's options evening

Before the options evening
- Shared the options booklet
- Subject assemblies

During the options evening
- Pre-recorded videos shared on the school website
- General presentation giving overview of the options process
- One minute subject voice-over of slides describing the Computer Science course

Most schools held online options evenings due to the pandemic, which has created uncertainty about what the process will look like going forward.

Most schools adopted an online or hybrid format (e.g., in-person options evening plus pre-recorded presentations about the options process on the school website) for options evenings held during the past two years. At least one school will be keeping options evenings online and another will be retaining some online elements.

Teachers thought online options evenings had several benefits, such as increased access for parents who could not attend in-person events and the ability for pupils and parents to view materials in their own time. In some cases, the online format allowed parents and pupils to access information about each class, something that was not possible with in-person evenings.

Although teachers saw the value in online options evenings, most preferred the in-person events. In particular, teachers thought parents were more engaged during in-person events and asked more questions. They also felt that interacting with pupils directly was an important part of options evenings. In addition, there were some aspects of in-person events

[81] The delivery of presentations also varied. For example, if powerpoints (or other additional) materials were used or who was giving the presentation (e.g., head teacher or individual teachers).

that did not translate well to online. For instance, having senior students available for informal chats or hands-on activities like interacting with robotics equipment - elements that might encourage girls to consider CS.

Teachers emphasised the importance of doing well during options evenings.

Teachers provided guidance around how pupils should select their subjects and prompted them to consider their future career and educational goals. As part of this, teachers emphasised the importance of selecting subjects that pupils would excel in. For example, *"The whole idea is to get as many GCSEs as possible in the highest grades you can"* and *"So if you're looking to go to university or elsewhere, you need to get the TOP GRADES you can."* For subjects like CS where girls may be less confident or may not have past experience to draw on (e.g., past grades or other benchmarks for performance), an emphasis on doing well could dissuade them. Girls on average are less confident in their computing skills[82] which may lead them to select more familiar subjects so they do not jeopardise their grades.

During options evenings, parents want to learn more about subjects and are concerned with whether their child will succeed if they select a particular subject.

Parents are typically engaged during options evenings and use the evenings to find out more about subjects their child is considering and ask the teachers clarifying questions. For CS, many parents do not have an accurate understanding of the subject or potential career paths, which makes speaking with knowledgeable teachers particularly important. For instance, one pupil and her parents were not able to speak with the CS teacher at the options evening and ended up picking another subject instead: "*There were some options I was debating on choosing but because options evenings was cancelled, I didn't speak to the teachers about it because I got a bit scared* ". In other cases, the teachers at options evenings did not have a good understanding of the CS GCSE and were unable to provide information to parents and pupils. A common concern among parents is how well their child will do if they take a particular subject. If teachers are unable to provide specific information or guidance at options evenings, parents may discourage the pupil from taking the subject.

4.2 How is Computer Science framed in options evenings and booklets?

4.2.1 Options evenings

CS was framed differently during options evenings depending on who was speaking about the subject. In general, there tended to be very little information on CS when presented by anyone other than a specialist. However, when CS was discussed, it was consistently framed as a difficult subject. For instance, one teacher cautioned parents and pupils that grades in CS GCSE tended to be one grade lower than other subjects. CS was also framed as less

[82] Förtsch, S., et al. (2018). "Keep it going, girl!" An empirical analysis of gender differences and inequalities in Computer Sciences. *International Journal of Gender, Science and Technology, 10(2), 265-286.*

important or useful than other subjects, as teachers did not encourage or actively promote it compared to EBacc or 'facilitating' subjects. Some teachers made efforts to make CS seem practical, highlighting potential careers or using material from commercial providers or Computing education charities to enhance their presentations.

4.2.2 Options booklets review

As with options evenings, the descriptions varied between schools in terms of standardisation (i.e., whether all subjects followed the same format and subheadings), length, and what content (if any) was included beyond a short description of the course structure and content. In particular, the descriptions varied in whether the potential attractions of the subject were being emphasised, or whether they simply presented the minimum information required to describe the GCSE course.

The descriptions typically contained jargon or technical terms (e.g., "network topographies, protocols and layers") when describing the course content. In addition they also portrayed CS as a maths intensive "hard" option. Both of which may discourage girls as they may feel less confident and opt for a more familiar subject that they believe they can do well in instead.

Figure 9: Selection of images from options booklets descriptions of Computer Science

Visually, the options booklets typically featured dark colours and images of technology or machines like circuits, computers, and robots. They also did not typically feature images of people. First, the use of stereotypically masculine colours and images may reinforce the idea that CS is a male-dominated space which could make girls feel less confident or like they do not belong. It could also deter girls if they anticipate few other girls in the class. Second, these images suggest the type of content that will be covered as well as signal potential applications for CS. This could reinforce stereotypes about CS and potentially undermine descriptions that attempt to expand or challenge these notions, for example, by listing non-traditional computing jobs. Lastly, having more images of objects and fewer (or no)

images of people is likely to be less appealing to girls than boys[83] which could contribute to the gender imbalance.

Across options evenings and booklets, CS was framed as preparing pupils to become a software developer or work in cyber security. Careers such as these may not appear social, fun, or to have obvious societal benefits to those who are less familiar with computing, which is more likely to be girls.[84]

4.2.3 Options booklets analysis

Descriptions of Computer Science are characterised by male language.

The CS descriptions tended to use more male coded words than the Geography descriptions (our chosen comparator - see section 3.4 for more details on method) - and this pattern was seen across adjectives, verbs and adverbs.[85]

Of the top 20 adjectives that are more common in CS booklets than Geography booklets,[86] 19 are coded 'male' rather than 'female'. These include the words: *computational*, *digital*, *practical*, *legal*, *technical*, *robust*, *logical* and *fundamental*. In Geography booklets, 13 of the adjectives that are more common in Geography descriptions than CS descriptions are coded 'male' rather than 'female' including: *global, urban, economic, coastal, local and different*.

Given the known stereotype of CS as a male subject, it is perhaps unsurprising that overall, the words used to describe CS were more male than those used to describe Geography, in part because some of the words that are necessary to describe the subject (e.g. computer, science, programming) are stereotypically 'male' words.

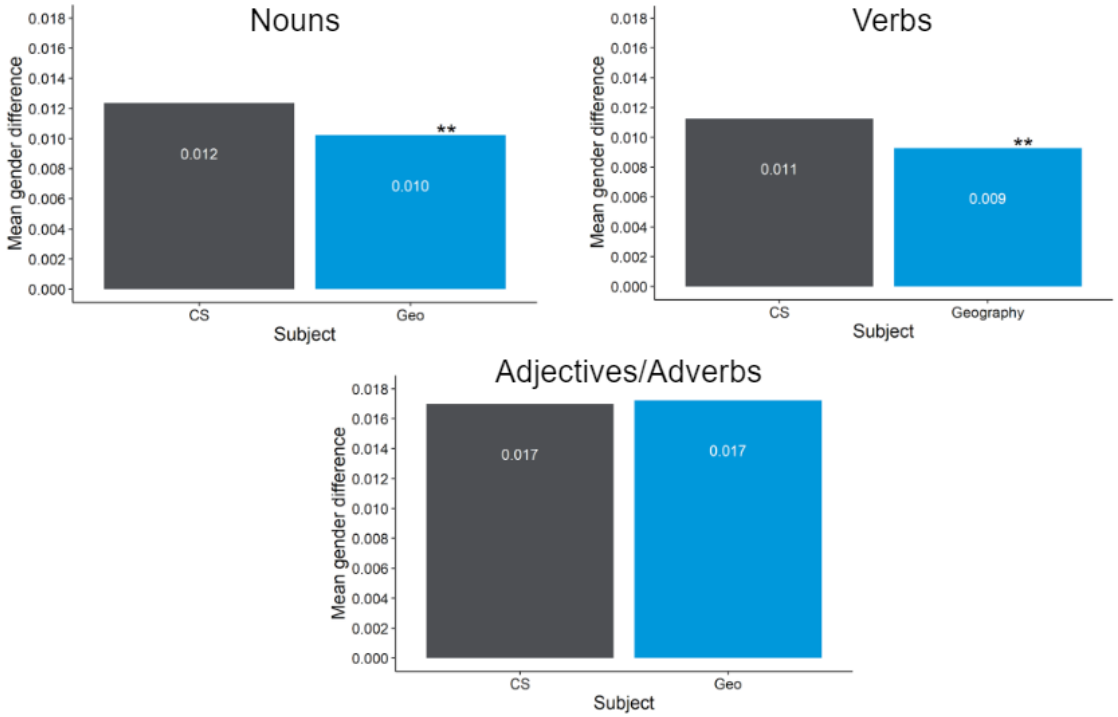
We wanted to investigate whether, aside from the subject specific language used to describe CS and Geography, the remaining language is more 'male' or 'female' for CS or Geography. These subject specific words were split into 'crucial' and 'optional' (see section 3.4.2 for a description of these categories).[87]

We found that once we removed the 'crucial' words from the analysis, the gender difference between CS and Geography remained for nouns and verbs (with CS being more 'male') but disappeared for adjectives/adverbs. Similarly, once we also removed the 'optional' subject words (such as technical and hardware), CS remained a more 'male' description than Geography. This finding, that even after removing the subject-specific words, CS is described in a more 'male' way than Geography, tells us that the general language used in the description is more 'male' than 'female'. Figure 10 shows the gender difference in booklet

[83] Hunter, A., & Boersen, R. (2016). Attracting girls to a career in programming: A New Zealand investigation. *International Journal of Gender, Science and Technology, 8*(3), 338-359.
[84] Neuhaus, J., & Borowski, A. (2018). Self-to-prototype similarity as a mediator between gender and students' interest in learning to code. *International Journal of Gender, Science and Technology, 10*(2), 234-252.; Yang, Y., & Barth, J.M. (2015). Gender differences in STEM undergraduates' vocational interests: People–thing orientation and goal affordances. *Journal of Vocational Behavior, 91*, 65-75.
[85] This was true of both samples of booklets.
[86] Using booklets Sample B.
[87] For this analysis, we looked at the average gender scores for booklet descriptions.

description between CS and Geography (for these 'other' words - once 'crucial' and 'optional' subject words have been excluded). Reducing the use of some of this language could go some way to avoiding the impression that CS is a subject for male pupils.

Figure 10: Gender difference in the language used in Computer Science (CS) and Geography (Geo) options booklets descriptions



* p <0.05, ** p < 0.01, *** p < 0.001

Descriptions of Computer Science use complex language.

Analysis of the average reading age for CS descriptions was consistent with our observations that CS was described using more complex or difficult language. The reading age of CS booklet descriptions is around 18 years old (based on the Flesch Reading Ease Scale).[88] In comparison, the reading age of Geography is around half a school year lower. This may reinforce perceptions of CS as a particularly difficult and highly technical subject.

