Computing education for underrepresented groups

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What this seminar will cover:

- Curriculum change in England
- Impact of curriculum change on underrepresented groups (Gender, ethnicity, poverty indicators, SEN, intersectionality)
- Whether a shift to CS was equitable / justified

Limitations

- Very little 2020 data
- England only and mainly GCSE (age 16)

A potted history of computing education in England

- 1966 to 68 - First local authority schools acquire computers
- **1972 to 75** - Computer studies introduced as a qualification by exam boards
- 1982 - BBC Computer Literacy Project
- 1985 - 80% of schools had a BBC Micro (Blythe, 2012)
  - the UK had the largest percentage of coders who learnt coding between the ages of 5 and 10, the majority being in their 30s and 40s (HackerRank, 2018).
- 1990 - IT part of the D&T national curriculum
- **1995** - IT a distinct national curriculum subject
- 1999 - ICT becomes a core component of all subjects
- 2007 - final iteration of ICT curriculum
- 2008 - foundation of Computing at School group
- 2011 - OCR trial of GCSE Computing
- **2011** - Eric Schmidt's MacTaggart lecture
- **2012** - Shut Down or Restart (Royal Society, 2012)
  - Computing == CS / IT / DL

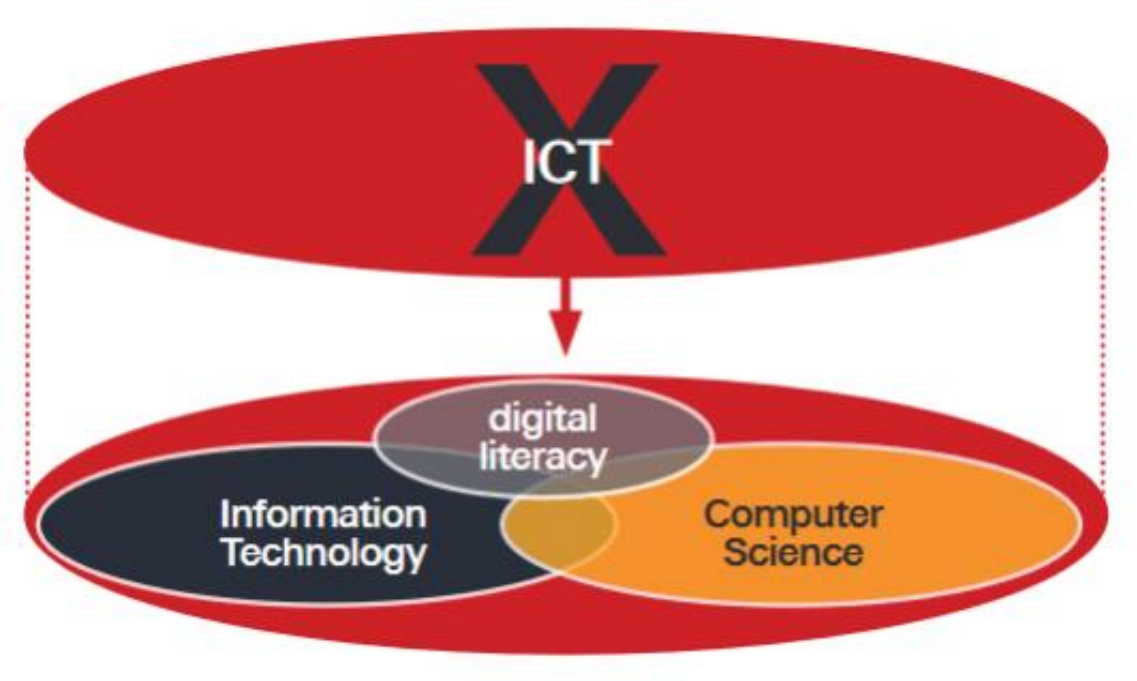
2013/14 - computing and the end of ICT

"...the then ICT curriculum - **universally acknowledged as unambitious, demotivating and dull** - had to go."

"...ICT used to focus purely on computer literacy - teaching pupils, over and over again, how to word process, how to work a spreadsheet"

Gove, BETT Show, 2014

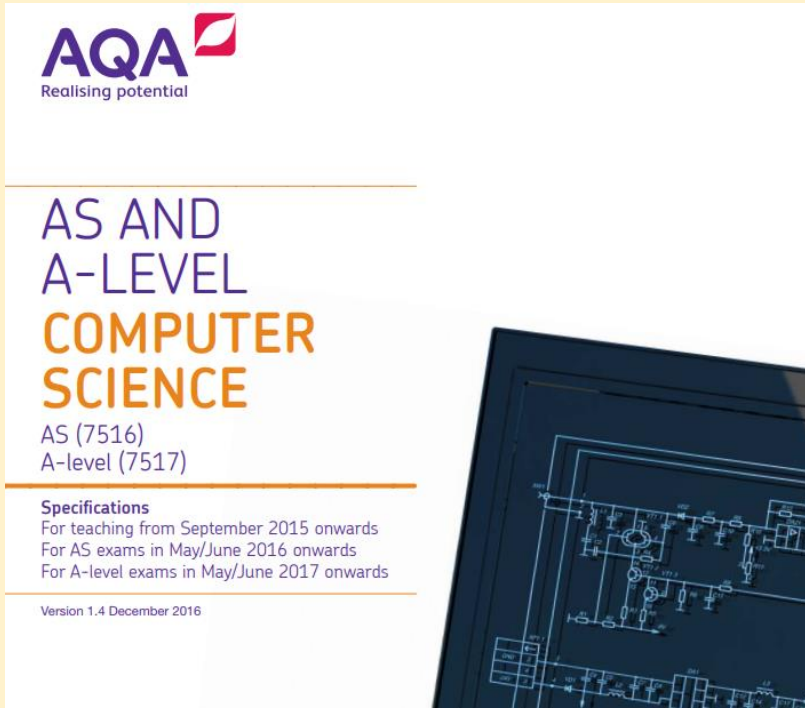
What is *computing*?



