British Male students continue to fall behind in secondary education

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It is common knowledge that boys fall behind in school performance, and UK policy makers have addressed this issue in the past decade. In fact, they seem committed to narrowing gender gaps of any kind. This paper asks whether actual progress has been made in reducing the degree to which boys fall behind, and also whether gender differences in subject preference have changed in the period 2001 to 2013. Using an analysis of British secondary-education exam data and a comparison with data from the Programme for International Student Assessment (PISA), it is concluded that no progress has been made: Boys attained fewer top grades in nearly all school subjects. Further, boys and girls continue to choose elective school subjects along traditional interest lines. The problem of boys falling behind is obscured by the finding that grades of all children have risen considerably in this period.

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However, a comparison of Mathematics and English exam grades with PISA data suggests that this rise is due to grade inflation, not real improvement. The paper closes with recommendations for solutions.

Keywords: education, psychology, gender gap, interests, policy

This paper investigates the degree to which boys fall behind in secondary education, using data from England, Wales, and Northern Ireland. The paper also discusses the necessity and challenges of changing the current situation. In this paper, both performance and participation are reported. Performance is here defined in terms of the quality of grades school children attain. Participation is defined as enrolling for elective optional courses (such as Psychology or French). Throughout the paper, the terms "boys" and "girls" will be used as a short for male and female adolescent students in the age groups from (around) 14 to 18 years old.

Educational performance gaps between boys and girls have been known for a long time. For example, already in the 17th century, the English philosopher Locke (1693) wrote that girls outperform boys when it comes to language skills. Still today, studies show that girls have better developed language skills (for a review, see Halpern, 2012), while boys typically perform equally well or better in Science, Technology, Engineering and Mathematics (STEM) subjects, and these gaps are far more extreme at the tails of the performance distributions (Stoet & Geary, 2013).

Understanding these performance gaps is necessary for addressing socio-political questions, such as whether the public and policy makers should be concerned and plan to change the current situation, and whether the educational gender differences can explain why there are unequal numbers of men and women in nearly all areas of employment. Indeed, not only the British government (Department For Education and Skills, 2007, Condie, McPhee, Forde, Kean, & Head, 2006), but all nations of the European Union have developed a long term vision and strategies to narrow these gaps (European Commission, 2011). One of the questions that researchers need to answer is whether today's school systems have been effective in ensuring that equal numbers of boys and girls leave school with similar knowledge and skill levels in all subject areas. This paper will show that this is not the case.

Further, this paper addresses a related issue, namely whether an overall increase in school performance should make us less concerned about existing gender gaps. Indeed, it is sometimes argued that when the school system improves, *both* genders benefit, and both genders improve their performance; the argument is that even when there continues to be a gender gap, at least all children improve (Department For Education and Skills, 2007, p.77); arguably, the latter situation is not ideal, but better when there remains a gap without any improvement. However, the current paper will argue that while schools in England, Wales, and Northern Ireland have seen considerable grade increases over more than a decade, but that these are likely due to grade inflation and not true improvement. That makes the current existing gender gaps potentially even more serious than people might think.

Background of studies on gender gaps in education

There is now a large body of literature about gender gaps in school attitudes and performance, and there are very different methodological approaches to understanding these gaps (e.g., focus on individual students or countries, quantitative vs. qualitative studies, psychological vs. educational focus, focus on boy's vs. girls' underachievement); it is impossible to give a full account of these different perspectives here. There are, however, some frequently cited frameworks that are important because of their influence.

Discussions about gender performance and participation gaps have changed considerably over time due to a change in the understanding of the gaps. In the late 1970s, the underperformance and underrepresentation of girls in STEM subjects received much attention (Benbow & Stanley, 1980, 1982a, 1982b, 1983), while boys' general underperformance across subjects and different stages of their educational pathways became a very active research topic in the late 1990s (Weaver-Hightower, 2003). We now know that male students not only fall behind in schools (e.g. Gorard, Rees, & Salisbury, 1999, 2001, Lai, 2010, Jürges & Schneider, 2011, Warrington, Younger, & McLellan, 2003, Burns & Bracey, 2001, Younger & Warrington, 2004) but also in higher education (e.g., Jacob, 2002, Machin & McNally, 2005, Buchmann & DiPrete, 2006, Conger & Long, 2010, Taylor, 2005, Ratcliffe, 2013, Ewert, 2012). This paper provides an up to date assessment of the situation in secondary education in England, Wales, and Northern Ireland (these parts of the United Kingdom use a similar exam system and collate their exam data together; Scotland uses its own, slightly different system). The overall performance and gender gaps in the U.K. are similar to observations in other countries in Western Europe (Stoet & Geary, 2013).

Over the years, different theoretical approaches to gender gaps in education have been established, although there is still no consensus in the field of education or psychology about these theories, and neither is there a consensus about which interventions could possibly narrow these gaps.

One of the best known frameworks for explaining gender gaps is the gender-similarities and gender-stratification framework (Hyde, 2005, Hyde, Lindberg, Linn, Ellis, & Williams, 2008, Else-Quest, Hyde, & Linn, 2010). This model states that there are negligibly small differences between men and women in the majority of psychological variables, including cognitive abilities; the hypothesis is that existing educational differences will disappear when men and women will have equal opportunities in social, economic, political and educational domains. Because of the assumption that the educational gender differences are caused by non-cognitive factors, interventions aimed at changing self belief, anxiety, and so on as well as eliminating sex discrimination will be able to resolve the gender gaps (Hyde, Fennema, & Lamon, 1990). The current paper will show that even though the U.K. has a relatively high level of gender equality, the gender gaps remained stable over more than 10 years.

Theoretical models that assume that gender gaps in performance and participation are *entirely* due to societal and environmental factors are not without criticism. This because some aspects of these gender gaps seem to be universal, that is, they are found all around the world (Stoet & Geary, 2013). For example, without accepting some role of biological factors, it is difficult to explain why there is no country in the world where boys have better reading comprehension skills than girls, as shown in the large international PISA surveys (Stoet & Geary, 2013). It is also difficult to explain why the countries with some of most restrictive attitudes to women's rights do not show a mathematics gender gap while many more progressive countries do (Fryer & Levitt, 2010, Stoet & Geary, 2015).

Further, it has been found that sex differences in vocational interests are consistently found around the world: on average, men are more interested in working with things, and women more interested in working with people (Lippa, 1998, Su, Rounds, & Armstrong, 2009, Lippa, Preston, & Penner, 2014, this is known as the "people-things dimension"). The universality of this phenomenon has been taken as an indication of possible biological factors involved in this. Indeed, there is considerable support for the influence of biological factors to explain sex differences in psychological variables (Geary, 2010). According to these latter studies, some of the largest sex differences are not so much found in cognitive abilities, but in interests. The explanation is that interests might have played a role in evolutionary gender-specific adaptations to activities such as hunting or child care. Groups of people who survived by successfully dividing labor might thus have passed on genes that are underlying psychological processes that support gender specific interests and thought processes. If the biologically inspired models of gender gaps in education are correct, we would expect that in particular the choices for eligible subjects in secondary education is relatively stable, despite continuously increasing efforts of "gender mainstreaming" in developed countries such as the United Kingdom and most other European countries. The current paper shows that indeed gender specific choices for subjects are relatively stable.

Secondary education in England, Wales, and Northern Ireland

This paper will report the performance in British secondary education for the period 2001-2013. Note that the data of Scotland (which constitutes less than 10% of the British population) are not included, because it has a different educational system and does not contribute data to the central databases of the "Joint Council for Qualifications" used here.