Some pupils reported that they found the description of CS difficult to read: *"It was quite wordy, talking about percentages, if they could simplify it and say this is where this subject can take you in laymans' terms…" (Pupil)*

4.2.4 Teacher survey

Of the Computer Science teachers who responded to the teacher survey[89], 52% reported that their school uses some kind of criteria to determine which pupils can take Computer Science GCSE. The most commonly used criteria were related to maths attainment ('on track for a 5 in maths' and 'only strong mathematicians would be encouraged'). Only a small

[88] This scale defines readability by the mean length of a text's sentences and the mean syllable count.
[89] And excluding the teachers who answered 'I don't know' or 'cannot answer'.

number of Computer Science teachers (4%) responded that their school used a language threshold, for example, 'On track for a 5 in a language'. In line with survey responses, interviewed teachers reported using maths thresholds for pupils choosing CS GCSE: *"[we say] if you are weak at maths, don't do computing."* However, it is worth noting that, whilst some schools do apply a criteria to pupils choosing Computer Science GCSE, not all schools view it as necessary.

When all secondary school teachers and school leaders were asked what criteria are needed for pupils to choose CS as a GCSE option, 44% did not know. This could reflect the fact that CS GCSE is a newer option or that these teachers are not involved in the options process. Practically, this could mean that almost half of teachers are not able to advise pupils who are considering the subject.[90]

4.3 What role do teachers, parents, and peers play in girls' decision making?

Teachers support the options process by providing information and guidance to both students and parents.

During options evenings and lessons, teachers provide information about the options process more generally and about specific subject options. Teachers also provide informal guidance to parents and students, answering questions and advising them about subjects to consider. This can include feedback on whether they expect a pupil will do well in CS GCSE and is often based on past grades in Key Stage 3 computing and maths, as well as perceptions of pupils' interest and ability.

Outside of options evenings, some teachers specifically encourage girls they think would enjoy or excel at CS to take the subject. Teachers also tried to encourage girls to take CS GCSE indirectly by building girls' confidence in the classroom. For example, by using positive reinforcement or making connections between computing-related skills that pupils do well, such as problem solving, to CS.

Parents appeared to play a large role in pupils' decision-making, while peers played a lesser role.

Teachers and pupils talked about parents as an important influence in pupils' decision making. In particular, parents advised pupils based on what they thought they would do well in and their perceptions of what subjects would be useful.

Pupils stated that peers were not a primary concern when selecting their subjects, and both parents and teachers echoed this sentiment. However, some teachers and pupils talked about the indirect influence of peers as impacting choice, for example, concerns about the number of other girls in the class, "nerdy" associations with CS, and the importance of seeing other students take it.

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[90] Note: 13% of teachers said this question was not applicable (e.g., they do not offer Computer Science GCSE), which means these percentages could be higher among schools that offer the GCSE.

Parents use information from options booklets and evenings to varying degrees, and discuss this with pupils.

Parents engaged with booklets and evenings differently. Some parents were highly involved, speaking with teachers and reading the options book thoroughly. For example, one parent stated *"it's been on my window sill for the last three or four months. As we were thinking about the balance, there was a lot of referring back to it. It was comprehensive, set out what they'd be looking at. It was really useful. I've kept it for the future."*

Other parents did not use these resources at all - sometimes because they had gone through the process recently with other children, were familiar with subjects and/or felt it was the pupil's choice, or did not find them useful. For instance, parents stated *"We got a booklet - didn't really look at it - we looked at what went in which buckets and that kind of thing."* and *"To be honest, we flicked through it. I didn't read it through."*

However, parents generally seemed to find options evenings and booklets helpful. Several parents mentioned that information about careers, and in particular, how CS could complement other subjects was helpful. Parents thought the booklets were particularly helpful if they were unfamiliar with a subject (e.g., "*Probably for me it was just confirming because I knew quite a bit anyway but it always helps if there's a subject you're not [familiar] with, it's useful to have the info.")*

4.4 How do girls use options booklets and evenings to make their decisions?

By the time the options evenings are held and the booklets distributed, many girls have already decided which subjects to take.

After selecting their required subjects, girls had a limited number of available slots for optional subjects. Most girls had an idea of what they wanted to take or had narrowed this down to a few options by the time they received options booklets or attended options evenings. This makes sense in light of the extended options process, but can affect the decision to take CS; for instance, if girls opt for a less "difficult" subject, want to take something "fun" or feel they do not have enough information about the subject to feel confident picking it.

> *"[They've] made their minds up before. We're working with a minority that haven't decided yet." (Teacher)*
>
> *"She had a piece of paper with the options on, she never looked at the booklet. She had her own list of definitely, maybe, no." (Parent)*
>
> *"Because she'd already decided about a lot of her subjects, we didn't look at it in a lot of detail." (Parent)*

However, these resources are helpful for pupils who are undecided and may be considering Computer Science.

Options evenings and booklets may play a larger role for pupils who have not decided what they will take. Options booklets and evenings can help clarify misconceptions about CS. For example, one parent said about the booklet, *"We didn't know that GCSE CS did include programming - we'd been told that it didn't. Others had said it's all about learning how to use Word."* In several cases, information from the options evening and booklet helped girls decide they did not want to take a class they had been considering.

> "*I think it was quite important, she kept looking through it at home - she kept referring back to it. She had a physical copy. She kept pouring over it, I can remember the agony now." (Parent)*
>
> *"I looked through it to see briefly what they were doing. But I already had in mind what I wanted to do beforehand. It changed my mind on one of them because I would have had too much coursework." (Pupil)*
>
> *"I went through it with my parents first but then throughout the week I looked through it by myself to check I definitely wanted to do things without the pressure of my parents being there." (Pupil)*

Girls primarily look at options booklets for the subject topics, how they will be assessed, and to a lesser extent career prospects. They use options evenings to talk to teachers.

Pupils looked at the subject content, including topics and assessment, for subjects they were considering. One pupil stated, *"I think when they're mostly exams for me, I think exams really stress me out - the more coursework was the better options for me but at the same time I didn't want to have too much."* At options evenings, pupils were interested in similar information but also wanted to speak with the teachers who would be teaching the subject. In some cases, pupils considered taking particular subjects because they liked the teacher.

The main concerns for pupils when deciding was anticipated workload and grades. This might discourage girls from selecting CS if the description or options presentation makes it seem particularly challenging or that they will get a lower grade than if they had selected a different subject.

The information in options evenings and booklets is useful, but other things may be more important in shaping pupils' decisions.

In general, teachers, parents, and pupils view the options resources as helpful but pupils' primarily base their decisions on interest, enjoyment, and what they think they will do well in, and to some extent future career goals: *"What she preferred best - how she finds the lessons and how she likes the teacher" (Parent).* This echoes what we heard from pupils about the quality of previous experiences influencing their attitude toward a subject and their emphasis on doing something they enjoy and find useful.

> *"For subjects they've not taken before, it's the lead up and exposure to the subject that matters more than booklets and the parents evening that they might talk about options in." (Teacher)*
>
> *"It's important but it's probably not the most important thing. It may have made a difference for [name] because she was trying to choose between it [CS] and French in the end. Prior experience with the subject is going to have a lot more influence." (Parent)*

Girls do not always talk to teachers informally about options, so options booklets and evenings can fill an important information gap for some pupils.

The main ways teachers support the options process is by providing information and guidance to pupils - much of this informal. However, not all pupils are comfortable speaking with teachers, which can influence their decision making. For instance by selecting subjects they are more familiar or confident in, which may not be CS: *"there were some options I was debating on choosing but because options evenings was cancelled, I didn't speak to the teachers about it because I got a bit scared."*

> *"The biggest thing was we didn't have an options evening, if you weren't confident enough to go and speak to a teacher, I personally went for my safer options because I knew I definitely wanted to do that." (Pupil)*

4.5 What are the barriers to choosing Computer Science GCSE?

4.5.1 Capability barriers

These barriers pertain to limitations on physical and mental capabilities, such as skills or knowledge required to perform a behaviour.

Computer Science is not well understood by parents and pupils.

Parents and pupils may not have a good sense of what the CS GCSE covers. Teachers stated that pupils and parents may not understand the difference between CS and ICT or assume that CS is narrowly about programming and coding with limited applied aspects (especially compared to ICT). This ambiguity could contribute to parents providing inappropriate guidance or pupils opting for subjects they understand better.

> *"We were told you could take computing or media - I wasn't sure what the difference was. I spoke to Mr. P [but] went for the safer options because I wasn't sure." (Pupil)*
> *"I know that we have a lot of Year 9 boys who have picked Computer Science because their dad made them pick it. I don't think those parents are reading the booklet - they just think they'll make loads of money." (Teacher)*

"We didn't know that GCSE Computer Science did include programming - we'd been told that it didn't. Others had said it's all about learning how to use Word." (Parent)

Some teachers who participate in the options process are unable to provide information about the Computer Science GCSE.

Teachers have different degrees of knowledge about CS and some are not able to provide information about the GCSE contents or computing career paths. This has implications throughout the options process as teachers will not be able to answer pupils' questions about CS or provide them with appropriate advice. This may present a lost opportunity for teachers to encourage girls who might be interested in CS to consider it.

"The headteacher has a speech for every subject but for Computer Science what I get is 'this is the teacher, I have no idea what he teaches.'" (Teacher)

Pupils are unaware of the range of careers that Computer Science is relevant to.

Pupils select subjects in part because of how useful they will be in the future. Many pupils (and parents) did not know what they could do with CS, and relied on teachers and options evenings / booklets for this information.

Teachers discussed potential careers and viewed this as a way to make CS appealing to girls: *"Then we think about career pathways, cyber securities, guaranteed jobs, use that as a bit of a carrot."* However, some options booklets highlighted traditional jobs like engineering and robotics, or focused on aspects of work that could be less appealing to girls, such as describing tasks instead of the social or prosocial aspects of a job.[91] In addition, some examples showcasing more unusual jobs may not be clear for pupils. For instance, one booklet listed 'GPS farmer' and 'digital doctor' as potential careers but did not provide additional information. Providing career descriptions that are clear, appealing to girls, and being able to provide additional, accurate information about career pathways could encourage more girls to select CS GCSE.

"I think potential jobs could be useful – it would need to say what they are and what they do. Like for a software engineer, you don't really know what they do. It's more interesting seeing actual examples of what they've managed to do - my Dad put an antenna on a McClaren car!" (Pupil)

"We have to get away from this idea that it's all about the games industry; I know it's a massive employer, but I think for the girls if they knew how technology was used in medicine and that tech is a force for good, they would find it a lot more appealing." (Teacher)

[91] Hunter, A., & Boersen, R. (2016). Attracting girls to a career in programming: A New Zealand investigation. *International Journal of Gender, Science and Technology, 8*(3), 338-359.

"The problem with those titles [in the booklet] is they're just random job titles - they're not specific. You could say 'an analyst working for Netflix, you'll be the one determining what people watch next.'" (Teacher)

4.5.2 Opportunity barriers

These barriers pertain to opportunities in the social and physical environment that may constrain behaviour, such as social/cultural norms or access to resources.