Royal Society
2012

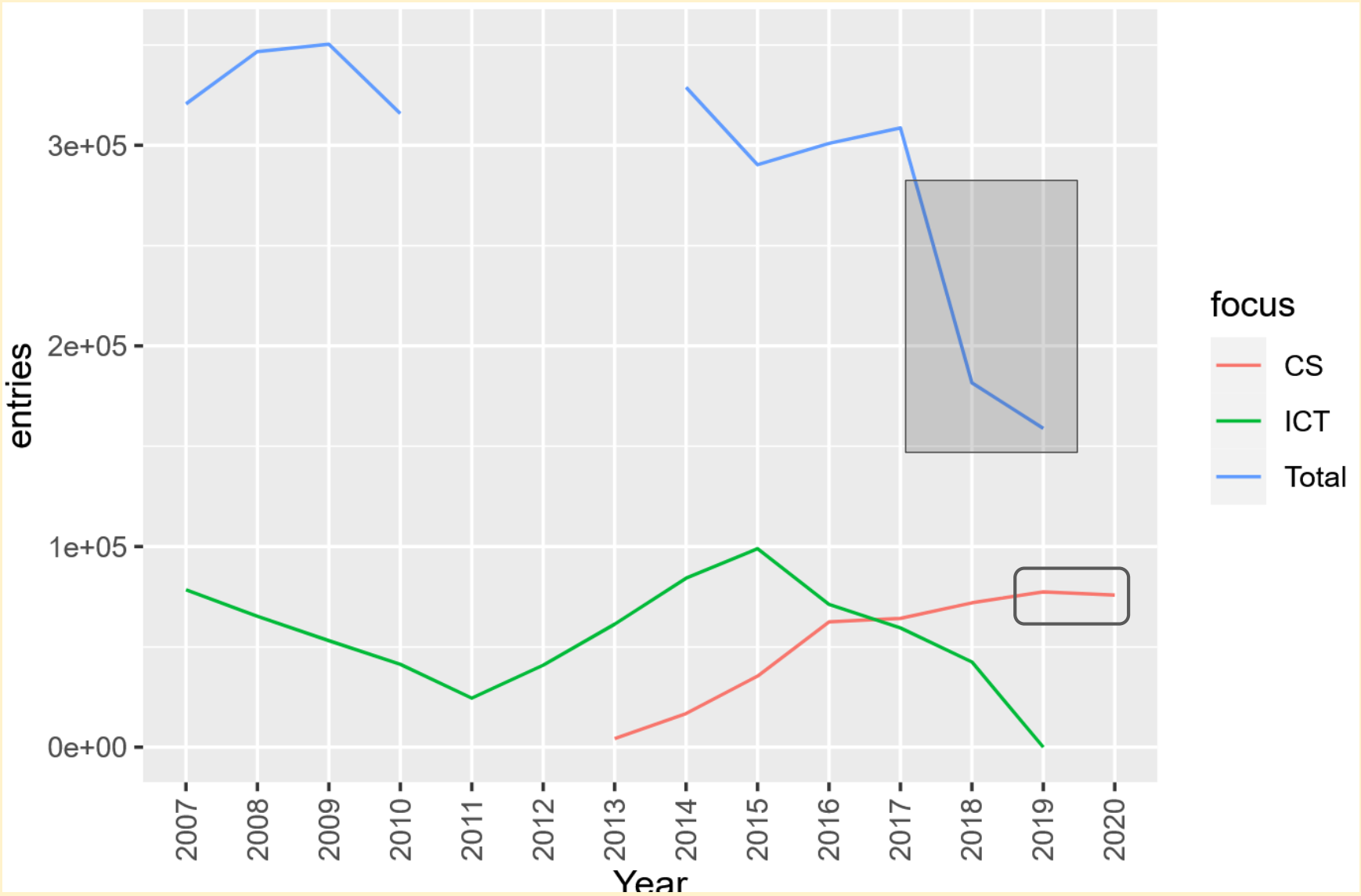
2014 onwards

- **2013/14** - new computing programme of study, disapplication of ICT
- 2015 - renewal of the A-level (e.g. AQA, OCR)
- **2015** - DfE decline to renew the ICT/IT A-level and GCSE
- 2016 - BBC micro:bit initiative sending devices into schools
- 2016 - development of new computer science GCSEs
- 2017 - announcement of the NCCE
- **2018** - establishment of the £84m NCCE
  - Upskilling 8,000 teachers
  - Computer Science GCSE in every school
- 2020 - online learning crisis



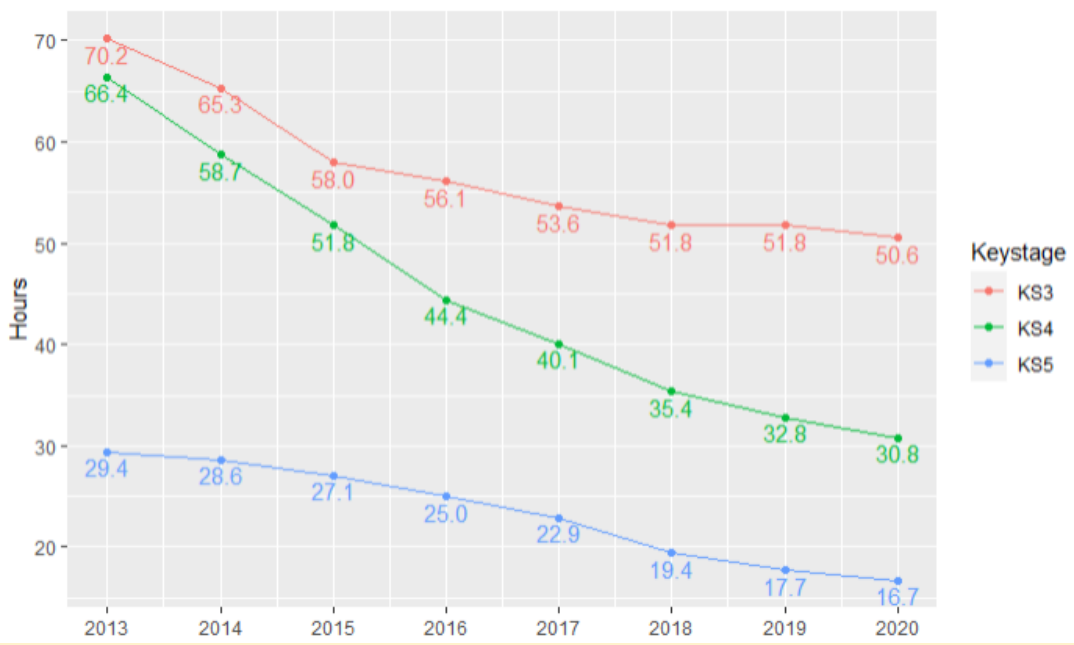
What has been the impact of the curriculum reform?

Digital qualifications at KS4 (incl GCSE ICT and CS)

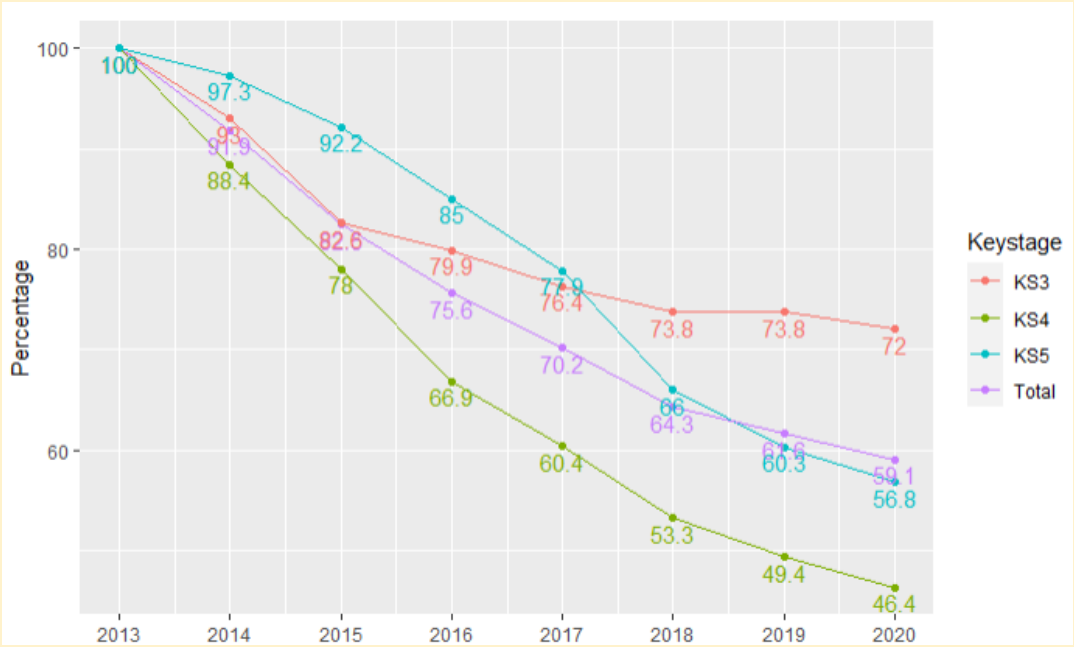


Hours (thousands) of *computing* in schools

- 41% of teaching time lost in 7 years since curriculum change
- KS3 28% ⬇ down
- KS4 54% ⬇ down
- KS5 43% ⬇ down



9 mins of non-GCSE computing per student in 2019



What does this mean for different courses and different groups in schools?

Who takes/can take GCSE CS?

% all - of whole population, who took it?
% possible - of those able, who took it?
Reach - students in schools where CS offered

Table 1: Schools offering GCSE Computer science

Year	Total students	Total URN	Subject URNs	Possible students	Actual students	% of possible students	URN %	% of all students	reach % of all students
2015	595827	4548	1446	260403	33492	12.9	31.8	5.6	43.7
2016	583798	4602	2355	404206	61938	15.3	51.2	10.6	69.2
2017	569710	4595	2686	438975	68992	15.7	58.5	12.1	77.1
2018	565686	4615	2827	447867	70061	15.6	61.3	12.4	79.2
2019	585982	4644	2970	475264	77302	16.3	64.0	13.2	81.1

Table 2: GCSE Computer science uptake by school type, 2018/19

Type	Total students	Total URN	Subject URNs	Possible students	Actual students	% of possible students	URN %	% of all students	reach % of all students
Comprehensive	505415	3056	2468	431436	68146	15.8	80.8	13.5	85.4
Grammar	23996	163	147	21787	5357	24.6	90.2	22.3	90.8
Ind Special	2246	227	13	201	46	22.9	5.7	2.0	8.9
Independent	47671	818	321	21486	3685	17.2	39.2	7.7	45.1
Special	6654	380	21	354	68	19.2	5.5	1.0	5.3
Total	585982	4644	2970	475264	77302	16.3	64.0	13.2	81.1

Who has the change impacted?

