Local Government Association

the impact of school size and single-sex education on performance

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EXECUTIVE SUMMARY

1. Introduction

NFER was commissioned by the Local Government Association (LGA) to explore two issues of enduring interest: the impact on performance of school size and single-sex education. There are arguments in favour of small schools and large schools. And although most comprehensive schools are coeducational, it is sometimes claimed that single-sex education is beneficial, particularly for girls.

In order to explore these issues, it was felt necessary to undertake a value-added analysis which took prior attainment and other key factors into account. The research comprised two strands: a review of published literature and some primary analysis.

2. Literature review

Most research on the subject of **school size** has focused on primary schools. There are concerns about whether very small primary schools are able to provide a broad curriculum for their pupils and give them the same opportunities as larger schools. The performance of very small schools (with cohorts of up to ten pupils) is difficult to judge. DfES figures suggest that their key stage 2 results are well below the national average, but this could be because special schools were disproportionately represented in this category.

When very small schools are excluded from the picture, it seems that school size has relatively little impact. Smaller schools obtain above-average results at key stage 1 and 2, but this can be explained by the fact that most are in relatively affluent areas with above-average indicators of socio-economic advantage. Some US studies have found that school size has a negative effect (i.e. small schools are better) but they are based on school-level data and make no allowance for pupils' ability at intake. One UK project found evidence of a non-linear effect of school size – the best results were achieved in small to medium schools with up to 160 pupils on the junior roll.

Research relating to the impact of **class size** on performance in primary schools was also explored. A number of studies, based on multilevel modelling, have found evidence that pupils tend to perform better in smaller classes.

We found only one study which used multilevel modelling techniques to identify the impact of school size on performance in **secondary schools**: it did not reveal any significant relationship between school size and achievement that was independent of student background characteristics.

The review of literature relating to **single-sex education** indicated a number of perceived benefits. Evidence, mainly from small-scale qualitative studies, indicated that it was thought to reduce sexually stereotyped subject choices, and to be academically advantageous, particularly for girls. Girls were said to be more confident in a single-sex environment, and to gain more attention from teachers; however, it was also claimed that single-sex classes can help underachieving boys.

It would be reasonable to assume that the perceived benefits, if real, would result in improved performance, but we found little published evidence to demonstrate that this was the case. The quantitative studies examined had limitations: most were based on school-level rather than pupil-level data, and the number of schools involved was relatively small. The research literature thus failed to provide convincing evidence that single-sex education has an impact on pupil performance.

3. Value-added analysis of pupil performance

A value-added analysis of national performance data was carried out using multilevel modelling techniques to investigate the impact of school size and single-sex education on pupil performance. Matched pupil-level datasets were used: the secondary national value-added dataset (NVAD), linking key stage 2 (1996) and GCSE (2001) results, and the primary NVAD, linking key stage 1 (1997) and key stage 2 (2001) results.

The analyses revealed that the relationship between **school size** and GCSE outcomes was curvilinear. In other words, after controlling for pupil, school and LEA background variables, performance improved with size up to a certain point, and then declined. The best results were obtained in medium-sized schools (with a cohort of approximately 180–200 pupils), and the worst in the very small or very large schools. The optimum size varied to some extent depending on certain key variables, such as sex of pupil, prior attainment and type of school (girls', boys' or mixed; grammar or comprehensive).

The presence and size of a sixth form were also significantly related to GCSE performance. Having a **large** sixth form was associated with better than expected results, while a **small** sixth form appeared to have a negative effect.

The analysis of primary data indicated that school size did not have a significant effect on any of the key stage 2 outcomes measured. This may be due to the relatively small size of the dataset used and it is possible that reanalysis with a full national value-added dataset could yield a different result.

The analysis of the impact of **single-sex education** on pupil performance indicated that, even after controlling for prior achievement and other background factors, girls in single-sex comprehensive schools achieved better results than their peers in mixed schools for all the outcomes measured, except the number of GCSEs taken. The measured difference was particularly striking for average GCSE science score, for which girls in single-sex schools could be expected to achieve over a third of a grade better than similar pupils in mixed schools. The analysis also suggested that single-sex schooling particularly benefited girls at the lower end of the ability range. In contrast, no performance gains were detected for girls attending single-sex grammar schools.

No overall differences were found between the performance of boys in single-sex and mixed comprehensive schools. However, more detailed investigation revealed that boys with lower prior attainment achieved better average GCSE scores in single-sex schools, while boys with higher prior attainment took slightly more science GCSEs and achieved higher total GCSE science scores in single-sex schools. It was also found that boys attending single-sex grammar schools achieved better results than those in mixed grammar schools for many of the outcomes measured.

4. Analysis of opportunities

The project explored the impact of school size and single-sex education on the opportunities available to students in secondary school, in terms of entry to higher key stage 3 tiers (mathematics and science) and GCSE subjects taken.

With regard to **school size**, logistic regression was used to test the claim that pupils in smaller schools do not have the same range of opportunities as those in larger schools. The analysis provided some evidence to support this hypothesis. Of the 23 common GCSE subjects included, the number offered was correlated with school size. Larger schools offered a wider range of science options and design technology subjects, and they were much more likely to offer both French and German. Students in larger schools were more likely to take double rather than single balanced science.

In relation to entry to tiers at key stage 3, there was no evidence that students in smaller schools have reduced opportunities for entering higher tiers. On the contrary, pupils in smaller comprehensive schools had a slightly greater chance of being entered for the higher tier in mathematics, though not in science.

With regard to **single-sex education**, it was investigated whether single-sex schools increase or reduce the range of opportunities available to students, and whether they counter or reinforce sex stereotyping, in terms of the subjects taken. Based on information about a limited number of GCSE options, it seemed that girls' schools do at least help counter the traditional stereotyping. Compared with girls in mixed schools, girls in single-sex schools were more likely to take resistant materials, less likely to take food technology, and more likely to take separate sciences. They were also less likely to take both French and German (although they may have taken other language combinations).

Boys' schools did not seem to have the same impact. Indeed, compared with boys in mixed schools, boys in boys' schools were almost three times as likely to take separate sciences, and only half as likely to take food technology.

Single-sex education also had an impact on the chances of being entered for higher tiers at key stage 3. After controlling for prior attainment, both boys and girls in single-sex schools had a greater chance of being entered for higher tiers of key stage 3 mathematics and science than their peers in mixed comprehensives. The greatest difference was in science, where girls in girls' schools had a 40 per cent greater chance of being entered for the higher tier.

5. Summary and conclusions

It would be possible to infer from the findings that, in order to maximise performance, comprehensive schools should be six-form entry (about 180 pupils per cohort) and single-sex. However, although medium-sized schools obtained the best results on all GCSE outcomes, the differences (while statistically different) were very small. The differences between single-sex and mixed schools were greater, especially for girls in comprehensive schools. However, it is possible that these could be explained by factors which we were not able to include in the analysis (such as ethnicity and parental support).

It is important to note that the research investigated the impact of size and single-sex education on performance, and to a lesser extent, on available opportunities. It did not explore the impact on other important outcomes, such as social and personal development, which are also worthy of consideration.

1. INTRODUCTION

This report outlines the findings from a research project, undertaken by the National Foundation for Educational Research (NFER) and funded by the Local Government Association (LGA), to explore the impact of single-sex education and school size on pupil performance. This chapter outlines the background, the research methodology and the overall structure of the report.

1.1 Background

The availability of national value-added datasets (NVADs), together with statistical tools such as multilevel modelling, make it possible to explore the impact of different types of school on pupil performance. NFER has recently undertaken studies designed to assess the impact of selective systems (Schagen and Schagen, 2001), specialist schools and faith schools (Schagen *et al.*, 2002).

NFER was commissioned by the LGA to investigate two other issues of enduring interest. First, school size. What is the ideal size for a school (secondary or primary)? There are arguments in favour of small schools and large schools. It is said that small schools create a better learning environment, in which children are known to staff, receive more attention from them and consequently flourish. On the other hand, it is claimed that children in larger schools benefit from more specialist teaching and a wider range of opportunities. The project aimed to explore what evidence there is to support these arguments, and whether pupils in a particular size of school tended to achieve better than expected test results, when all other factors were taken into account.

The second issue to be explored was that of single-sex education. Although a very large majority of comprehensive schools are now coeducational, single-sex education still has its champions. It is argued that girls in particular benefit from being educated separately, that their opportunities for participating in classroom discussions increase when no boys are present, and that they may be more willing to try traditionally male-dominated subjects in such circumstances.

Such convictions have led some mixed schools to experiment with single-sex classes in certain subjects. In the light of the current concern with boys' underachievement, it is argued that they too may benefit from separate classes, in subjects where girls traditionally excel. But what evidence is there to support these beliefs? Do boys and/or girls perform better in single-sex schools than their equally able peers in mixed schools? The research described in this report aimed to find answers to questions such as these.

1.2 Research Methodology

NFER was commissioned by the LGA to undertake a full review of the available evidence in order to assess the impact of school size and single-sex education on performance. The research project comprised two distinct though related activities:

- a critical review of published literature on this topic, assessing the findings of research already undertaken
- primary analysis of national datasets, in order to explore the impact of school size and single-sex education in value-added terms.

Literature review

A range of databases was searched, including the British Education Index, the British Official Publications Current Awareness Service (BOPCAS), the Educational Resources Information Centre (ERIC) and the NFER's own publications database.

The review focused on literature published from 1990 onwards; however, as little published evidence was found relating directly to the impact of school size and/or single-sex education on performance, some earlier key documents were also included. The literature review was mainly concerned with research carried out in England; nevertheless, some pertinent research studies from the USA and other countries are reported.

The internet and education press were also scanned for relevant information.

Statistical analysis

We suspected (and the literature search confirmed) that there was little published evidence relating directly to the impact of school size and/or single-sex education on performance. It was therefore planned that we would undertake our own value-added analysis of performance data designed for this purpose.

It is essential to undertake 'value-added' analyses, since raw results are strongly influenced by the prior attainment of the pupils concerned, and (to a lesser extent) by other school- and pupil-level factors. For example, if league tables showed that smaller primary schools obtained better results in national tests, this could simply mean that smaller schools (situated in rural or suburban areas) had more able pupils than larger schools (situated in deprived inner-city areas).

National value-added datasets now provide matched data at pupil level, including details of gender and age as well as the results obtained in national tests. (Further school-level information, including the percentage of pupils eligible for free school meals (FSM) was added from NFER's Schools Database.) The secondary NVAD for 2001 became available just as this project began. This links individual GCSE outcomes with the results of pupils' key stage 2 tests in 1996, so it is possible (for the first time) to examine the impact of pupil- and school-level factors on the whole five years of secondary education. Although hardly any primary schools are single-sex, size is a potential influence in both phases of education, so the primary NVAD (linking key stage 1 1997 and key stage 2 2001 results) was also used.

The main statistical technique employed was multilevel modelling. This is a recent development of linear regression which takes account of the fact that data is grouped in similar clusters at different levels. For example, individual pupils are grouped into cohorts, and these cohorts are grouped within schools. There may be more in common between pupils in the same cohort than between those in different cohorts, and there may be elements of similarity between different cohorts in the same school. By taking account of this hierarchical structure of the data, multilevel modelling can identify with greater accuracy differences which are due to certain school types or characteristics, rather than to the influence of individual schools.

The analysis aimed to show:

- for both primary and secondary phases, whether there is a link between school size and pupil performance, i.e. do schools of any size produce better than expected results, when all other factors were taken into consideration?
- within secondary education, whether boys and girls perform better in single-sex schools or mixed schools.

The issue of single-sex education is relevant only in the secondary phase of schooling, as almost all primary schools are coeducational. Logistic regression was also used to assess whether any school-level factors influenced the chances of boys and/or girls being entered for particular GCSE subjects, or higher tiers at key stage 3.

1.3 Structure of the Report

Following this introduction, Chapter 2 summarises and assesses the significance of existing research relating to school size and single-sex education. This links to Chapter 3, which provides evidence from the new 'value-added' statistical investigations of pupil performance carried out by NFER especially for this study. Chapter 4 outlines the findings from further analysis which aimed to show whether opportunities available to girls and boys (in terms of the tiers they are entered for at key stage 3, and the subjects they take at GCSE) are influenced by the type of school they attend.

The report concludes in Chapter 5 by summarising the findings of the study and by highlighting issues which merit consideration and further investigation.

Appendix I provides details of the multilevel value-added analysis undertaken in order to identify the impact of school size and single-sex education on performance. Appendix II describes the analysis of opportunities in different types of school, in terms of entry to higher tiers at key stage 3 and certain subjects at GCSE.

2. LITERATURE REVIEW

In order to assess the impact of school type or school size on performance, we need to find out whether, for example, single-sex schools achieve better results than mixed schools. Looking at league tables is not a satisfactory way to answer this question, as the 'raw' results achieved may simply reflect the quality of a school's intake. In order to make a reliable assessment of the impact of school type, it is necessary to undertake a 'value-added' analysis, which allows for the prior attainment of pupils and other key factors known to influence performance outcomes.

Saunders (1998) has identified best practice in calculating value added as follows:

- data should be collected at individual pupil level on a large and representative sample
- outcome measures should reflect all levels of pupil performance
- there should be prior attainment measure(s) plus background information for each pupil
- school context factors should be included
- multilevel modelling should be used to analyse the data
- there should be rigorous quality assurance and quality control procedures.

Aitkin and Longford (1986) have also emphasised the importance of multilevel modelling in school effectiveness research, as it is the only statistical technique capable of taking account of the hierarchical nature of educational datasets (the fact that we need to investigate the effects on performance of the characteristics of schools, of classes and of pupils simultaneously and to assess their relative importance in accounting for differences in performance).

There have as yet been relatively few attempts to investigate the impact of school size which would satisfy the above criteria. In England, the data needed for such an analysis (providing matched test results for individual pupils at different stages) has only recently become available. NFER's analysis, undertaken for this research project, is reported in the next chapter. Meanwhile, we consider the evidence from published studies.

2.1 The Impact of School Size

The issue of the ideal school size has been debated for many years, and there are arguments in favour of both small and large schools. However, it is important to note that 'small' and 'large' are relative terms. While 'mixed' and 'single-sex' are mutually exclusive categories – all schools are one or the other – size is a continuous variable, with a very wide range. A school with 20 pupils is obviously small, and one with 2,000 obviously large, but there are many medium-size schools which do not clearly belong to either category, and there is no agreement about where the boundary should be drawn.

A further point to bear in mind is that primary schools are, in general, much smaller than secondary schools. A primary school of 750 pupils would be considered large, while a secondary school with the same number would be considered small. There are issues concerning very small primary schools (those with perhaps 50 pupils or fewer) which would not apply to secondary schools. The phases of education are therefore considered separately, although most of the published research relates to primary schools.

2.1.1 The impact of school size in primary schools

There have been some concerns about whether very small primary schools are able to provide a broad curriculum for their pupils and give them the same opportunities as larger schools. The Plowden Report (1967), for example, argued that very small primary schools lacked the necessary resources to provide an effective education, limited pupils to a narrow curriculum and were unable to provide the necessary range of specialist teacher knowledge. The report recommended that every school should contain at least three teachers and 60 pupils. Later, the HMI Survey of Primary Education (DES, 1978) suggested that a school needed at least eight teachers in order to provide specialist teaching in an adequate range of subjects.

More recently, an OFSTED (1999) review of primary education in England, based on inspections of over 18,000 primary schools, found no evidence to suggest that pupils in small schools (51–100 pupils) are disadvantaged because their teachers lack sufficient subject knowledge to teach the required broad curriculum. The review reported that the quality of teaching in small schools was slightly better than in other schools, with the exception of the teaching of children under five years of age. No comment was made, however, about the quality of teaching in very small schools (up to 50 pupils). Teachers are often concerned about professional isolation and a lack of resources in small schools (see, for example, Hopkins and Ellis, 1991). It has been suggested that teachers in small schools have less opportunity to attend training to gain further expertise, due to the lack of cover for absences (Curriculum Council for Wales, 1989). The OFSTED review, however, indicated that teachers in small schools were just as likely to attend courses, observe colleagues at work and have visits from advisers as teachers in larger schools.

Research on primary education has also suggested that in small primary schools, there can be a greater ease of communication among members of staff, and particularly between the headteacher and the other teachers. This not only enables the sharing of ideas and experiences of staff and helps to create a positive atmosphere in the school, but also allows each child's progress to be monitored more closely (Hopkins and Ellis, 1991). Small primary schools also develop closer links with parents, as teachers have more frequent informal discussions with parents about their children's progress than in larger schools (Hopkins and Ellis, 1991). Moreover, small schools tend to have stronger links with the local community than larger schools. Small primary schools are often observed to have more cooperative and supportive environments.

In small schools, it is often necessary to combine children from more than one age-group in a single class. Teachers have to teach children of a wide range of ages and abilities, which can be very demanding; further, the HMI First Schools Survey (DES, 1982) suggested that mixed-age classes may cause social difficulties for pupils, as they may not have enough contact with others of their peer group, resulting in a lack of stimulus and competition. There is also some evidence that the performance of pupils in mixed-age classes can suffer. The HMI Survey of Primary Education (DES, 1978) found that 11-year-old pupils in mixed-age classes achieved lower scores on reading and mathematics tests than pupils in single-age classes.

Mixed-age classes can, however, have advantages as well as disadvantages (see Hopkins and Ellis, 1991). Pupils do not have to make as many transitions between forms as in larger schools, and do not have to adjust to so many different teachers. And since teachers in small schools generally have students in their care for longer than in larger schools, teachers can get to know their students better and understand their needs more effectively.

The impact of size on performance

The research summarised above suggests that there are certain disadvantages (but possibly also certain benefits) associated with very small primary schools. Key stage 2 data recently published by the DfES (see National Small Schools Forum, 2002) suggested that pupil performance was also lower in very small primary schools. The results indicated that in primary schools with a cohort of fewer than ten pupils,[1] pupils were twice as likely to fail to reach the expected standard in KS2 tests as their peers in larger schools. For example, in the English key stage 2 test, only 59 per cent of pupils in very small schools reached level 4, compared with 75 per cent overall; the differences for mathematics and science were similar.

However, these findings should be treated with caution because it is difficult to interpret reliably the results for very small schools. Moreover, the DfES noted that special schools make up a great proportion of the sample (see Slater, 2002). The key stage 2 data indicated that for schools with a cohort of more than ten pupils,[2] school size appeared to have little significant effect on pupil performance.

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1 Tables provided in the Hansard Written Answers have overlapping size categories (0–10 and 10–20 pupils per cohort). It is therefore not clear whether schools with ten pupils per cohort would be classified as very small or not.

2 See note 1 above.

The OFSTED (1999) review of primary education found more favourable evidence for small schools. The review was based on inspection reports from the first cycle of primary school inspections, and an analysis of National Curriculum test data. Approximately 2,700 of the 18,000 schools were defined as small (schools with up to 100 pupils), of which about 700 were very small (schools with up to 50 pupils). The review reported that in the end-of-key-stage National Curriculum tests, small schools performed better on average than larger schools. For example, in the 1998 National Curriculum English tests at both key stage 1 and key stage 2, pupils in schools with between 51 and 100 pupils achieved results around six percentage points higher than those in larger schools. The very small schools also achieved results well above average overall,[3] although their performance was more variable, and a disproportionate number of schools in that category had serious weaknesses or required special measures.

The report highlighted, however, that the positive effect of small school size could be due to the fact that the majority of small schools are in relatively affluent areas with above-average indicators of socio-economic advantage. In support of this, when National Curriculum test data was used to compare small schools with others in similar socio-economic circumstances, there was little difference in performance: '*if anything, the balance of judgement moves in favour of larger schools*'. The authors concluded, therefore, that factors other than school size probably have a greater overall impact on student achievement in small primary schools.

In the USA, Fowler and Walberg (1991) also claimed that small schools were better. Based on a literature review, they commented: '*A number of studies conducted during the past 20 years, particularly at the elementary-school level, have found small school size to have an independent, positive effect upon student achievement*' (p.191). In their own research study, Fowler and Walberg analysed data from state administrative records for 293 public secondary schools, using multiple regression analyses. Eighteen school outcomes, including the average scores on state-developed tests, student retention, and college attendance, were regressed on 23 school characteristics (including district socio-economic status, percentage of pupils from low-income families, school size) and teacher characteristics. School size was treated as a continuous variable in the analysis. District socio-economic status and the percentage of students from low-income families in the school were found to be the most influential factors related to educational outcomes. School size was the next most influential variable and was negatively related to outcomes. This indicates that smaller schools have beneficial effects on student achievement and other educational outcomes, after controlling for socio-economic status. However, only school-level data was used in the analysis, and no allowance was made for pupils' ability at intake.

[3] It will be noted that the OFSTED findings are in direct contrast with the DfES figures quoted above. OFSTED found that small schools and very small schools obtained above-average results; according to the DfES tables, small schools were average and very small schools much below. The results quoted probably relate to different years, but this does not seem sufficient to account for the difference. The explanation may be that the DfES included special schools, and OFSTED did not.

Lamdin (1995) analysed student performance on the California Achievement Test (CAT) in 97 public elementary schools in Baltimore. Once again, the data analysed was school-level (and grade-level) rather than pupil-level. The percentage of students not qualifying for a free school lunch was used as a proxy for socio-economic status. The effect of school size was generally negative (suggesting that small schools are better) but never statistically significant.

However, Lamdin made the interesting observation that the perceived benefits of small schools and large schools could cancel out as school size increases, and thus no relationship between pupil achievement and school size would be observed. So the absence of a statistically discernible effect does not necessarily mean that size has no impact: it could be that there are different advantages attaching to small and large schools. There could, in theory, be a non-linear effect of size; for example, medium-size schools could be better (or worse) than small or large schools. Additional analysis was therefore undertaken to test this hypothesis, but no evidence of a non-linear effect could be found.

Interestingly, an earlier UK research project (Mortimore *et al.*, 1988) had found evidence for a non-linear effect of school size. Based on a study of 2,000 pupils in 50 inner London primary schools, they concluded that the best results were achieved in '*middle to small sized schools with a junior roll* [i.e. Years 3–6] *of around 160 or fewer pupils*'. They concluded that, while '*very small schools inevitably face a number of difficulties*', large schools were also less effective (the reasons for this were less obvious, although Mortimore *et al.* speculated about '*the difficulty of maintaining coherent school-wide policies on the curriculum*'). The ideal primary school had to be large enough to provide a range of experiences, resources and specialisms, but small enough to avoid other problems; hence '*it was the schools with between one and two form entry which were likely to be the most effective*'.