Broadly speaking, secondary education in England, Wales, and Northern Ireland has two different main stages, namely the General Certificate of Secondary Education (GCSE) and the Advanced level of the General Certificate of Education (A-Level). GCSE courses are part of compulsory education. This system is "comprehensive", that is, students of all levels of ability can participate and prepare for the same set of exams set by national exam boards under the oversight of the national government.

Typically, students start the GCSE programme at the age of 14 and sit exams at the age of 16. The A-Levels are a non-compulsory part of secondary education that follows the GCSEs, typically for students from 16 to 18 years old. Because A-Level exam scores in a number of subjects are typically required as a qualification to enter higher education, they are considered of great importance for career development, and a large proportion of the population participates (the government target for participation was set to at least 50% in 2002, BBC, 2002).

Students are awarded grades ranging from the highest A* ("A-star") to the lowest G or F (for details see Methods). Relevant is that around 50% of children get an A*, A, B, or C in the GCSEs. In order to get access to some of the top-tier universities, students might need to have three A grades in the A-

Levels.

The grading of students' exam scripts follows strictly regulated procedures. There are five different organizations that implement the curriculum guidelines of the Department for Education; they produce teaching material and exams. These organizations work closely together under the umbrella of the "Joint Council for Qualifications", and also publish one data set of exam results (as used in this study). Each year, more than 25 million scripts are marked by around 60,000 examiners and there are persons who check the consistency of grading standards. The details of the exam data and grades are further explained in the Methods section.

Programme for International Students Assessment

The data for the GCSE exam scores are of great interest for comparison with the data of the Programme for International Student Assessment (PISA). PISA is the largest international survey of student performance with a focus on the question whether students at the end of their compulsory secondary education can apply their knowledge and skills in the areas of reading, mathematics, and science to real life problems of modern economies (example problems can be viewed here: http://pisa-sq.acer.edu.au/). It surveys student performance from 15 to 16 year olds around the world, including a representative sample of children in England, Wales, and Northern Ireland (for comparison: the majority of students sitting GCSE exams are 16 years old). Further, because English and Mathematics are compulsory in GCSEs, the GCSE exam scores in these two subjects are highly representative of the population of 16 year olds, and we can safely assume that scores in GCSE exams and PISA of the matching years are therefore representing the same population.

PISA scores are expressed on a scale which has an average of 500 PISA points for students in countries in the Organisation for Economic Cooperation and Development (OECD), and a standard deviation of 100 points. Because PISA is carried out every three years, changes over time can be analyzed. Further, for both reading and mathematics, six different proficiency levels have been defined, with level 6 the highest (see detailed descriptions of these levels in the Supplementary Online Matrial, SOM). This paper matches the grades used in the GCSEs to these proficiency levels.

Methods

This study uses exam data publisehd by the Joint Council for Qualifications (JCQ) and performance data of 15-year olds published by the Programme for International Student Assessment.

Exam data

The exam results data used in this study were retrieved from the website of the JCQ, which collates exam results from all school children in England, Wales, and Northern Ireland. These results were downloaded as PDF files from the JCQ web site, and the data were then copied and pasted into text files and subsequently read-in using the statistical software R (R Development Core Team, 2014).

For each year from 2001 to 2013, the proportion of male to female students sitting GCSEs (full course) and A-Levels (i.e., gender-specific participation) as well as their grade marks were analyzed. The number of students enrolling in English, a compulsory subject, gives the best estimate of total students participating in each year. The number enrolled in the subject GCSE English between 2001 and 2013 was on average 697,826 students (ranging from 649,553 to 732,293). In the A-levels, English is the most chosen subject, with an average of 85,113 per year (ranging from 72,196 to 91,815).

For GCSEs, grade marks range from A* (highest) to G (lowest), and for A-Levels grade marks range from A to F (and since 2010, A* has been added). Because the A* grade was not available for all years included in this study, the A and A* grades have been collated for analysis (to make the findings easier to interpret). For some analyses, A* and A grades are considered separately.

The number of study subjects varied slightly from year to year, with some subjects discontinued (e.g., A-Level Home Economics was available until 2006) and others introduced (e.g., Statistics in 2004 GCSEs). Please note that GCSE and A-Level subject names are capitalized here. Also note that when listing performance and participation differences in exam data between boys and girls no inferential statistics are given intentionally. This because the reported numbers are not samples of a larger population, but *are* averages of the total population of all examined school children.

PISA data

The U.K. data from the Programme for International Student Assessment (PISA) are freely available from the website of the Organisation for Economic Cooperation and Development (http://www.oecd.org/pisa/). For this analysis, the datasets from 2003, 2006, 2009, and 2012 were used. PISA distinguishes between two subsets in the U.K. data, namely those from Scotland on the one hand, and those from England, Wales, and Northern Ireland (combined) on the other hand; in the current paper, only the latter data were used (because GCSEs and A-Levels are only used in England, Wales and Northern Ireland, while Scotland uses a different system). For all analyses of PISA data, the recommended statistical procedures were used as described in the extensive PISA documentation (OECD, 2003b).

Participants in the PISA survey are between 15 years and 3 months and 16 years and 2 months old. The average number of participants in the English, Welsh, and Northern Irish data sets was 9,196 (ranging from 6,812 to 10,708). Details about the PISA sampling procedures can be read elsewhere, but it should be pointed out that great effort is put into these data to be highly representative of the sampling population (OECD, 2003a).

The sampling of the very first PISA survey of the year 2000 have been judged problematic due sampling problems, and therefore, it is debatable whether the decrease in U.K. PISA scores from 2000 to 2003 reflects reality (Jerrim, 2013). What is relevant to the current study is whether there might actually have been an increase in PISA scores (as is shown in final exam data). While a decrease in U.K. scores might not have actually happened, there is no doubt that no increase in PISA scores has been observed in U.K. (OECD, 2013). In any case, the PISA data of 2000 are not included in the current study.

Results

In the following, the data of the GCSEs and A-Levels will be reported separately, starting with the former. These sections will be followed by a comparison between GCSE and PISA data. In all these analyses, the focus lies on the differences between boys and girls.

GCSEs (ages 14-16)

The percentages of boys and girls attaining an A grade (i.e., A or A*) *across* all subjects were analyzed first (Fig. 1). The overall performance level averaged over all study subjects shows three salient phenomena: First, the percentage of school children (boys and girls alike) attaining an A grade has increased considerably over the years to a maximum in 2011, and has gone down slightly since then. Second, girls consistently attained considerably more A grades than boys (between 5.3 and 7.2 percentage points difference). Third, the overall gap between boys and girls has grown from a 5.3 percentage points gap in 2001 to a 7.2 percentage points gap in 2013 (further below, this increase will be compared to changes in PISA over that period).