England now sees fewer people receiving a digital education at school, in particular:

- Girls
- Black students
- Students from poorer backgrounds

Boys and Girls

Girls and computing

Girls made up:

- c. **22%** of the GCSE CS cohort
- c. **15**% of the A-level CS cohort

- c. **43%** of the old ICT qualification

(JCQ, 2017, 2018, 2019, 2020)

Girl numbers

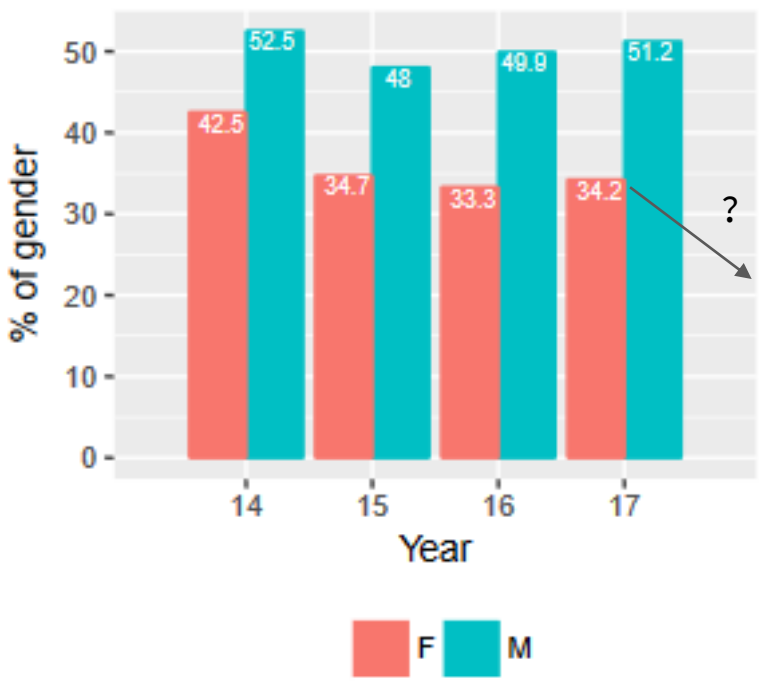
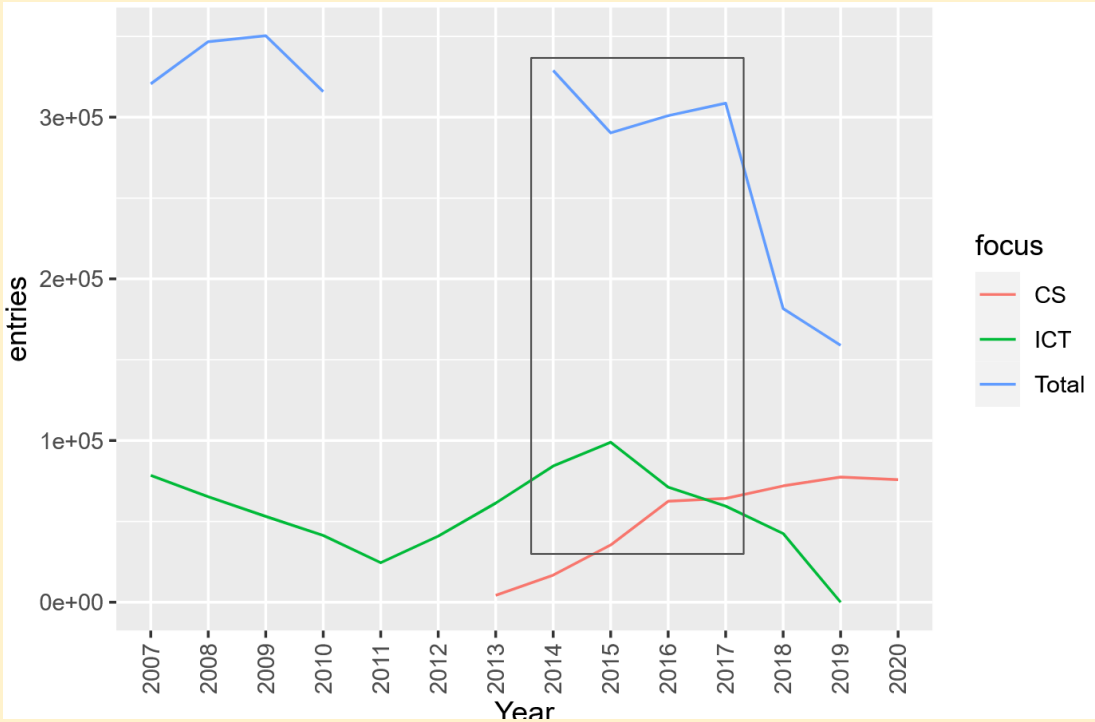


Figure 110: KS4 computing uptake by year and gender. 2014-17



Who takes/can take GCSE CS?

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% possible - of those able, who took it?
reach % - students in schools where CS offered

Type	Gender	Total students	Total URN	Subject URNs	Possible students	Actual students	% of possible students	URN %	% of all students	reach % of all students
Comprehensive	Boys	13482	95	82	12071	2787	23.1	86.3	20.7	89.5
Comprehensive	Girls	23190	145	109	17721	2016	11.4	75.2	8.7	76.4
Comprehensive	Mixed	468743	2816	2277	401644	63343	15.8	80.9	13.5	85.7
Grammar	Boys	7987	55	50	7315	2233	30.5	90.9	28.0	91.6
Grammar	Girls	9007	61	54	8014	1598	19.9	88.5	17.7	89.0
Grammar	Mixed	7002	47	43	6458	1526	23.6	91.5	21.8	92.2
Ind Special	Boys	181	19	4	92	29	31.5	21.1	16.0	50.8
Ind Special	Girls	20	5							
Ind Special	Mixed	2045	203	9	109	17	15.6	4.4	0.8	5.3
Independent	Boys	5309	74	21	1507	404	26.8	28.4	7.6	28.4
Independent	Girls	9132	163	70	4661	825	17.7	42.9	9.0	51.0
Independent	Mixed	33230	581	230	15318	2456	16.0	39.6	7.4	46.1
Special	Boys	543	43	3	39	7	17.9	7.0	1.3	7.2
Special	Girls	33	2							
Special	Mixed	6078	335	18	315	61	19.4	5.4	1.0	5.2
Total		585982	4644	2970	475264	77302	16.3	64.0	13.2	81.1

Poverty indicators

Who can sit the qualification?