Impact of class size on performance

Small schools have small cohorts of pupils and may have smaller than average class sizes. The issue of class size has been the subject of investigation for many years, primarily exploring whether there is any relationship between class size and pupil achievement. One would assume that in smaller classes, teachers can increase the amount of individual attention given to each pupil, which might improve performance. Nevertheless, the research evidence is inconclusive.

A number of studies have reported a positive relationship between class size and pupil performance, with pupils performing better in larger classes (for example, Foxman *et al.*, 1991). Blatchford and Mortimore (1994), however, identified three possible factors which could explain this positive impact of class size on performance: low-attaining students tending to be put in smaller classes; teachers changing their style in larger classes; and better teachers being given larger classes.

A US study, the Tennessee Project STAR (see Blatchford *et al.*, 2002), attempted to isolate the effects of class size, by randomly assigning children in 65 schools to small (about 15), regular (about 25) and regular with teaching assistant classes. This study revealed that pupils in the small classes performed significantly better on standardised reading and mathematics tests than pupils in the regular-sized classes. The pupils in the smaller classes were also reported to perform better than those in the regular classes two years later.

More recent research has attempted to control for various pupil and school background variables, in particular, the prior attainment of pupils, and has also found evidence that pupils achieve better in smaller classes. An evaluation of the National Numeracy Project (Felgate *et al.*, 2000) analysed mathematics performance data for a total of 87,300 pupils in 768 primary schools in 15 LEAs. This study used multilevel modelling techniques to control for a range of pupil and school background variables and found tentative evidence that pupils in larger classes were making less progress than might be expected.

Further evidence in support of small class size was found in a study of class size effects in English school Reception Year classes (Blatchford *et al.*, 2002), which followed 9,330 children in 200 schools in eight LEAs. A series of multilevel models was used to examine the effects on achievement and progress in literacy and mathematics. The analyses demonstrated a clear effect of class size on pupil achievement, after various confounding factors (such as gender, school entry ability) had been allowed for, with pupils performing better in smaller classes. There were also differential effects for initial low achievers and for those eligible for free school meals. The results indicated that small classes work best for pupils not eligible for free school meals and for low-achieving pupils in the case of literacy. The sample analysed in this study was, however, relatively small, and as the authors acknowledged, the findings may not generalise to other areas of the UK where education policy and practice may vary.

2.1.2 Impact of school size in secondary schools

Secondary schools also need to be of a sufficient size to cater for a wide range of abilities and offer a wide range of options at GCSE and (if applicable) in the sixth form. On the other hand, there is a general dislike of very large schools which was used as an argument against comprehensive education (see Schagen, 1996). But **evidence** about the impact of school size on performance in secondary schools appears to be virtually non-existent.

We have not been able to find any English research on this subject. The only statistical evidence is the work of Luyten (1994), who employed multilevel modelling to investigate school size effects on mathematics and science achievement in The Netherlands, Sweden and the USA. Five existing secondary datasets (two American, two Dutch and one Swedish), collected from previous studies, were analysed, controlling for gender, achievement motivation, socio-economic status, cognitive aptitude and curriculum track. Five school-size categories were used. The analyses did not reveal any statistically significant relationship between school size and achievement that was independent of student background characteristics. The author warned, however, that the generalisability of the findings is limited due to a number of sources of inconsistency in the analyses.

2.1.3 Conclusion

Although the issue of school size has been the subject of discussion for many years, the evidence of its impact on student achievement is still inconclusive. Most of the published research on school size effects relates to primary education and there are difficulties in generalising the findings to secondary education, due to differences in size and organisation between primary and secondary schools.

There have been some concerns about whether very small primary schools are able to provide a broad curriculum for their pupils and give them the same opportunities as larger schools. Mixed-age classes can cause difficulties, although they can have benefits as well as disadvantages.

When very small schools are excluded from the picture, it seems that school size has relatively little impact. OFSTED has suggested that the quality of teaching in small schools is slightly better than in other schools. Small primary schools are also reported to benefit from a greater ease of communication among members of staff and closer links with parents, which helps to create a positive atmosphere in the school and allows each child's progress to be monitored more closely.

Factors such as these may explain the findings of Mortimore *et al.* (1988) that the best results were achieved in 'smallish' primary schools: those large enough to avoid the specific problems of very small schools, but small enough to enjoy the benefits outlined above. However, other published research has identified very little, if any, impact of school size on performance. In most cases, apparent differences could be explained by other factors: once prior attainment and/or socio-economic status were taken into account, no significant effect of school size was found.

Research relating to the impact of class size on performance in primary schools was also explored. A number of studies have used multilevel modelling techniques to take account of various pupil and school background variables, and have found evidence that pupils tend to perform better in smaller classes.

We were able to identify only one study which had used multilevel modelling techniques to investigate the impact of school size on pupil performance in secondary schools. This study (from outside the UK) did not reveal any significant relationship between school size and achievement that was independent of student background characteristics.

2.2 The Impact of Single-Sex Schooling

Girls now outperform boys at all levels of compulsory education (see OFSTED and EOC, 1996). Much has been written about gender differences in achievement (see, for example, Sukhnandan, 1999), but our research was confined to the impact of single-sex **schools**. In other words, we aimed to explore how the achievements of girls in girls' schools differed from that of girls in mixed schools, and how the achievement of boys in boys' schools differed from that of boys in mixed schools; the project did **not** involve comparing the performance of boys and girls.

The popular view is that single-sex schooling benefits girls in particular, by providing them with an environment in which they can participate with confidence, free from the distractions caused by the presence of boys in the classroom. In theory, this should lead to higher attainment, but there is little hard evidence to support the theory. Below we review first, some small-scale qualitative studies, and then some statistical analyses of performance data.

2.2.1 Small-scale studies and qualitative evidence

Several small-scale studies are available which examine the effects of single-sex and coeducational schooling on a limited number of pupils. These studies provide mainly case-study evidence of teachers' and pupils' perceptions of the advantages and disadvantages of single-sex education, with some reference to effects on achievements and other outcomes. However, given the small sample sizes, the findings from these studies cannot easily be generalised to a wider population, but instead only provide indications of the possible impacts of single-sex schooling.

A study by Stables (1990) involved 13 comprehensive schools in England (seven coeducational and six single-sex) and explored students' attitudes towards science subjects via questionnaires in the different types of schools. It suggested that **single-sex education reduced sexually stereotyped subject choices**; in particular, physics was more popular among girls in single-sex schools than in mixed schools and boys in single-sex schools were much keener on drama, biology and languages than those in mixed schools. As Stables argued:

> *The danger is that subject interest and specialisation may be guided to a greater extent by a desire to conform to a received sexual stereotype in mixed schools than in single-sex schools, thus effectively narrowing career choice for co-educated pupils* (p. 229).

Based on inspection evidence, OFSTED and EOC (1996) took a rather less positive view of the impact of single-sex schools on sexual stereotypes. They noted that, '*although most girls' schools now have facilities for work with resistant materials and in control technology, a large number of boys' schools still have inadequate facilities for work in textiles or in food technology and may therefore provide narrower opportunities than local* *mixed schools*'. They concluded that '*girls' school in average and disadvantaged areas, and boys' schools more generally, do relatively little to try to broaden pupils' horizons beyond traditional and often stereotypical expectations*'. Although this may appear to contradict Stables' findings, it should be noted that girls and boys may tend to make different choices in a single-sex environment, even if the schools do not positively attempt to encourage non-traditional options.

A longitudinal study by Marsh *et al.* (1989) in Australia followed the transition of a boys' and a girls' school serving the same catchment area to form two coeducational schools (see also Jackson and Smith, 2000). The study found no measurable effect of the transition on students' academic achievement. This contrasted with the perception of teachers interviewed as part of the study who believed that girls performed better in mathematics, science and computer studies in the single-sex environment, while boys' achievements were thought to have improved with the introduction of coeducational schooling. In contrast, the mixed school environment was seen by teachers to benefits boys' and girls' social development, including maturity, appearance and interpersonal behaviour.

A qualitative study by Robinson and Smithers (1999), which complemented a much larger analysis of pupil-level data (see below), also found mixed evidence of the advantages and disadvantages of single-sex schooling. In-depth interviews were carried out with 100 male and female students at one UK university, asking them to reflect on their experiences of school and the ease of the academic and social adjustment to higher education. Single-sex schools were seen as benefiting girls academically. Perceived disadvantages included high levels of competitiveness and spitefulness and a less easy adjustment to higher education. Male students, on the other hand, emphasised the social development value of attending coeducational schools as it helped them to grow up at ease with the opposite sex.

Single-sex classes

Only about ten per cent of comprehensive schools are single-sex (see OFSTED and EOC, 1996), but some mixed schools have attempted to gain the perceived benefits of single-sex education by introducing separate classes in certain subjects for girls and boys. This is considered by some to be the optimal solution, as it offers the academic benefits of single-sex education combined with the social advantages of mixed schools. Originally seen as a way of helping girls to progress in traditionally male-dominated subjects such as science, single-sex classes have recently been seen as a means of addressing boys' underachievement.

Three small-scale studies were identified, which examined the impact of the introduction of single-sex classes within coeducational schools. Sukhnandan *et al.* (2000) reported on strategies adopted by 19 schools across England and Wales to address gender differences in achievement. Eight of the schools had adopted single-sex classes; they found that girls felt more confident to take part in lessons and that they received more teacher attention because less of their time was spent on managing the behaviour of boys. The study also identified some disadvantages, in particular that girls missed out on the opportunity to gain the perspective of the opposite sex.

A study by Jackson (2002), which examined the impact of the introduction of single-sex mathematics classes for one cohort of students over three terms in one school, reached similar conclusions. The research, which was carried out in an English coeducational comprehensive school, found that the majority of girls favoured the learning environment such classes offered. Girls felt more confident in single-sex classes – '*they were not made fun of for getting something wrong and... they did not feel embarrassed for scoring a low mark*' (p. 417). In contrast, the majority of boys preferred mixed classes both for learning and social reasons.

Finally, Arnot and Gubb (2001) reported on a study which explored various ways of adding value to boys' and girls' education and, in particular, the experiences of three schools which had introduced single-sex classes. This approach was found to be of particular benefit to underachieving boys, as it allowed teachers to reshape the curriculum and their teaching styles to cater for their needs. In one school, single-sex classes had been successfully used by the English department: '*Tasks were chosen that "suited boys" – factual work, factual writing, boy-friendly content and cloze procedure tasks.*'

2.2.2 Larger-scale studies

Several larger-scale studies have examined the impact of single-sex schooling on pupil achievement and other effects. However, relatively few meet the criteria for best practice outlined at the beginning of this chapter (specifically, the use of multilevel modelling, using pupil-level data including measures of prior attainment).

A study carried out by Bell (1989) involved a comparison of the uptake of, and performance in, science by 15-year-old boys and girls in single-sex and coeducational schools in England, Wales and Northern Ireland and was based on a reanalysis of an existing, relatively large dataset. The data was collected between 1982 and 1984 and included science test results, examination entry intentions and pupil selection of science subjects. The effect of the school type was measured by calculating the **mean test results** for each of the schools included in the sample. The analysis showed that, on average, boys and girls in single-sex schools performed between six and ten percentage points higher on the six science tests than pupils in coeducational schools. However, once pupils in independent or grammar schools, who can be expected to have higher prior attainment and/or come from higher socio-economic backgrounds, were excluded from the sample, the results painted a very different picture. For comprehensive schools only, the study identified **no significant effects** for girls or boys attending single-sex schools, even though the mean scores for boys attending single-sex schools were higher on all but one of the tests (by around three to four percentage points). The main limitation of this study was that, even by restricting the analysis to comprehensive schools only, it did not, in the author's own words, control for '*different average intake abilities within the various types of schools*' (p. 202).

Another large-scale study was carried out more recently by Robinson and Smithers (1999; see also Smithers and Robinson, 1997) using national data supplied by the Department for Education and Employment, OFSTED and the Independent Schools Information Service. The research examined whether significant differences could be identified between the GCSE examination results of pupils in single-sex and coeducational schools, separately for both independent and comprehensive schools. The authors concluded that, for both types of schools, single-sex education appeared to have much less of an effect on achievement than other factors. For example, in relation to comprehensive schools they found that a better predictor of the average GCSE point score of pupils is whether they attended a school with a sixth form rather than whether their school was single-sex or coeducational. However, a serious limitation of this study is that it did not collect pupil-level data, instead comparing the average achievement of students within schools. Furthermore, no measures of prior attainment were used to assess the relative impact of single-sex versus coeducational schooling.

A more sophisticated analysis of the effects on single-sex and coeducational schooling was carried out by Lee and Bryk (1986), using multivariate and regression analysis techniques. The sample for this study consisted of 1,807 students in 75 private Roman Catholic secondary schools in the USA, of which 45 schools were single-sex institutions, drawn from a larger dataset collected as part of a separate study. The impact of single-sex schooling was measured while controlling for pupils' personal and family background, curriculum track and the school social composition. The study suggested that girls benefit particularly from single-sex schools, with statistically significant gains in reading and science achievement and other positive outcomes. Girls in single-sex schools were found to be more likely to associate with academically oriented peers, to do more homework and to be '*considerably less likely to evidence stereotyped sex role attitudes*' (p. 389) than their peers in coeducational schools.

However, the data used by Lee and Bryk was reanalysed by Marsh (1989), who contended that the original research had not adequately controlled for pre-existing differences between pupils. As Marsh argued, '*when appropriate controls were introduced, almost no differences ...could reasonably be attributed to the effect of school type, and there was no tendency for the few differences that did exist to consistently favour students from single-sex or co-ed schools*' (p. 80).

A more recent UK-based study by Kelly (1996), which also identified significant advantages of single-sex schooling for both boys and girls, can be seen to have similar limitations. The research was based on an analysis of data collected by the National Consortium for Examination Results (NCER) of GCSE results and linked with information on the proportion of

Year 11 pupils entitled to free school meals (FSM). Based on the fact that there is a strong (negative) correlation between average total point scores and proportion of FSM entitlement, the latter was adopted as a proxy measure for a school's intake. The analysis of pupil achievement in single-sex and coeducational schools, while controlling for FSM entitlement, revealed that both girls and boys performed significantly better in a single-sex environment. As regards individual subjects, Kelly identified the following differences:

> *Girls achieved better in single sex schools in a wide swathe of subjects. The effect was most marked in foreign languages, but was also evident in sciences, mathematics, English and history. The single sex advantage was smaller for boys, and was most obvious in English and foreign languages* (p.15).

However, a weakness in this research was that no controls were used for measuring individual students' prior ability. Furthermore, this research only compared the average achievement of students within schools and did not examine the effects of school type on individual students.

Four recent studies are available which use a multilevel modelling approach in order to take account of the hierarchical nature of the data, thereby providing more accurate and reliable estimates of school-level effects on student performance. Unfortunately, none were conducted in England or Wales.

The most recent published research of this type was carried out by Harker (2000) in New Zealand. New Zealand provides a good test case for examining the effects of single-sex education on student achievement as it contains a substantial number of single-sex schools in the public sector. The research was based on analysis of data obtained from a longitudinal study of 5,300 students in 37 schools and sought to examine whether school type could account for differences in achievement at the Year 10 certificate examination, while controlling for prior attainment. The analysis showed that, although girls at single-sex schools scored higher than those at coeducational schools on all outcome measures used, the differences could be explained by the higher prior attainment of the former group of students. Harker concluded that:

> *What these data show, then, is that the difference in the average attainment of girls who attend single-sex as against coeducational schools is more apparent than real. When adequate control is exercised for the different ability levels and the social and ethnic mix of the two types of school, the initial significant differences between them disappear* (p. 216).

However, it should be noted that this study provided evidence of the effects of single-sex schooling on girls only. As Harker explained, boys were excluded from the analysis due to the fact that two out of the six boys' schools in the sample were 'elite' schools. This issue points to a more serious weakness of the study, the relatively small number of schools (37) included in the sample. As Kelly (1996) has pointed out, the danger with using such small samples is that '*the results can be distorted by one or two outstandingly successful (or unsuccessful) schools*' (p.14).

Two other studies, which also used multilevel modelling, reached similar conclusions to Harker, and both have similar limitations. Daly (1996; 1995) reported on a study, which was based on a reanalysis of public performance data obtained from two surveys of pupils in Northern Ireland. Pupil performance was assessed in relation to a weighted measure of overall achievement and to separate measures of achievement in English and mathematics at public examinations at 16. The first dataset consisted of over 1,000 girls across 21 schools, while the second dataset consisted of just under 800 girls randomly selected from 153 schools.

The analytical models for both studies indicated that the impact of coeducational schooling on girls' achievement was negative, although none of the measured differences were statistically significant. Daly (1996) concluded that the small differences identified could not be used to substantiate any claims that single-sex schooling has any significant effect on girls' achievements. However, as in the case of Harker's research, the findings are only applicable to girls and are based on relatively small datasets.

Young (1994) reanalysed data collected in 1983 in Australia. The database included 4,917 students aged 14 (2,565 girls and 2,352 boys) from 233 schools, a considerably larger number of schools than Harker, and a larger number of students than Daly. Science achievement was measured using a multiple choice test consisting of eight items. The study sought to test the assertion that girls and boys in single-sex schools outperform their peers attending coeducational schools, with particular reference to physics achievement. Once again, the inclusion of background data in the model, such as students' socio-economic background and prior achievement, explained the differences between pupils in single-sex and coeducational schools. Young concluded that '*it is not the type of school or sex composition of the school which influences student performance in physics, but rather the average socio-economic status of the students attending the school*' (p. 325).

Hannan *et al.* (1996) reported on a study carried out in the Republic of Ireland, which used multilevel modelling to examine the effects of single-sex education on pupils' performance and personal and social development. The research, which was conducted in 1994, was based on a questionnaire survey of over 10,000 pupils across 116 schools in their Junior Certificate (aged 15–16) and Leaving Certificate (aged 17–18) years and linked with these pupils' examination performance. The prior ability of students aged 15–16 was assessed using Verbal Reasoning and Numerical Ability (DATS) tests.

The study found that for Junior Certificate students most of the differences between single-sex and coeducational schools could be accounted for by pupils' social background and ability, although single-sex schools had a slight positive effect on girls' overall performance, especially on those of low ability. The greatest impact identified was in mathematics achievement, where '*girls' performance in coed schools* [was] *significantly lower than in single-sex schools, by about half a grade*'. No overall impact of single-sex education was identified for Leaving Certificate pupils, although a similar effect was measured for mathematics achievement as for Junior Certificate students. Apart from students' academic performance, the study found that pupils in coeducational schools had a '*more positive view of their schools' impact on their personal/social development than pupils in single-sex school*', even though this was not reflected in other more objective measures such as students' academic self-image.

No studies using multilevel modelling were identified which focused specifically on the impact of single-sex schooling in England or Wales. However, an analysis of 1992 GCSE results in seven metropolitan LEAs by Thomas *et al.* (1994) indicates that, as in other countries, single-sex education does not have a significant effect on pupil achievement once other factors such as free school meal entitlement are taken into consideration.

During the 1990s, NFER offered a value-added analysis service to secondary schools in England and Wales. A technical report by Schagen (1996) details findings for the 93 schools which subscribed to the service in 1993–5. The analysis suggested that '*boys' schools tend to perform better in terms of GCSE results than would be expected*'. However, the study did not use adequate controls for the relatively high proportion of selective and independent schools in the sample.

Finally, OFSTED and EOC (1996) reported the findings from '*recent statistical analysis undertaken by OFSTED, that girls and boys in single-sex schools now achieve slightly better GCSE results than girls and boys in mixed schools, after account has been taken of available socio-economic data including free school meal entitlement*'. Unfortunately, they gave no details of the methodology or the sample on which these findings are based, but their later remarks make it clear that prior attainment was not taken into account. Moreover, OFSTED and EOC suggest a number of additional factors which could help to explain the apparent advantage of single-sex schools, including social class, parental support, and a high proportion of pupils from ethnic minority groups, '*in particular from ethnic minority families with high educational aspirations*'. It is important to bear in mind that there may be factors influencing the performance of single-sex schools which even the most robust statistical analyses may not be able to take into account.

2.2.3 Conclusion

The literature reviewed indicated a number of perceived benefits of single-sex education (in single-sex schools, or in single-sex classes within mixed schools). While mixed schooling was perceived to be best in terms of social development, single-sex education was thought to reduce sexually stereotyped subject choices, and to be academically advantageous, especially for girls. Girls were said to be more confident in a single-sex environment, and to gain more attention from teachers; however, it was also claimed that single-sex classes can help underachieving boys.

There was however little hard evidence to substantiate these claims, in statistical studies which analysed the performance of pupils in mixed and single-sex schools. In most cases, the findings indicated that single-sex education had a very small impact, or none at all. However, it should be noted that the studies reviewed had a number of limitations for our purpose. Some did not use pupil-level data and take prior attainment into account. Of the four studies which used multilevel modelling to investigate single-sex education, two focused on girls only and none were located in England or Wales. More importantly, the number of schools involved in the studies was relatively small, ranging from 37 to 233: in order to provide an accurate estimate of school-level effects, a much larger sample is ideally required.

3. VALUE-ADDED ANALYSIS OF PUPIL PERFORMANCE

In our literature search, we found little published evidence relating directly to the impact of school size and/or single-sex education on performance. We, therefore, carried out a value-added analysis of national performance data to investigate school size and single-sex education.

National value-added datasets now provide matched data at pupil level, including details of gender and age, as well as results in GCSEs and National Curriculum tests. The secondary NVAD for 2001, which links individual GCSE outcomes with the results of pupils' key stage 2 tests in 1996, became available just as this project began. The primary NVAD (linking key stage 1 1997 and key stage 2 2001 results) was also used in the analysis of the impact of school size.

3.1 The Impact of School Size

Our study was concerned with the impact of school size on pupil performance in both primary and secondary schools. The analysis was, therefore, based on data from two separate cohorts: key stage 1 1997 to key stage 2 2001, and key stage 2 1996 to GCSE 2001.

3.1.1 Key stage 2 to GCSE

The NVAD of GCSE results in 2001 linked to key stage 2 (KS2) performance in 1996 contained matched records of 369,341 pupils[4] from 2,954 maintained mainstream schools in England (2,798 comprehensive schools[5] and 156 grammar schools).

Table 3.1 shows the percentage of schools and pupils included in the analysis, grouped according to the size of the schools' Year 11 cohort. The size of the schools in the dataset ranged from 25 pupils to 405 pupils in Year 11. The majority of schools had between 100 and 249 pupils in Year 11, and one-third had a Year 11 cohort of between 150 and 199 pupils. Only a small proportion of schools had fewer than 50 pupils or more than 300 pupils in Year 11.