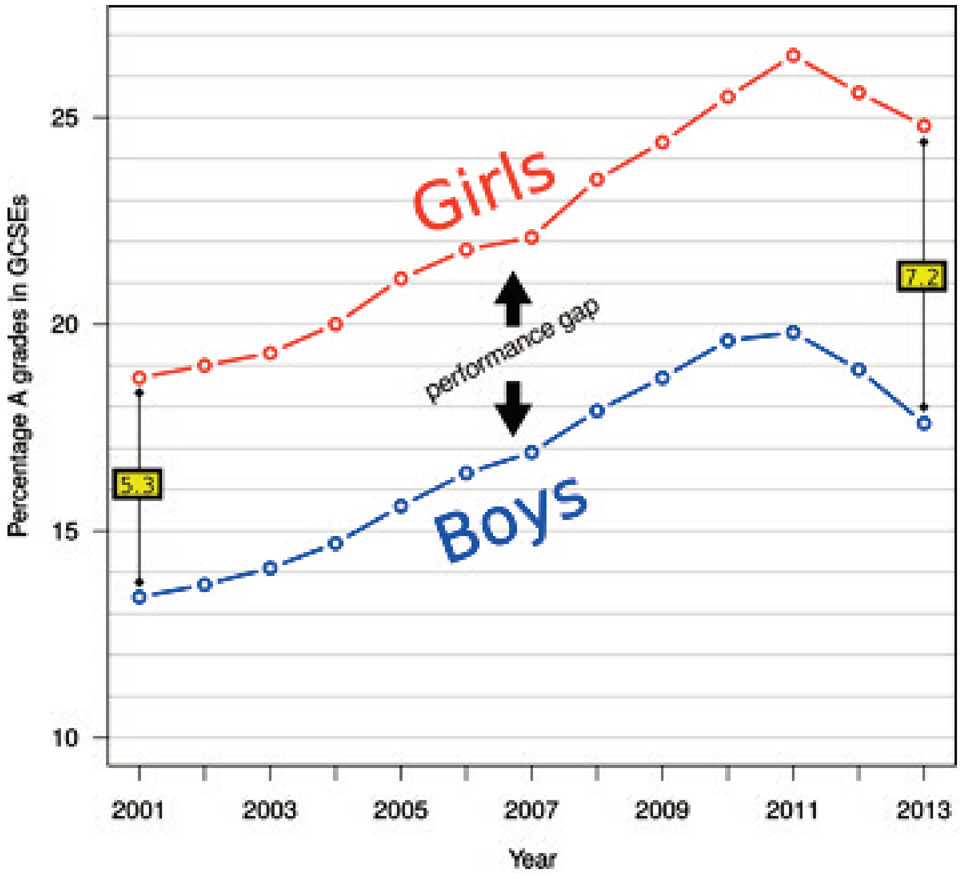

Figure 1: Gender performance gap in GCSEs over the period 2001-2013. Girls consistently attained more A (A* or A) grades (across subjects) than boys. This gap has grown over the years from 5.3 in 2001 to 7.2 percentage points in 2013.

Because the gender performance gap varies from subject to subject, performance for academic subjects will now be reported separately, starting with the compulsory subjects English and Mathematics (Fig. 2). Consistently, the percentage of girls attaining an A grade in English was higher; on average, 19.0% of girls attained an A grade compared to 11.1% of boys, that is a 7.9 percentage points gap in favor of girls. In contrast, the difference between the percentages of boys and girls awarded an A grade in Mathematics was minimal; on average, 13.7% of girls and 13.8% of boys attained an A grade. Thus, while there is a clear advantage for girls in English, boys and girls performed equally well in Mathematics.

The two most closely related subjects to the compulsory topics English and Mathematics, English Literature and Additional Mathematics, are of interest as well (Fig. 2). English literature is a popular subject, although its popularity has declined over the past decade. In 2001, 81% of the students enrolling in English choose English literature as well, and that has gradually gone down to 65% in 2013. The gender performance gap in English Literature (8.9 percentage points in favor of girls) was slightly higher than in English (7.9 percentage points). Further, the topic *Additional Mathematics* was introduced in 2004 and, unlike English Literature, relatively unpopular, with total student numbers ranging from 3,205 (2004) to 18,765 (in 2009); that is, at its maximum enrollment only 2.5% of the students that were enrolled in Mathematics choose this topic. In 2012, the number of students had dropped by nearly 10,000 students in only one year (and in 2013, it was similarly low with 3,478 students). The variation in the "Additional Mathematics" gender gap from year to year has been considerable. In 2004, while girls lead with 5.4 percentage points, boys lead in 2011 with 6.1 percentage points. Possibly, this variation is partially due to the small number of students enrolling in the topic. Thus, it is concluded that the student performance in these related subjects is similar to that of the compulsory counterparts. At the very least, this shows that the gender differences between language and mathematical skills are not just shown in "compulsory topics", but also in the voluntarily chosen topics.

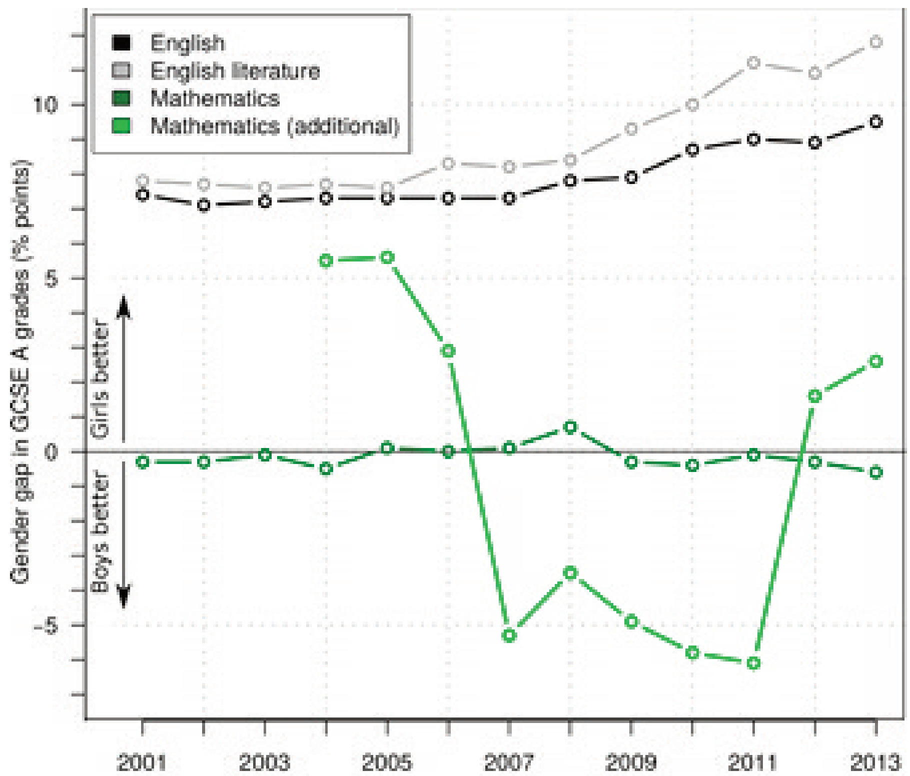

Figure 2: Sex differences in GCSE Mathematics and English performance over the period 2001-2013. Values represent the difference between percentage of girls that attained an A grade minus the percentage of boys that attained an A grade. Positive values indicate that girls did better than boys.

There are a few subjects in which boys did not fall behind (for a complete list of the gender performance gaps by subject, from high to low, see SOM Appendix A). As for Mathematics, in Physics the same percentage of boys and girls attained A grades (in some years girls attained more A grades and in some years more boys, with an average advantage for boys of 0.5 percentage points). Boys' advantage was most notable in Manufacturing, introduced in 2011, but because so few students choose this (174 boys and 9 girls in 2012; 219 boys and 17 girls in 2013), this finding does not carry much weight. Somewhat surprisingly, the topic Engineering, also introduced in 2011 and more popular than Manufacturing (2685 boys and 212 girls in 2012), showed exactly the opposite picture as Manufacturing: Girls attained 23.2 percentage points more A grades in 2011, and 29.2 percentage points more in 2012, but this advantage dropped to 4.4 points in 2013. Thus, even though boys fall behind in most subjects, they play even in non-organic STEM subjects.

A-Levels (ages 16-18)

Similar to GCSEs, across subjects the percentage of male students attaining A grades was lower than that of females, although the gap was smaller than in GCSEs. Across subjects and years, the gap was 2.0 percentage points (compared to 5.8 in GCSEs, Fig. 3, SOM Appendix B). Further, unlike in GCSEs, the gender performance gap in A-Levels has not been growing. In fact, the performance gap in A grades was largest in 2003 (2.9 percentage points) and lowest in both 2001 and 2013 (0.8 percentage points). That said, changes in the gap itself were not large in either GCSEs or A-Levels. The only considerable *general* change over time was the increase in grades (similar to GCSEs). Across subjects, the percentage of students with an A grade went from 18.6% in 2001 to a peak of 27% in 2010, and has dropped a little bit since then (to 26.3% in 2013).