- Schools serving poorer communities are less likely to offer CS.
- Graph shows grammar and comprehensive schools only

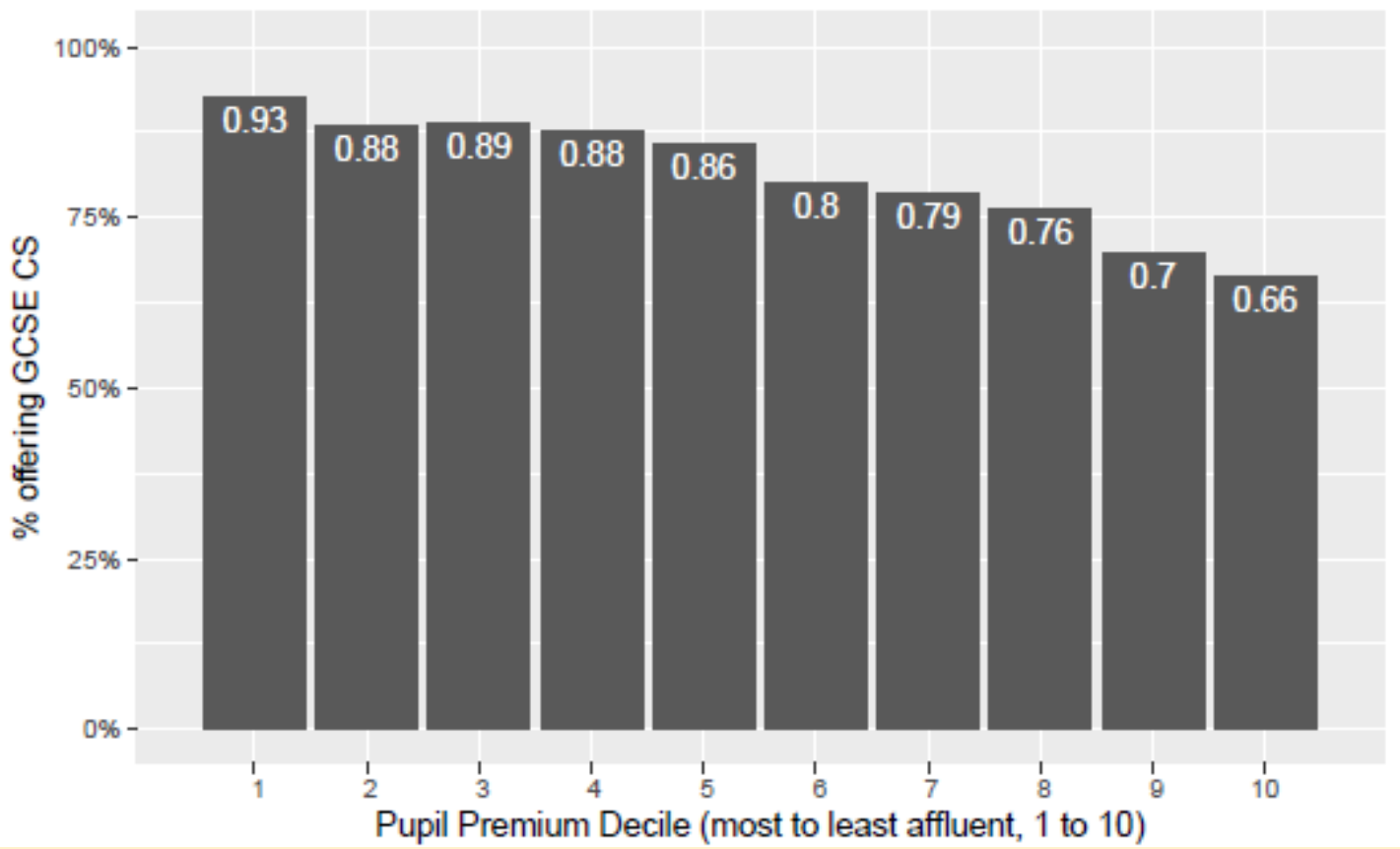


Fig. 1. GCSE computer science and ICT, influence of IDACI on uptake by gender

Ethnicity

GCSE uptake by ethnicity as % of those taking subject

The change in qualification space has impacted different ethnic groups