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4 Data for approximately 200 pupils was excluded from the KS2-GCSE analysis, due to discrepancies between the school-level and pupil-level data. In these cases, performance data was available for Year 11 pupils, but the school data indicated that there were no Year 11 pupils in the school. Extreme cases, where schools had very small numbers of pupils in Years 9 or 11, were also excluded from the analysis.

5 In the context of the analysis, the term 'comprehensive' is used to denote all schools other than grammar schools, although we recognise that this includes schools in selective areas which are not comprehensive in the sense of catering for the full ability range.

Table 3.1 Pupils and schools by size of Year 11 cohort

Size of Year 11	Number of schools	Percentage of schools	Number of pupils	Percentage of pupils
0–49	14	0.5	376	0.1
50–99	246	8.3	13722	3.7
100–149	814	27.6	72399	19.6
150–199	982	33.2	123131	33.3
200–249	617	20.9	100334	27.2
250–299	208	7.0	41664	11.3
300+	73	2.5	17715	4.8
Total	**2954**		**369341**	

Due to rounding errors, percentages may not sum to 100.
Source: NVAD, 2001.

Eight outcome variables were investigated. Full details of these and the background variables included are provided in Appendix I, Section 1. It should be noted that the number of pupils in Year 11 was used as a proxy measure of school size. It was felt that measuring the total number of students in a school could be confused by the number of year groups in that school. Our study, therefore, examined the impact of the size of cohort on pupil performance.

The impact of class size was also investigated, although there was some uncertainty regarding the definition of class size. On Form 7,[3] schools are asked to specify the 'average size of one-teacher classes in the school', but it is not clear how the figures provided would have been calculated, as pupils may be in classes of varying size for different lessons. The data provided may not, therefore, be comparable across schools, and so should be treated with caution.

It is important to note that due to the differences in the profiles of selective and non-selective schools, and the relative small numbers of grammar schools in the sample, the following discussion is primarily focused on the impact of school size in comprehensive schools. The impact of school size in grammar schools is discussed separately.

Overall impact of school size

Multilevel models were set up for each of the eight GCSE outcome measures. Previous research has suggested that differences in student achievement between small and large schools could be explained by other differences in student characteristics, such as prior attainment or socio-economic status (see Section 2.1). The current analysis controlled for prior attainment and other important background variables in order to provide an accurate assessment of the impact of school size.

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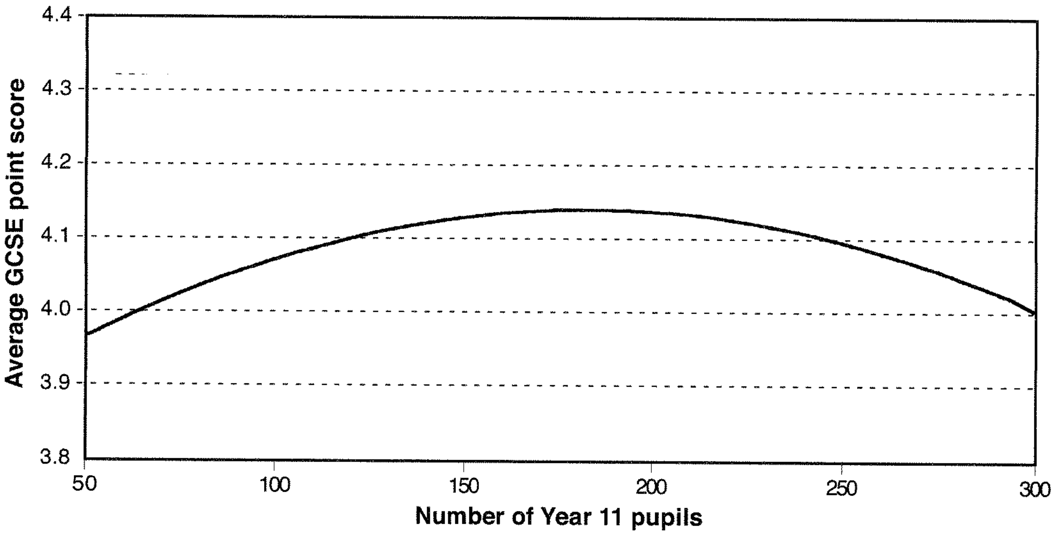
[6] Form 7 is the census form completed by schools each January.

In contrast to previous research on school size that used a multilevel approach (see Section 2.1), significant effects relating to size were found for all the outcomes measured, independent of other pupil, school and LEA variables. As school size increased, performance on all of the GCSE outcomes improved, although only up to a certain size of school. Figure 3.1 illustrates this school-size effect in relation to pupils' average GCSE point score. This graph (and the following figures in the chapter) shows the 'expected' GCSE attainment of a pupil, assuming average values for all variables except those stated on the graph.

As Figure 3.1 shows, the best results (in terms of average GCSE point score) were obtained in schools of medium size, rather than in the very small or the very large schools. A similar relationship was found for each of the GCSE outcomes measured. An optimum year size was found, after which increasing the size of Year 11 resulted in a decrease in the outcome variables. For all of the outcomes, except the number of science GCSEs taken, the analysis suggested an optimum size of between approximately 175 and 200 pupils in Year 11. This suggests that when the size of Year 11 exceeds approximately 200 pupils, there is a negative impact on pupil performance and GCSE achievement tends to decline. With regard to the number of science GCSEs taken, the optimum number of pupils in Year 11 appeared to be much higher, around 230. It is important to note, however, that due to the preliminary nature of this research, these figures should be treated with caution. Moreover, the observed impact of school size, although statistically significant, is quite small; after controlling for prior attainment and other factors, the difference attributable to school size is approximately 0.15 points in terms of average GCSE score.

Figure 3.1 Average GCSE point score by number of Year 11 pupils (comprehensive schools only)



Interestingly, Mortimore *et al.* (1988) found a similar curvilinear relationship between school size and effectiveness at primary level.

Our analysis revealed differential effects of school size depending on the following background variables:

- percentage of pupils in the school eligible for FSM
- sex of pupil
- prior attainment (at KS2)
- size of the sixth form
- type of school (selective or comprehensive).

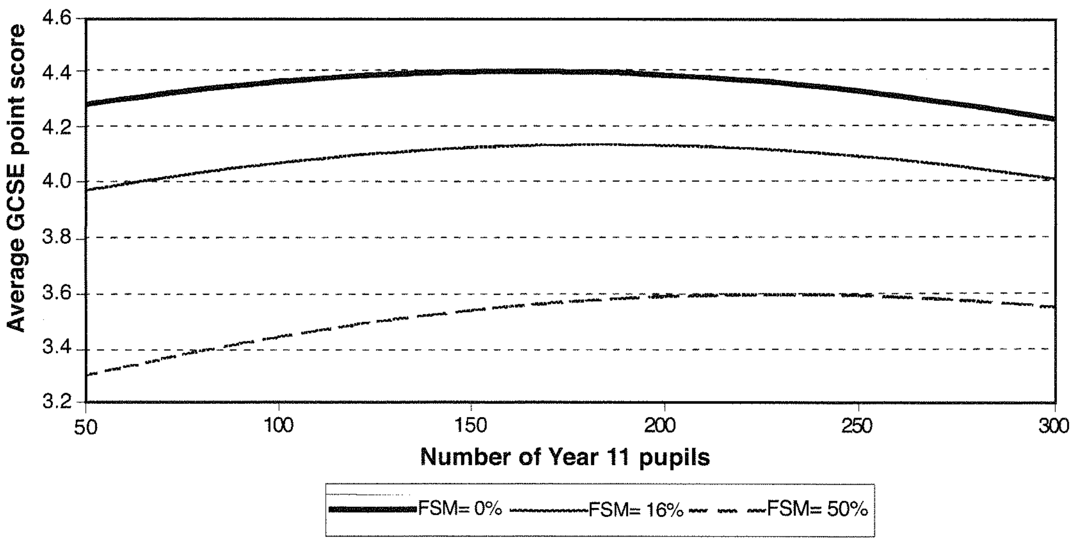
The following sections explore these effects in further detail.

Impact of school size on schools with different percentages of FSM

For all the outcome variables measured, except for English point score and average science point score, the optimum size for a school with low numbers of children eligible for FSM was much lower than for a school with high numbers of FSM children. This suggests that in schools with a low percentage of children eligible for FSM, the performance of pupils tended to be better when the school was small. In contrast, in schools with high numbers of FSM children, pupils' performance tended to benefit from a larger school.

Figure 3.2 shows that, with regard to average GCSE points score, the optimum size for a school with no pupils eligible for free school meals was 162 pupils in Year 11. In a school with the average level of pupils eligible for FSM (16 per cent), the optimum size of Year 11 increased to 183 pupils. For a school with 50 per cent FSM, the optimum size was 227.

Figure 3.2 Average GCSE point score by number of Year 11 pupils: comprehensive schools with low, average and high percentages of FSM



This may be because eligibility for FSM is associated with lower prior attainment. In order to be successful, schools perhaps need a 'critical mass' of pupils with high ability and positive attitudes to learning. Schools with a high proportion of FSM pupils would need to be larger in order to provide sufficient numbers of such pupils. It is not clear, however, why in secondary schools with a low proportion of FSM children, pupil performance is better when the school is small.

Impact of school size on boys and girls

With regard to total and average GCSE attainment, the optimum school size for girls in mixed schools (183 and 189 respectively) was virtually identical to that for boys (178 and 181 respectively).

A different picture emerged, however, with regard to single-sex schools. In girls' and boys' schools, the optimum school size in relation to total GCSE attainment was much lower than for girls and boys in mixed schools. The difference was particularly striking for girls: the optimum size in girls' schools was 108/132 (for total/average score) compared with 183/189 in mixed schools, as stated above. This suggests that girls in single-sex schools achieve a higher total GCSE point score when the school is small, whereas pupils in mixed schools perform better when the school is of medium size.

These differential effects of school size in relation to total and average GCSE attainment are illustrated below in Figures 3.3 and 3.4. We should note, however, that there are very few large single-sex schools (with more than 230 pupils) so it would be unwise to draw conclusions about the performance of schools in that category.

Figure 3.3 Total GCSE point score by number of Year 11 pupils: single-sex and mixed comprehensive schools (girls and boys)

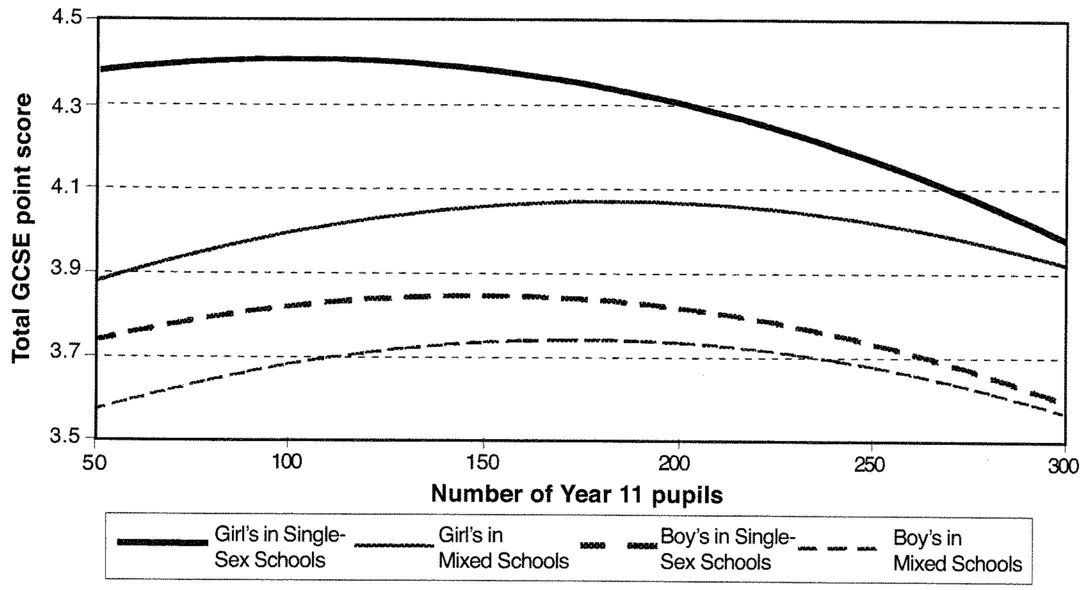
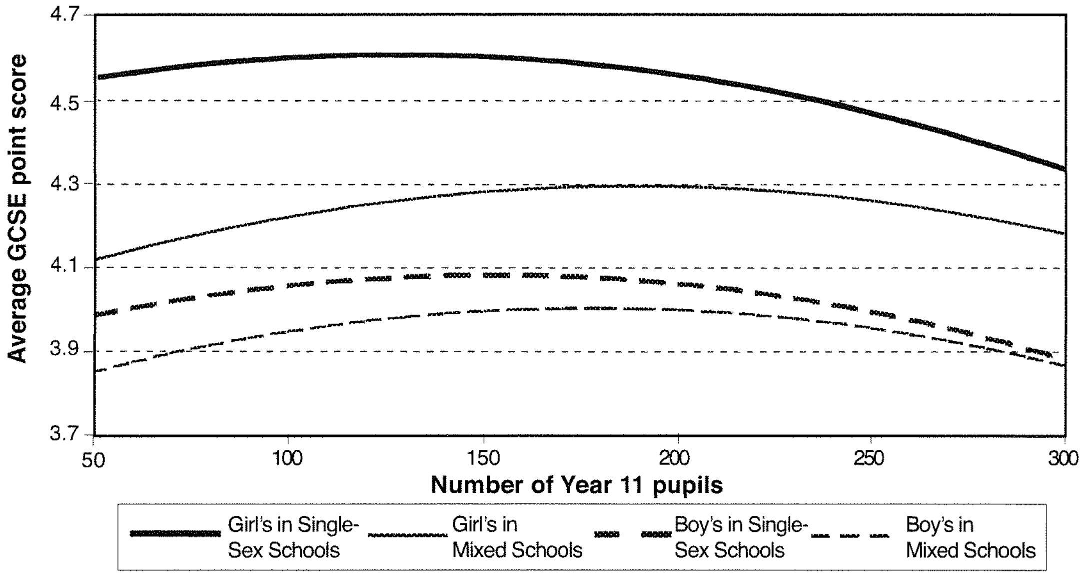


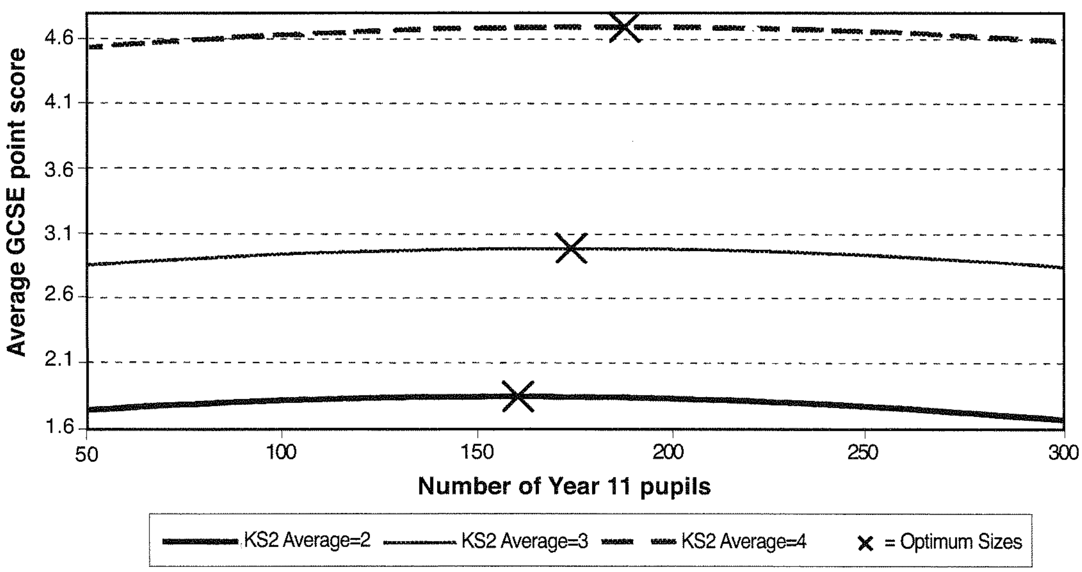
Figure 3.4 Average GCSE point score by number of Year 11 pupils: single-sex and mixed comprehensive schools (girls and boys)



Impact of school size on different ability groups

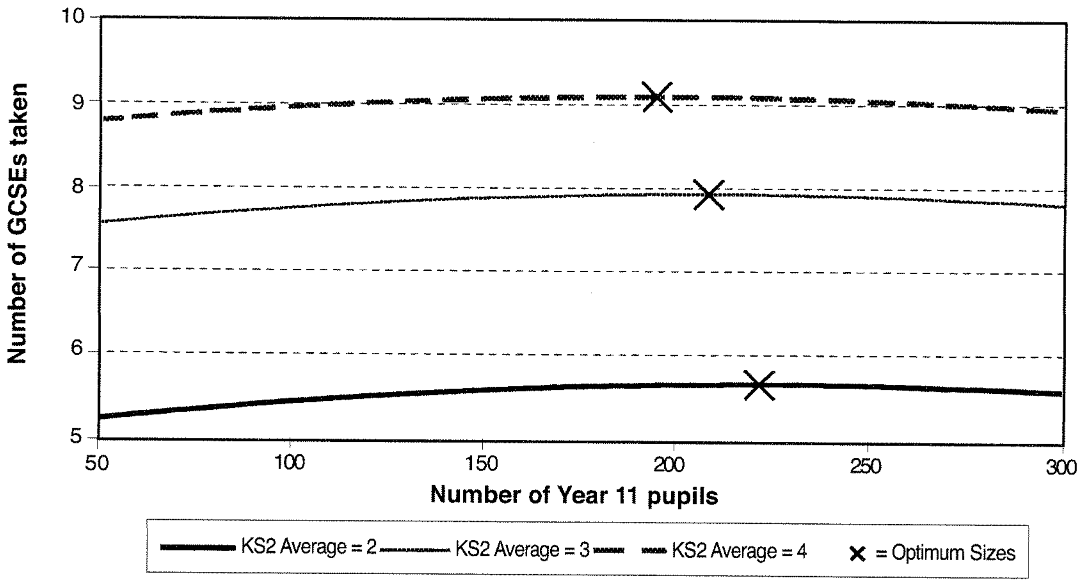
School size had a differential impact on pupils of differing prior attainment, with regard to total and average GCSE score, mathematics, science and number of science GCSEs taken. As Figure 3.5 demonstrates, the higher the prior attainment of a pupil, the larger the optimum school size for this pupil. Pupils of a higher prior attainment, therefore, tended to make most progress in a larger school, compared with the optimum size for lower-ability pupils. This does not appear to be a very noticeable difference on the graph below because, although there is a significant effect of school size, the effect of prior attainment is much greater.

Figure 3.5 Average GCSE point score by number of Year 11 pupils: KS2 average level 2, 3 and 4 (comprehensive schools only)



Pupils with low prior attainment (KS2 average level 2) were entered for most GCSEs in schools of 222 Year 11 pupils. Those with average (KS2 level 3) or high (KS2 level 4) prior attainment were entered for most GCSEs in smaller schools (optimum size 209 and 195 respectively). These findings are illustrated in Figure 3.6. They may suggest that low-ability pupils make more progress in bigger schools, although this would conflict with the findings reported above and illustrated in Figure 3.5. It is possible, of course, that if pupils are entered for more GCSEs, their performance in each subject may suffer, leading to a lower average point score.

Figure 3.6 Number of GCSEs by number of Year 11 pupils: KS2 average level 2, 3 and 4 (comprehensive schools only)

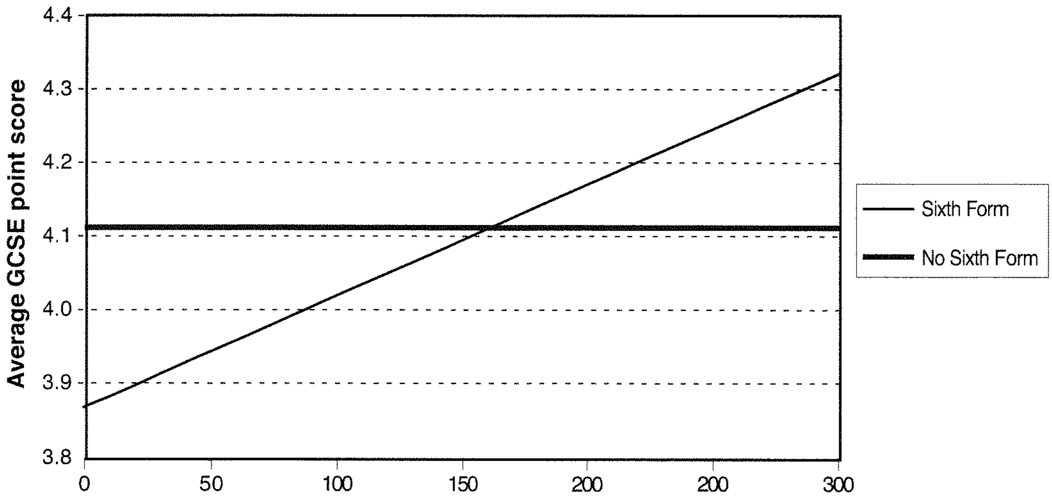


Impact of size of sixth form

Our analysis examined whether the presence of a sixth form and its size had any impact on pupil performance in Year 11. The investigation revealed that the presence of a sixth form had a significant impact on pupil performance on all outcomes except the overall number of GCSEs taken. Figure 3.7 shows that pupils in schools with a large sixth form performed better than those in schools without a sixth form, who in turn performed better than those in a school with a small sixth form. This partly confirms the research by Robinson and Smithers (1999) which found that attendance at a school with a sixth form had a positive effect on pupils' average GCSE point score.

The crossover point, at which pupils appeared to benefit from the presence of a sixth form, ranged between 110 and 180 pupils for all the outcome variables, except the number of science GCSEs taken. For this outcome, the crossover was at approximately 260 pupils in the sixth form. However, given the preliminary nature of this research, these figures should be treated with caution.

Figure 3.7 Average GCSE point score by size of sixth form (comprehensive schools only)



Evidence has been adduced (for example, by OFSTED, 1996) to suggest that small sixth forms are not educationally or financially viable: they may not be cost-effective and they tend to offer students a more limited choice of subjects. Our research indicated that they are also linked with poor GCSE performance, although it would be wrong to assume that the association is necessarily causal. It could be that schools with relatively poor performance at GCSE do not attract many pupils into the sixth form. Conversely, in schools with good GCSE results, more pupils may tend to enter the sixth form; it need not be the case that large sixth forms have a direct impact on GCSE performance. It is possible, however, that schools with large sixth forms are able to employ more specialist teachers, whose presence could benefit younger pupils.