Constraints on choice due to timetabling, limited options outside of 'facilitating subjects', and competition with EBacc subjects were barriers to selecting Computer Science.

Pupils and parents reported that girls sometimes didn't feel that they had many optional 'slots' left available to them, after they had chosen the subjects strongly recommended by their school (for example, triple science, a humanity and a language). In some cases, pupils only had one 'option' left to fill, and some, whilst they would have been keen to take CS, unless it was their top choice which they valued above all other subjects, they did not elect to take it.

"I probably would have taken CS had I not valued other subjects over it. I always wanted to take drama and history and I had to take a language and that only left one spot. It was between quite a lot of things, and I had to make a decision eventually." (Pupil)

"[My daughter] found it difficult because there were many things she wanted to do but there was a limited choice because she could only choose two subjects and so it was hard for her to decide what to choose. This was partly because she was doing triple science." (Parent)

"She decided against computing - she really wanted to do German and French and because she was doing all three sciences, she didn't have a lot of slots. It came down to French or computing." (Parent)

Some teachers mentioned a lack of support from the senior leadership team in the teaching and promotion of Computer Science GCSE.

Teachers talked about a concern among senior leadership in some schools that pupils do not do as well in CS compared to other subjects which could affect the school's position in GCSE league tables. In fact, one school stopped offering CS GCSE for a few years because they were concerned it was dragging down their pupils' grades. Senior leadership teams may also not promote CS as it is not incentivised by the EBacc.

> "*School leadership have got to do stuff [to incentivise Computer Science GCSE]. Computing is seen as a pain in the neck in most schools…it's hard to get colleagues that are trained, hard to get the top results." (Teacher)*
>
> *"If it had its own contribution in its own right to an EBacc outcome, that would have made a significant difference" (Teacher)*

Teachers also talked about a lack of dedicated subject teachers in some schools, which could have implications for other aspects of the options process, such as pupils' experiences and teachers' ability to provide accurate information. Some schools may also have limited resources to support CS GCSE and pre-GCSE computing experiences for pupils. To increase uptake of the GCSE, one teacher suggested *"Having computers in schools that actually work would help - the internet at the right speed and things like that."*

> *"Having computers in schools that actually work would help - the internet at the right speed and things like that." (Teacher)*
>
> *"If they are not getting the experience leading up to their choices, because we are short staffed, then they are less likely to choose CS." (Teacher)*

4.5.3 Motivational barriers

These barriers include internal or automatic motivations that can impact behaviour, such as habits and beliefs.

Descriptions of Computer Science that use technical language and terms can discourage girls from considering it as an option.

Parents and pupils found some of the language in the CS descriptions in the options booklet hard to understand. This tended to refer to the use of technical and specialised terms. In addition to technical jargon, complex descriptions and a high reading level (as noted in the booklet analysis) may reinforce the idea that CS is a particularly difficult subject.

> *"For me, it's like talking another language. I do remember we looked at what it did and we Googled some of it…If I'm honest it could well have been written in a foregin language for as much as I understood it." (Parent)*

The use of technical terms and in particular, an emphasis on "programming" and "coding" may be less appealing to girls. Both teachers and pupils mentioned these specific terms

might put some girls off the subject, despite some evidence that girls do enjoy these tasks when they are framed differently.[92]

Options booklets that visually reinforce notions of Computer Science as 'masculine' or are 'boring' may discourage girls from engaging with the material.

Visual cues and images convey meaning and can influence our behaviour even without our awareness.[93] Aesthetic cues in options booklets and presentations may reinforce beliefs about CS that make the subject less appealing to girls. For example, the use of "gendered colours" (e.g., dark blue) and depictions of objects instead of people may reinforce beliefs that CS is a 'masculine' subject and does not involve working with others. There is also some evidence that exposure to gendered colours can activate gender stereotypes and associated beliefs.[94] Likewise, the absence of engaging visual elements could reinforce the idea that CS is uninteresting. It may also fail to capture girls' limited attention as they review the booklets.

> *"I found the booklet quite wordy, it was black and white text all of it." (Pupil)*
>
> *"More colour, [the booklet was a] bit boring." (Pupil)*
>
> *'"Need to stop and look at the page in the first place. We didn't consider computing for a while, one of her friends or teachers suggested [it] and she went and looked at the page." (Parent)*

Options presentations and guidance that emphasise the difficulty of Computer Science can discourage girls from considering it as an option.

Students and parents believe CS is "harder" than other subjects. This was reinforced at multiple points in the options process - including evenings and booklets. This appears to be true on average, but some teachers also expressed that difficulty depends on the individual pupil (e.g., interest, ability, and motivation). This emphasis on CS as a difficult subject may disproportionately deter girls as they may be less confident in their computing abilities.

> *"We say it's really academically rigorous - we say please don't choose it unless you know you can do it…We tell parents that CS is predicted one grade lower than all other subjects." (Teacher)*

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[92] Neuhaus, J., & Borowski, A. (2018). Self-to-prototype similarity as a mediator between gender and students' interest in learning to code. *International Journal of Gender, Science and Technology, 10*(2), 234-252.
[93] Over, H., & Carpenter, M. (2009). Eighteen-month-old infants show increased helping following priming with affiliation. *Psychological Science, 20*(10), 1189-1193.; Shantz, A., & Latham, G.P. (2009). An exploratory field experiment of the effect of subconscious and conscious goals on employee performance. *Organizational Behavior and Human Decision Processes, 109*, 9-17.
[94] Cunningham, S.J., & Macrae, C.N. (2011). The colour of gender stereotyping. *British Journal of Psychology, 102*(3), 598-614.

Emphasis on maths may disproportionately discourage girls from selecting Computer Science GCSE.

Many teachers view good maths performance as an important prerequisite for CS GCSE. However, an emphasis on being 'good' or 'strong' in maths without providing an objective benchmark could discourage girls from taking CS, as girls tend to rate their ability as lower than boys despite equivalent performance[95] and may require stronger "signals" of mathematical ability in order to opt for a male-dominated field.[96]

> *"Young girls definitely hesitate to describe themselves as 'good at maths' especially when the question is framed by authority (male) in a suit!" (Teacher)*
>
> *"I think the maths things at the end [of the booklet description] isn't the greatest. It makes the whole CS seem as though it's all about maths but when you speak to Mr. P individually it's not like it's all about maths." (Pupil)*

Teachers' guidance is often based on subjective assessments of which pupils are "well suited" and have the "ability" to do well in Computer Science, which may disadvantage some girls who are interested in the subject.

The most common ways teachers support pupils to make their decisions is by providing information and guidance. Some teachers are able to provide concrete guidance, often based on past performance in maths, but others provide guidance based on their sense of a pupil's interest in CS and/or how "well suited" they are for the subject. These subjective assessments may provide an opportunity for unconscious bias and gender stereotypes to affect teachers' guidance. One pupil felt that she had been discouraged from taking CS because of her maths ability, which her teachers saw as 'fixed': *"It seems as though you're saying, if you're not the best at maths this maybe isn't the course for you. I get it in the long run, but you can always get better at maths over time." (Pupil)*

In addition, a major factor that teachers considered when advising students was their sense of how interested a pupil was in CS. This could be problematic as boys may have more opportunities to explore these interests and be more comfortable speaking about them. For example, one teacher stated that boys tend to be more vocal whereas girls who are interested in CS will often not publicly engage or ask as many questions - which teachers might perceive as being uninterested or less passionate about computing.

A lack of other girls taking Computer Science discouraged girls from the subject.

Teachers, parents, and pupils all mentioned a lack of other girls in the class as a reason why pupils would not want to take CS. Teachers and parents proposed several reasons for this,

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[95] Förtsch, S., Gärtig-Daugs, A., Buchholz, S., & Schmid, U. (2018). "Keep it going, girl!" An empirical analysis of gender differences and inequalities in Computer Sciences. International Journal of Gender, Science and Technology, 10(2), 265-286.; Grimalt-Alvaro, C., Couso, D., Boixadera-Planas, E., & Godec, S. (2022). "I see myself as a STEM person": Exploring high school students' self-identification with STEM. *Journal of Research in Science Teaching, 59*(5), 720-745.

[96] Justman, M., & Mendez, S.J. (2018). Gendered choices of STEM subjects for matriculation are not driven by prior differences in mathematical achievement. *Economics of Education Review, 64*, 282-297.

such as being in a classroom of mostly boys could be intimidating or uncomfortable for girls, and may exacerbate girls' lack of confidence. The literature also suggests that a lack of other girls may be discouraging because girls anticipate a lack of support were they to enter that environment.[97]

When reflecting on the gender disparity in computing, teachers thought that peers could play an important role in encouraging girls to take CS (e.g., encouragement from other girls, more opportunities to interact informally in computer labs or clubs). One teacher thought that knowing just one girl was taking CS could be motivating: *"Most of the girls that choose it know other girls so they might choose it as a pair."* Some teachers invite senior pupils to speak at options evenings specifically to encourage more junior girls to take the subject.

> *"It was a bit discouraging because everyone I knew was not taking Computer Science and everyone who was taking it were boys. I think it's helpful that the CS teacher is a girl, at least there's one other person". (Pupil)*
>
> *"I'm saddened by the fact that it's hard for me to…get girls into Computer Science. It almost feels like you're fighting a losing battle. Because the moment you hit a situation where a girl says 'there's going to be more boys in that room than girls', it isn't about what's going on in that room anymore. It's about something else that's going on in their lives". (Teacher)*

A lack of role models for women in computing is a barrier to girls' career aspirations.

Teachers believed that a lack of career role models affected girls' perceptions of CS, but interestingly, this was not mentioned by the pupils themselves. This echoes the literature on gender and computing which highlights the importance of role models in encouraging girls and women to pursue fields that may be seen as non-traditional or "masculine".[98] Some teachers brought in parents, including mothers, who worked in computing to talk with pupils during the options process. Others discussed prominent women in computing during lessons and on materials in schools, but many teachers also mentioned a lack of modern role models that would be appealing to girls. Some teachers also invited older pupils to options evenings to talk to girls and act as more relatable role models[99]: *"[We] have 2 girls in their A level classes who talk to prospective students. [The] girls like to talk to the other girls, they respond well to this".* This chimes with the behavioural science concept of a 'messenger effect' - it is not just the content of the message that matters, but also who is delivering it.[100]

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[97] Tellhed, U., Bäckström, M., & Björklund, F. (2017). Will I fit in and do well? The importance of social belongingness and self-efficacy for explaining gender differences in interest in STEM and HEED majors. *Sex Roles, 77*, 86-96.

[98] González-Pérez, S., de Cabo, R.M., & Sáinz, M. (2020). Girls in STEM: Is it a female role-model thing? *Frontiers in Psychology, 11*, 2204.; Lockwood, P. (2006). "Someone like me can be successful": Do college students need same-gender role models? *Psychology of Women Quarterly, 30*, 36-46.

[99] Role models that are seen as highly relevant (e.g., shared identity, domain) can increase their influence among girls (Lockwood & Kunda, 1997).