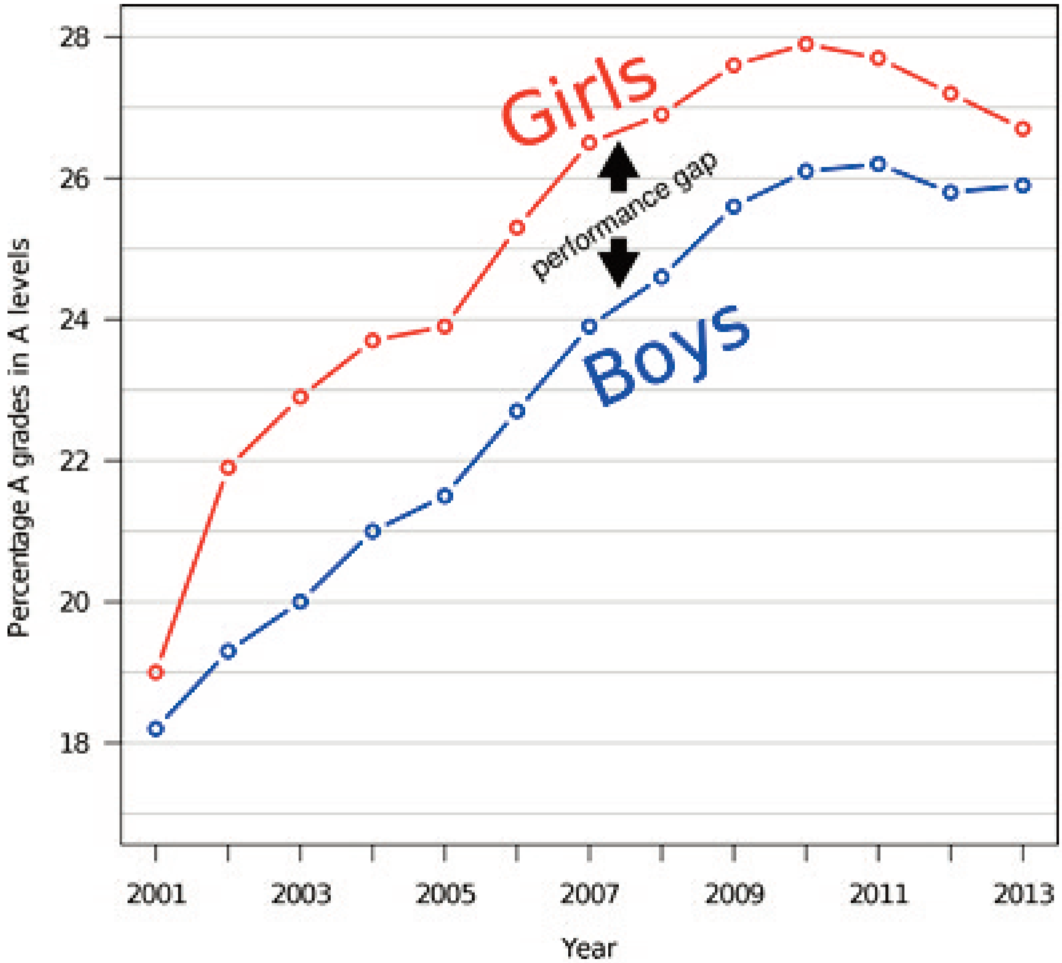

Figure 3: Performance gap in A-Levels across all subjects in the period 2001-2013. As in GCSEs (Fig. 1), girls consistently attained more A (A* or A) grades than boys.1

A second difference between A-Levels and GCSEs is that in A-Levels boys and girls did not score equally in Mathematics; instead, girls outperformed boys in Mathematics, and also in other STEM fields (Figure 4). In Mathematics, the average difference over the years has been 2.4 percentage points in favor of girls, with a peak in 2006 (4.5 percentage points) but with less than 1 percentage points difference in last three years. For Physics, the advantage of girls over boys is considerably larger than in Mathematics. While there was no gender gap in the GCSEs, girls lead in attaining A grades with 6.1 percentage points.

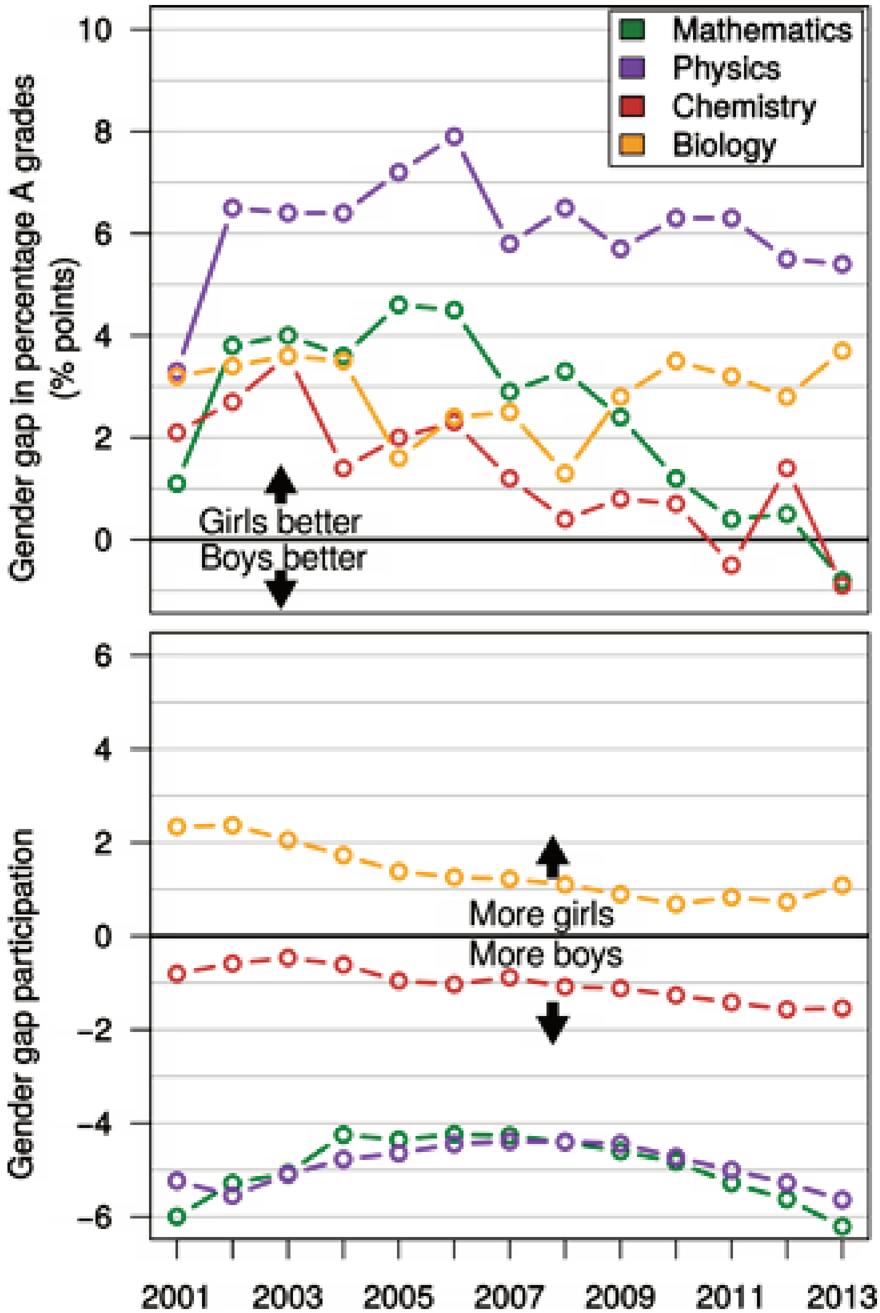

Figure 4: Performance gap in A levels in STEM subjects from 2001 to 2013. Top: The gender gap in attainment of A grades. Bottom: Differences in percentages of boys and girls choosing subjects.