Impact of school size on selective schools

The foregoing discussion has concerned comprehensive schools only. The identified impact of school size on grammar schools was similar, but there was a differential effect of the size of Year 11 between selective schools and non-selective schools, in relation to total GCSE score, mathematics score, English score and the number of GCSEs entered for. The optimum school size for grammar schools with regard to these GCSE outcomes was lower than for comprehensive schools.

Impact of class size on pupil performance

As well as the impact of the size of Year 11, the effect of class size on pupil performance was investigated. The only outcome that class size had any significant effect on was the number of GCSEs taken by pupils. The larger the class size, the more GCSEs pupils within a school were entered for. The reason for this association is unclear, but there is in any case uncertainty about how 'one-teacher classes' are interpreted, particularly in a secondary school context.

3.1.2 Key stage 1 to 2

A nationally representative[4] value-added dataset of key stage 2 results in 2001 linked to key stage 1 (KS1) performance in 1997 for nine LEAs was used in the analysis. The dataset included a total of 979 maintained mainstream schools in England with pupils in Year 6. These consisted of 850 primary or combined schools, 111 junior school, and 18 middle schools. The dataset contained matched records of KS1 and KS2 results for 31,748 pupils.

The schools in the dataset ranged in size from two pupils to 224 pupils in Year 6. Table 3.2 shows the percentage of schools and pupils included in the analysis, grouped according to the number of Year 6 pupils in the school. Most of the schools in the sample had fewer than 75 Year 6 pupils. Nearly half of the schools had between 25 and 49 Year 6 pupils.

Table 3.2 Pupils and schools by size of Year 6 cohort

Size of Year 6	Number of schools	Percentage of schools	Number of pupils	Percentage of pupils
0–24	179	18.3	2042	6.4
25–49	460	47.0	11574	36.5
50–74	241	24.6	10438	32.9
75–99	69	7.0	4593	14.5
100–124	18	1.8	1585	5.0
125–149	4	0.4	440	1.4
150–174	2	0.2	236	0.7
175+	6	0.6	840	2.6
Total	**979**		**31748**	

Due to rounding errors, percentages may not sum to 100.
Source: NVAD, 2001.

Four outcome variables were investigated:

- average KS2 level
- mathematics level
- English level
- science level.

The pupil background variables controlled for were the same as for the KS2-GCSE analysis (except that prior attainment was the level achieved at KS1 in reading, writing, mathematics and spelling). Full details are provided in Appendix I, Section 2.

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7 It should be noted that, while the secondary NVAD contains data from the majority of English schools, the primary NVAD represents a much smaller sample.

The number of Year 6 pupils in the school was used as a proxy measure of school size, in order to avoid the confounding influence of the number of year groups in the school when measuring school size.

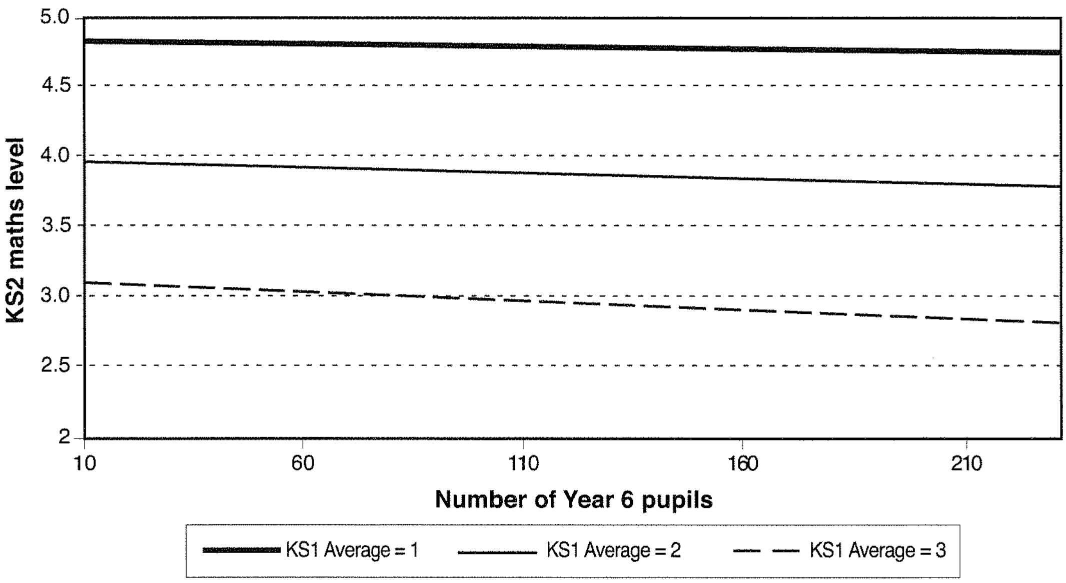
Overall impact of school size

In contrast to the performance at GCSE level, school size did not have a significant effect on any of the KS2 outcomes measured. There was, however, a differential effect of school size on pupils of different prior ability with regard to KS2 mathematics performance. This effect is discussed in further detail below.

Impact of school size on different ability groups

With regard to KS2 mathematics achievement, there was an increasingly negative effect of school size with decreasing prior attainment. This means that as school size increased, pupils with low prior attainment (below level 2 at KS1) tended to perform worse in mathematics at KS2, as shown in Figure 3.8. There was no significant effect of school size, however, on pupils with KS1 attainment above level 2. It may be that lower-performing pupils particularly benefit from a smaller school, because in these schools each child's progress is able to be monitored more closely and they tend to have more supportive environments, which encourages performance (see Section 2.1). However, if this is the case, one would expect class size to be even more relevant; but although there is a link between school size and class size (particularly in the primary context), class size did not have a significant impact on any of the outcomes measured.

Figure 3.8 KS2 mathematics by number of Year 6 pupils: KS1 average level 1, 2, 3



3.1.3 Summary of findings on the impact of school size

The analysis aimed to discover whether there was any impact of school size on pupil performance after controlling for prior attainment, and other pupil- and school-level factors.

Significant effects relating to school size were found for all the GCSE outcomes measured, independent of the pupil, school and LEA background variables. As school size increased, performance on all the GCSE outcomes improved, although only up to a certain school size. When the size of Year 11 exceeded a certain number of pupils, there was a negative impact on pupil achievement. This suggests that both very small and very large schools have a detrimental effect on performance.

A number of differential effects of school size were observed, depending on several of the background variables. Girls, low-ability pupils, and pupils in schools with low FSM, tended to achieve more highly in smaller schools; for boys, high-ability pupils and those in high-FSM schools, the optimum size was greater.

The presence of a sixth form was associated positively or negatively with GCSE performance, depending on the size of the sixth form.

3.2 The Impact of Single-Sex Schooling

Table 3.3 provides details of the number and types of schools for which data was available in the NVAD for GCSE results in 2001. This shows that by far the largest proportion were mixed comprehensive schools, with only a relatively small proportion of single-sex comprehensive schools. As regards selective schools, this trend is reversed – the large majority of grammar schools (117) are single-sex, with only around one-quarter of such schools being coeducational.

Table 3.3 Pupils and schools by school type

Type of school	Number of schools	Percentage of schools	Number of pupils	Percentage of pupils
Mixed comprehensive	2514	85.1	325543	88.1
Girls' comprehensive	161	5.5	18039	4.9
Boys' comprehensive	123	4.2	12389	3.4
Girls' grammar school	61	2.1	5438	1.5
Boys' grammar school	56	1.9	4478	1.2
Mixed grammar school	39	1.3	3454	0.9
Total	**2952**		**369341**	

Due to rounding errors, percentages may not sum to 100.
Source: NVAD, 2001.

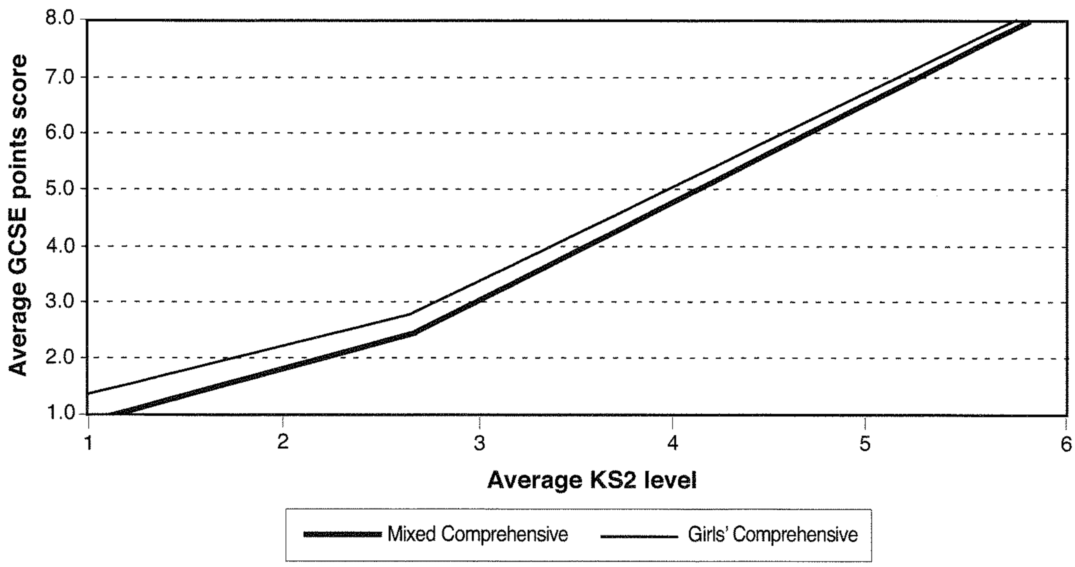
The eight outcomes investigated were the same as in the analysis of the impact of school size on pupil performance at GCSE (see Appendix I, Section 1). The background variables included in the model were also the same.

3.2.1 Overall impact of single-sex education

This section examines the impact of single-sex education on boys' and girls' performance in comprehensive schools (see Section 3.2.3 for a separate analysis for selective schools).

Previous research (see Section 2.2.2) using a multilevel modelling approach has suggested that apparent differences between the performances of pupils in single-sex and coeducational schools disappeared when prior attainment and other background variables were taken into account. In other words, after controlling for these variables, no significant differences could be identified between the types of schools for either girls or boys. In contrast with these studies, our analysis revealed significant differences between girls in single-sex and coeducational comprehensive schools. Thus, the performance of girls in single-sex schools was a little better for almost every attainment outcome in comparison with their peers in mixed schools. The only exception to this was for the number of GCSEs taken, for which no significant differences were identified for the different types of schools. There was no evidence, therefore, that girls in single-sex schools were being encouraged to take more GCSE subjects than their peers in coeducational schools. This rules out the possibility that the measured effect of single-sex education on girls' total GCSE scores is simply due to these pupils taking more subjects.

Figure 3.9 Average GCSE point score by KS2 level: mixed and single-sex schools (girls)

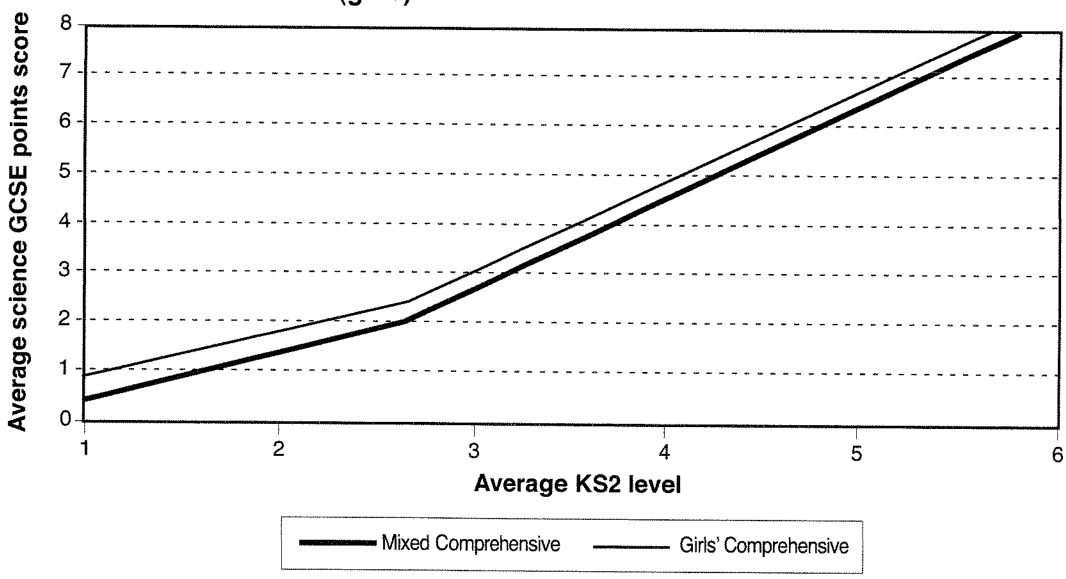


Figures 3.9 and 3.10 illustrate the measured effects of single-sex education as regards girls' average GCSE scores and average science scores. Figure 3.9 provides a comparison between the expected average GCSE point score

of girls in single-sex and coeducational comprehensive schools. It illustrates that, averaged over all GCSE subjects, girls in single-sex schools perform about a quarter of a grade better than girls of the same prior attainment in mixed schools, although the measured difference was slightly higher for pupils of lower prior achievement at key stage 2 (see Section 3.2.2).

Previous research (Lee and Bryk, 1986; Kelly, 1996; Stables, 1990) has suggested that single-sex environments are particularly conducive to girls' achievement at subjects traditionally associated with boys, especially science. Figure 3.10, which compares the expected average GCSE science point score of girls in single-sex and coeducational schools, supports this view. Pupils in girls' schools could be expected on average to achieve over a third of a grade better than similar girls at mixed schools. This was the largest measured effect of single-sex schooling on girls' achievement and was, more or less, constant across the ability range, unlike most of the other outcomes.

Figure 3.10 Average science GCSE point score by KS2 level: mixed and single-sex schools (girls)

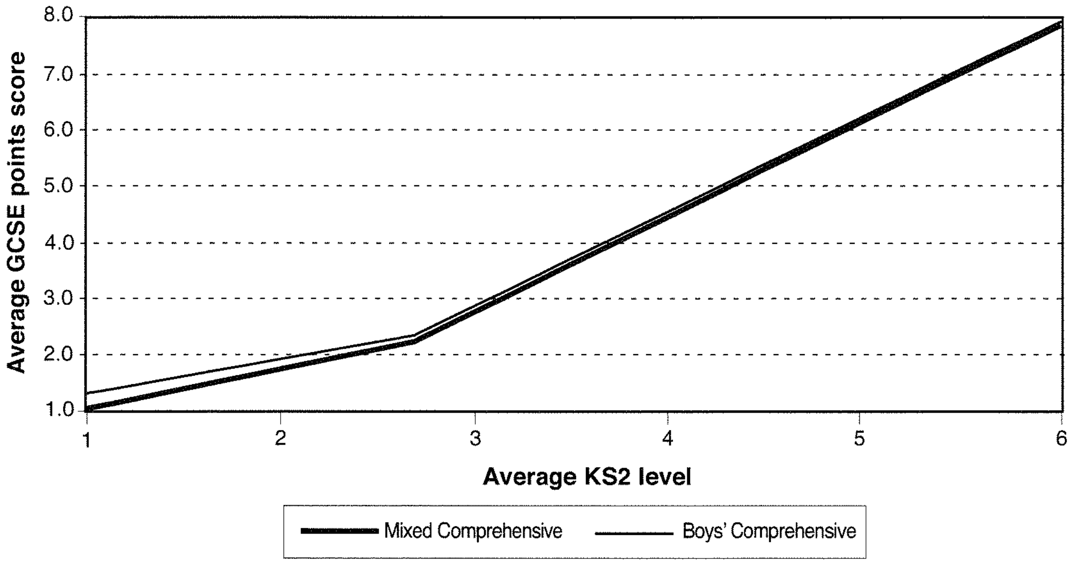


The analysis suggests, therefore, that, based on the available evidence, single-sex schooling has a small, but significant, effect on girls' achievement, with an especially marked effect on their performance in science. However, it should be noted that the analysis was not able to control for pupils' ethnicity. Further research would need to explore whether the measured differences could, as Kelly (1996) has suggested, be explained by the fact that a disproportionate number of Asian girls, who tend to perform better than their peers, attend single-sex schools.

As regards boys' comprehensive schools, no significant differences were identified for any of the measured outcomes after controlling for pupils' prior attainment and other background variables. Thus, overall no significant benefits were found to exist between boys attending single-sex as compared to coeducational schools (although differences were identified for boys in selective schools – see Section 3.2.3).

Figure 3.11 provides a comparison between the expected average GCSE point score of boys in single-sex and coeducational comprehensive schools. Boys of low prior attainment performed better in boys' schools, but for boys of higher prior attainment there was no significant difference.

Figure 3.11 Average GCSE point score by KS2 level: mixed and single-sex schools (boys)



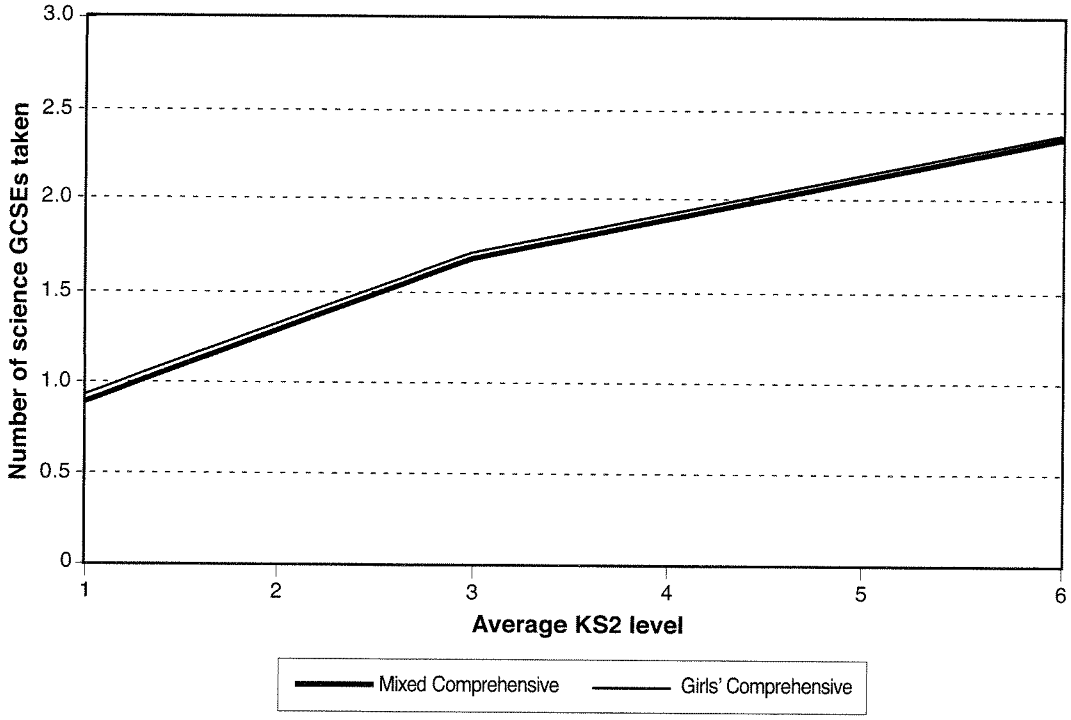
The following section provides a more detailed focus on the impact of single-sex education on girls and boys in comprehensive schools with differential prior achievement at key stage 2.

3.2.2 Impact of single-sex schools on different ability groups

As illustrated by Figures 3.9, 3.10 and 3.11 (see above), for most outcomes the pupils benefiting most from the impact of single-sex education were those at the lower end of the ability range (as measured by prior achievement). This suggests that pupils of lower prior achievement (at key stage 2) tend to benefit particularly from a single-sex environment, making more progress than their peers in coeducational schools. In contrast, the measured effect of single-sex education is much smaller for pupils of higher prior attainment for most outcomes, with much smaller differences identified compared to students in mixed schools. The only exception to this concerned students' total science score and the number of science GCSEs taken.

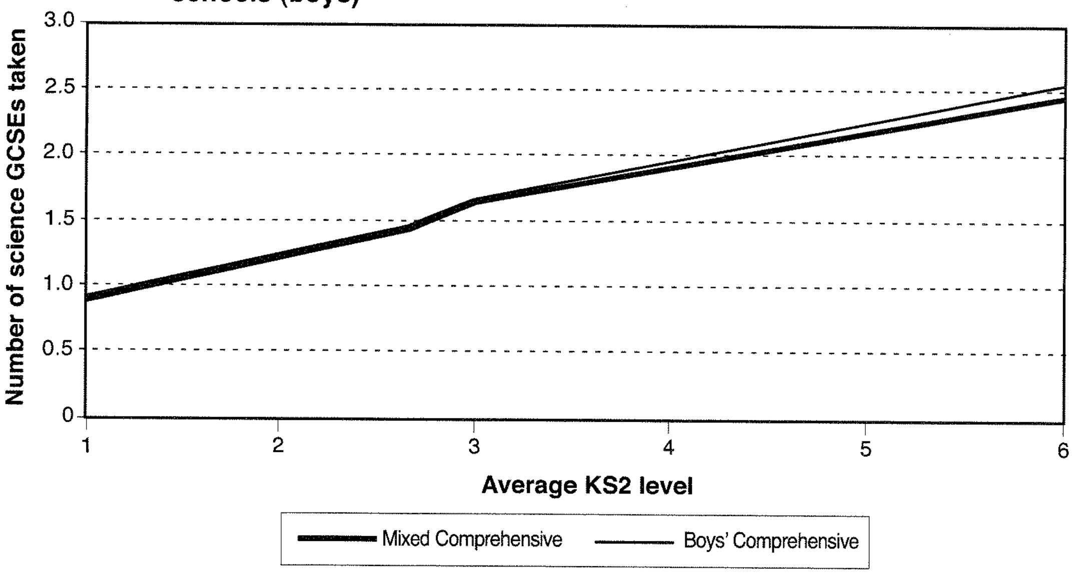
For girls, no variation was identified between girls of different prior attainment attending single-sex and coeducational schools for these outcomes. Figure 3.12 provides an illustration of this with regard to the number of science GCSEs taken by girls in the different types of schools. Although girls in single-sex comprehensive schools tend to take slightly more science GCSEs than their peers in coeducational schools, the measured difference was, more or less, constant across the prior attainment range.