[100] Wilson, E.J., Sherrell, D.L. (1993). Source effects in communication and persuasion research: A meta-analysis of effect size. *Journal of the Academy of Marketing Science, 21*, Article 101.

Stereotypes about Computer Science as a masculine domain and boys as more naturally inclined toward technology can discourage girls from pursuing computing.

Stereotypes about computing are well documented, as is the deterrent effect on girls' participation in computing-related fields.[101] Girls themselves have likely internalised some of these stereotypes well before the options process,[102] but it provides an opportunity for parents and teachers to either reinforce or challenge them. Teachers and parents endorsed stereotypes about gender and computing to various degrees, and most often in very subtle ways. For instance, one parent said: *"Having a boy and a girl, it seems their brains are wired differently. He went straight for CS and maths whereas she doesn't. He's excellent at maths as well. She has to work at it.* These beliefs may subtly influence the advice that parents and teachers give to girls and discourage some pupils from pursuing CS.

> *"I know that we have a lot of year 9 boys who have picked computer science because their dad made them pick it. I don't think those parents are reading the booklet - they just think they'll make loads of money. You have some parents who read the booklet but they're not the ones that have the preconceived idea that only the boys should be doing it." (Teacher)*

[101] Master, A., Cheryan, S., & Meltzoff, A.N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in Computer Science. *Journal of Educational Psychology, 108*(3), 424-437.
[102] Blum, R.W., Mmari, K., & Moreau, C. (2017). It Begins at 10: How Gender Expectations Shape Early Adolescence Around the World. *Journal of Adolescent Health, 61*(4 Suppl), S3-S4.

5. Recommendations

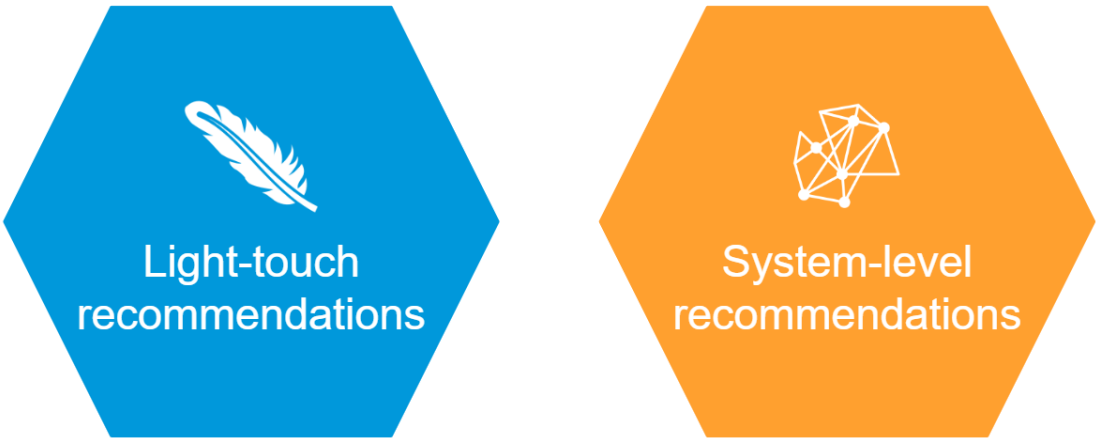
5.1 Introduction and summary

5.1.1 Introduction

In this section, the proposed interventions are combined into a series of recommendations from the report authors. We present the rationale for this particular combination and for recommending a bundle of interventions. These recommendations are informed both by the research activities reported on here, and the findings from our prior research exploring the role of GCSE options systems (i.e. fixed choice, free choice) in the subject selection process, particularly for girls.

These recommendations all aim to increase the number of girls taking CS at GCSE by addressing the barriers identified which are currently preventing girls from taking this option. We have divided the recommendations into two categories, as set out below:

Figure 11: Categories for our proposed recommendations



Light-touch recommendations are those which encourage behaviour change without significantly altering someone's incentives and should be fairly straightforward to implement. [103] Much of BIT's previous work, including with DfE, has taken this form. In this case, these recommendations would aim to encourage girls to choose CS GCSE, without making any changes to the system in which they are making the decision.

Some elements of the recommendations we suggest here have previously been implemented by schools as strategies to encourage pupils to take CS. Other elements would

[103] This definition is based on Thaler, R. & Sunstein, C. (2008). *Nudge: Improving Decisions About Health, Wealth and Happiness.* Penguin Books.

be new in this context. We recommend that the ideas are tested in randomised controlled trials (RCTs), where feasible, to assess effectiveness.

System-level recommendations are wider-reaching changes to the structure in which pupils are making their decisions. These changes are designed to encourage greater prioritisation of CS GCSE at the school level, rather than take-up at the individual pupil level. We have proposed these as suggestions but are conscious that they involve trade-offs which would need to be weighed and there may be additional constraints which would make implementation a challenge. These recommendations are less amenable to RCTs, but could possibly be evaluated using different methods.

5.1.2 Summary of recommendations

Table 2: Summary of recommendations

Light-touch recommendations 	
Recommendation	**Summary**
Recommendation 1: Provide a checklist for what a good options evening/options booklet looks like and example resources for schools to use **Target group:** teachers and school leaders	Share with schools a checklist of elements to include in their options presentations / options booklets. Also share an example options booklet and an example options evening presentation which would meet the criteria described in the checklist.
Recommendation 1.1: Female role models	Use female role models in the options process including at options evening events, in quotes in options booklets and in images used in booklets and presentations.
Recommendation 1.2: Reframe the maths requirement	Explore reframing the maths requirement, which could provide scope for encouraging more girls into CS. The aim is to avoid girls unnecessarily ruling themselves out from taking CS due to a lack of confidence.
Recommendation 2: Teachers send letters to select pupils and their parents encouraging them to take CS GCSE	Teachers could identify pupils who they think might enjoy and do well in CS GCSE and then invite those pupils to take CS GCSE, explaining why they think that pupil would enjoy it/excel in it. This invitation would be through a letter, designed to

Target group: pupils and parents	provide a tangible point of conversation for parents and pupils.
Recommendation 3: Use peer-to-peer communication to encourage a focus on reducing the gender imbalance in CS **Target group:** teachers and school leaders	Send a letter to schools from a headteacher who has succeeded in reducing the gender imbalance in CS in their school. The aims of the letter would be twofold: 1. Encourage the school to prioritise improving the gender balance in CS GCSE, 2. Share what the sender's school had done to encourage girls to choose CS, and the impact they had seen.
Recommendation 4: Provide CS subject training for non CS teachers to address lack of knowledge about the GCSE **Target group:** teachers and school leaders	Sharing training resources or a presentation that schools could use to train non CS secondary school teachers in what CS is as a subject and to equip these teachers to support pupils towards CS, where appropriate. These resources could be developed by a trusted Computing education body (such as NCCE or RPF) and delivered by CS teachers within schools at sessions within staff meetings or INSET days.
Recommendation 5: Use parental messaging to target parent perception of CS **Target group:** parents and pupils	Use parent messaging to encourage parents to talk to their children about the possible applications of CS, and could improve parental understanding and perceptions of CS GCSE. Schools could use an updated version of the Codestars-Belonging intervention for parents of pupils who will choose their GCSEs in the next year (our research suggests that this intervention would be best delivered in Year 7 or Year 8). This intervention has been trialled with Year 5 pupils and parents and involves sending parents weekly conversation prompts to encourage discussion of CS with their children.
Recommendation 6: Group pupils across schools to avoid small cohorts of girls **Target group:** pupils	Schools could facilitate across-school CS clubs (for example RPF Code clubs). Arranging a club across schools would increase the total number of pupils who could attend. This might reduce the risk that girls are concerned that they will be the only girl / one of a very small number of girls within the club.

System-level recommendations	
Recommendation	**Summary**
Recommendation 7: Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE **Target group:** teachers and school leaders	This recommendation would be for the structure of the EBacc to be adapted, so that CS sits within the 'Languages' category, as well as/instead of the 'Science' category.
Recommendation 8: DfE to provide financial incentives for schools to increase their percentage of girls taking CS GCSE **Target group:** teachers and school leaders	Schools could receive additional funding if they achieved specific targets relating to the number of girls taking CS GCSE. For example, if 5 more girls took the subject, schools would receive additional funding. The effectiveness of the financial incentive could be increased through the application of behavioural insights. For example, loss aversion[104] (people dislike loss more strongly than they like gains of equal value) could be harnessed with schools receiving the additional funding immediately, and then losing it if they did not hit the target.
Recommendation 9: Publish a gender balance in computing comparison tool to be used by individual schools **Target group:** teachers and school leaders	Develop a tool which allows headteachers to look up how a school is doing on gender balance in CS GCSE compared to other schools. This could be combined with existing databases of school information, like the Education Endowment Foundation's families of schools database or the 'Find and Compare Schools in England' website.[105]

[104] Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent mode. *The Quarterly Journal of Economics, 106*(4), 1039-1061.
[105] https://www.gov.uk/school-performance-tables

5.2 Light-touch recommendations

This section provides a full overview of each recommendation, including the rationale behind it, a summary of how it could work, and (in some cases) an illustrative mock-up.

5.2.1 Provide a checklist for what a good options evening/options booklet looks like and example resources for schools to use

Summary

Barriers addressed:

- CS is not well understood by parents and pupils
- Pupils are unaware of the range of careers that CS is relevant to
- Technical language can be off-putting
- Lack of female role models in the presentation of CS

Medium: DfE or Raspberry Pi Foundation could share a checklist and example resources with schools. CS department leads could then use the checklist and example resources when preparing options evening and options booklet resources.

Rationale: Providing teachers with an easy-to-follow checklist of what makes a good options booklet / options evening alongside example resources would make it easy for teachers to adapt the way CS is being presented in line with what this review found would be most appealing to girls.

Rationale for using a checklist and example resources

- The idea of a checklist is driven by the idea that schools have pre-existing booklet descriptions and options presentations, and in many cases, have school-specific constraints on what needs to be included. By providing a checklist, schools can assess their current presentation of CS, and adapt their options evening presentation and options booklet so that they are meeting the criteria on the checklist.
- Checklists can help to reduce cognitive load as they remove the requirement for people (in this case, busy teachers) to be simultaneously 'keeping in mind' all of the different elements that might affect how appealing their subject is presented. Previous BIT research has found that providing a checklist with key actions can increase the number of people who complete a desired action.[106] In one trial, a postcard with a checklist of key actions led to a 7-8% boost in online licence plate renewals.
- Example resources could include an example CS options booklet description and an example CS options evening presentation.
- Teachers told us that producing the computing science resources was an additional burden and that they tried to spend as little time as possible on it. "*In an oversubscribed short staffed school, the GCSE options booklet is not something*

[106] Behavioural Insights Team. (2016). *2015-2016 Update Report.*

people are spending a lot of time on" (*Teacher*). By providing example resources, we can make it easy for schools to present CS in options booklets and options evenings in a way that is appealing to girls, without creating additional work for teachers.