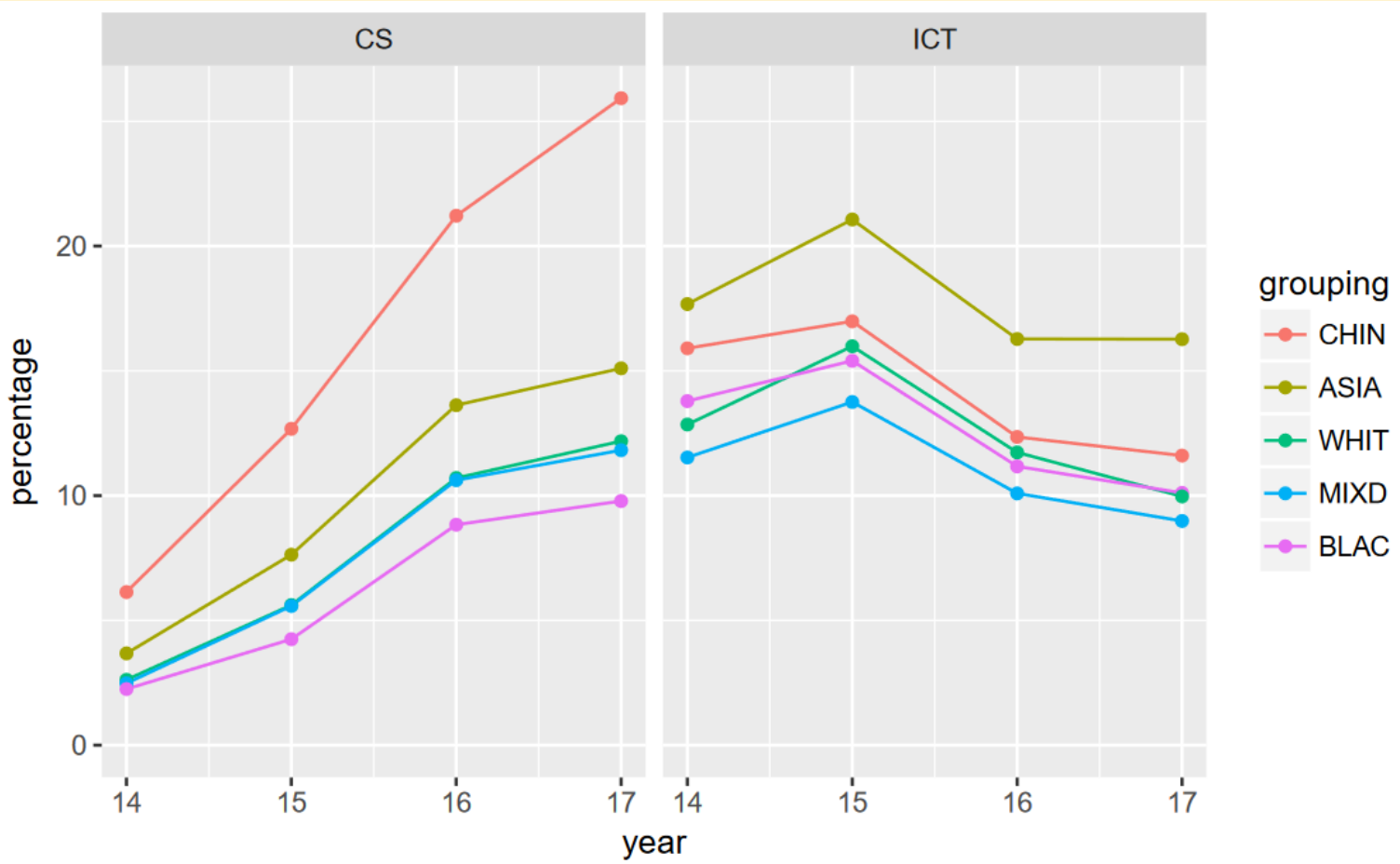


Figure 86: Longitudinal: GCSE uptake by ethnicity as % of those taking subject

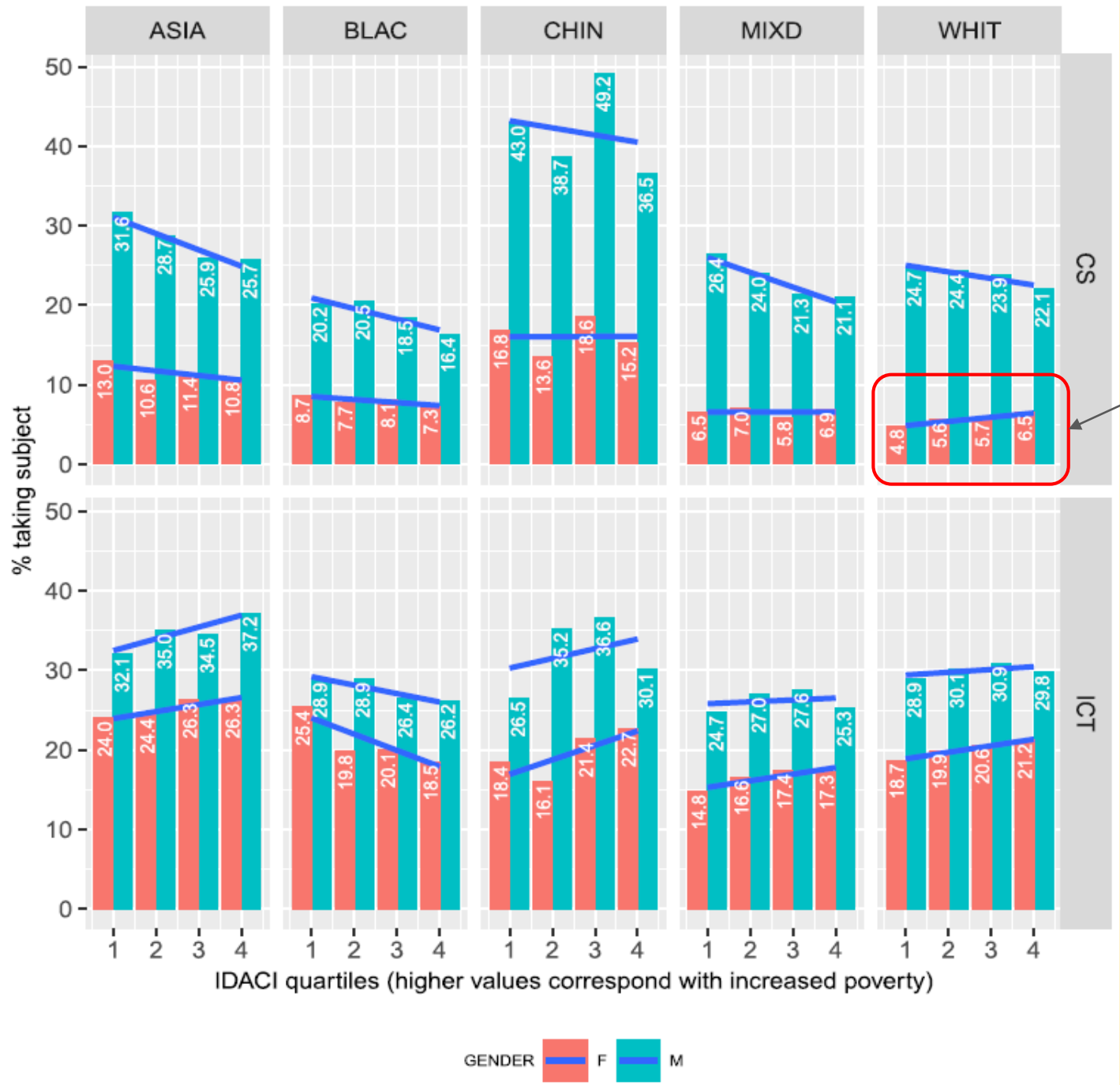


Fig. 3. GCSE computer science and ICT uptake, gender, ethnicity, and IDACI quartile.

- White girls least represented group
- White working class girls more likely to sit CS

(Kemp, 2019)