Figure 3.12 Number of science GCSEs by KS2 level: mixed and single-sex schools (girls)



As regards boys, single-sex education was found to have a positive effect on the number of science GCSEs taken and total GCSE science scores for those of higher prior attainment. As Figure 3.13 illustrates, while very little difference can be identified in the number of science GCSEs taken between boys of lower ability in single-sex and coeducational schools, the gap widens considerably for students who achieved above level 3 at key stage 2. This means that for this outcome, while overall no significant effect of single-sex education was measured on boys' achievement, a positive impact could be identified for those of higher prior attainment.

Figure 3.13 Number of science GCSEs by KS2 level: mixed and single-sex schools (boys)



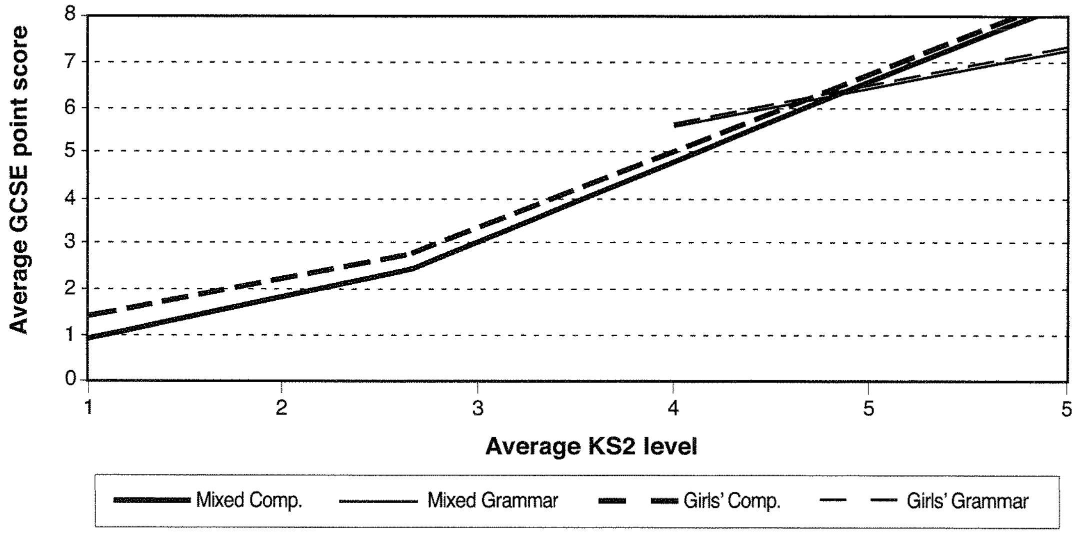
3.2.3 Impact of single-sex education on pupils in selective schools

This section examines the measured effect of single-sex education in selective schools.

The analysis showed that, while single-sex education had no overall impact on boys in comprehensive schools, it had a significant impact on boys in selective schools for a number of outcomes. In contrast, single-sex education was found to have a much smaller effect on girls in selective schools.

Figure 3.14 provides an illustration of the differential impact of single-sex education on girls in comprehensive and selective schools with reference to average GCSE point scores. Even though girls in single-sex grammar schools perform slightly better than similar students in mixed grammar schools, the difference is not significant and considerably smaller than for their peers in comprehensive schools.

Figure 3.14 Average GCSE point score by KS2 level: mixed and single-sex grammar and comprehensive schools (girls)



In contrast, the model highlighted significant differences between the performance of boys in single-sex and mixed grammar schools for several outcomes. Thus, single-sex schooling in grammar schools was found to have a significant positive effect on boys' total GCSE score (see Figure 3.15), English point score (see Figure 3.16), total science score, the number of science subjects taken, and the number of GCSEs taken.

Figure 3.15 provides a comparison of total GCSE point scores of boys in mixed and single-sex comprehensives with boys in mixed and single-sex grammar schools. It shows that while there is a slight, non-significant effect of single-sex schooling on boys of lower ability in comprehensive schools, the difference is much greater for pupils in grammar schools. In fact, the analysis suggested that boys in single-sex grammar schools achieve on average 3.5 GCSE points more than similar pupils in mixed grammar schools.

Figure 3.15 Total GCSE score by KS2 level: mixed and single-sex grammar and comprehensive schools (boys)

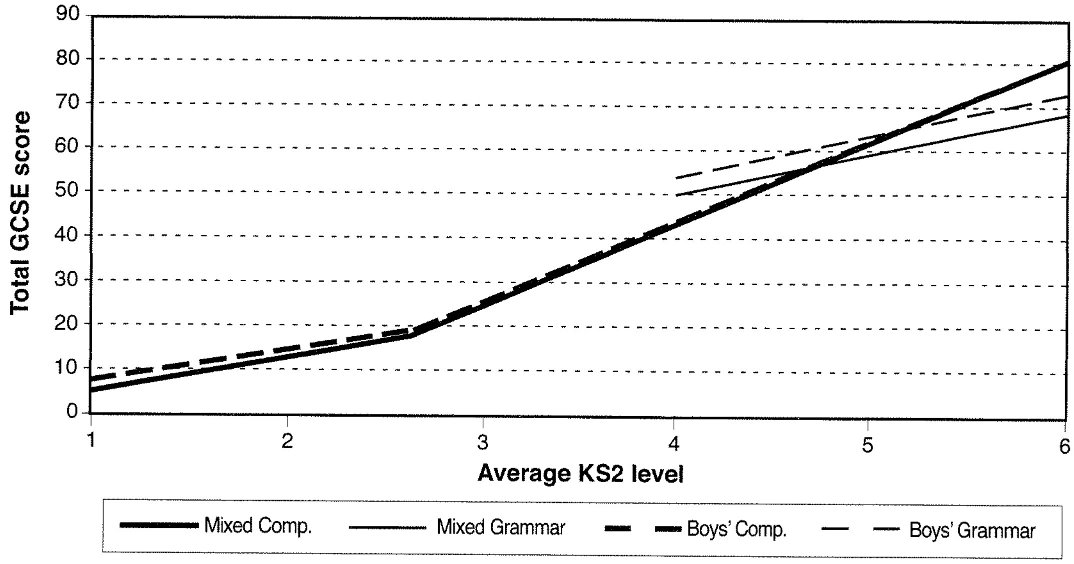
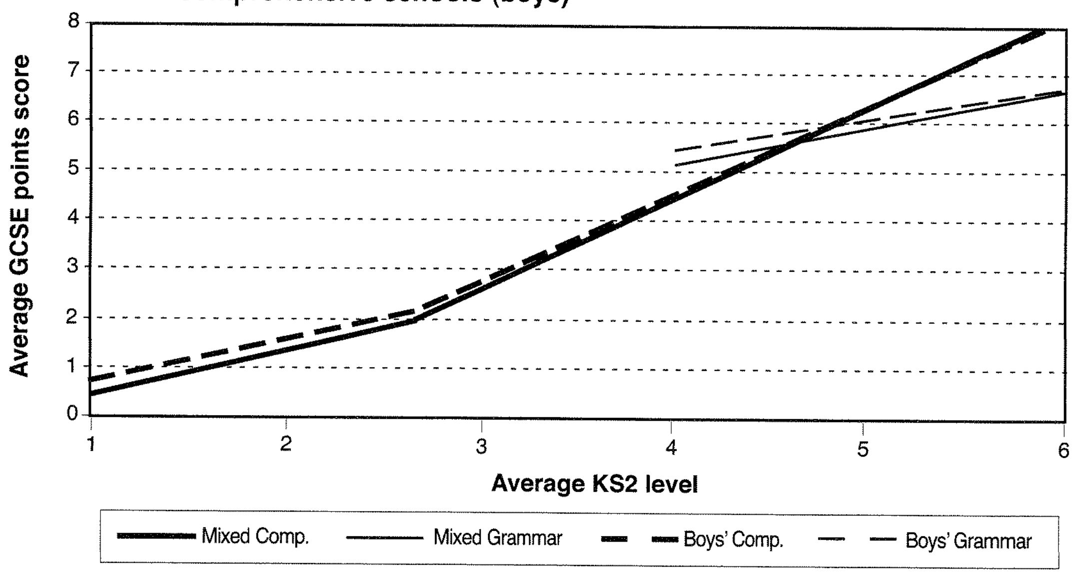


Figure 3.16 illustrates the differential impact of single-sex schooling on boys' achievement in English in comprehensive and selective schools. Again the difference was not found to be significant in comprehensive schools, while there was a significant difference between the achievement of boys in selective schools. The analysis suggested that boys in single-sex grammar schools achieve on average a quarter of a grade higher at GCSE English than similar pupils in mixed grammar schools.

Figure 3.16 English GCSE score by KS2 level: mixed and single-sex grammar and comprehensive schools (boys)



3.2.4 Summary of findings on the impact of single-sex schooling

This section examined the impact of single-sex education on pupil performance while controlling for prior attainment, and other pupil- and school-level factors.

The analysis indicated that, overall, single-sex education had a positive effect on girls in comprehensive schools for all outcomes, except the number of GCSEs taken. The measured difference was particularly striking for average GCSE science score, for which pupils in single-sex schools could be expected to achieve over a third of a grade better than similar pupils in mixed schools. The analysis also suggested that single-sex schooling particularly benefited girls at the lower end of the ability range – students with lower prior attainment at key stage 2. In contrast, no effects were measured of single-sex education on girls attending selective schools.

As regards boys, single-sex education was found overall not to have any effects on their performance in comprehensive schools, although students of low prior attainment demonstrated some performance gains. Furthermore, a positive effect was identified on the number of science GCSEs taken and total GCSE science scores for students with higher prior attainment. In contrast, the analysis highlighted significant performance gains for boys attending single-sex selective schools for several outcomes.

4. ANALYSIS OF OPPORTUNITIES

In this chapter, we explore the impact of, first, size, and second, single-sex education, on the opportunities available to students in secondary schools, in terms of entry to higher key stage 3 tiers and GCSE subjects.

4.1 The Impact of School Size on Opportunity

It is sometimes argued that pupils in smaller schools do not have the same range of opportunities as those in large comprehensives. The NVADs include two kinds of information which could be used to test this claim: tiers entered at key stage 3 (mathematics and science) and GCSE subjects taken.

4.1.1 Entry to key stage 3 tiers

In the key stage 3 tests for mathematics and science, pupils have to be entered for a particular tier (higher, lower, or – in mathematics only – middle). This determines the papers they will take, and the range of possible outcomes. Young people who are preparing for higher mathematics, for example, will have to complete a syllabus which goes beyond what their peers will learn. It therefore makes sense for them to be placed in a separate class or set. However, a small school may have only a few students capable of taking higher mathematics, and may not be able to justify forming a class for them. It is thus possible to hypothesise that a pupil's chance of being entered for a higher tier – with access to the highest levels – would be diminished in a small school.

A logistic regression was carried out to assess the impact of various factors on pupils' chances of being entered for higher tiers (see Appendix II, Section 1). The results tended to disprove the hypothesis outlined, as they indicated that pupils in smaller comprehensive schools had a marginally **greater** chance of being entered for the higher tier in mathematics (school size appeared to have no impact on entry to the higher tier in science). Interestingly, for both mathematics and science, pupils in schools with sixth forms had a greater chance of being entered for higher tiers at key stage 3. Possibly schools with sixth forms tend to be more 'academic', and therefore have higher expectations of their younger pupils. Our value-added analysis suggests that these expectations are at least partly justified, as pupils in schools with **large** sixth forms obtained better results than those in schools without sixth forms. Small sixth forms, however, did not have the same impact (see Section 3.1.1).

In line with previous research (Schagen and Schagen, 2001), the analysis showed that, after controlling for prior attainment and other relevant factors, pupils in grammar schools were very much more likely to be entered for higher tiers. In mathematics, the chances of a grammar school pupil being entered for a higher tier were 17 times as high as for the equivalent pupil in a comprehensive school; however, in a small grammar school, this advantage was effectively halved.

4.1.2 GCSE subjects taken

The NVADs contain details of grades awarded in a range of 23 subjects (those most commonly taken at GCSE). This information can be used to analyse the probability of individual students being entered for particular subjects. It can also be used to test the hypothesis that students in larger schools have a broader range of subjects to choose from.

By aggregating the individual student data, it is possible to count the number of subjects for which each school enters pupils. It should be noted that this process has two important limitations. First, it is possible that schools offer a subject which no student chooses – the NVAD data would provide no indication of that. Second, schools may of course offer subjects not included in the 23 most common. Nevertheless, the number of subjects (out of 23) for which students are entered provides a rough guide to the breadth of courses on offer.

This analysis confirmed that larger schools offer a wider range of subjects. In small schools, the average was 15.13, in medium schools 16.50 and in large schools 17.06 (we should again bear in mind that these figures represent the number of popular subjects offered; the total number offered would be higher in many cases). The correlation between school size and number of subjects taken existed for both grammar schools and comprehensive schools.

Further analysis focused on three subject areas: science, languages and technology.

Science

At GCSE, pupils may take single balanced science, double balanced science, or separate science subjects (physics, chemistry and biology). Schools may therefore offer up to five science options, although separate sciences are now much less common, certainly in comprehensive schools. Again, there was a correlation with size: only five per cent of small comprehensives entered students for five GCSEs, compared with ten and 14 per cent of medium and large comprehensives respectively.

Logistic regression was used to analyse the probability of students taking double rather than single science (i.e. excluding those who took neither). This also indicated a link with size, as (relative to students in medium-sized schools) students in large schools were rather more likely to take double science (odds ratio 1.077) and pupils in small schools rather less likely (0.895). The same held true for the three separate sciences: the probability of a student taking physics, or chemistry, or biology was higher in large schools and lower in small schools.

Languages

Only two modern foreign languages (French and German) are included in the NVADs, which makes it difficult to assess the range of language teaching, as a number of schools offer Spanish and other subjects. Nevertheless, the proportion of comprehensive schools offering both French and German was strikingly related to size: 56 per cent of small schools, 75 per cent of medium schools and 84 per cent of large schools.

Logistic regression showed that the probability of an individual student taking both French and German was actually slightly reduced in a large school (odds ratio 0.905). A possible explanation may be that larger schools are more likely to offer a third MFL (not included in the NVAD) and if students can choose any two of three languages, the chances of them taking both French and German will be reduced.

Design technology

The NVAD includes entries for the three most common DT subjects: food technology, graphics and resistant materials. Once again, the possibility of comprehensive schools offering all three was associated with school size: 61 per cent of small schools, 77 per cent of medium schools and 85 per cent of large schools.

Logistic regression showed that, in small comprehensives, the chances of an individual student taking food technology or resistant materials increased (odds ratios 1.136 and 1.168 respectively) while the probability of taking graphics decreased (0.928). This probably reflects the fact that food technology and resistant materials are the most popular DT subjects, so even small schools tend to offer them, but as they may offer fewer other DT options, the probability of individual students taking these subjects is increased. A quarter of small schools do not offer graphics, and hence the probability of it being taken by students in those schools is reduced.

4.2 The Impact of Single-Sex Schooling on Opportunity

Do single-sex schools increase or reduce the range of opportunities available to students? Do they reinforce sex stereotyping (in terms of the subjects traditionally taken) or counter it?[8] Analysis of key stage 3 tiers and GCSE subjects was used to help answer these questions.

4.2.1 Entry to key stage 3 tiers

Logistic regression (see Appendix II) showed that girls in mixed comprehensive schools were slightly more likely to be entered for higher tier mathematics than boys (odds ratio 1.069). Being in a girls' school

[8] As suggested by Stables (1990) – see Section 2.2.1.

increased the probability by a further 1.064: hence the probability of a girl in a girls' school being entered for higher mathematics would be 1.137 times that of a boy in a mixed school (the 'base case' against which other odds are calculated). For boys, the advantage of being in a single-sex comprehensive was greater: compared with boys in mixed schools, their chance of being entered for the higher tier is one and a quarter (1.260) times as high.

Grammar schools presented a similar picture. Taking prior attainment into account, students in grammar schools were 17 times as likely to be entered for a higher tier. Being in a girls' grammar school increased the probability by 30 per cent (odds ratio 1.303), while being in a boys' grammar school doubled it (2.089). It seems that, in both comprehensive and selective education, girls and boys in single-sex schools were more likely to be entered for the higher tier in key stage 3 mathematics.

In science, girls were generally less likely than boys to be entered for the higher tier (odds ratio 0.873). But, as with mathematics, single-sex education increased the probability of entry to the higher tier for both boys (1.215) and girls (1.391). The odds for students in girls' schools were higher, and effectively cancelled out the disadvantage of being a girl in this context (0.873 x 1.391 = 1.214, so the probability of a girl in a girls' school being entered for the higher tier was the same as that for a boy in a boys' school).

Being in a boys' grammar school conferred a similar advantage (1.399), but being in a girls' grammar school did not further increase the probability of entry to the higher tier in science above that of being in a grammar school of any kind.

4.2.2 GCSE subjects taken

Bearing in mind the limitations explained in Section 4.1.2, the information on the NVADs provides an indication of the range of subjects available at boys' and girls' schools. A preliminary analysis suggested that single-sex schools offer slightly fewer subjects, on average, than mixed schools. However, single-sex schools tend to be smaller than mixed schools, and so the difference could be a reflection of size rather than single-sex education *per se*. The analysis was therefore repeated controlling for size, and the difference between boys', girls' and mixed schools was no longer significant.

The impact of single-sex education in specific subject areas is considered below.

Science

Overall, boys' schools offered more science options than girls' schools. Since grammar schools and school size could influence the results, the analysis was repeated for comprehensive schools only, controlling for school size. The difference between girls', boys' and mixed schools was then statistically significant only for medium-sized comprehensives, although within that group the difference was striking: 44 per cent of boys' schools offered four or five science options, compared with only 23 per cent of girls' schools (and about the same proportion of mixed schools). This reflects the fact that boys' schools were more likely than other comprehensives to offer separate sciences.

Logistic regression similarly showed that the chance of a student in a boys' school being entered for physics, chemistry or biology GCSEs was almost three times as high as for boys in mixed schools. Being in a girls' school also increased the chance of taking separate sciences, but by a much smaller amount (30–40 per cent). Being in a girls' school thus counteracted the effect of being a girl (since girls in mixed schools were less likely to take separate sciences than boys); it means that girls in girls' schools were at least as likely to take separate sciences as boys in mixed schools, though not as likely as boys in boys' schools.

Of those students taking balanced science, girls were less likely than boys to take double rather than single. Boys in boys' schools were also less likely to take double science than boys in mixed schools (odds ratio 0.747). This may reflect the fact that boys' schools offer greater opportunities for taking separate sciences.

Languages

Unlike science, MFL is a traditionally female-dominated area, and the logistic regression confirmed this: girls generally were almost twice as likely as boys (odds ratio 1.828) to take both French and German. However, for girls in girls' schools the difference was significantly reduced (odds ratio 0.797). It could be that girls' schools are countering tradition by encouraging girls to explore other curriculum areas; on the other hand, it could be that girls' schools offer a wider choice of languages and therefore the chances of taking one particular combination (French and German) are reduced.

Further analysis showed that the proportion of girls' schools offering both French and German was higher than the proportion of boys' schools, but not as high as the proportion of mixed schools. The difference was significant only for small comprehensive schools. Again, it must be noted that many schools will offer different languages, but no information about this is provided on the NVAD.

Design technology

The National Curriculum requires all students to study design technology at key stage 4, but there are several different subjects which satisfy this requirement. The NVAD provides data on three: food technology, resistant materials and graphics.

Logistic regression provided evidence of traditional sex-stereotyping: girls were much more likely than boys to take food technology (odds ratio 3.676) and much less likely to take resistant materials (odds ratio 0.237). However, the analysis suggested that girls' schools were helping to counter rather than reinforce these distinctions. Being in a girls' school increased the probability of a girl taking resistant materials (odds ratio 1.591) and reduced the probability of taking food technology (odds ratio 0.554). Boys' schools, however, did not seem to have the same effect: boys in boys' schools were even less likely to take food technology (odds ratio 0.509).

This is perhaps not altogether surprising, given that the drive to encourage girls to take up scientific and technical subjects has not been matched by a drive to encourage boys to take up the 'softer' traditionally female subjects. Hence, the majority of boys' comprehensives (62 per cent) did not offer food technology as an option; only a third offered all three of the design technology subjects included, compared with nearly half of girls' schools and three-quarters of mixed schools.[9] After controlling for size, the differences were no less striking: in the medium-size category, 32 per cent of boys' schools offered three subjects, compared with 52 per cent of girls' schools and 81 per cent of mixed schools.

It is important to note once again that there are a number of design technology options (e.g. textiles, systems and control) not included in the NVAD. The data discussed above does not therefore yield a complete picture; however, there is no reason to suppose that the tendencies observed are not an accurate reflection of the differences between boys', girls' and mixed schools. The findings suggest that mixed schools offer a wider range of subjects, but girls in girls' schools are more likely to attempt non-traditional subjects.

Although not directly relevant to the subject being investigated, it is worth noting that grammar school students were much less likely than those in comprehensive schools to take any of the design technology subjects included in the NVAD (odds ratios 0.617 for graphics, 0.490 for food and 0.364 for resistant materials). In some cases, these probabilities were reduced yet further by attendance at a single-sex grammar school. It would seem that, either grammar school students were taking one of the less common design technology options (such as systems and control) or they were not studying technology at all.

[9] This is consistent with the view of OFSTED and EOC (1996), quoted in Section 2.2.1.

5. SUMMARY AND CONCLUSIONS

This chapter summarises the findings from the literature review, the value-added analysis and the analysis of opportunities, relating to school size and single-sex education.

5.1 School Size

Although the issue of whether there is an ideal school size has been the subject of investigation for many years, the research evidence is still inconclusive. A review of published literature was complemented by some primary analysis which aimed to highlight the impact of school size.

Secondary schools

There is hardly any published research literature dealing with the impact of school size on secondary education. A study which used multilevel modelling and controlled for other factors, such as prior attainment and socio-economic status, found that school size had a negligible impact.

One possible disadvantage of small schools is that they may not offer the same range of subjects as larger schools. Analysis of the secondary 2001 NVAD provided some evidence for this. Of the 23 common GCSE subjects included, the number offered was correlated with school size. Larger schools offered a wider range of science options and design technology subjects; they were much more likely to offer both French and German. Students in larger schools were more likely to take double rather than single balanced science.

It is also possible to hypothesise that students in smaller schools have reduced opportunities for entering higher tiers at key stage 3, but our analysis indicated that this was not the case. On the contrary, pupils in smaller comprehensive schools had a slightly greater chance of being entered for the higher tier in mathematics, though not in science.