- Here we are applying the concept of reducing 'friction' to make it as easy as possible (with the least effort required) for schools to present CS in a way that is appealing to girls, without having to create anything from scratch. In a previous education trial, BIT has found that pre-filling forms increased the number of applications to teaching positions.[107]

Rationale for the points on the checklist

- **Make the most important information salient:** pupils and parents are facing a large cognitive load when considering all of the subject options and some pupils only look at the booklets for a few minutes.
- **Use accessible and familiar language**: pupils and parents are more likely to read and engage with the information if it is presented in a way which is straightforward for them to understand.[108]
- **Present a range of career options** that include creative, prosocial, and collaborative careers / uses: pupils reported that the jobs that are often presented in options booklets and presentations are not appealing. Pupils responded positively to the idea of using CS to solve societal issues and there is some evidence that this framing may reduce the gender "interest gap".[109]
- **Include hands-on activities** (e.g., collaborating to edit a narrative / puzzle game with prosocial storyline) that are fun for the pupils: this could challenge some pupils' concern that CS is 'boring' or 'not fun'; and the narrative, problem solving, and social elements could be particularly appealing to girls.[110]
- **Share labour market statistics** on how well pupils with a CS degree do in the labour market[111]: highlighting the value of a CS qualification for joining the workforce could motivate some girls.
- **Use female role models**: pupils seeing or hearing from 'someone like me' could enable them to picture themselves taking the subject, and might make them more likely to choose CS.[112] This could take the form of images in the booklet or presentation, quotes from female pupils or having older girls who have taken (or are taking) CS GCSE at the options evening. See section 5.2.1.1 for the full rationale.

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[107] Behavioural Insights Team. (2019). *The Behavioural Insights Team Annual Update Report 2017-18*.
[108] Robinson, C D., Lee, M G., Dearing, E., & Rogers, T. (2018). Reducing student absenteeism in the early grades by targeting parental beliefs. *American Educational Research Journal*, *55*(6), 1163-1192.
[109] Weisgram, E.S., & Bigler, R.S. (2006). Girls and science careers: The role of altruistic values and attitudes about scientific tasks. *Journal of Applied Developmental Psychology, 27*(4), 326-348.; Yang, Y., & Barth, J.M. (2015). Gender differences in STEM undergraduates' vocational interests: People–thing orientation and goal affordances. *Journal of Vocational Behavior, 91*, 65-75.
[110] Çakır, N.A., Gass, A., Foster, A., & Lee, F.J. (2017). Development of a game-design workshop to promote young girls' interest towards computing through identity exploration. *Computers & Education, 108*, 115-130.; Stewart-Gardiner, C., Carmichael, G., Latham, J., Lozano, N., & Greene, J. L. (2013). Influencing middle school girls to study computer science through educational computer games. *Journal of Computing Sciences in Colleges, 28*(6), 90e97.
[111] In time, it would be more useful to have labour market statistics on pupils who have taken Computer Science GCSE. Unfortunately, as it is a relatively new GCSE, labour market information is not yet available.
[112] Lockwood, P., & Kunda, Z. (1997). Superstars and me: Predicting the impact of role models on the self. *Journal of Personality and Social Psychology*, *73*(1), 91-103.

- **Reframe computing as an enjoyable / fulfilling challenge** rather than a 'hard' subject that requires advanced maths: this could help to avoid some girls unnecessarily ruling themselves out because they lack confidence that they can meet the requirements. See section 5.2.1.2 for the full rationale.

How this recommendation would work

Through trusted Computing education bodies (such as the National Centre in Computing Education), the DfE could share this checklist and example resources with secondary school Computing teachers. As booklets are often distributed towards the start of the Spring term, these resources could be shared around October half term. Teachers would download the checklist and the (editable)[113] example options booklet description and options presentation. They could then use those resources to assess the way they are currently presenting CS and make adaptations to their resources.

Illustration of what the recommendation could look like

The specific content of the checklist could be finalised alongside discussion with schools and RPF. To demonstrate the kinds of criteria it might include, we have included an illustrative draft below (we recommend that this recommendation be developed and prototyped by designers if taken forward).

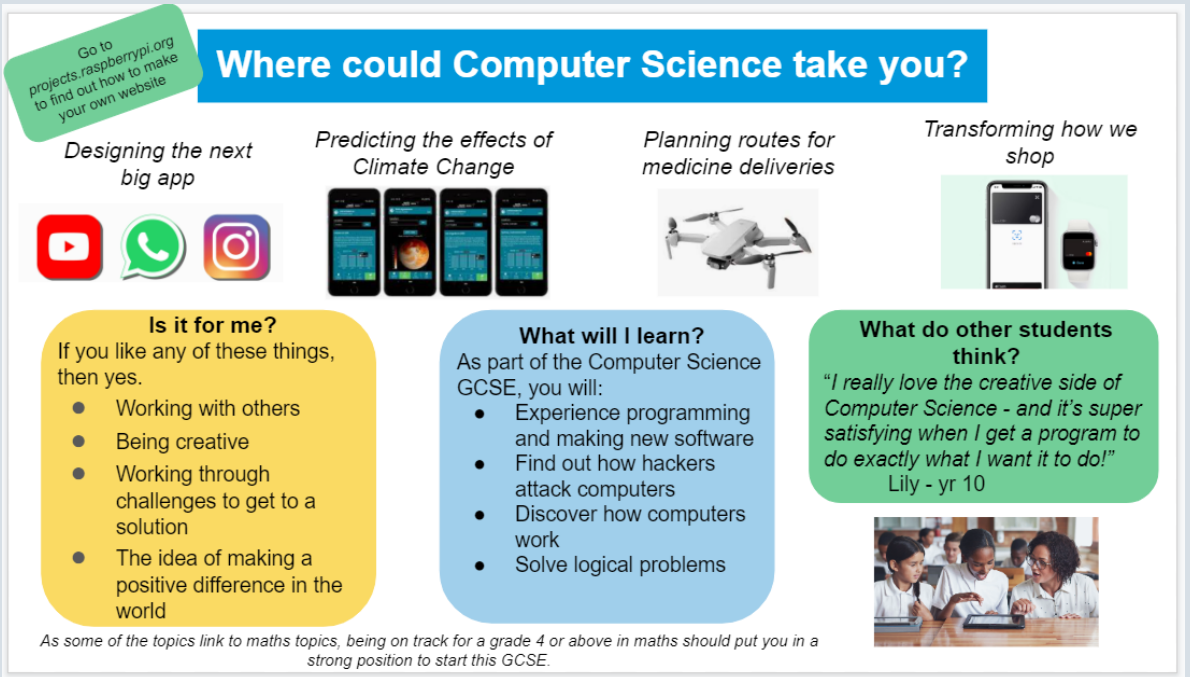
Options booklet / evening checklist

- ☐ Use **familiar language** - remove detailed descriptions of course content
- ☐ Include **female role models**
  - ☐ Include at least one image of a female in computing (e.g. from the RPF website)
  - ☐ For options evenings, invite older girls who are currently studying / have studied CS GCSE to come to the options evening to talk to the pupils who are considering their options
  - ☐ For options booklets, include quotes from girls who have chosen CS GCSE about why they enjoy the subject or what they have got out of it.
- ☐ **Present computing as an enjoyable challenge** rather than a 'hard' subject
- ☐ (Where appropriate) **Reframe the threshold** for how 'good' a pupil needs to be at maths to choose CS GCSE
- ☐ Present a **range of career options**, including careers that are creative (e.g., creating interfaces for large online platforms), social (e.g.,working with climate scientists to predict the environmental impacts of deforestation) or help others (e.g., working out the most efficient ways to get medicine to where it is needed).
  - ☐ Ensure that pupils will understand what the careers involve or are directed to where they can find out more about them.

[113] As schools tend to have specific templates or requirements for subject descriptions in options booklets, it will be important for the resources to be editable.

- ☐ Emphasise that a background in CS can make you **appealing to potential employers**, no matter what sector you want to go into.[114]
- ☐ **Direct pupils to resources/games** where they can find out more about CS e.g. Go to projects.raspberrypi.org to make a game, a website, music, a robot, digital art.
- ☐ Frame **requirements in terms of behaviours** rather than traits or innate abilities
- ☐ Clarify that the intended audience is **both parents and pupils**
- ☐ Make the **most important information salient.** Given the large amount of information contained in the booklet, and the short amount of time some parents and pupils reported spending on the booklet, it will be important to attract the reader's attention to the most relevant parts of the CS description.

Options evening presentation example slide (illustrative draft)



[114] In 2019, a survey by the Department for Culture, Media and Sport found that 14% of businesses had at least one vacancy in the digital sector.

Options booklet CS description example (illustrative draft)

Computer Science GCSE - OCR

"The quality and impact of the products made by the technology sector can only be improved by having the people who are building them represent the people who are using them." Tracy Chou – Software Engineer at Pinterest

"I really love the creative side of Computer Science – and it's super satisfying when I get a program to do exactly what I want it to do!" Lily – year 10

Why should I choose Computer Science GCSE?

Computer Science GCSE will **get you ready for the modern, digital world**. It's an exciting, creative subject that you can apply to almost any issue that you care about, from supporting people's mental health, to finding sporting opportunities. Doing Computer Science GCSE will develop your computational thinking which is the ability to think about any problem in a logical way, compare it to previous experiences and develop the solution.

What will I learn?

As part of Computer Science GCSE, you will:

- Experience programming and making new software
- Find out how hackers attack computers
- Discover how computers work
- Apply what you've learnt to solve problems

How will I be assessed?

Two exams each worth 50%
Component 1: Computer Systems
Component 2: Computational thinking, algorithms and programming

What can I do next with Computer Science?

Almost every career in the future will have an element of computing involved. Technology is moving so fast that Computer Science knowledge will become an essential part of general knowledge and will help you pursue your chosen career for almost any area of work.
You might work in film, finance, the NHS, journalism, manufacturing, music or security. You could design the next big app, work with climate scientist to predict the environmental impacts of deforestation or work on the most effective ways to get medicine where it is needed.

Is Computer Science for me?

If you enjoy working with others, being creative, working through challenges to get to a solutions and the idea of making a positive difference in the world, then Computer science could be for you.

As some of the topics in the GCSE link to maths topics, being on track for a grade 4 or above in maths should put you in a strong position to start this GCSE.

If you want to try it out for yourself, **go to projects.raspberrypi.org**. There you can make your own website, build a game or even create some digital art.

The following two recommendations: including female role models and reframing the maths requirement would both sit within the checklist for a good options booklet or options presentation. We present them here as separate (but linked) recommendations here because a) both themes came through strongly in our research and b) there is scope to incorporate these ideas into the options process more generally, as opposed to solely in options booklets descriptions and options presentations.