The enrollment data show that girls remained underrepresented in STEM fields (Figure 4, Bottom). Girls were underrepresented in Physics, Chemistry, Mathematics, but overrepresented in Biology. The change over the years in these fields has not been large, though. If anything, the sex difference seems to grow, except for Biology. This is particularly the case for Computing (not in Figure 4 because the variation between years is so large compared to that in other years), with more than 14x more boys than girls in 2013. What is unusual about Computing is how strong the percentage of participating girls has dropped, from its maximum of 26% in 2003 to a minimum of 7% in 2013.

In the social science subjects (Figure 5) the enrolment has not changed much over the years. Boys were underrepresented in Psychology and Sociology, yet overrepresented in Economics and Political Studies. Irrespective of over or underrepresentation, girls attained more A grades in these subjects.

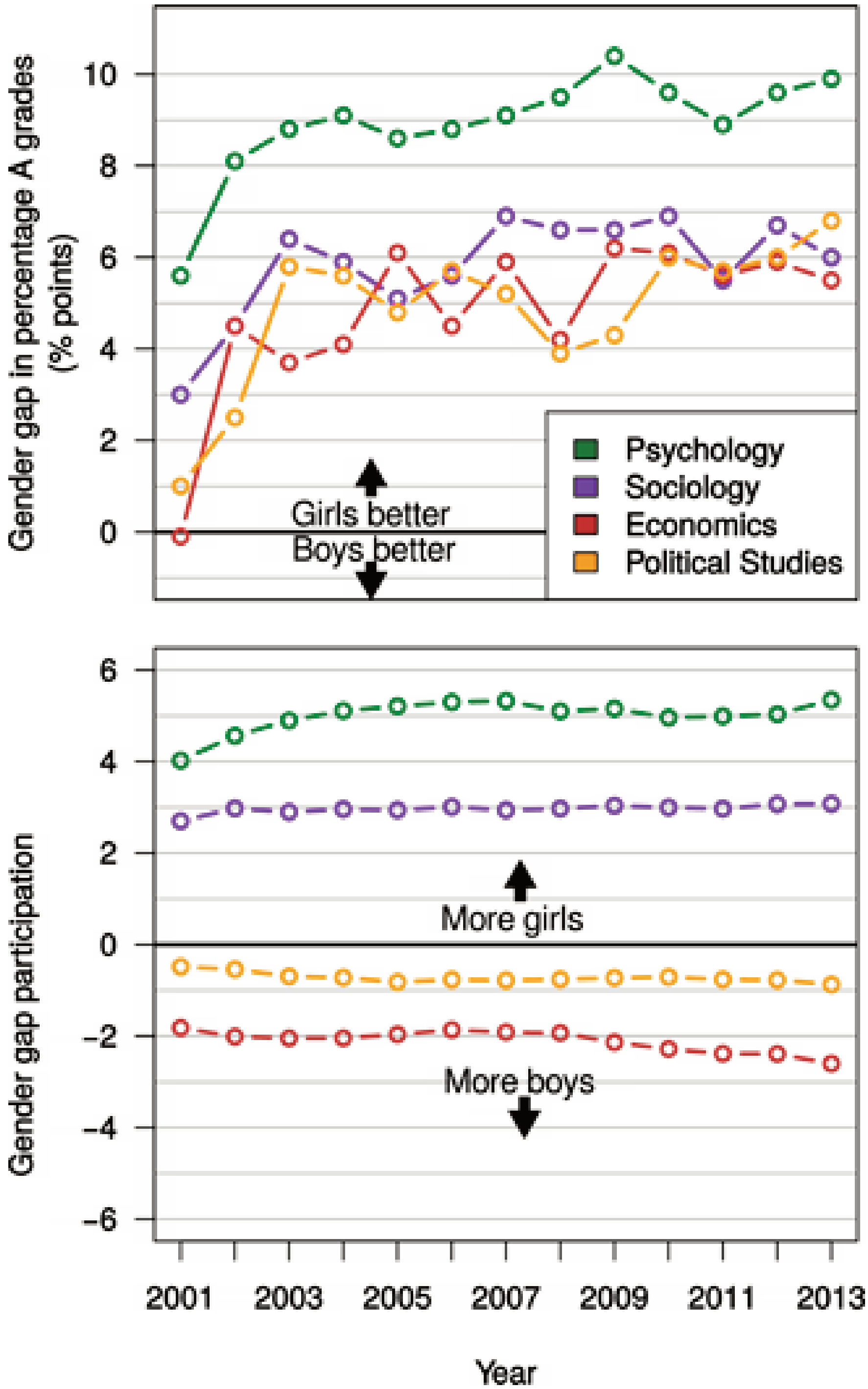

Figure 5: Performance gap in A-Levels in social science subjects from 2001-2013. Top: The gender gap in attainment of A grades. Bottom: Sex differences in percentages of boys and girls choosing subjects.

Given boys' general underperformance in English and known difficulties with reading skills, it is of special interest that boys were at an advantage are modern foreign languages (French, German, and Spanish, SOM Appendix B). That said, boys were strongly underrepresented in these courses (with around one in three students male).

Altogether, girls attained higher grades in the A-Levels, including in the STEM subjects in which there was no gap during the GCSEs. It is important to note that this does not necessarily mean a change performance of the same children, but that this might reflect that far fewer students participate in the (voluntary) A-Levels than in the (compulsory) GCSEs.

Comparison to PISA

The first analysis addresses whether the increased performance in U.K. exam scores in Mathematics and English matched the PISA scores. The overall sex difference in Mathematics and English in the U.K. has been reported elsewhere (Stoet & Geary, 2013), and we know that U.K. girls have, on average, consistently better reading skills, while boys perform consistently better than girls in Mathematics. For the current paper, the distribution of the students in England, Wales, and Northern Ireland for Mathematics and English is similar to that of other OECD countries. That is, in Mathematics, the performance gap is smaller at the low end of attainment, whereas in Reading, the performance gap is smaller at the high end of attainment (Figure 6). This finding has direct implications for interventions aiming to reduce the gap (see Discussion).