In terms of performance, the relationship between school size and GCSE outcomes proved to be curvilinear; in other words, after controlling for pupil, school and LEA background variables, it was pupils in medium-sized schools (cohort of approximately 180–200 pupils) who obtained the best results. The optimum school size varied to some extent depending on certain key variables: sex of pupil, prior attainment, and type of school (girls', boys' or mixed; grammar or comprehensive). However, the general pattern was clear. Performance improved with size up to a certain point, and then declined. Hence the best results were obtained in medium-sized schools and the worst in the very small or very large schools.

The reasons for this are not obvious, and although it is interesting to speculate, it is important to note that statistical analysis can only establish the nature of the link between size and performance, not the explanation for it. It is also important to remember that association does not prove causality. For example, if large schools obtain good results, this may not be because they are large; it could be that schools which obtain good results become popular, and therefore grow in size.

On this basis, it is relatively easy to see why there might be a positive effect of school size. Moreover, as suggested above, smaller schools might offer a limited range of opportunities, and perhaps have limited resources. It is less easy to see why school size should have a negative impact after a particular size has been reached. Possibly structures become too complex, or pupils too easily 'lost' within the system.

Whatever the reason, it is important to bear in mind that the impact of school size, although statistically significant, is relatively small compared to the effect of other pupil- and school-level variables. In terms of average GCSE scores, the difference between schools of optimum size, and the very smallest or largest schools, was no more than 0.15 of a grade.

The existence of a sixth form, although clearly related to school size, was considered as a separate variable, which also proved to have a significant relationship with GCSE performance. Having a **large** sixth form was associated with better than expected results, while a **small** sixth form appeared to have a negative effect. One possible explanation for this is that schools with large sixth forms are more likely to employ more specialist staff who might also teach Year 11 pupils. However, the causal relationship is unclear, and it is possible that in schools with good GCSE results, more pupils tend to enter the sixth form.

Primary schools

Published research suggests that small primary schools have positive advantages, in terms of school ethos, communication with families and links with the local community. There are however concerns about whether very small schools (with up to about 50 pupils) can provide a sufficiently broad curriculum, with specialist teacher knowledge in an adequate range of subjects. Moreover, small schools often have mixed-age classes, which can be problematic, although they can have benefits as well as disadvantages.

According to OFSTED, the performance of very small schools is highly variable. DfES figures suggest that their results are significantly below the average, but this may be because special schools are over-represented in the smallest size category.

When very small schools are excluded from the picture, it seems that school size has relatively little impact. OFSTED noted that the apparently superior performance of small schools may simply reflect the fact that they tend to be situated in relatively affluent areas. Studies in the USA have found that small school size has a positive effect on achievement, but these were based on school-level rather than pupil-level data.

An earlier UK research project, based on pupil-level data, found evidence of a curvilinear effect of school size. The analysis showed that, after controlling for other factors, the best results were achieved in schools of small-to-medium size. But although we found a similar effect in terms of secondary schools (see above), our value-added analysis of primary data indicated that school size did not have a significant effect on any of the key stage 2 outcomes measured. It is possible that reanalysis with a full national value-added dataset could yield a different result.

5.2 Single-Sex Education

Compared to the number of mixed comprehensive schools, the number of single-sex comprehensive schools in England is small. In contrast, the majority of grammar schools are for boys or girls only. However, some mixed schools have adopted a policy of separating the sexes for some classes as a response to claims that, for certain subjects, boys and/or girls benefit from being educated separately. Small-scale studies suggest that girls are more confident in a single-sex environment, and gain more attention from teachers, while single-sex classes can also benefit underachieving boys. Further, it has been claimed that single-sex schooling may help to reduce sexually stereotyped subject choices.

Published research provided little hard evidence of the impact of single-sex education on performance. Although girls' and boys' schools do tend to achieve good examination results, previous statistical analysis has indicated that, after controlling for prior attainment and other relevant factors, single-sex schools is not significant.

National value-added datasets, linking performance at key stage 2 with GCSE outcomes, have recently become available, so it is possible for the first time to assess progress through the five years of secondary schooling and analyse the value added by different types of school. To our knowledge, the research detailed in this report is the first attempt to carry out such an analysis, by means of multilevel modelling. Logistic regression was also used, to assess the impact of single-sex education on the chances of entry to certain GCSE subjects, and to higher tiers at key stage 3 mathematics and science.

Traditionally, certain subjects are dominated by either boys or girls, in the sense that they are more likely to take those subjects (if optional) and/or excel in them. Boys tend to outperform girls in mathematics and science;

girls perform better than boys in English, and are more likely to specialise in MFL; within design and technology, food and textiles are seen as mainly girls' subjects, while boys form the large majority of students taking resistant materials. We wished to find out whether single-sex schools counter or reinforce these tendencies.

Based on information about a limited number of GCSE options, it seemed that girls' schools do at least help to counter the traditional divisions. Logistic regression confirmed that, compared with girls in mixed schools, girls in girls' schools were:

- more likely to take resistant materials
- less likely to take food technology
- more likely to take separate sciences
- less likely to take both French and German (although they may have taken other language combinations).

Boys' schools did not seem to have the same impact. Indeed, compared with boys in mixed schools, boys in boys' schools were almost three times as likely to take separate sciences, and only half as likely to take food technology. Boys' schools appeared to have no significant effect on the probability of taking two languages, resistant materials or graphics.

Analysis of the data using logistic regression also identified an impact of single-sex schools on the chances of being entered for higher tiers at key stage 3. After controlling for prior attainment, both boys and girls in single-sex schools had a greater chance of being entered for higher tiers of key stage 3 mathematics and science than their peers in mixed comprehensives. The greatest difference was in science, where girls in girls' schools had a 40 per cent greater chance of being entered for the higher tier. It suggests that teachers in single-sex schools have higher expectation of their students, but are these expectations justified?

The popular view is that girls perform better in single-sex schools, while boys are more successful in mixed schools. Contrary to most of the evidence in the previous literature, our analysis found that, even after controlling for prior achievement and other background factors, girls in girls' comprehensive schools achieved better results than their peers in mixed schools for almost all the measured outcomes. The measured difference was particularly striking for average GCSE science score, for which girls in single-sex schools could be expected to achieve over a third of a grade better than similar girls in mixed schools. For almost all outcomes, students with lower prior achievement tended to make greatest progress in single-sex schools. However, no performance gains could be detected for girls attending single-sex grammar schools. These findings suggest that teachers' expectations of students in single-sex schools are to a large extent also matched by girls' better performance at GCSE in comparison with their peers in mixed schools.

No significant differences were measured between the performance of boys in single-sex and mixed comprehensive schools overall, although boys with higher prior achievement at key stage 2 were found to take slightly more science GCSEs and achieve higher total GCSE science scores. In contrast, the performance gains for boys attending single-sex grammar schools across all levels of prior attainment were significant for many outcomes, including total GCSE score and English total point score. The analysis found that boys in single-sex grammar schools achieve on average a quarter of a grade higher at GCSE English than similar pupils in mixed grammar schools. However, it should be noted that the comparison group of mixed selective schools was relatively small – only 39 schools compared to 117 single-sex grammar schools.

5.3 Conclusions

This research project aimed to identify the impact of school size and single-sex education. Primary schools are virtually all coeducational, and our analysis identified no significant effects of school size. For **secondary schools**, the key findings are as follows:

- pupils in larger schools had a wider range of GCSE options
- medium-sized schools obtained better results than very large or very small schools
- girls' schools helped to counter traditional sex-stereotyping in subject choices
- girls in single-sex comprehensive schools performed better than girls in mixed comprehensives
- boys of low prior attainment in single-sex comprehensive schools performed better than boys of similar ability in mixed schools
- for boys of middle or high prior attainment there was no significant difference between single-sex and mixed comprehensives
- boys in single-sex grammar schools performed better than those in mixed grammar schools.

It would be possible to infer from these findings that, in order to maximise performance, comprehensive schools should be six-form entry (about 180 pupils per cohort) and single-sex. However, there are important caveats to bear in mind. In terms of size, although medium-sized schools obtained the best results on all GCSE outcomes, the differences (although statistically significant) were very small.

The differences between single-sex and mixed schools were greater, especially for girls in comprehensive schools. However, it is possible that these could be explained by factors which we were not able to include in the analysis. The NVADs include information on a range of important pupil- and school-level factors, but there are other possibly relevant factors which are not included. There is, for example, no data on student ethnicity, which is important because Asian families in particular often choose to send their daughters to single-sex schools, and Asian girls tend to obtain particularly good examination results.

Single-sex schools may also benefit from high levels of parental support and commitment, as noted by OFSTED and EOC (1996). Girls' schools in particular are often fully or over-subscribed, and some pupils travel a considerable distance to attend them; this suggests that they are deliberately chosen by parents who are informed and interested in their children's education.

Another possibly relevant factor is the background and heritage of individual schools. With the move from selection to comprehensive education, some grammar schools retained their single-sex character. We suspect, therefore, that single sex-schools include a disproportionate number of ex-grammar schools, which may have retained some of their ethos and academic emphasis. Further research is needed to explore these additional factors and see to what extent they may explain the apparent advantage of single-sex (particularly girls') schools.

Finally, it is important to note that our research only investigated the impact of size and single-sex education on performance, and to a lesser extent on available opportunities. It did not explore the impact on other important outcomes, such as girls' and boys' social and personal development, which also need to be considered when deciding what kind of school is best.

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APPENDICES

Appendix I Multilevel modelling

Multilevel modelling was the statistical method used to provide a value-added analysis of pupil progress from key stage 2 to GCSE, and also from key stage 1 to key stage 2. Multilevel modelling is a recent development of regression analysis which takes account of data which is grouped into similar clusters at different levels. For example, individual pupils are grouped into year groups or cohorts, and those cohorts are grouped within schools. There may be more in common between pupils within the same cohort than between pupils in different cohorts, and there may be elements of similarity between different cohorts in the same school. Multilevel modelling allows us to take account of this hierarchical structure of the data and produce more accurate predictions, as well as estimates of the differences between pupils, between cohorts, and between schools.

1. Analysis of the National Value-Added Dataset from Key Stage 2 1996 to GCSE 2001

The national value-added dataset used contained the GCSE (2001) results of 369,341 students in 2,954 schools, linked to their key stage 2 performance in 1996. Progress from key stage 2 to GCSE was analysed to see if there were significant effects related to single-sex education or to various aspects of school size.

Models fitted and background variables

Eight different GCSE outcomes were investigated:

- total GCSE point score[1]
- average GCSE point score
- number of GCSEs taken
- mathematics point score
- English language point score
- total science score[2]
- average science score
- number of science GCSEs taken.

The following background variables were taken into account:

pupil-level

- prior attainment (level achieved at KS2 in mathematics, English and science)

[1] Points were derived from subject grades in the standard manner, i.e. A*=8, A=7, B=6 ... G=1.

[2] Points were derived from science grades in the manner described above, e.g. grade CC for double balanced science = 10 points.

- sex (girl or boy)
- age (in years and months)

school-level

- grammar or comprehensive[3]
- percentage of pupils eligible for free school meals
- boys' school, girls' school or mixed school
- average size of one-teacher classes in school
- number of Year 11 pupils in school
- whether school has a sixth form
- size of sixth form

LEA-level

- percentage of pupils entering grammar schools.

It was felt that the relationship between size and achievement might be non-linear, i.e. the effect of size might differ as size increases. The simplest way of representing a non-linear relationship is with a quadratic term (the number of Year 11 students squared) so this was included in the model.

In addition, extra variables were created which allow for interactions between these predictor variables. Some of these allowed for the fact that the relationship between prior attainment and outcome may be affected by background factors. Background variables that it was thought might affect the relationship between key stage 2 levels and GCSE outcomes were:

- sex (girl or boy)
- boys' school, girls' school or mixed school
- grammar or comprehensive school
- percentage of LEA pupils in grammar schools
- percentage of pupils in school eligible for free school meals
- number of Year 11 pupils in the school.

It was thought possible that the relationship between the number of Year 11 pupils in a school and progress from key stage 2 to GCSE might be affected by some background variables. As a result the model attempted to measure the effect of the following background variables on this relationship:

- sex (girl or boy)
- boys' school, girls' school or mixed school
- grammar or comprehensive school
- percentage of pupils in school eligible for free school meals.

[3] In the context of the analysis, the term 'comprehensive' is used to denote all schools other than grammar schools, although we recognise that this includes schools in selective areas which are not comprehensive in the sense of catering for the full ability range.

In looking at the impact of single-sex schools, it is important to note that many single-sex schools are selective. (Indeed, the majority of grammar schools are single-sex, compared with a tiny minority of comprehensive schools: see Table A2.) It was therefore considered important to make a distinction between single-sex comprehensive schools and single-sex grammar schools. Interaction terms were included that attempted to test whether the effect of single-sex education on grammar schools was significantly different from that on comprehensives for pupils of differing ability.

Two terms were included to quantify how the impact of grammar schools changed with the percentage of selection within the LEA. One measured the effect of percentage of selection on the effect of grammar schools; the other measured the impact of percentage of selection on the relationship between prior attainment and GCSE results in grammar schools.

During preliminary analysis, a slight deficiency in the linear model relating key stage 2 and GCSE results was discovered. It was found that pupils who performed very poorly at KS2, achieving an average level below 3, performed better than would be predicted by a linear model at GCSE. It should be noted that about ten per cent of the dataset (around 40,000 pupils) fell into this subgroup. To investigate this more fully, two further variables were created: an indicator variable of whether a pupil's key stage average was below 3, and an interaction of this variable with key stage 2 average. This second variable measures the effect of differences in prior attainment between pupils within this low-performing group.

Finally, two variables were created to measure the differences between boys and girls in this low-performing subgroup.

Table A5 provides a full list of all the variables used in the multilevel modelling.

A note on the dataset

As the analysis developed, the possible danger of extreme cases influencing the results became apparent. As a result all schools with fewer than 20 pupils in either Year 9 or Year 11, and those schools with a difference between the size of Year 9 and Year 11 greater than 60, were removed from the analysis. It should be noted that this accounts for less than 2.5 per cent of the sample, so the results we presented here are applicable to the vast majority of schools. It was felt that the highly unusual data from these schools was likely to be inaccurate, so removing them from the dataset was necessary in order to produce valid results.

Summary of results

Tables A6 to A13 provide details of the multilevel analysis of each of the GCSE outcomes. Each table shows the variances at each level in the 'base case' (with no background variables), and the results for the final model. Coefficient signs and sizes for each outcome are summarised in Table A14.

Figures A2–A9 show normalised coefficients (also known as standardised coefficients or partial correlation) for each of our models. These measure the 'strength' of the relationship between each predictor and the relevant outcome given all the other background variables. It indicates how serious it would be to drop any one of the variables.

Gender differences were significant for all outcomes. Boys performed better than girls of similar prior attainment in mathematics and science, whilst girls performed better in English, and in terms of total and average score. The difference between the genders in English is particularly large. Girls took more GCSEs than boys on average, while boys took more science GCSEs.

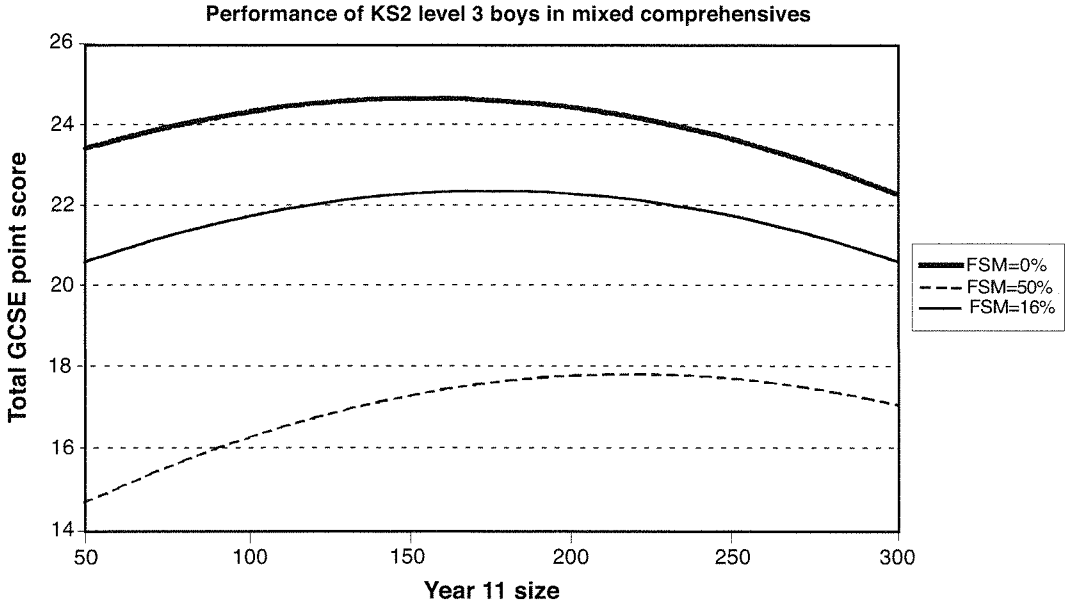
There was some evidence of interaction between sex and prior attainment. Girls showed greater differentiation between differing levels of prior attainment than boys for average GCSE score and for average science score. There was greater differentiation between boys of differing prior attainment for English and for number of subjects entered.

As found in previous work (see Schagen and Schagen, 2001), grammar schools tended to have a positive effect on attainment, but less differentiation between pupils of differing ability on entrance. As such, grammar schools seemed to show the greatest benefit for those pupils at the lower end of the grammar school ability range. The most able pupils in grammar schools appeared to take fewer GCSEs than their counterparts in comprehensive schools. However, pupils of all abilities in grammar schools tended to take more science GCSEs.

School size was found to have a non-linear effect on all outcomes. It was found that each variable tended to increase with school size until an optimum year size was reached, after which increasing year size related to decreases in the outcome variables. For most outcomes, the results indicated an optimum size of between 170 and 190 pupils in Year 11. The exception to this was with regard to the number of science GCSEs taken, for which the optimum number appeared to be much higher (approximately 220). It would be wrong to place too much emphasis on these precise numbers, and further work would be required to investigate more fully; nevertheless, these results provide some indication of the effect of school size.

The most significant interaction with size is the percentage of pupils eligible for free school meals (FSM) within the school. There is a positive interaction for all outcomes except English and average science point score. This means that the optimum size for a school with low numbers of FSM children is much lower than for a school with a high number. For example, for total GCSE point score, if there are no FSM children in the school, the optimum size is around 150 pupils in Year 11. With 16 per cent FSM (the average level), this rises to 175 pupils. With 50 per cent FSM, the optimum size is 215. Again it is important to stress that care must be taken with these numbers; however, they are useful for giving a sense of the order of magnitude of the effect. Figure A1 illustrates the effect of school size on boys in mixed comprehensive schools for low, medium and high levels of FSM.

Figure A1 Expected total GCSE score of KS2 Level 3 boys in mixed comprehensives



The size of Year 11 has a more positive effect on girls than on boys in terms of average and total GCSE point scores, i.e. for these outcomes the optimum school size is higher for girls than for boys. However, in girls' schools the optimum size in relation to total GCSE score is lower than for average score. There is no significant interaction between gender and Year 11 size for any other outcome.

The interaction between Year 11 size and grammar schools is significant for total GCSE score, mathematics, English, and number of GCSEs entered. In each case, the optimum school size is reduced for grammar schools.

For total and average GCSE score, mathematics, science, and number of science GCSEs taken, there is a significant positive interaction between Year 11 size and prior attainment. That is, the greater the prior attainment of a child the larger the optimum school size for this child. There is a significant negative interaction for number of GCSEs entered. In this case, the school size associated with pupils doing the most GCSEs decreases as the prior attainment of the pupil increases. In small schools, pupils of high ability take more GCSEs; in large schools, there is less differentiation.

The coefficient relating to the presence of a sixth form was significant and negative for all outcomes except the overall number of GCSEs taken. Meanwhile the coefficient relating to the size of a sixth form was always significant and positive. This means that pupils in schools with a small sixth form performed worse than those in schools without a sixth form, who in turn performed worse than those in a school with a large sixth form. The crossover point (at which pupils appear to benefit from the presence of a sixth form) ranges between 110 and 190 pupils for most outcomes, the exception being the number of science GCSEs taken, where the crossover is at around 220 pupils. However, given the preliminary nature of this research, these figures should be treated with extreme caution. It may be that a large sixth form has a positive impact, but it could equally be that in 'good' schools, more pupils stay on into the sixth form.

Class size was found to have a significant and positive relationship with number of GCSEs taken, but had no significant effect on any other outcome.

A major aim of this study was to assess the impact of single-sex education. For almost every attainment outcome, it was found that pupils in girls' schools performed a little better than equivalent pupils in mixed schools. (The only exception was for numbers of GCSEs taken, where girls' schools showed no difference overall compared to mixed schools.) However, boys' schools performed no better than other types of schools.

There were significant interactions between prior attainment and single-sex education. For most outcomes, it was found that there was less difference between pupils of differing prior attainment in single-sex schools. The only exception to this was in total science score and number of science GCSEs taken. For these outcomes, girls' schools showed no interaction with prior attainment, whilst boys' schools showed a positive interaction. That is, in boys' schools there is more difference in the number of science GCSEs taken by boys of differing ability.

For girls' schools, there was barely any significant interaction with selective schools. This means that the effect of single-sex education does not have a significantly different effect on grammar schools and that selective education does not have a significantly different effect on girls' schools. There was one exception to this. Single-sex education had a smaller effect on average GCSE scores in grammar schools than on average GCSE scores in comprehensive schools.

Boys' schools showed some significant interaction with selective schools. There were significant positive effects on total GCSE score, number of GCSEs taken, total science score, number of science GCSEs taken, and English. That is, in each case boys' grammar schools appear to perform better than mixed grammar schools.

All the points relating to single-sex education are illustrated by Figures 9–24. These show the expected value of each GCSE outcome for boys and girls in mixed comprehensive, mixed grammar, single-sex comprehensive and single-sex grammar schools, assuming average key stage 2 performance and average levels for all other variables (such as school size and FSM eligibility). It is further assumed that the pupil scores equally in each of the three key stage 2 subjects to achieve the average shown on the horizontal axis. Dashed and dotted lines show boys' and girls' schools respectively. Bolder lines represent comprehensive schools.

It is important to note that due to the small number of grammar schools, apparently large differences between the effect of single-sex education on grammar schools and comprehensives may not be significant. As described above, there are only a few significant interactions between single-sex and grammar schools. Tables A1 and A2 show the number of pupils and schools of each type involved in the analysis.