Special Educational Needs

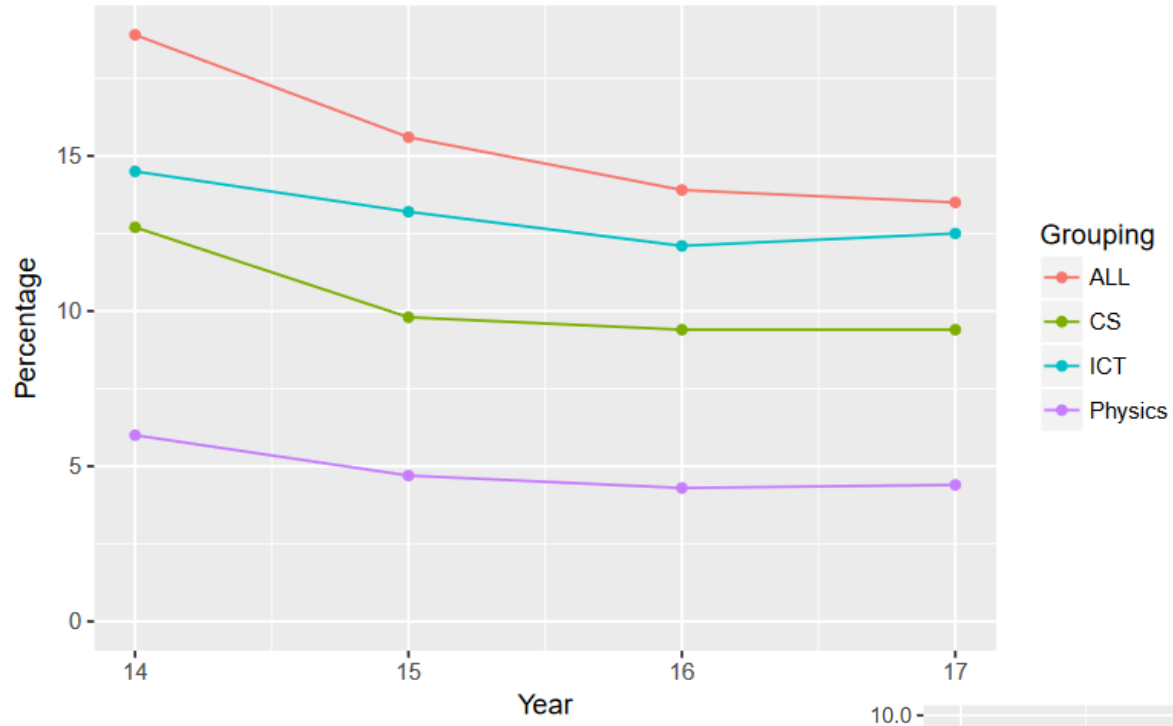


Figure 98: Longitudinal: GCSE students who have SEN categori

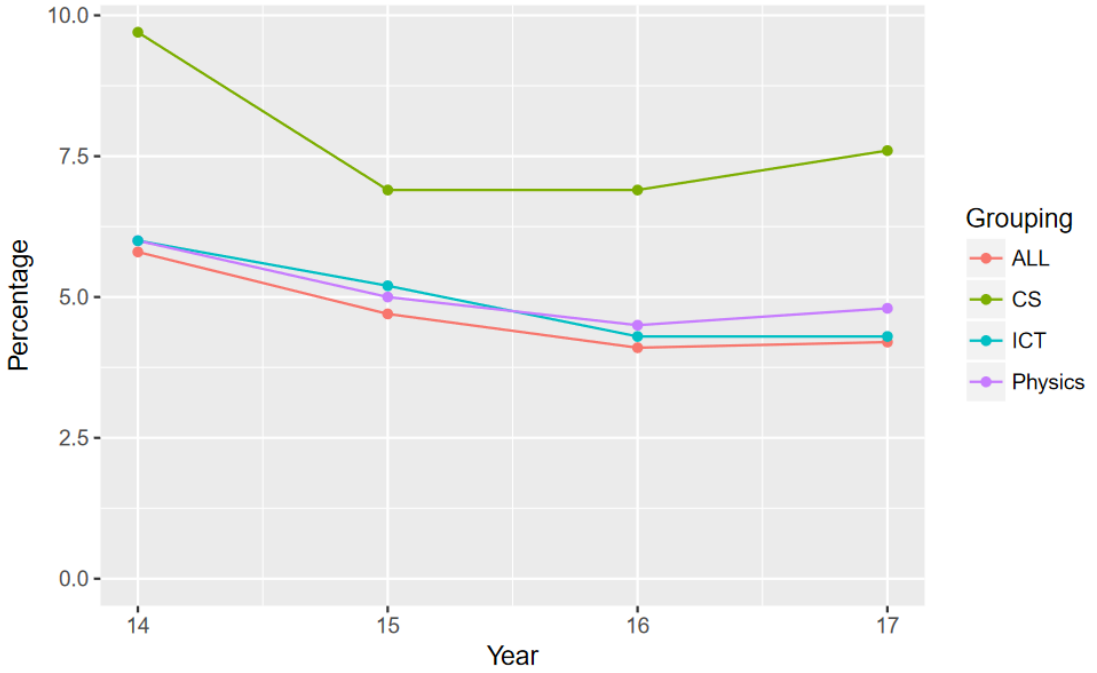
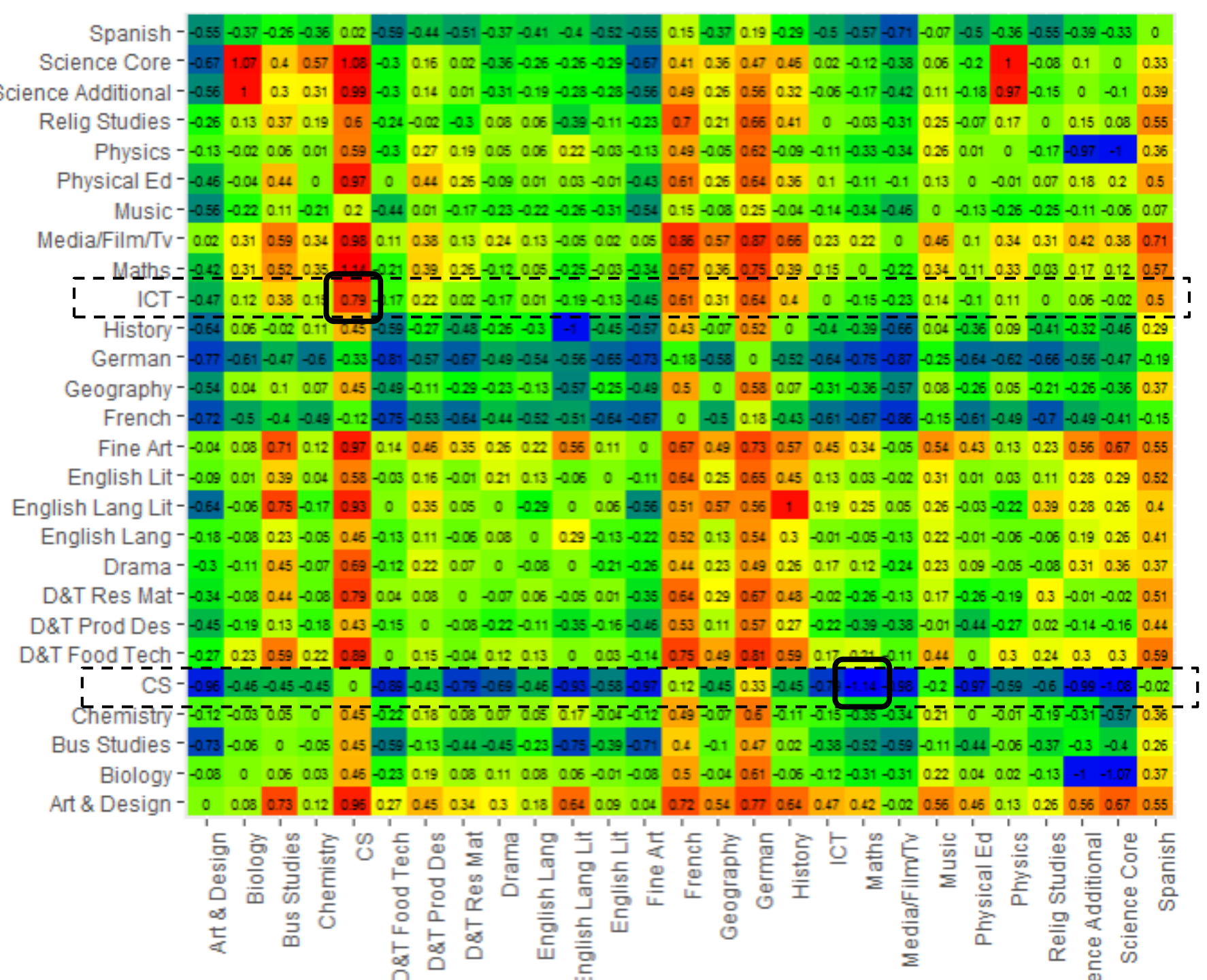


Figure 99: Longitudinal: A level students who have SEN categorisation, by subject and year

How do students do at CS?

*“A primary route to improvement will be to displace some of the routine ICT activity with more creative, **rigorous** and **challenging** Computer Science”*

Furber 2012


Spanish
Science Core
Science Additional
Relig Studies
Physics
Physical Ed
Music
Media/Film/Tv
Maths
ICT
History
German
Geography
French
Fine Art
English Lit
English Lang Lit
English Lang
Drama
D&T Res Mat
D&T Prod Des
D&T Food Tech
CS
Chemistry
Bus Studies
Biology
Art & Design
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Spanish

CS outcomes and gender

Girls outperform Boys in CS (and almost everything).

A model to look for *relative achievement*, how does a student do in CS compared to other subjects. E.g.

Maths-A (7) History-B (6) Physics-C (5) | CS-C (**5**)

Average Attainment of 6 (7 + 6 + 5 / 3)

they will be doing worse in computer science by one grade (i.e. 6-5)

Comparisons with other subjects

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Maths-A (7) History-B (6) Physics-C (5) | CS-C (**5**)

Average Attainment of 6 (7 + 6 + 5 / 3)

they will be doing worse in computer science by one grade (i.e. 6-5)