5.2.1.1: Incorporate female role models into the options process

Rationale

- The lack of representation of girls and women in the CS options booklet descriptions and options evening presentations could create a barrier: girls aren't given the impression that CS is for 'people like me'.
- High school age pupils are sensitive to the gendered nature of their environment: evidence from American High Schools showed that how stereotypically male or female the learning environment was significantly affected girls' interest in CS.[115]
- Role models that are relatable (i.e., that girls can identify with) and that girls view as possible to emulate (i.e., that the role model's success is attainable) should be selected as they are more likely to be influential and motivating (than role models without these attributes).[116]
- Another study found that perceived belonging mediated the deterrent effect of masculine words in job ads,[117] meaning that increasing girls' perceived support (e.g., by highlighting a community of other girls in CS) may help counter the effects of potentially off-putting course descriptions and stereotypical beliefs about gender and computing.

How this recommendation would work

There are multiple opportunities to incorporate female role models into the options process. Through the checklist and example resources, schools could be encouraged to:

- Invite older girls to come to options evenings
- Include quotes from named female students in their options booklet and options evening presentation
- Include images of girls doing CS in their options booklets and presentations.

5.2.1.2: Reframe the maths criteria

Rationale

- It's possible that the ambiguity of the criteria used in some booklets (e.g., "Pupils need to be confident mathematicians") could lead to girls ruling themselves out from

[115] Master, A., Cheryan, S., & Meltzoff, A.N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in Computer Science. *Journal of Educational Psychology, 108*(3), 424-437.
[116] Lockwood, P., & Kunda, Z. (1997). Superstars and me: Predicting the impact of role models on the self. *Journal of Personality and Social Psychology, 73*(1), 91–103.
[117] Gaucher, D., Friesen, J., & Kay, A.C. (2011). Evidence that gendered wording in job advertisements exists and sustains gender inequality. *Journal of Personality and Social Psychology*, *101*(1), 109.

CS to a greater extent than boys despite the fact that girls tend to outperform boys in GCSE maths.[118] We know that girls have a different attitude to risk and ambiguity[119] and this, combined with evidence that girls rate themselves as less 'good' compared to boys at some subjects[120] could contribute to subjective criteria differentially affecting girls.

- In order to avoid this ambiguity, booklets could use more objective thresholds, such as pupils' expected grades in maths. Because there is still scope for girls' to tend towards feeling less confident they will reach their expected grade than boys (even using an objective measure), schools could consider using a lower threshold than the current norm.[121] This could go some way to avoiding the possibility of girls wrongly excluding themselves from CS because they think they are 'not good enough'.

How this recommendation would work

The threshold or criteria that a school uses for whether they consider a pupil to be eligible for CS can be communicated through a range of channels. In addition to adapting the wording in the options booklets and options presentations (as suggested in Recommendation 1), schools could ensure a consistent message is being shared through pupils' and parents' informal discussions with their CS teachers, as well as through the other members of staff at the school.

Illustration of what this recommendation might look like

> "*As some of the topics covered in Computer Science GCSE link to maths topics, being on track for a grade 4 or above in maths should put you in a strong position to start Computer Science GCSE.*"

5.2.2 Teachers send letters to select pupils and their parents encouraging them to take Computer Science GCSE

Summary

Target barriers: Girls' lack of confidence in their ability to succeed in CS.

Medium: Letter to pupils and parents.

Rationale: Pupils hearing directly from CS teachers that they (the teacher) think that the pupils could suit CS GCSE could boost girls' confidence. This increase in confidence could provide the momentum to overcome some of the other barriers girls face to taking CS

[118] Ofqual. (2021). *Summer 2021 results analysis and quality assurance - A level and GCSE*.
[119] Borghans, L., Heckman, J.J., Golsteyn, B.H., & Meijers, H. (2009). Gender differences in risk aversion and ambiguity aversion. *Journal of the European Economic Association*, 7(2-3), 649-658.
[120] Exley, C L., & Kessler, J.B. (2019). *The gender gap in self-promotion* (No. w26345). National Bureau of Economic Research.
[121] According to our findings in the Teacher Tapp survey (described in Section 3.5), 'On track for a grade 5 in maths' was the most commonly used threshold.

GCSE. We know that trusted adults can be important sources of advice for young people, so hearing from a teacher could be a significant influence on girls' decision making.

Rationale

- This recommendation draws on the research finding that teachers are powerful influencers:[122] pupils are more likely to choose this subject if a key adult has conveyed the worth of the subject to them, along with the belief that they can do well at it.
- We know that sending students letters to encourage them to apply to particular courses can be effective. Students being sent a letter to encourage them to apply to a prestigious university increased applications by 34%.[123]
- As well as targeting pupils, the letter could be addressed to parents. This could serve the dual purpose of appealing to pupils and encouraging parents to consider CS as a GCSE option.
- Parents may be an important target, as the evidence suggests that they have a large influence on pupils and they may hold beliefs (e.g., that science is more difficult and less interesting for their daughters as compared to sons)[124] that could affect the guidance they provide.

How this recommendation would work

- Teachers could identify pupils who they think might enjoy CS GCSE. This could be based on computing lessons, maths lessons or other discussions of topics related to CS.
- Teachers could then send a letter addressed to the pupil and their parent(s), inviting that pupil to take CS GCSE, explaining why they think that pupil would enjoy the subject, and why it is a valuable and appealing subject at GCSE.
- It would be important for teachers to identify a large enough number of girls in this group so that teachers are not unintentionally dissuading any girls from taking CS by not sending them an invitation.

Illustration of what this recommendation could look like

Dear {{pupil name}} and {{parent name}},

Are you considering Computer Science as a GCSE option?

The GCSE options selection process is coming up, and I think Computer Science might be a good course for you. I've noticed that {you've been excelling in maths/you've been really

[122] Archer, L., & Tomei, A. (2013). *What influences participation in science and mathematics*. A briefing paper from the Economic and Social Research Council (ESRC) Targeted Initiative on Science and Mathematics Education (TISME). ESRC.
[123] Sanders, M., Chande, R., Selley, E., & Behavioural Insights Team. (2017). *Encouraging people into university*. London: Department for Education.
[124] Tenenbaum, H. R., & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities? *Developmental Psychology, 39*(1), 34-47.

persisting in computing lessons/you've got the kind of creative and problem solving skills} which made me think that Computer Science might suit your skills.

Pupils who take Computer Science GCSE are in high demand and the skills you learn can be useful as you get older, in almost any job that you decide to do.

Choosing your GCSEs isn't always an easy decision, so if you have any questions, do email me or come and find me at {place}, {time} *(e.g. lunchtimes in the Computing Suite).*

All the best,

{{Teacher name}}

5.2.3 Use peer-to-peer communication to encourage a focus on reducing the gender imbalance in Computer Science

Summary

Barriers addressed: School senior leaders' possible lack of motivation to encourage more pupils to choose CS GCSE and to tackle the gender imbalance in CS GCSE.

Medium: Letter from a headteacher or CS head of department.

Rationale: Previous BIT work with DfE has successfully used peer-to-peer communication methods to encourage behaviour change. We propose sending a letter to headteachers from one headteacher who had identified the gender imbalance in computing as a concern at their school, implemented strategies to try to address the imbalance, and seen greater numbers of girls taking CS GCSE as a result.

Rationale

- This recommendation draws on the 'messenger effect': the behavioural science concept that people react differently to information depending on who communicates it.[125] The messenger effect is explained in more detail below.
- This recommendation satisfies two distinct aspects of the messenger effect. First, headteachers who have successfully improved their gender balance in pupils taking CS GCSE would be perceived as experts in this area due to their first hand-experience. Second, they are likely to be the most relatable messengers for other headteachers on this issue.

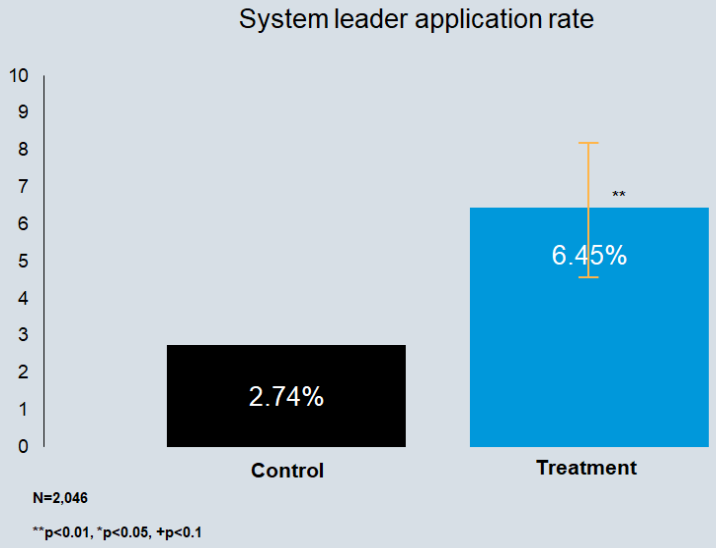
[125] Durantini, M.R., Albarracín, D., Mitchell, A.L., Earl, A.N., & Gillette, J.C. (2006). Conceptualizing the influence of social agents of behavior change: A meta–analysis of the effectiveness of HIV–prevention interventionists for different groups. *Psychological Bulletin, 132*, 212-248.

The 'messenger effect' in action

The 'messenger effect' is the idea that people react differently to information depending on who communicates it.[126] The weight we give to information, and the reaction we have to it, depend on the source and their perceived authority. There is also evidence that we find messages to be more persuasive if the messenger is similar to us in some way.[127]

BIT has used this insight to develop interventions with DfE in the past. In one example, we used peer-to-peer communication to encourage teachers to apply for 'system leadership' roles (in which high performing schools share best practice with less well performing schools in their area).[128] In the trial, behaviourally informed letters were sent to headteachers from a peer and a respected figure in the education system. The rationale was that these individuals were the most likely figures to be perceived as experts and to be relatable to headteachers receiving the letters.

Results from the trial (shown in the graph below) were that the treatment group were more than twice as likely to apply for a system leader role than the control group (6.45% of the treatment group applied for a system leader role, compared to 2.74% of the control group).



How this recommendation would work

- A school leader who had successfully improved the gender balance in computing at their school would help to draft the letter.

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[126] Durantini, M.R., et al. (2006). Conceptualizing the influence of social agents of behavior change: A meta–analysis of the effectiveness of HIV–prevention interventionists for different groups. *Psychological Bulletin, 132*, 212-248.
[127] Maclean, J., Buckell J. & Marti, J. (2019). *Information source and cigarettes: Experimental evidence on the messenger effect.* NBER Working Papers 25632.
[128] Department for Education & Behavioural Insights Team. (2018). *Can behaviourally informed communications increase applications, and appointments, to System Leadership roles?*

- The letter would emphasise to recipients the importance of addressing the gender imbalance in computing, and would share a ‘success story’ of what has worked well for that school.
- The letters would be sent to headteachers near the start of the school year. A similar process could be run with a letter written by a head of CS being sent to the heads of CS at other schools.

Illustration of what this recommendation could look like

The specific content of the letter would depend on the experience of the school(s). However, as an illustration of scope and to demonstrate the kind of messages it might include, we have included a draft below.

Dear Mrs Atkins,

I hope this finds you well.