Another feature of these graphs that must be treated with care is the apparent 'top end gap' between grammar and comprehensive schools. It should be noted that very few pupils score above Level 5 at key stage 2 and so the gradient of the grammar school slopes is based mainly on students with average levels less than or equal to 5. Tables A3 and A4 compare total and average GCSE scores for pupils in this group. They show that pupils in grammar schools perform better than pupils of similar ability in comprehensive schools, although it is important to note that these tables have not been adjusted for FSM eligibility and other background factors.

Table A1 Numbers of pupils in analysis in schools of different types

	School				**Total**	
	Comprehensive		**Grammar**			
	N	%	N	%	N	%
Boys' school	12389	3.5	4478	33.5	16867	4.6
Girls' school	18039	5.1	5438	40.7	23477	6.4
Mixed school	325543	91.5	3454	25.8	328997	89.1
Total	**355971**		**13370**		**369341**	

Due to rounding, percentages may not sum to 100.

Table A2 Numbers of schools of different types in analysis

	School				**Total**	
	Comprehensive		**Grammar**			
	N	%	N	%	N	%
Boys' school	123	4.4	56	35.9	179	6.1
Girls' school	161	5.8	61	39.1	222	7.5
Mixed school	2514	89.8	39	25.0	2553	86.4
Total	**2798**		**156**		**2954**	

Due to rounding, percentages may not sum to 100.

Table A3 Total GCSE scores of pupils with high prior attainment

KS2 average level	School			
	Comprehensive		Grammar	
	No. of pupils	Total GCSE score	No. of pupils	Total GCSE score
5.00	13333	64.3	3138	68.7
5.33	438	71.2	143	73.1
5.67	24	74.9	4	72.9
6.00	4	65.9	1	91.0

Table A4 Average GCSE scores of pupils with high prior attainment

KS2 average level	School			
	Comprehensive		Grammar	
	No. of pupils	Total GCSE score	No. of pupils	Total GCSE score
5.00	13333	6.42	3138	6.82
5.33	438	7.02	143	7.24
5.67	24	7.34	4	7.47
6.00	4	6.65	1	7.91

Figure A2 Normalised coefficients for total GCSE score

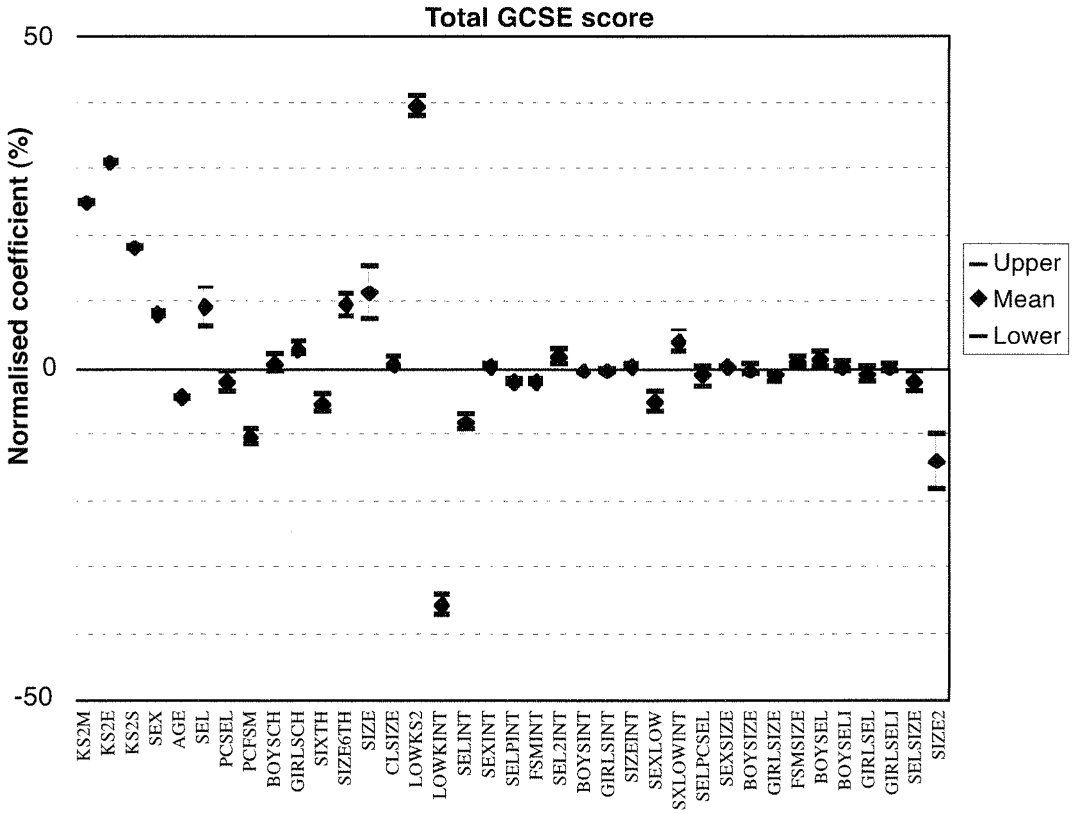


Figure A3 Normalised coefficients for average GCSE score

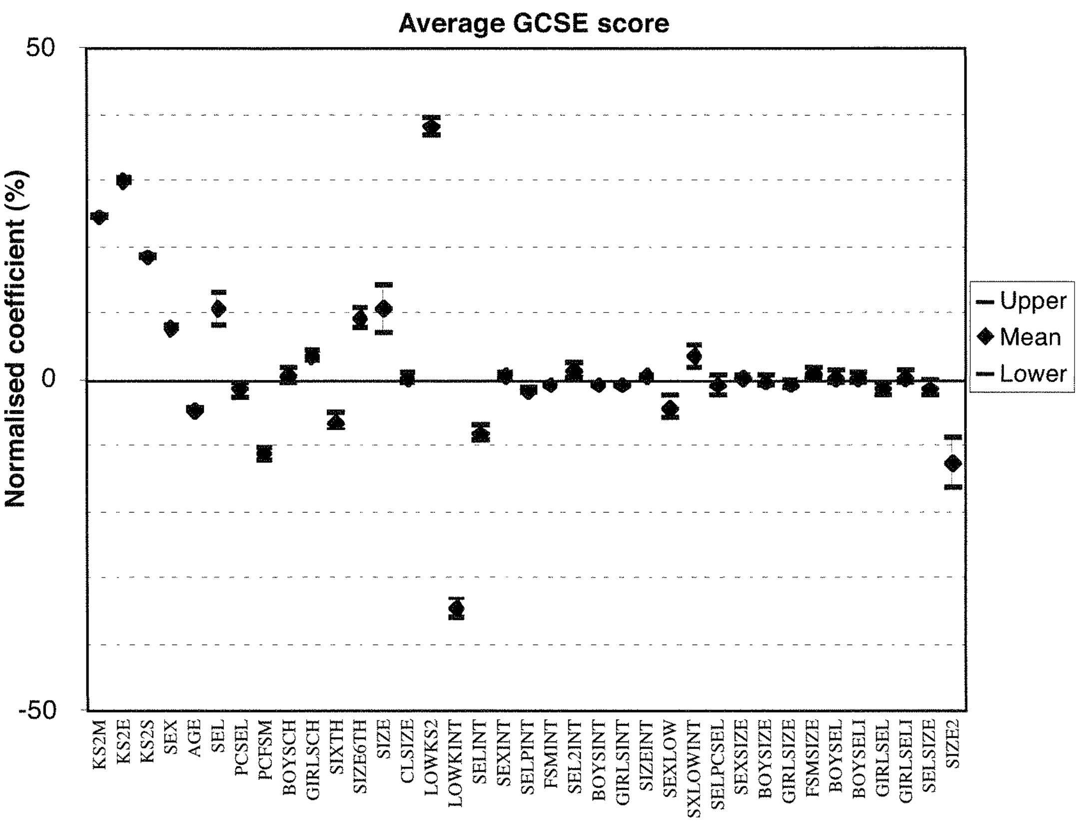


Figure A4 Normalised coefficients for number of GCSEs taken

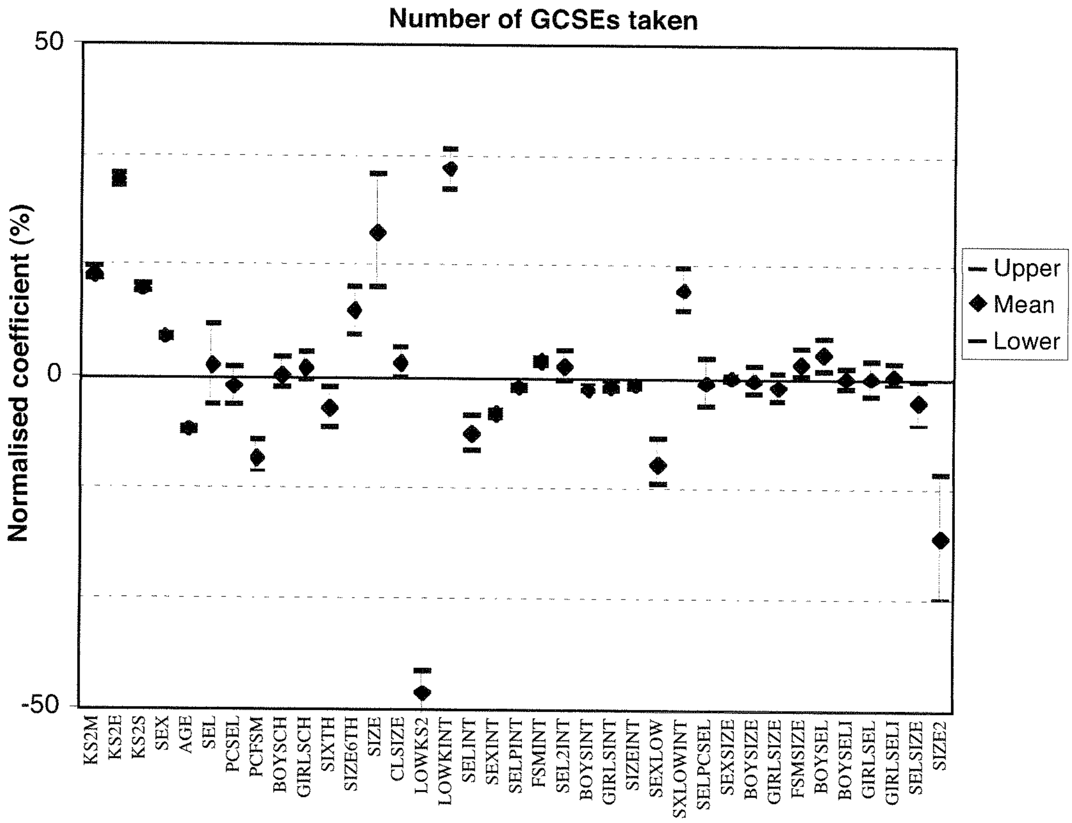


Figure A5 Normalised coefficients for mathematics GCSE score

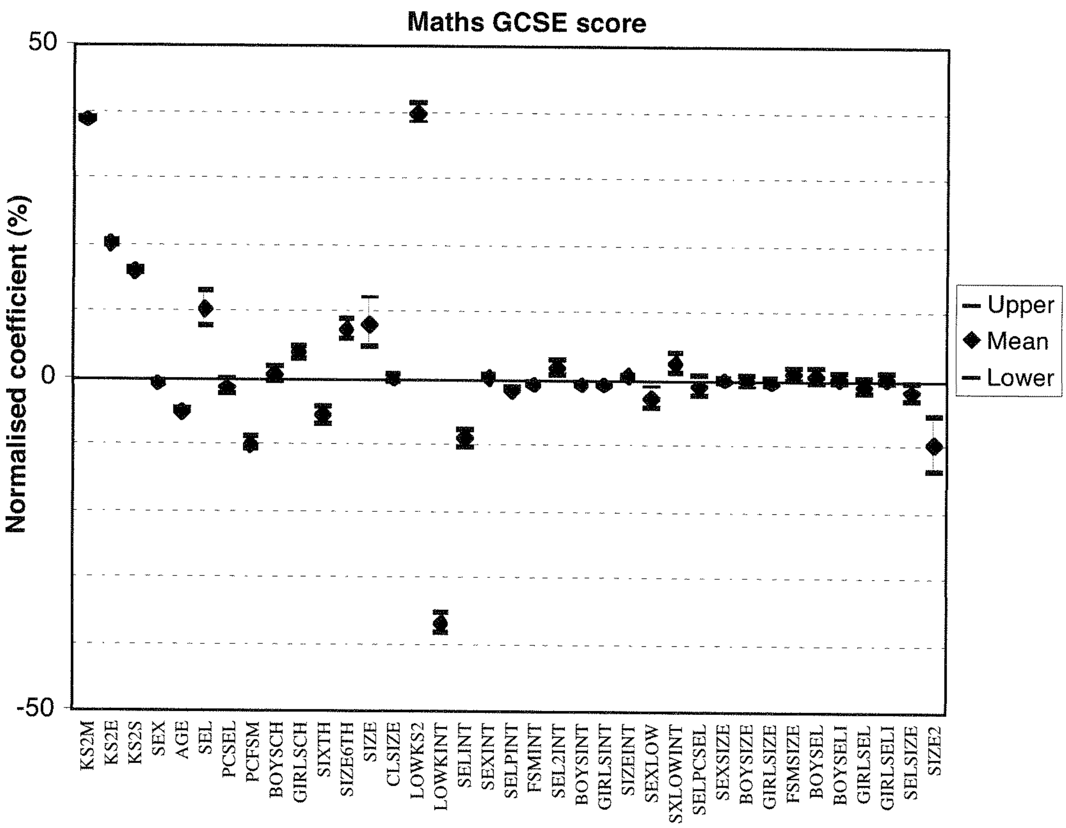


Figure A6 Normalised coefficients for English GCSE score

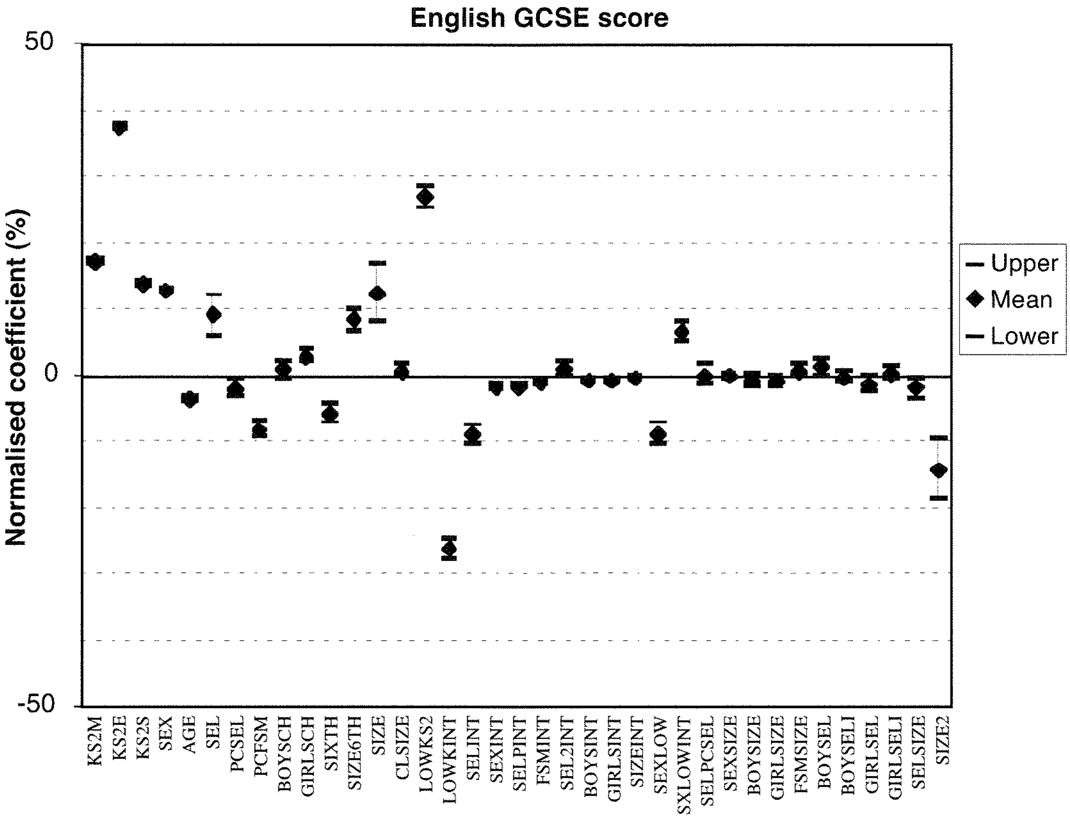


Figure A7 Normalised coefficients for total science GCSE score

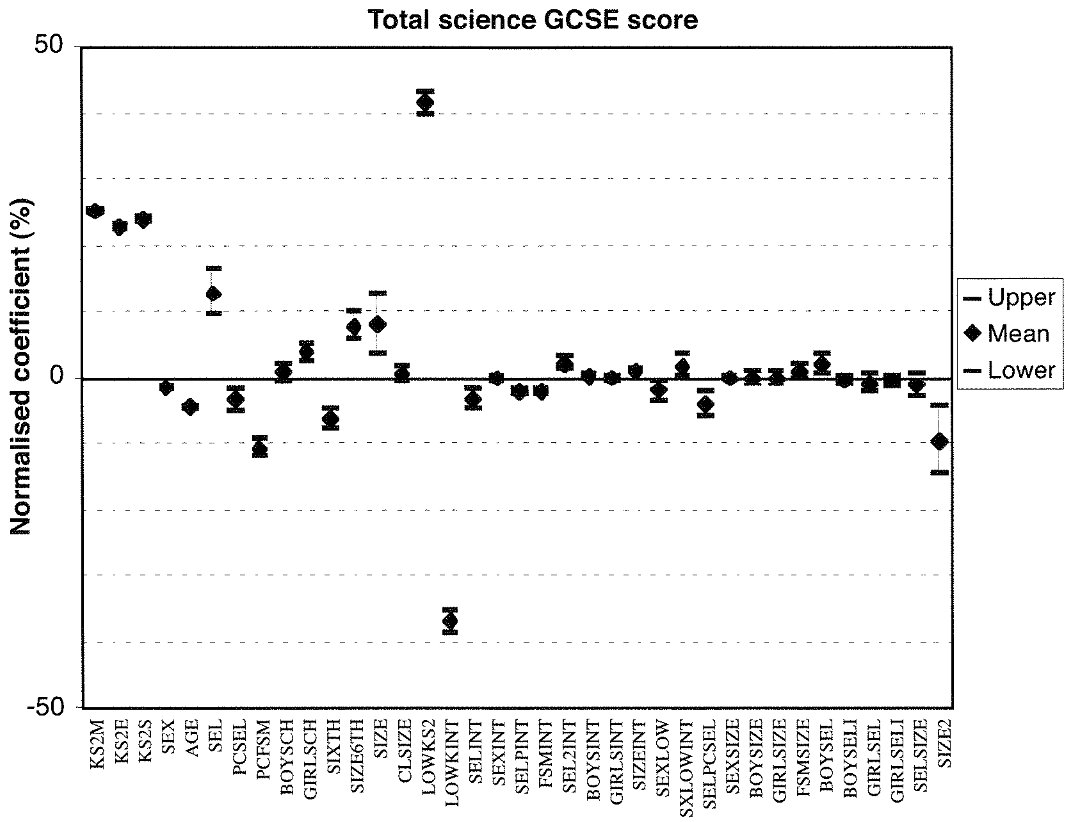


Figure A8 Normalised coefficients for average science GCSE score

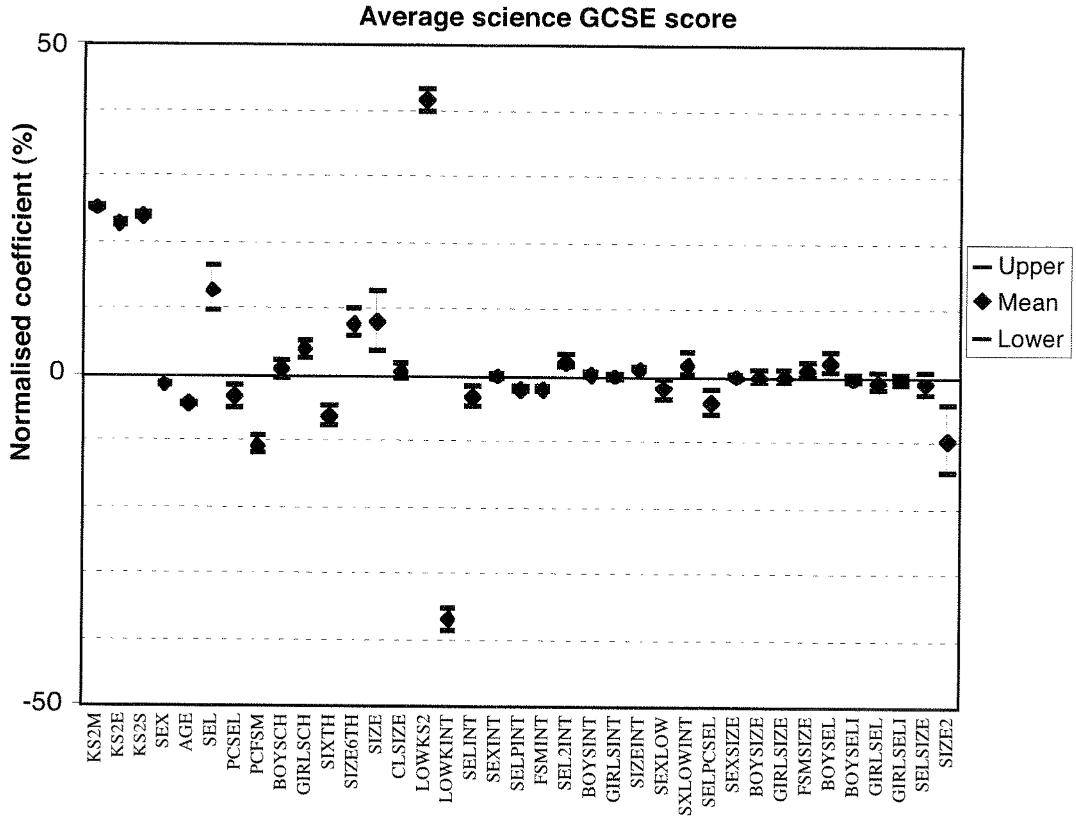


Figure A9 Normalised coefficients for number of science GCSEs taken

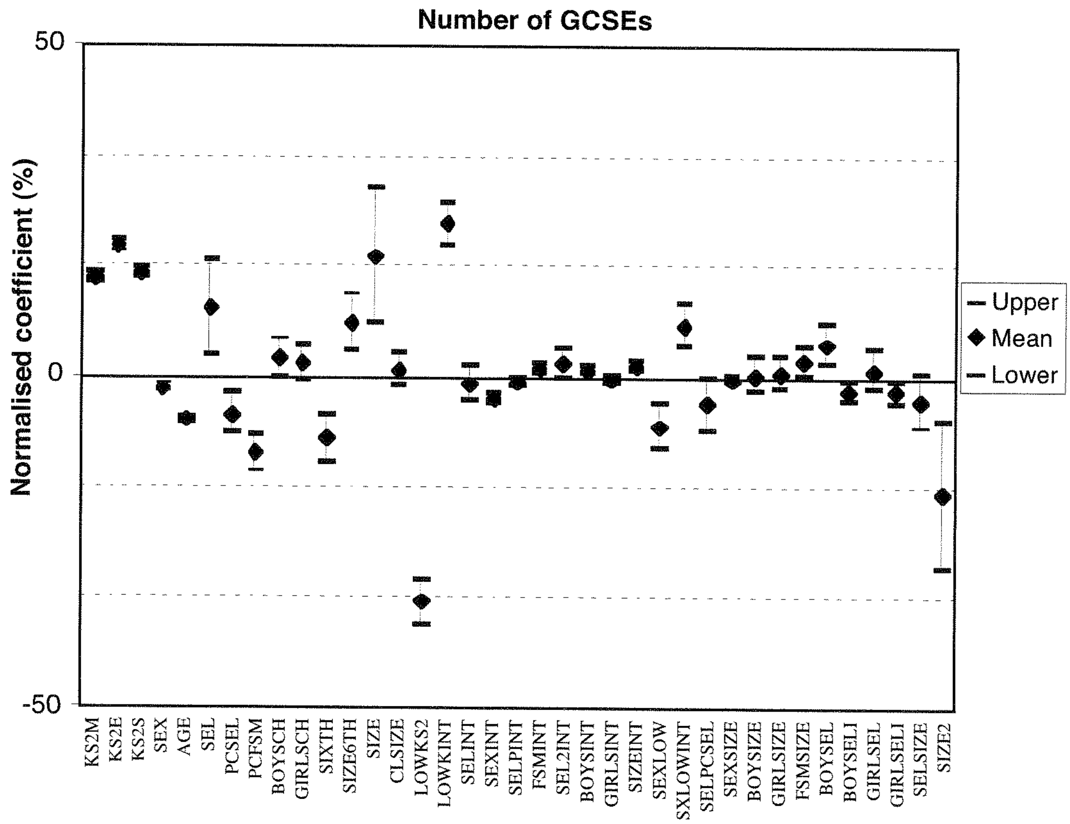


Figure A10 Relationship between average KS2 level and total GCSE score for boys in various types of schools