General linear model used:

```
Attainment in CS ~
                Avg attainment in other subs
                +
                Gender
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E.g.
when *controlling* for achievement, i.e. a boy and girl have the same average grade in their other subjects

the girl would get 0.25 of a grade more in English lang.

the boy would get 0.31 of a grade more in CS and 0.46 of a grade more in maths.

Table 8. GCSE Grade Outcome Predicted by Average GCSE Grade and Gender

		Avg Grade (SD)		Estimate of Subject Result Predictors		
Subject Name	n	F	M	Avg.Grade	Gender	R^2
Maths	521,790	5.09(1.78)	5.00(1.86)	0.99***	0.46***	0.68
Physics	127,800	6.17(1.24)	6.16(1.25)	1.06***	0.41***	0.71
CS	60,736	4.87(2.05)	4.70(2.02)	1.22***	0.31***	0.61
Science Additional	347,749	4.81(1.49)	4.55(1.54)	0.97***	0.24***	0.72
Science Core	246,700	4.38(1.48)	4.14(1.50)	0.89***	0.22***	0.72
Physical Ed	110,951	5.35(1.51)	5.03(1.41)	0.76***	0.21***	0.52
Chemistry	127,545	6.26(1.25)	6.05(1.27)	1.07***	0.18***	0.72
Bus Studies	70,892	5.03(1.72)	4.81(1.76)	1.18***	0.16***	0.70
Biology	125,890	6.28(1.23)	6.04(1.26)	1.03***	0.14***	0.74
History	237,045	5.28(1.94)	4.83(2.02)	1.26***	0.05***	0.73
Music	40,138	5.57(1.64)	5.32(1.76)	0.87***	0.05***	0.53
ICT	67,359	5.21(1.77)	4.75(1.84)	1.00***	0.02.	0.59
Geography	222,742	5.34(1.83)	4.89(1.82)	1.15***	0.02***	0.77
Drama	65,948	5.53(1.46)	4.96(1.55)	0.73***	−0.19***	0.50
German	46,152	5.54(1.39)	5.15(1.45)	0.90***	−0.21***	0.54
D&T Res Mat	45,511	5.41(1.70)	4.53(1.74)	0.88***	−0.24***	0.61
French	129,414	5.43(1.52)	4.98(1.57)	0.92***	−0.25***	0.54
Spanish	83,120	5.52(1.63)	5.03(1.71)	0.92***	−0.25***	0.47
English Lang	306,514	5.63(1.32)	5.06(1.41)	0.78***	−0.26***	0.69
English Lit	372,197	5.65(1.40)	5.00(1.53)	0.83***	−0.32***	0.70
Relig Studies	246,302	5.66(1.79)	4.91(1.97)	1.08***	−0.38***	0.69
Fine Art	48,590	5.76(1.48)	4.98(1.65)	0.66***	−0.39***	0.48
Media/Film/Tv	42,115	5.46(1.51)	4.59(1.61)	0.88***	−0.41***	0.60
Art & Design	77,963	5.60(1.50)	4.64(1.61)	0.63***	−0.47***	0.48

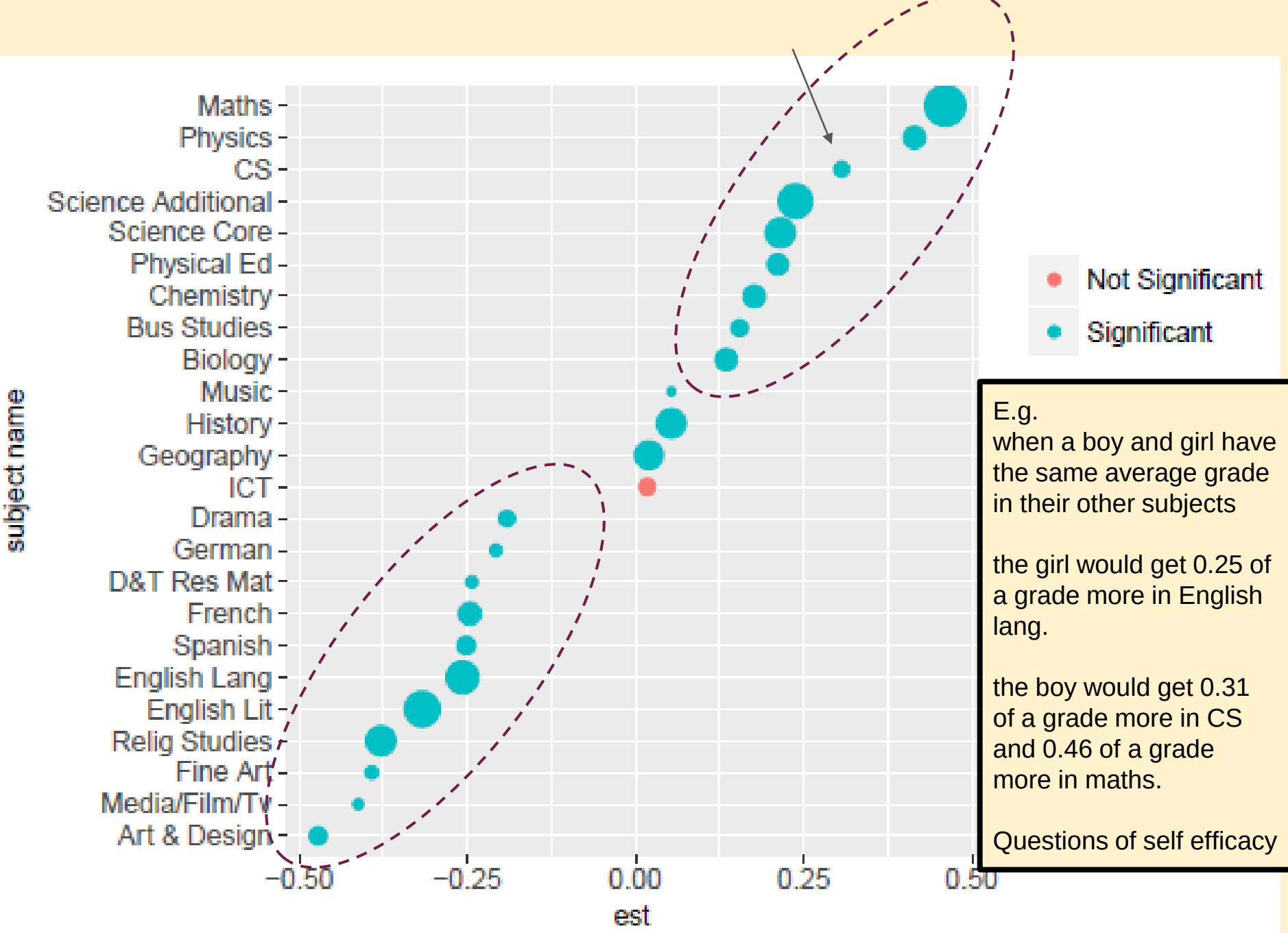


Fig. 5. Influence of gender on grade, controlling for ability in other subjects. Positive–males doing better

Summary

- *Digital* education in schools has decreased substantially since the introduction of the new curriculum
- There are serious disparities in access to the GCSE CS qualification
- The computing qualification changes in England do not appear to be equitable for girls, working class, SEN and some ethnic minority groups
- The exam system tells girls (and boys to a lesser extent) that they have strengths elsewhere. What does this mean for their self-efficacy?
- The majority of girls still outperform boys in CS and the new computing curriculum in England has only been around since 2014

So,was the curriculum change a good idea?

Wide support for change, but some concerns:

Over-influence of industry (Larke 2019, Williamson 2017, Rudd 2014)

“This is reinforced by a school curriculum that focuses in ICT on office skills rather than the more rigorous computer science and programming skills **which high-tech industries like video games and visual effects need**” - Hope and Livingstone 2011

“[Academisation means] that schools without fully trained teachers could just drop computing altogether” - Williamson 2017

Computing = Computer science?

"Overall, a [reform] narrative of ICT as **academically weak and vocationally useless** prevailed"

- Larke 2019

"I remember one of my kids coming back from school one day muttering, disgustedly: "**Dad, you'd never guess what we had to do today – learn to use Microsoft Word!**" This from a kid who had been using Word since he learned to write."

- Naughton 2020

"We were told unless we got it back to the minister by 9 o'clock on Monday morning with a greater emphasis on Computer Science, then computing would not be in the national curriculum"

- Member of drafting panel quoted in Williamson 2017

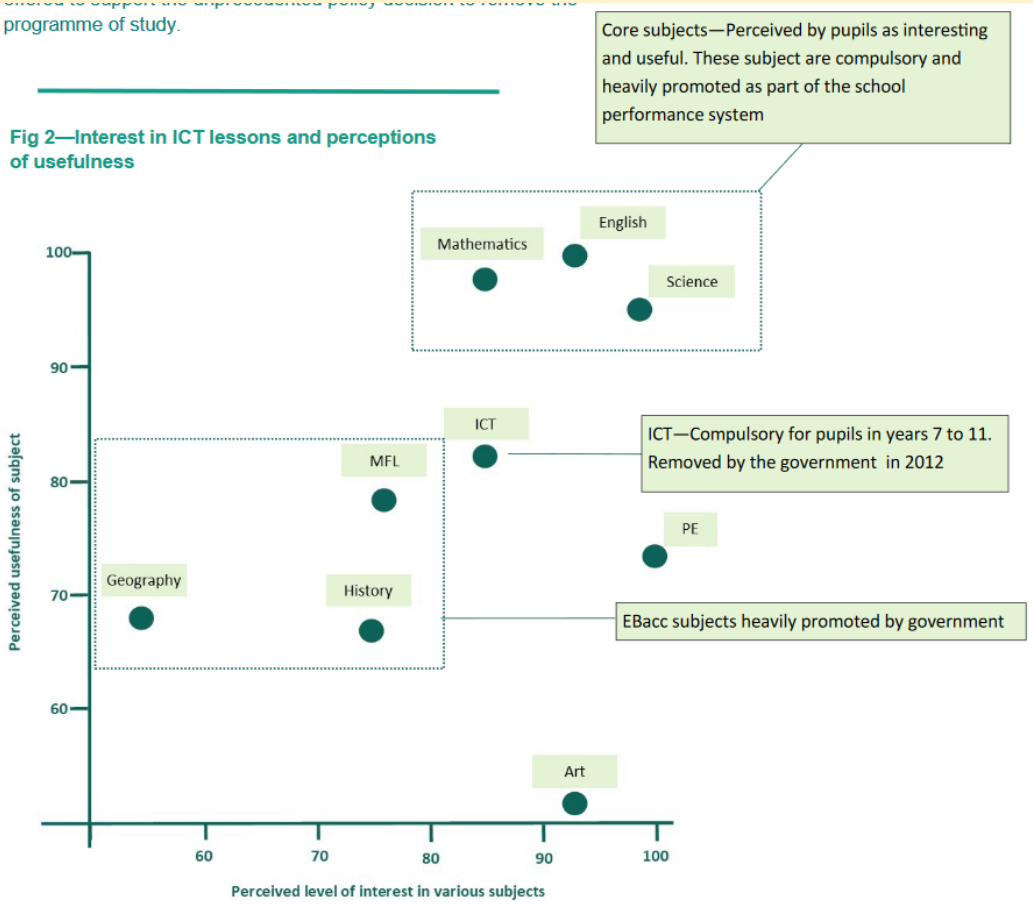
Useless and uninteresting?