My name is Rebecca and I’m the Headteachers of Woodland Secondary School in Sheffield. I am writing to share my recent experience of increasing our number of female pupils choosing Computer Science GCSE.

We noticed that very few girls were opting for Computer Science GCSE, even though they were doing well in their Key Stage 3 computing lessons. We wanted to make sure that all of our pupils are equally well equipped for entering the digital labour market, so we spoke to some of our pupils, to get a better picture of what was driving their decisions.

Having found out that our girls didn’t see how Computer Science could be relevant to the types of jobs that would be interesting to them, we did some research into the wide ranging careers that Computer Science can lead to, including X, Y and Z. We adapted our options evening booklet and options presentation and brought current female Computer Science students along to our in-person options evening, to talk to the Year 8s about their choices.

This year, girls are making up over a third of our Year 10 cohort, up from just 10% the year before. We were really pleased to see how positively our students responded to the changes we made, and wanted to share this story with other schools.

If you have any questions about encouraging girls to choose Computer Science in your own school, do get in touch - I’d be happy to talk through how the process worked for us.

Kind regards,

Rebecca Styles

5.2.4 Provide CS subject training for non CS teachers to address lack of knowledge about the GCSE

Summary

Barriers addressed: Some teachers who participate in the options process are unable to provide information about the CS GCSE.

Medium: Training materials made freely available for schools to use.

Rationale: Teachers play an important role in the GCSE options process, yet many do not have a sense of what CS GCSE contains so are unable to support their students to make the decision about whether or not to take CS. Light-touch training could equip all teachers to support Key Stage 3 pupils with their decision making, and could be a pathway through which to communicate with teachers the value of CS and its complementarity with other subjects.

Rationale

- This recommendation is based on the idea that there is currently an 'information gap' amongst non CS teachers about the GCSE itself.
- This information gap is particularly problematic for CS GCSE as it is a relatively new GCSE and course descriptions contain language that may seem unfamiliar.
- One way to address this information gap is to provide training / professional development resources which schools can deliver themselves.
- Alongside equipping teachers to explain the CS GCSE course, the skills required and the appeal of the subject, the training could also identify links between CS and the other GCSE subjects. For example, training could include ideas for how teachers could use the CS skills their pupils had learnt in Key Stage 3 in their other GCSE subjects, along with a discussion of the subject specific issues that could be addressed.

How this recommendation would work

- Organisations such as NCCE or RPF could develop resources which could be used in school INSET days, twilight sessions or staff meetings which would introduce non CS teachers to CS as a subject
- Teachers would receive the training (possibly delivered by the CS teacher at their school) and would have the opportunity to query any further uncertainties they have about the subject
- These non CS teachers would then take part in the options process as normal, for example, the assistant headteacher giving the overall options presentation with a one line summary of each of the optional subjects or the form tutor having meetings with all of the pupils in their form about which subjects would work best for them. These non specialist teachers would then be better equipped to discuss CS in a positive light.

5.2.5 Use parent messaging to target parent perception of Computer Science

Summary

Barriers addressed: Parental unfamiliarity with CS as a subject, the narrow presentation of job opportunities available following CS qualifications.

Medium: Messages sent to the parents of Year 7 or Year 8 pupils

Rationale: Parents are an important factor in girls' decision making but many parents lack an understanding of what CS GCSE would be like, and why it might be helpful for their child. Sending conversation prompt messages to the parents of pupils before they begin the GCSE subject selection process could stimulate discussion between parents and pupils about the applications of CS, and provide parents with more information about the subject.

Rationale

- This recommendation is built on the idea that sending parent text message prompts can facilitate parent-child discussion which then affects pupils' behaviour. For example, sending parents messages about upcoming assessments can give parents the information they need to support their child, which led to an average of one month's additional progress in maths attainment in a previous trial.[129]
- With the exception of parents who worked within the computing industry, interviewed parents reported that they lacked understanding of CS GCSE, in part because it has been introduced relatively recently. Both the evidence review and our own research point to the view that parents can be an important lever in encouraging pupils to take particular GCSE subjects.[130]
- Conversation prompts sent to parents' phones could spark discussion between parents and their children, for example about the real-world challenges CS can help to tackle.
- The effects of this could be twofold: (1) parents could be more likely to support their child to choose CS if they have a better understanding of the subject (2) pupils might be more motivated by the types of problems that can be addressed by CS.

How this recommendation would work

- This idea has been developed and trialled through RPF with Year 5 students.

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[129] Education Endowment Foundation. (2016). *Texting parents about tests and homework can improve maths results and reduce absenteeism.*

[130] Harackiewicz, J.M., Rozek, C.S., Hulleman, C.S., & Hyde, J.S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899-906.

- For a term, parents could receive a weekly text message with a conversation prompt linked to some aspect of CS. For example, the prompt might encourage them to watch the trailer for 'Hidden Figures' (a film about female mathematicians) with their child, or point them to resources on scratch.com where pupils can create their own programmes.
- Parents would then discuss this prompt with their child and (in some cases) complete the activity.

Illustration of what this recommendation might look like

To illustrate what these messages could look like, we have provided two indicative messages below.

- Try watching the trailer for 'Hidden Figures' here. It's about three female mathematicians in NASA's team of 'human computers'.
- People who study Computer Science at university can earn a lot of money and get to work on lots of different things, from music and fashion to healthcare. Watch this short video with your Year 7 to see all the different jobs they could do with Computer Science.

5.2.6 Group pupils across schools to avoid small cohorts of girls in computing clubs

Summary

Barriers addressed: Girls' concern that they might be the only girl in their cohort.

Medium: CS teachers to set up clubs across schools.

Rationale: Girls report that an important driver of decision making is enjoyment of the subject. One opportunity for girls to have fun with CS is through clubs, but girls might be concerned that they are the only girl, or one of a small number of girls in their computing club in their school. By combining computing clubs across schools, the total number of pupils who could attend would be larger- this might reduce the risk that girls are concerned that they will be the only girl/one of a very small number of girls within the club.

Rationale

- This recommendation draws on the 'social norms' effect - if girls are aware that very few of their (female) peers are taking CS, this can act as a powerful dissuader.[131]

[131] Behavioural Insights Team. (2014). *EAST: Four simple ways to apply behavioural insights.*

- Enjoyment of the subject is a key driver of girls' GCSE options decision making. It's possible that taking part in extracurricular activities such as computing clubs, trips or talks could provide a good opportunity for girls to enjoy doing computing.
- At the moment, girls might be concerned that they would be the only girl (or one of only a small number of girls) at these extracurricular activities.
- By arranging CS activities (for example, Code Clubs[132], trips or competitions) across multiple schools, this should pool the number of girls who could take part and, in turn, lead to more girls participating and less concern that participating girls will be the only girls taking part.

How this recommendation would work

Computing education organisations could encourage schools to consider setting up joint clubs and activities between schools. It would also be important to ensure that participating girls know that they would not be the only girl attending. RPF would be well placed to do this, due to its established network of coding clubs and recognised name.

5.3 System-level recommendations

5.3.1 Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE

Summary

Barriers addressed: Possible lack of school level incentives to encourage pupils to take CS GCSE.

Medium: Structural change to the EBacc.

Rationale: Within school options evenings and options booklets, generally CS is not emphasised as an option which schools are encouraging pupils towards. Some teachers felt this was because where CS currently sits within the EBacc does not incentivise pupils to take CS over other subjects. By providing a school level incentive, schools might then be more likely to prioritise addressing the gender imbalance in CS, possibly through using some of the strategies suggested in section 5.2.

Rationale

- This recommendation would increase schools' motivation to encourage pupils to take CS GCSE. Increasing schools' motivation, alongside providing schools with practical steps to encourage pupils into CS, could lead to more pupils overall taking CS, which would likely be reflected in more girls taking CS GCSE.

[132] See Raspberry Pi Foundation website: https://codeclub.org/en/start-a-code-club/

- We know that the introduction of the EBacc led to significant shifts in the GCSE courses Key Stage 3 pupils were choosing.[133] It's likely that further changes to the structure could shift GCSE options further.
- Whilst CS does sit within 'Sciences' in the current EBacc, it's possible that it is not acting as a meaningful incentive in most schools.[134]
- The 'Languages' category of subjects could be a good fit for CS because the CS GCSE involves pupils learning to code in different programming languages, and using text to communicate instructions. In this way, it can be thought of as linked to the other language subjects.
- Given the importance of preparing our future workforce for the digital skills they will need, it would be reasonable for DfE to make this change for CS specifically, whilst still acknowledging the importance of maintaining a broad and balanced curriculum.

How the recommendation would work

- The DfE could adapt the structure of the current categories of the EBacc, so that CS sits both within 'Sciences' (its current position) and 'Languages' (which would be a new position). In this set up, a student who was already doing combined or triple science plus a humanity could 'meet' the EBacc criteria by choosing either a modern language or CS.
- Before making this decision, it would be important to analyse the current pattern of subject choices at GCSE, to ensure that a change to the structure could incentivise CS to a greater extent than it is currently incentivised.
- For continuity, DfE would be able to continue to report school data based on both the original EBacc structure and the Updated EBacc structure.

5.3.2 DfE to provide financial incentives for schools to increase their percentage of girls taking Computer Science GCSE

Summary

Barriers addressed: Possible lack of school level incentives to encourage pupils to take CS GCSE.

[133] National Centre for Social Research. (2011). *The English Baccalaureate and GCSE chives*. Research Brief.
[134] If a GCSE pupil is already taking combined science, whether or not they choose to take CS does not affect whether they have met the EBacc criteria. Similarly, if a student is taking 'triple' science, and is doing single biology GCSE, single chemistry GCSE and single physics GCSE, whether or not they also take CS does not affect whether they have met the EBacc requirements. The only condition in which whether or not a pupil took CS GCSE was the deciding factor between meeting the EBacc requirements and not, is if a pupil is doing two single GCSEs (e.g., single chemistry and single biology) and alongside that, considering whether to take CS GCSE. In the schools which took part in the qualitative interviews, pupils had the option of taking combined science or 'triple science': it did not seem to be common practice to offer two of the 'single sciences' (biology, chemistry and physics) together." Therefore, it's possible that the fact that CS sits within 'sciences' in the EBacc does not frequently act as an incentive for pupils to take CS GCSE.

Medium: Funding allocated to secondary schools based on their number of female pupils choosing CS GCSE, as a proportion of their cohort.

Rationale: Some schools may be aware of the gender imbalance in their students choosing CS GCSE, but may not currently be prioritising this issue. Funding tied to the number/proportion of girls choosing CS could enable schools to invest in ideas which could support female engagement with CS (e.g. clubs, trips and competitions) and could incentivise and reward schools for improving their gender balance.