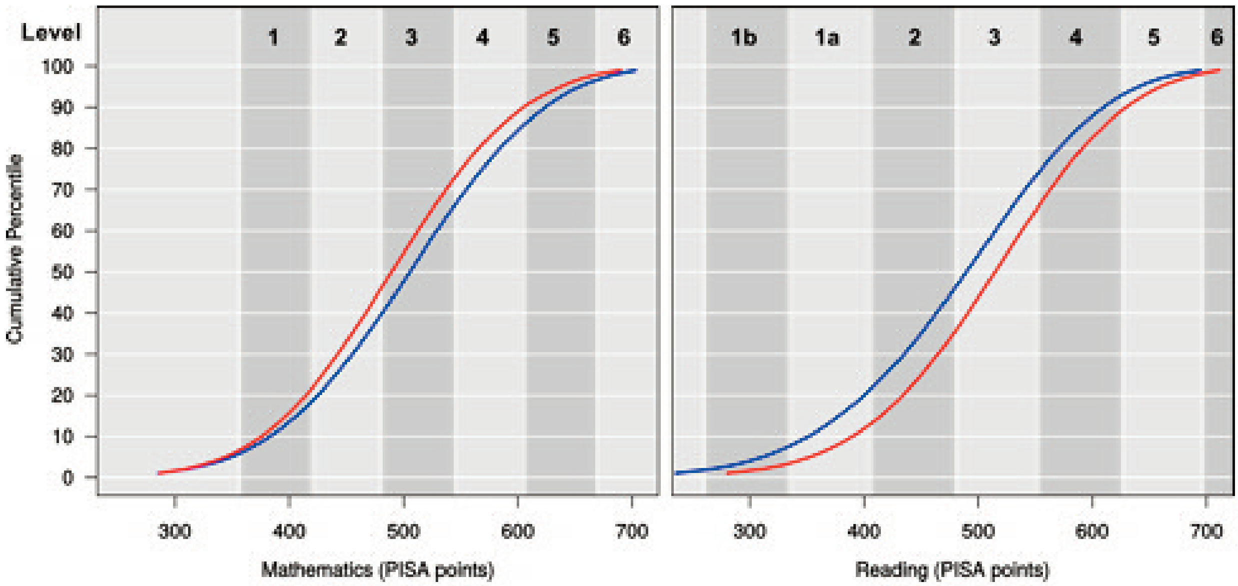

Figure 6: The distribution of Mathematics (left) and Reading (right) PISA scores of boys (blue line) and girls (red line), averaged over the PISA assessments of 2003 to 2012. Note that the difference between Mathematics scores for boys and girls is larger at the higher end, whereas the opposite pattern is found for Reading scores. PISA scores can be categorized into different levels of proficiency (see SOM).

The next analysis addresses the relation between the GCSE grade increase and PISA scores. For both 2003 and 2012, the cumulative percentages of children attaining a certain PISA score was simply matched to the percentages of GCSE candidates attaining a certain grade (Figure 7). This is best explained with an example. We know that in 2003, 97% of students attained a GCSE score lower than an A* (because 3% of students attained an A*). Similarly, in 2003, 50% of children attained a score lower than a C. We can match these grades to PISA scores. If we know that 97% of children attained a score lower than an A*, we can match this to the 97% of children who had a PISA score of 678 or lower. Thus, the children that attained an A* in GCSE most likely had a PISA score over 678 points, which is within the highest Mathematics proficiency level (see SOM Appendix C). However, in 2012, we know that 94% of children attained lower than an A*, which corresponds to a PISA score of 641 PISA points, which lies in proficiency level 5. Thus, one can conclude that in 2003, only school children who had the highest proficiency level in mathematics could attain an A* grade in the GCSEs, whereas this has dropped to the second highest level in 2012 (this drop is indicated with the red lines along the x-axis in Figure 7). Interestingly, the A and C grades also dropped one PISA proficiency level (for A it dropped from level 5 to level 4, and for grade C it dropped from level 3 to level 2). Grade B just stayed on the border of the fourth proficiency level.

The same matching method was applied to PISA Reading and GCSE English data (Figure 7, right panel). Of interest is that few children reached the highest level 6, and that an A* grade corresponded to the second highest level (5). Although the drop in matching PISA scores is smaller than for Mathematics, it is the case that the a proficiency level 3 was necessary for a C grade in 2003, whereas this could be reached with a proficiency level of only 2 in 2012. Similarly, the necessary skills necessary for grade D also dropped one proficiency level.

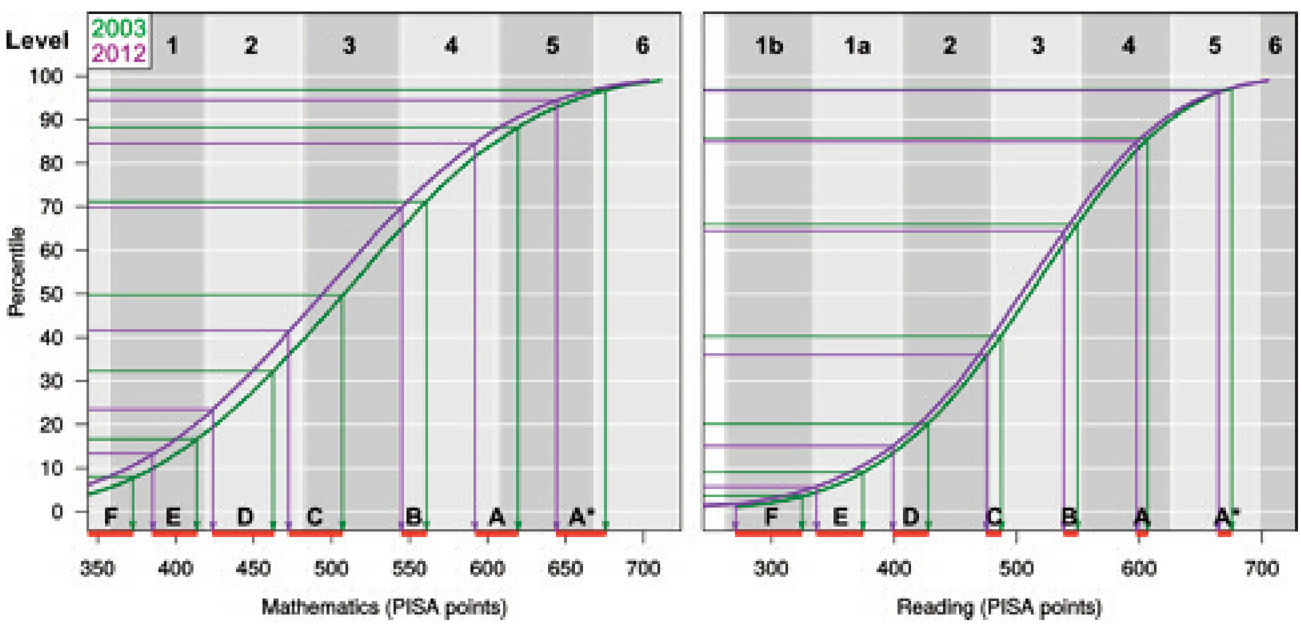

Figure 7: The relation between PISA scores and GCSE grades. The distribution of scores (with boys and girls taken together) for the years 2003 (green curve) and 2012 (purple curve) for Mathematics (left panel) and Reading (right panel). The cumulative percentages of children attaining a GCSE grade are mapped on the cumulative percentages of PISA scores (y-axes), and the corresponding grades in PISA scores are shown on the x-axes. The thick red lines on the x-axes indicate the downward shift from 2003 to 2012.

General Discussion

This study found considerable sex differences in exam performance and subject choice in secondary education in England, Wales, and Northern Ireland: Boys fall behind in performance in most subjects, and boys and girls choose subjects along traditional interest lines. Further, the observed grade increase over the first decade in Mathematics and English did not match the stability of performance observed in PISA surveys for England, Wales, and Northern Ireland. This means that the British school system is ineffective in narrowing the gender gaps. Further, the finding that PISA scores showed no increase in performance suggests that the failure to narrow gender gaps has not been softened by on overall increase of both girls and boys (instead, here it is argued that the increase was due to grade inflation).

This discussion will start with a more detailed summary of the most important findings of this study, problems facing research into this issue, and implications in the longer run.

Detailed summary of findings

In regard to sex differences, the percentage of boys attaining an A grade was lower than that of girls in nearly all GCSE subjects. This pattern of boys falling behind across subjects matches the findings of the PISA, in which boys generally underperform compared to girls (Stoet & Geary, 2015). In GCSEs, the major exception to this pattern was found for the STEM subjects Mathematics and Physics, in which boys and girls performed similarly. Despite this latter positive note, boys' attained fewer A grades in a number of technology-related subjects, in particular in the popular Design and Technology. As in the GCSEs, boys attained fewer A grades in most A-Level subjects. The main difference from the pattern in GCSEs was that boys attained fewer A grades in the STEM subjects Mathematics and Physics as well.