The girls surveyed identified nine areas of learning which they enjoyed. In order of the frequency mentioned these were:

1. Data handling activities
2. Web design
3. Audio visual work
4. Desktop publishing and CAD
5. Programming with Scratch
6. Making presentations
7. Using the Internet
8. E-safety
9. Modelling and simulations

programme of study.

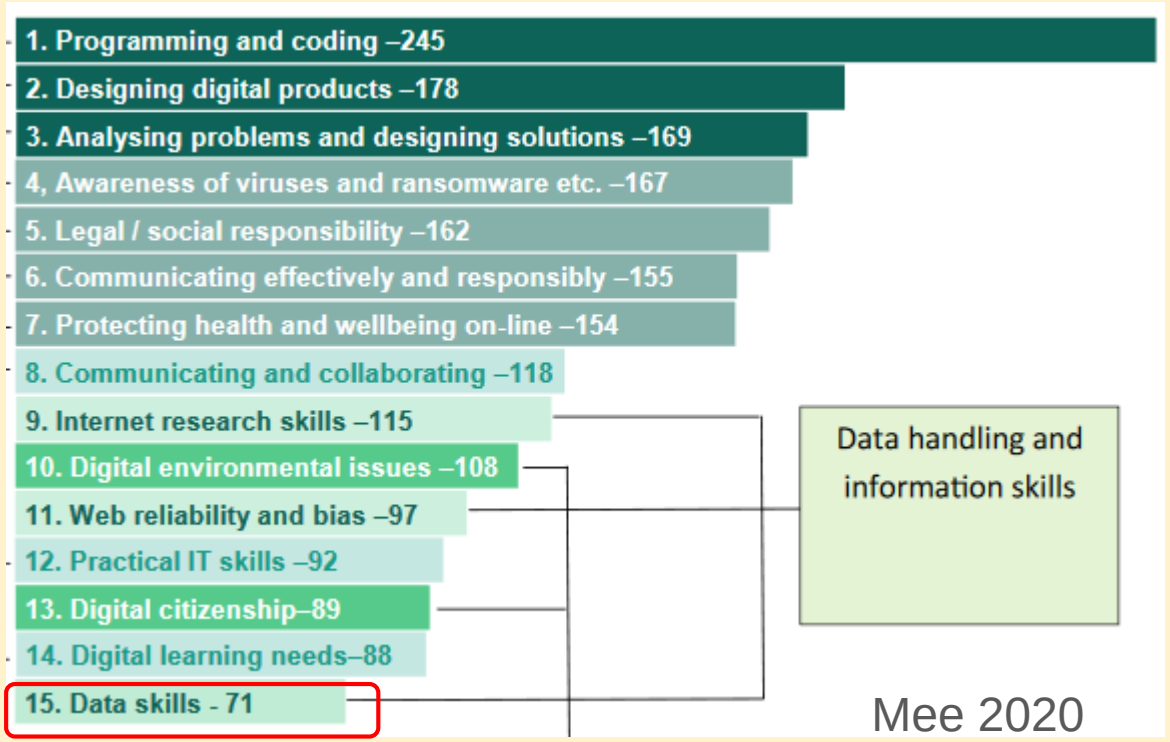
Fig 2—Interest in ICT lessons and perceptions of usefulness



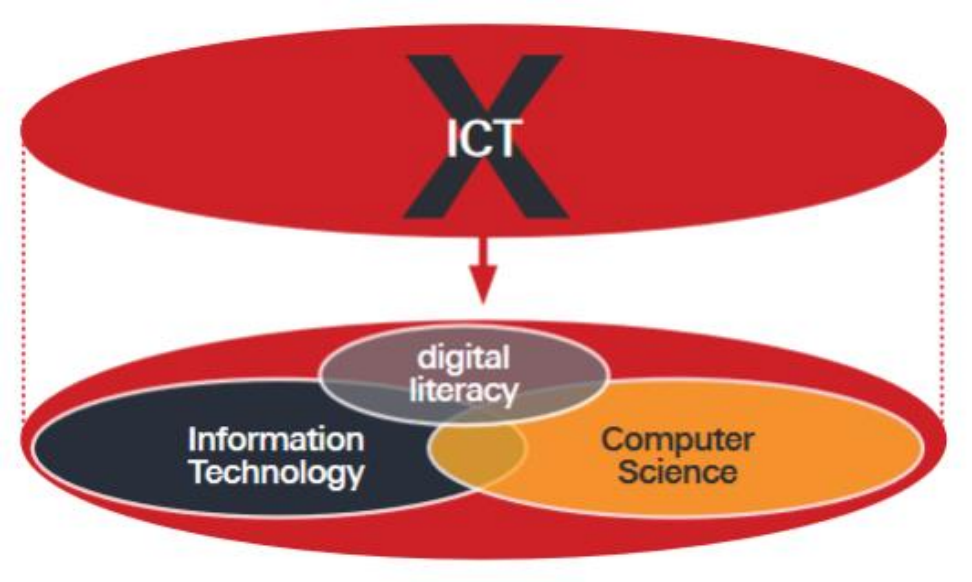
Girls' perceptions of ICT as a subject at Key Stage 3. Mee 2020 (2011 data)

Computing in the school curriculum: a survey of 100 teachers

- KS3 Computing is being used to prepare for GCSE CS
- GCSE CS not available to less able pupils
- Limited options at KS4



Policy: intended, actual, in-use (Ball & Bowe 1992)



Department for Education

Computing programmes of study: key stages 3 and 4

National curriculum in England

Purpose of study

A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world. Computing has deep links with mathematics, science, and design and technology, and provides insights into both natural and artificial systems. The core of computing is computer science, in which pupils are taught the principles of information and computation, how digital systems work, and how to put this knowledge to use through programming. Building on this knowledge and understanding, pupils are equipped to use information technology to create programs, systems and a range of content. Computing also ensures that pupils become digitally literate – able to use, and express themselves and develop their ideas through, information and communication technology – at a level suitable for the future workplace and as active participants in a digital world.

Aims

The national curriculum for computing aims to ensure that all pupils:

- can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation
- can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems
- can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems
- are responsible, competent, confident and creative users of information and communication technology.

Attainment targets

By the end of each key stage, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study.

2012

Reasons for underrepresentation: Psychological

'Natural' or biological differences: Different ways of working (Baron-Cohen, 2009)

Self-efficacy: ‘if you think you can, you can’ (Bandura, 1987)

Reasons for underrepresentation: Sociological

Social identities and inequalities - Good but not good enough / not for ‘people like me’ (Archer et al, 2010; Mendick 2005; Wong, 2017)

Stereotypes and expectations: Gender - technical boys and creative girls (Butler, 1990; Varma, 2007; Wong & Kemp 2018); Ethnicity - cultural and family values/aspirations for children (Wong, 2016)

Science and STEM capital - Resources and access inequality (Archer et al., 2015; Bourdieu, 1977; Moote et al., 2020)

Intersectionality: ethnicity, social class, gender and other social factors (Crenshaw, 1988)

The role of teachers and schools - implicit and un/conscious assumptions

Forthcoming research

2021-2024 - Gender/Girls, attainment and subject choice in computing education

Strand 1 - A NPD analysis of attainment, subject choice and student characteristics

Strand 2 - A qualitative and quantitative study on ‘successful' schools - what worked and what can be shared/amplified?

Research questions:

1. What are the main predictors of female attainment in GCSE CS?
2. What are the factors that explain schools with high female participation in GCSE CS?
3. How do students’ attitudes and attainment in school level computing influence uptake and performance of the subject at later exam levels?

Questions to discuss

1. Is underrepresentation ‘normal’ and ‘expected’? When and why should we be concerned?
2. Should initiatives be ‘targeted’ or ‘available to all’?
3. Are some interpretations of ‘computing’ more inclusive than others?
4. What can teachers and practitioners (realistically) do to support the participation and engagement of underrepresented students in computing?