Rationale

- As in section 5.3.1, the broad idea behind this recommendation is that increasing schools' motivation to encourage pupils (in this case, girls) to take CS GCSE, could, in turn lead to more girls deciding to take CS GCSE at an individual level.
- We know that financial incentives can be used in the education context to change behaviour, for example encouraging teachers from diverse backgrounds into leadership training[135] or improving the physical quality of a school.[136]
- The effectiveness of financial incentives can be increased through the application of behavioural insights. For example, loss aversion[137] (people dislike loss more strongly than they like gains of equal value) could be harnessed with schools receiving the additional funding immediately, and then losing it if they did not hit their target.
- This concept has been applied effectively in an education context - when teachers were paid in advance and asked to return money if students didn't improve, students improved (other incentive schemes not based in loss aversion have failed).[138]

How the recommendation would work

Schools could receive additional funding if they achieved specific targets relating to the number of girls taking CS GCSE. For example, if 5 more girls took the subject, schools would receive additional funding. The financial incentives could be structured in a way which maximised impact, for example, allocating funding to schools to put towards strategies that could encourage girls to choose CS GCSE, and asking for the school to return the money if they do not meet their target.

5.3.3 Publish a 'gender balance in computing' school comparison tool

Summary

Barriers addressed: Possible lack of school level incentives to encourage pupils to take CS GCSE.

[135] https://www.gov.uk/guidance/condition-improvement-fund
[136] https://www.gov.uk/guidance/equality-and-diversity-funding-for-school-led-projects
[137] Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent mode. *The Quarterly Journal of Economics, 106*(4), 1039-1061.
[138] Fryer, R.G., Levitt, S.D., List, J. & Sadoff, S. (2012). *Enhancing the efficacy of teacher incentives through loss aversion: A field experiment.* NBER Working Paper No. 18237.

Medium: A freely available online tool for teachers and senior leaders to use.

Rationale: Teachers and senior leaders may not be aware of their own level of gender imbalance within CS GCSE, and are unlikely to be aware of how their levels of balance/imbalance relates to 'schools like them'. By providing them with a tool to make comparisons, schools will be able to see if there is scope for improvement, and could find out which strategies seemed to work in a school 'like theirs'

Rationale

- This information is based on the concept of 'social influence'. We know that comparing people's behaviour to 'people like them' can be an effective way of changing behaviour. For example, telling doctors they were in the top 20% of doctors re: antibiotics prescription led to a decrease in the rates of antibiotics prescription.[139] Similarly, the government Compare Gender Pay gap tool exists in part to motivate employers to address the gap themselves.[140]
- Within education, external accountability measures such as league tables can be a powerful driver of behavioural change, for example motivating teachers to target certain groups of pupils for academic support.[141]
- In this context, enabling schools to compare their gender balance in CS with the gender balance of other schools could act as an incentive at the school level to encourage more girls into CS GCSE.
- Creating a social comparison of 'school like yours' could make the message more persuasive as the searching school would know that the comparison school faced similar challenges in a similar context.

How the recommendation would work

An online comparison tool could be created which would allow schools to input their number of female pupils taking CS GCSE and their number of male pupils taking CS GCSE. The tool could display how the 'searching' school's gender balance compared to the national average, and how it compared to other schools 'like them', possibly using an idea like the Education Endowment Foundation's families of schools database.[142]

[139] Hallsworth, M. et al. (2016). Provision of social norm feedback to high prescribers of antibiotics in general practice: A pragmatic national randomised controlled trial. *The Lancet, 387*(10029), 1743-1752.
[140] Gender pay gap service: Employer comparison.
[141] Wilson, D., Croxson, B., & Atkinson, A. (2006). "What gets measured gets done" Headteachers' responses to the English secondary school performance management system. *Policy Studies*, *27*(2), 153-171.
[142] Education Endowment Foundation. Families of schools database.

6. Priorities

In this section, we present the combination of recommendations we would prioritise, alongside rationale for this particular combination and for recommending a bundle of ideas.

We recommend prioritising the following recommendations:

- Provide a checklist of what a good options booklet and options evening look like (E)
- Develop CS subject training for non CS teachers (B)
- Letters to pupils and parents inviting pupils to take CS (D)
- Parental messaging (C)
- Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE (A)

Figure 12 maps these recommendations to the timeline of the options process.

Prioritising a bundle of recommendations

Within our priority recommendations, we have included recommendations for designing and delivering the CS options evenings and booklets in a way that is appealing to girls (see Box 1); recommendations that aim to set up pupils and parents to be thinking positively about CS as a GCSE option, as they enter the options process (see Box 2); and recommendations that encourage schools to prioritise motivating pupils to take CS GCSE, so that the schools themselves are motivated to implement strategies/other recommendations (see Box 3).

It is important to note that addressing the gender imbalance in computing is a huge challenge - a number of ideas have been tried, and some schools are already putting a lot of effort into encouraging girls into CS, sometimes with fairly modest or minimal results. Given the scale of the challenge to be addressed, it's unlikely that a single solution will significantly shift the dial. This is part of our motivation for prioritising the implementation of a range of ideas, as opposed to single strategies. The scale of the challenge also motivates our more radical, system-level recommendations, such as adapting the structure of the EBacc.

Box 1: Recommendations for designing and delivering the Computer Science options booklets and evenings in a way that is appealing to girls

- **Provide a checklist of what a good options booklet / evenings look like**
- **Develop CS training for non computing teachers**

These recommendations are designed to affect how CS is presented in options evenings and options booklets.

Our checklist captures our thinking on the most promising areas for change when it comes to options booklets and evenings. This is grounded in the finding that descriptions of CS that emphasise prosocial goals and social careers, use gender neutral language (when possible) and frame requirements in terms of behaviour instead of traits or innate abilities may change perceptions of the subject and encourage girls to consider it. Preparing non CS teachers to discuss CS with their pupils at options evening events puts teachers in a strong position to support pupils' decision making.

We would expect these to be fairly low cost recommendations that are straightforward to implement in most schools.

Box 2: Encourage parents and pupils to think positively about CS as a future GCSE option

- **Letters to parents and pupils inviting pupils to take CS**
- **Parental messaging recommendation**

These recommendations have been designed to be used alongside the two recommendations in Box 1 so that pupils and parents are set up to think positively about CS as an option, as they go into the options process.

From our research, we found that many factors affecting decision making were acting well before the options booklet was shared and the options evening took place. We know that the moment of intervening is an important factor in how effective an idea will be.[143] Therefore, bringing forward the strategies to encourage girls to choose CS, to the point when they are forming their perception of CS as a subject, is likely to be more effective than focusing solely on the point of decision making, and could put parents and pupils in a more open frame of mind to respond to the recommendations described in Box 1.

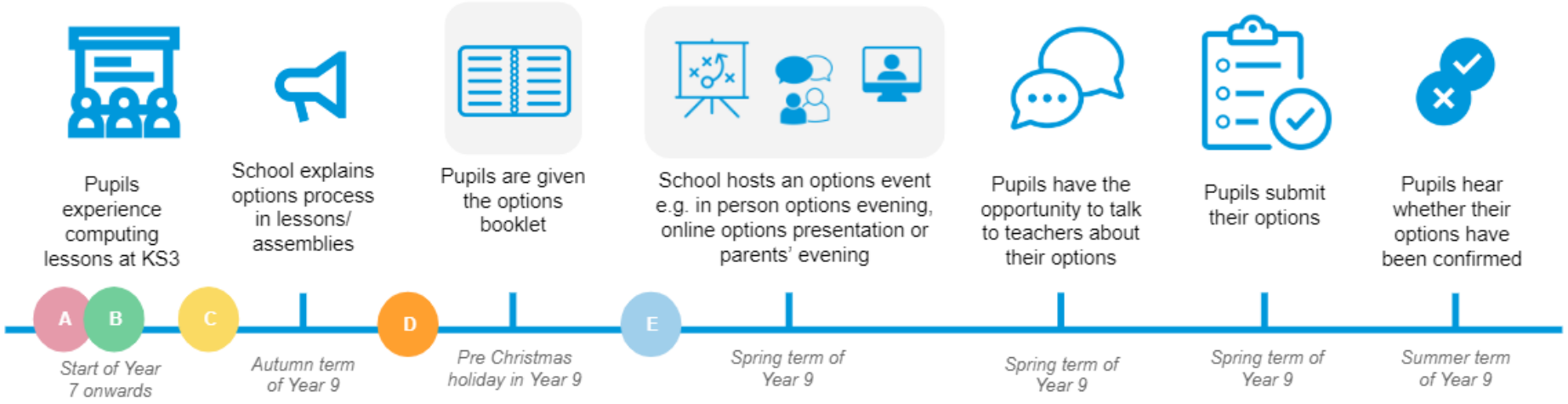
[143] Duflo, E., Kremer, M., & Robinson, J. (2011). Nudging farmers to use fertiliser: Theory and experimental Evidence from Kenya. *American Economic Review*, *101*(6), 2350-2390.

Box 3: Incentivise schools to prioritise promoting CS GCSE

- **Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE**

For the options evening and options booklet strategies in Boxes 1 and 2 to be implemented by schools, the schools will first need to be prioritising encouraging more girls into CS GCSE. While some schools may already be prioritising this issue, our review also identified that some CS teachers felt that the school leadership team were not invested in encouraging girls into the subject. Adapting the structure of the EBacc to further incentivise CS could provide motivation at a whole school level which could then drive the implementation of our light-touch recommendations.

Figure 12: Recommendations mapped onto the options process timeline



A	Add CS to the 'Languages' section of the EBacc to further incentivise CS GCSE
B	CS subject training for non CS teachers
C	Parental messaging interventions
D	Letters to parents / pupils inviting pupils to take CS
E	Checklist of what a good options booklet and options evening look like

7. Conclusions

In line with evidence on GCSE subject decision making, this report supports the finding that options booklets and options evenings are probably not the most significant of all of the drivers that shape whether or not girls choose to take CS at GCSE. Having acknowledged that, these two information sharing points do appear to have some influence on decision making. In this report, we've identified a variety of ways in which we think they could be improved to encourage more girls to choose CS GCSE.

How should Computer Science be presented in options evenings and options booklets?

This review found that descriptions of CS that emphasise prosocial goals and social careers, use gender neutral language (where possible) and frame requirements in terms of behaviour instead of traits or innate abilities may change how pupils, parents and teachers perceive the subject and encourage girls to consider it.

Whilst recommendations about the presentation of CS in options booklets and at options evenings alone are unlikely to fully address the gender imbalance in CS GCSE, we think that they could lead to marginal improvements in the number of girls taking CS and, more broadly, could support good subject selection at GCSE through helping pupils and their parents make better decisions about the subjects that will work for them.

Due to the scale of the current gender imbalance in GCSE CS, it's likely that a bundle of ideas will be necessary, with initiatives targeting different actors and points along the GCSE subject selection process timeline. We have recommended implementing a bundle of recommendations which address: the presentations of CS in the options evenings and booklets themselves; parents' and pupils' perceptions of CS; and the school level prioritisation of addressing the gender imbalance in CS.

Ideally, a two pronged approach (targeting both school level and pupil level decision making) would lead to school leaders and CS teachers increasing their motivation for girls to take CS GCSE, alongside being equipped with strategies (such as our light touch recommendations) which they could use within their school.

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