The gender performance gap is only one dimension of sex differences in education. At least as important is the sex difference in student numbers enrolling for optional subjects (i.e., participation gap); from a socio-political point of view, this is relevant because if girls are outnumbered in STEM subjects at school, they will certainly also be outnumbered in employment. Therefore, an important finding of this study is that both in GCSEs and A-Levels, girls continue to be underrepresented in STEM subjects, whereas boys were particularly underrepresented in social sciences, languages, and art-related subjects. This phenomenon is relatively stable over time, except for girls' under-representation in Computing, a relatively novel subject most important for the development of modern technology, which has changed much: the percentage of girls in this subject has dropped from a high of 26% in 2003 to currently 7%.

Further, an interesting observation was that girls outperformed boys in topics in which they were underrepresented (e.g., Physics). This phenomenon was not so common for boys. For example, boys were not only underrepresented in Psychology, they also underperformed in this subject. On the other hand, the phenomenon was actually observed for boys in the modern languages, in which there were fewer but highly performing boys. There are different possible interpretations of this phenomenon, and the different interpretations have different policy implications; therefore, it is important to consider these. First of, one could possibly interprete this as girls generally be better in physics, and therefore that if only more girls would choose physics, girls would be highly competitive in the STEM employment market. A second interpretation is that only high-achieving girls are willing to choose physics, and if this would be the case, one would predict if more girls could be encouraged to choose physics, this larger group would include lower attainers, thus lowering the gender gap in exam scores. The latter interpretation could also imply that girls, in general, have lower self-confidence about their own STEM performance, and that they are only willing to choose it if they know they are high achieving. A similar interpretation is possible for boys in the modern languages, in which boys are in the minority but score higher than girls. Importantly, though, it is not true for Psychology, in which boys are not only in the minority, but they are also underperforming. The latter observation about boys in Psychology seems to clash with the self-confidence interpretation. It is possible that self-confidence is not the causal factor, but that some types of assessments work better for boys than for girls (e.g., writing essay questions is a common method of assessing Psychology). At this point, the best way forward to resolve this outstanding question is further analysis in both cognitive and non-cognitive factors, such as self-confidence in gender stereotyped subjects. Also, we need to consider if specific assessment types are more easily dealt with by boys than by girls. For example, it is possible that psychology assessments require non-psychology specific essay-writing skills that boys find more difficult than girls.

Finally, the PISA scores in Mathematics and English were compared to the GCSE scores. The conclusion is that in 2012 lower skill levels were required to attain the same grades as in 2003. In particular in Mathematics, the drop in required skill levels dropped whole proficiency levels. For example, in order to attain the highest exam grade in 2003 GCSE (an A*) for Mathematics, students had to have the highest PISA proficiency level (level 6, see Appendix for description); in 2012 students could attain an A* grade while being in proficiency level 5. In other words, if we trust the reliability and validity of the extremely well tested and validated PISA surveys, it has over the years become easier to attain a top grade. Indeed, this matches the opinion of mathematicians and policy makers (Kounine, Marks, & Truss, 2008).

Have gender gaps narrowed?

One of the main questions is whether gender gaps have been or can be narrowed. This paper has clearly shown that the performance gap across subjects has not been narrowed (if anything, it has grown), and the participation gap stayed the same. This is both true for the general underperformance of boys and the gaps in participation along traditional lines. Nevertheless, some people might argue that at least in terms of girls' performance in Mathematics, girls now do perform similarly to boys in the U.K., a finding that matches findings from other countries (Hyde et al., 2008, Voyer & Voyer, 2014).

The finding that girls do now equally well in mathematics as boys is not evidence that boys and girls have become more similar to one another, though. Instead, one can argue that at least in school exams, boys have fallen so far behind that even in the subjects in which they were often stronger they now just manage to break even. This is a problematic finding for two reasons. First of all, it means that the educational system has failed to deal with the problem of boys' general underachievement, an issue that has been actively researched for more than 20 years, and which the U.K. government (including Scotland) has aimed to deal with (Younger & Warrington, 2004, Department For Education and Skills, 2007, Condie et al., 2006). Second, it means that when the overall performance of boys would rise, the first subjects in which girls would fall behind in would be STEM subjects such as Mathematics and Physics. This because, relatively speaking, boys do better in STEM subjects than in languages, whereas for girls it is the opposite way around (observed around the world, Stoet & Geary, 2015). In other words, if the average score of boys would be raised, boys will likely outperform girls in Mathematics and Physics. In summary, the apparent elimination of the mathematics gender gap seems to be nothing more than a side effect of boys' overall lower educational performance, and not a genuinly positive development of equipping boys and girls with the same skills.

Finally, the finding that the gender gaps were somewhat smaller in the A-levels is likely due to a selection mechanism: The A-levels are optional, and the poorest performing students will most likely not participate in the A-levels. Many more boys than girls performed poorly in the compulsory GCSEs, and as a consequence more boys than girls will not even start with the A-levels. Therefore, the underperformance of boys in the GCSEs seems to be a limiting factor for boys' educational and career opportunities.

Can psychological attitudes really be changed?

A common assumption underlying much educational interventions as well as current policies is that changing the gender differences in psychological attitudes (such as in confidence and interest) would be a great way to narrow the gender gaps. For example, recently, the U.K. Minister of Education Elizabeth Truss argued that the PISA gender gap in mathematics is not due to competence but due to a lack of confidence in girls (Truss, 2014). Others have argued that girls suffer from anxiety (Maloney & Beilock, 2012), for example due to stereotypes (Nguyen & Ryan, 2008). And again others argue that role models might change girls' attitudes (Donald, 2011). And some argue that changing interests can change gender gaps in participation (Meece & Glienke, 2006).

The big question is, though, whether it is really possible to change these attitudes. We need to be sceptical about the proposed solutions, some of which are disputed. For example, there is reasonably good evidence that same-sex role models do not make a difference in schools (Carrington, Tymms, & Merrell, 2008, Helbig, 2012), and it has been argued that girls' mathematics performance is not negatively affected by stereotype threat (Stoet & Geary, 2012, Ganley et al., 2013). The stability of gender differences in vocational interests shows that decades of gender equality initiatives and gender-equality campaigns making women aware of the possibility of non-traditional career paths have not made much of a difference in actual subject choices (Lippa, 1998, Su et al., 2009, Lippa et al., 2014).

The challenge for the idea that we can change performance through changing attitudes is that this idea is strongly based on the basic assumption that attitudes are both learned and remain changeable to further experience. But it seems that this idea is far more popular in the media and among some social scientists than it is among other researchers. For example, the era that experimental psychologists assumed that children's minds were blank slates has had its heydays long ago (Pinker, 2003). Over time, researchers have developed a far more balanced view of the role of nature and nurture in development. Indeed, among psychologists it is now far more accepted than in the past that gender differences in attitudes are influenced by biological variables which cannot be changed through learning or experience. For example, vocational interests appear to be influenced by exposure to prenatal hormones (Beltz, Swanson, & Berenbaum, 2011), and similarly, gender differences in affective responses (e.g., anxiety related responses) can be linked to biological factors (Altemus, 2006). This does not at all mean that everything is fixed; instead it means that opportunities for change through education are more challenging and difficult than many have hoped or expected (the actual lack of change despite political will for change supports this argument).

Of course, one can further debate the role of nature and nurture in explaining gender differences in attitudes. For example, the fact that there are international differences in gender gaps demonstrates unequivocally that society and culture play a role in gender gaps. What matters most in the current discussion is that the possibility that these gender differences might be fairly stable needs to be taken more seriously by policy makers. Currently, there is little reason to believe that policy makers (e.g., Truss, 2014) take the possibility of relatively fixed attitudes very seriously into consideration. Yet, we risk that aims are being set that are unrealistic, and this would likely lead to an ineffective use of limited educational and financial resources.

The fact that boys and girls continue to choose subjects along traditional lines in even some of the most progressive countries suggests that gender-specific interests are indeed hard to change. It might of course be possible, but if so, nobody knows how it can be done (again, if somebody would have known, we should have seen an effect by now, but we have not). A solution to this problem is rather than trying to change children's gender specific attitudes, we might adjust teaching to the existing attitudes of children, which can have a positive effect on performance (Oakhill & Petrides, 2007, Kerger, Martin, & Brunner, 2011). A possible answer to whether attitudes can be changed or how teaching can be adjusted to existing gender differences in attitudes can only come from a closer collaboration between educational researchers and psychologists. Yet, there seems a lack of collaboration between educational researchers and psychologists, which is the topic of the next section.

Lack of interdisciplinary work

In writing this article, I became aware of the lack of crosstalk between educational researchers and psychologists when it comes to the study of sex differences. This is somewhat surprising, because these researchers share many interests, such as the causes of differences in cognitive performance and the role of attitudes, affective states, and meta-cognitive factors (such as attention). The lack of collaboration between disciplines makes it also difficult to understand and compare previous work. For example, the review of literature and strategies written by educational researchers for the Scottish government (Condie et al., 2006) has 84 pages, but the word "psychology" is only used once (in an unrelated way). Similarly, a report by the Department of Education (Department For Education and Skills, 2007) with more than a 100 footnotes refers to only 3 papers in psychology journals.

It is important to note that psychologists often seem to be more "accepting" of the notion that boys and girls have different interests. Such differences are often observed from a young age, and aims to socially engineer such differences away might, in part, be inspired by an unrealistic believe of educators in the malleability of the mind. Of course, this latter point might be viewed by some as a fairly strong generalization of the disciplines psychology and education (with a varied group of researchers), but at the same time, in the face of a stagnation in any change in educational gender gaps, despite a political and societal will for change, researchers should be willing to speculate and explore possible reasons why this stagnation occurs. At the very least, I hope that readers will agree with me that there is much more room for collaboration between educational researchers and psychologists.

Why do PISA and GCSEs show different results?

One of the surprising finding of this paper is that girls do not fall behind in mathematics in GCSE exams (and even outperform boys in A levels). It is surprising because PISA data show the opposite pattern for England, Wales and Northern Ireland in all five PISA surveys that have been carried out from 2000 to 2012. And this gender gap in PISA clearly influences ideas about narrowing the gender gap among the highest level policy makers (e.g., Truss, 2014).

At the very least, this mismatch of results implies that the PISA surveys measure a (slightly) different type of skill than GCSEs. It is difficult to explain why exactly girls perform (in comparison to boys) equal or better in British exams than in PISA. I propose that there are two major possible explanations that require further study. First of all, it is possible that girls do better than boys to prepare for exams because girls have more positive attitudes to school and learning, which helps them to prepare better for curriculum-specific questions (Martin, 2004, Condie et al., 2006).

Second, there is evidence that during their school career, boys try out more varied strategies to solve problems than girls (Bailey, Littlefield, & Geary, 2012). Thus, it might be that because PISA requires solutions to problems that less directly match the curriculum and which require alternative strategies, which girls are less likely to employ. Of course, one could make many different conjectures, such as the stakes being different in exams than in the PISA assessment, which has no direct effect on student's further school career. The bottom line is that at this point, we can only speculate, and it is important to find out what the cause of the difference between exam scores and PISA results is. This is not only important for the U.K.; it is well possible that similar differences between exam results and PISA occur in other countries (e.g., Voyer & Voyer, 2014, found no mathematics gaps in exams around the world), and it would be of great interest and importance to find out why this might be the case. For example, if it is the case that children are not very good in dealing with novel problems that do not exactly match the text book problems they have learned at school, there is an urgent need for change in learning strategies. After all, if anything, the aim of schools is for children not to merely succeed in exams, but to apply their skills in novel situations (which is exactly what PISA tests).

Increase and decline of grades

One of the results reported here is the degree to which grades have increased until around 2011 and since then decreased. The U.K. Office of Qualifications and Examinations Regulations has stated that grade inflation explains at least part of the rise in GCSEs and A-Levels (Henry, 2012). Now, grade inflation is not the main point of this paper, yet it is highly relevant as a context for the discussion about gender differences. After all, if we would have observed that the gender gap in performance stays similar but that at the same time both genders improve considerably, we have a situation that is not great, but which still has a positive message for both boys and girls (Department For Education and Skills, 2007, p.77). But here it is argued that this is not the case.

Grade inflation is generally a big problem and difficult to solve, because nearly all stakeholders (students, parents, teachers, schools, politicians) in the educational system seem to benefit in the short term: Students and their parents equally desire high grades to get access to universities, and the higher the grades, the better the universities students will have access to (in terms of prestige and job prospects). Higher grades reflect well on schools who compete for fee-paying students. In the U.K., teachers benefit from higher grades in their performance evaluation, and this can play a role in their career progression. And finally, politicians will benefit from the success of their educational policies as measured by an increase in performance (note that the Department of Education has recently started to address the rise, but this should have happened much earlier).

Nonetheless, these perceived benefits are short term and are long-term disadvantages for the educational system as a whole. The biggest problem of grade inflation is that it makes it harder to differentiate between the true abilities of students. Differentiation is an important purpose of grades in the U.K. educational system (e.g., grades determine eligibility for higher education). If students cannot be differentiated based on their A-Level grades, universities will be forced to choose other methods of selection, such as university entry admission tests. In a sense, one could argue that if that were to happen, the grading system in the U.K. would have proved to be useless for university admissions, which is the most important use of A-Level grades.

It is also important to note that there are no examples of countries that have made real progress in changing gender gaps (Stoet & Geary, 2013). One of the main problems with changing the gender gaps is that a change in the mathematics gap (often negatively affecting girls) seems to be associated with a change in the reading gap in the other direction (negatively affecting boys) (Stoet & Geary, 2013). Thus, even if a country could narrow the gender gap in mathematics (good for girls), the same country will likely increase the gender gap in reading skills (bad for boys). Currently, no government has proposed a plan to tackle this issue and there is not a single government that has both no mathematics gap and no reading gap; in fact, some highly developed countries with no mathematics gap have an unusually high reading gap (such as Finland, see Stoet & Geary, 2013). Thus, even if we could make progress in subject domain, we might fall behind in another subject domain.

Implications

This study has a number of implications for policy makers in the domains of gender equality and education. First of all, the fact that boys continue to fall behind requires a new approach to this problem. Given that psychological researchers appear to have a different view on the issue than educational researchers and policy makers, and given that previous plans to deal with the issue have not translated into progress, it is time to foster more interdisciplinary approaches to the problem. Second, the fact that girls today do equally well in maths in British exams (this is similar in the US), might be a side effect of boys' general underperformance, rather than real progress. If it is indeed a side effect of the male underperformance, this will have negative consequences for girls. This because it would mean that when an effective intervention to help boys is found, girls will soon again fall behind in mathematics and physics. Thus, our dealing with boys' underperformance and ways of resolving this is not only relevant for boys, but also for girls and their participation in technology subjects. Third, the fact that boys and girls continue to choose subjects along traditional lines needs to be considered in discussions about aims to have more gender diversity among occupations. If individual school children choose subjects that they find most interesting and enjoyable, in whose benefit would the aims to change these choices actually be? If the only argument is that some male dominated occupations enjoy higher earnings, the national discussion should probably be about a different distribution of payment across occupations rather than about changing boys' and girls' decision to study the subjects they find most interesting.

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