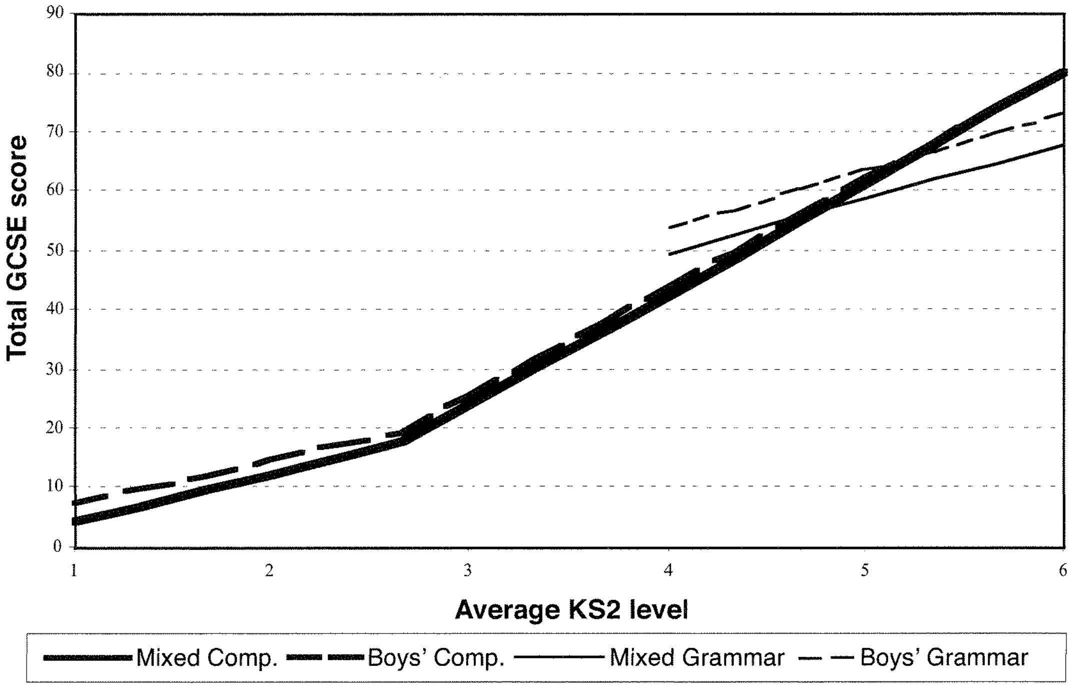


Figure A11 Relationship between average KS2 level and total GCSE score for girls in various types of schools

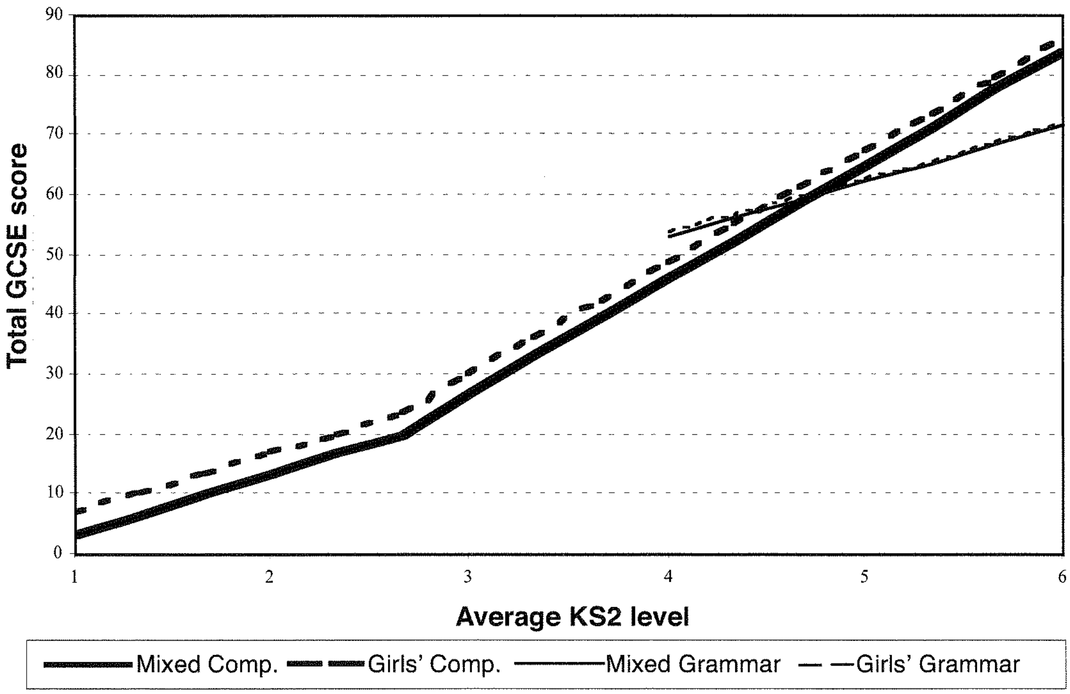


Figure A12 Relationship between average KS2 level and average GCSE score for boys in various types of schools

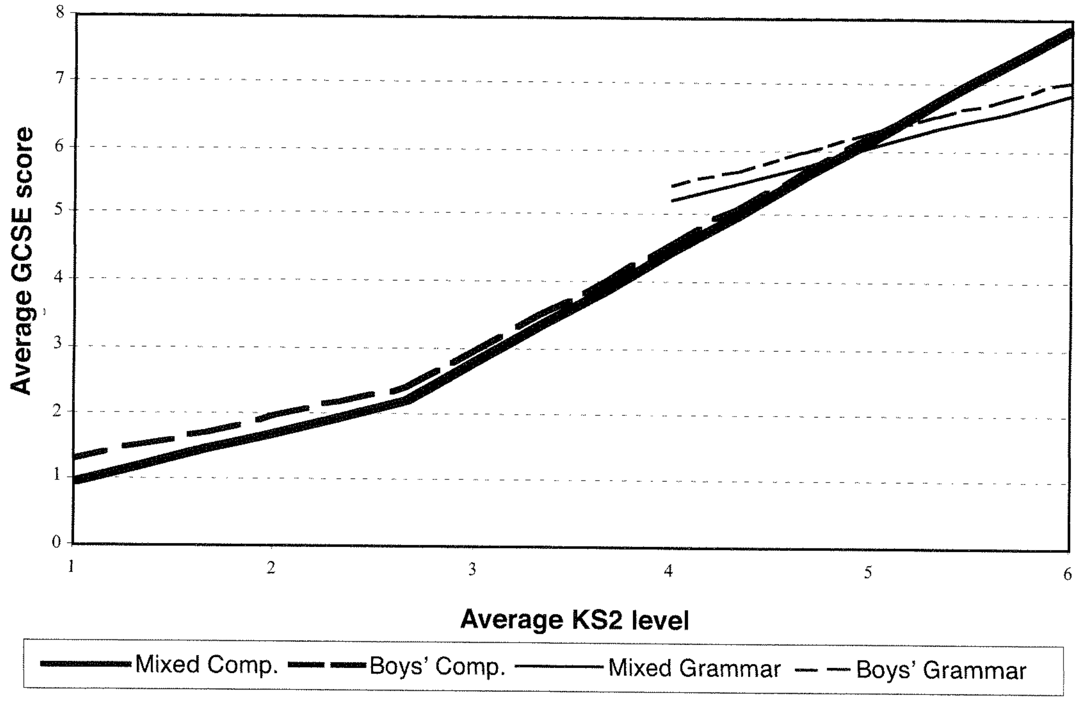


Figure 13 Relationship between average KS2 level and average GCSE score for girls in various types of schools

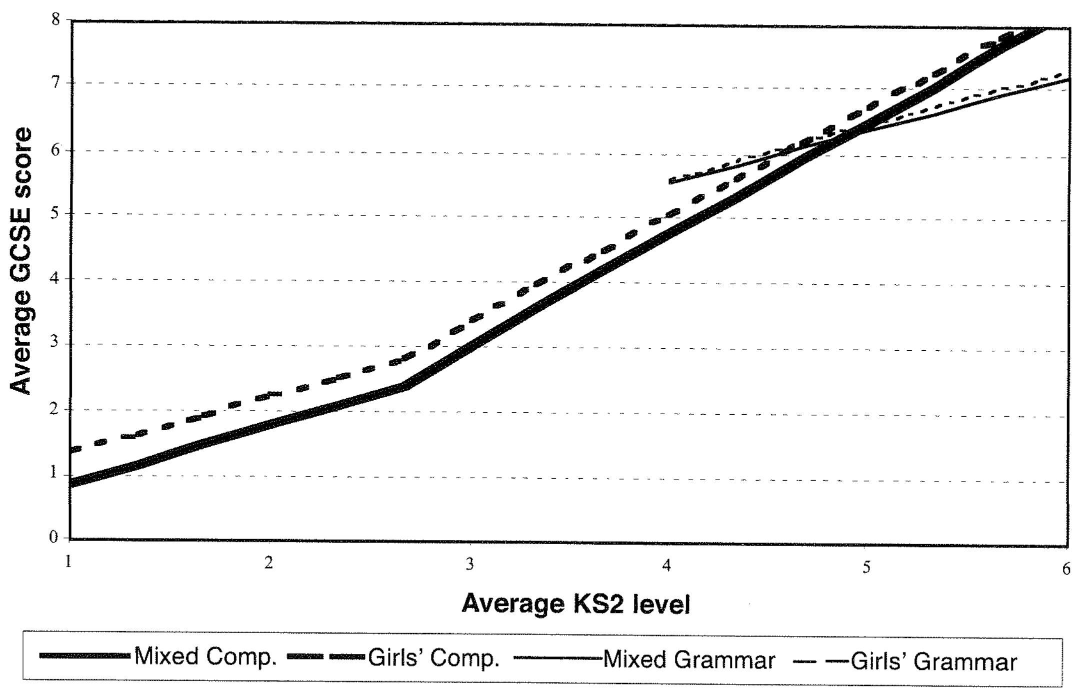


Figure A14 Relationship between average KS2 level and number of GCSEs taken for boys in various types of schools

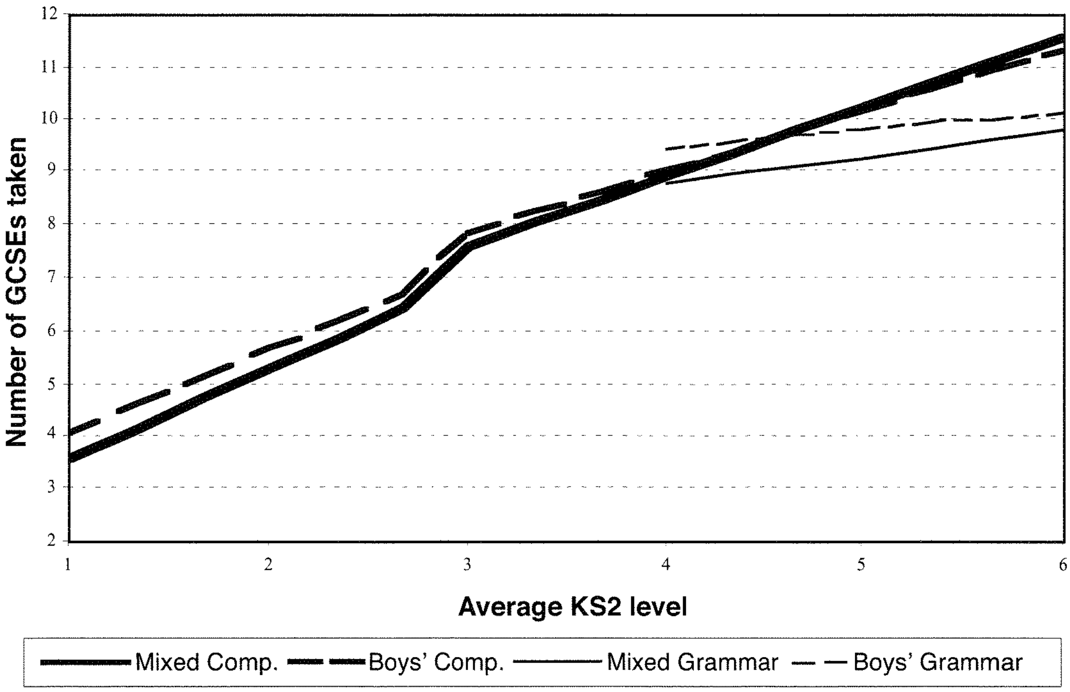


Figure A15 Relationship between average KS2 level and number of GCSEs taken for girls in various types of schools

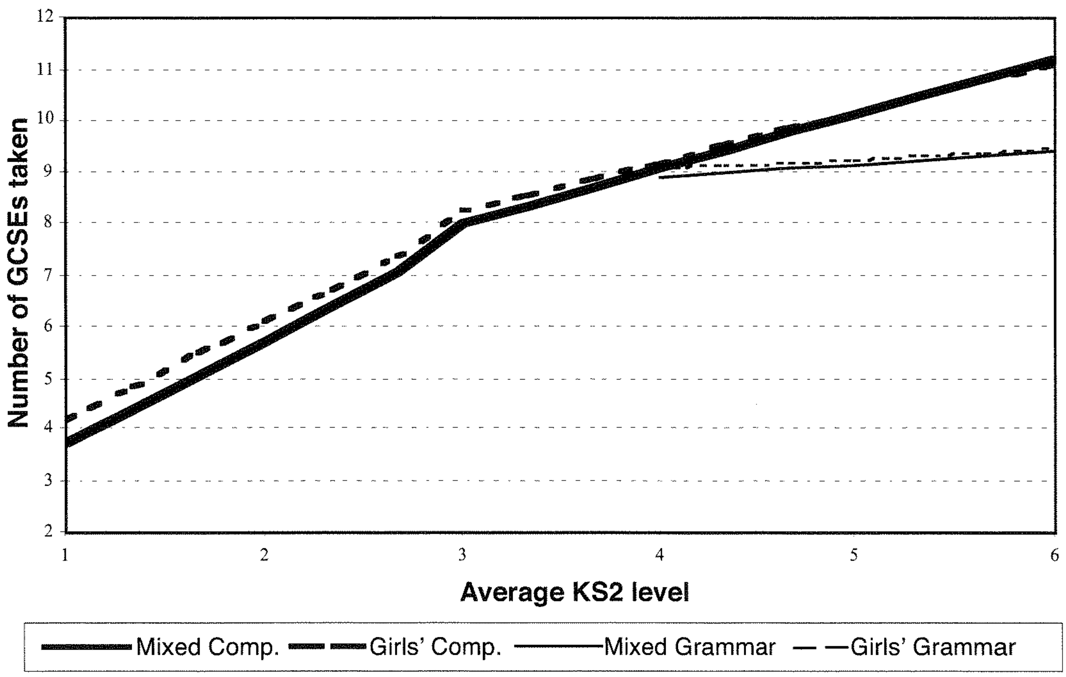


Figure A16 Relationship between average KS2 level and mathematics GCSE score for boys in various types of schools

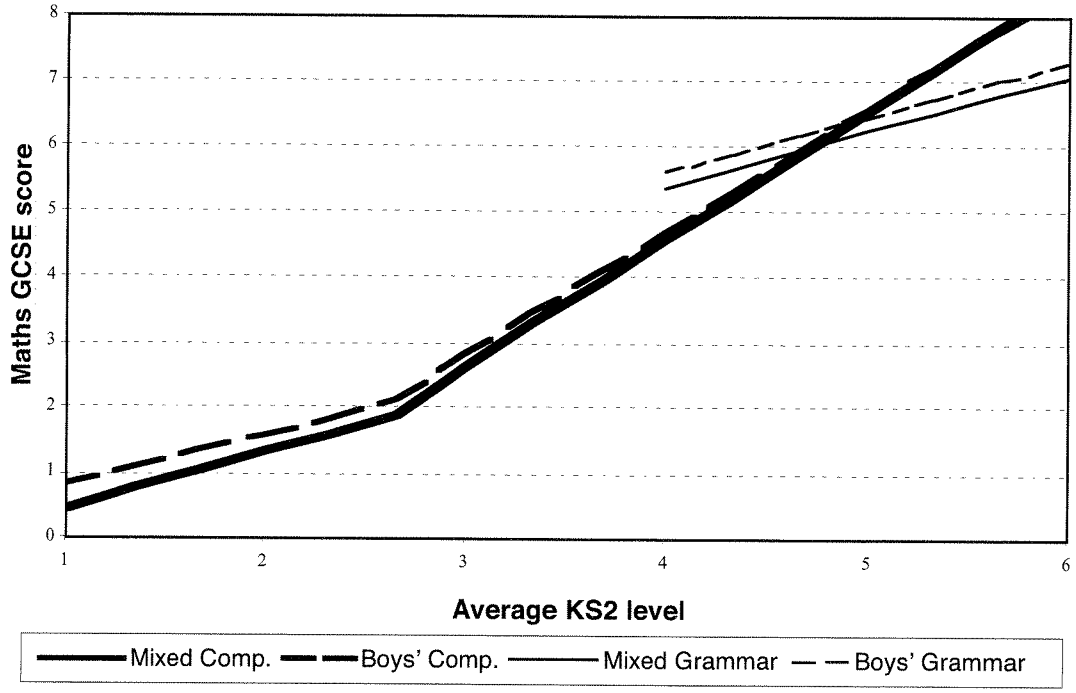


Figure A17 Relationship between average KS2 level and mathematics GCSE score for girls in various types of schools

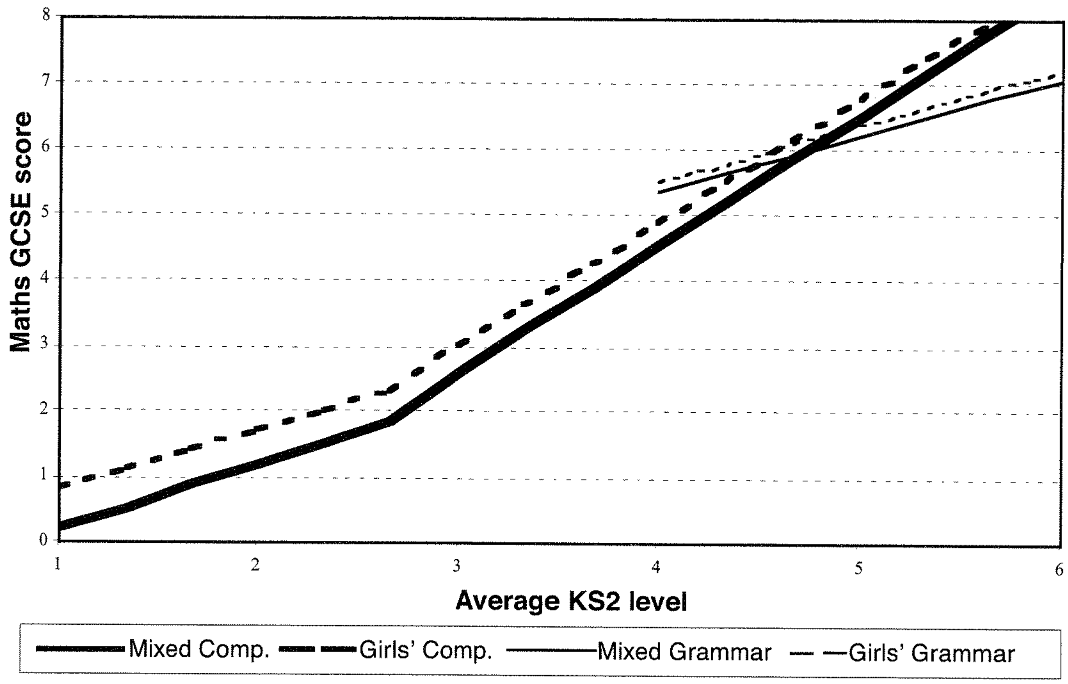


Figure A18 Relationship between average KS2 level and English GCSE score for boys in various types of schools

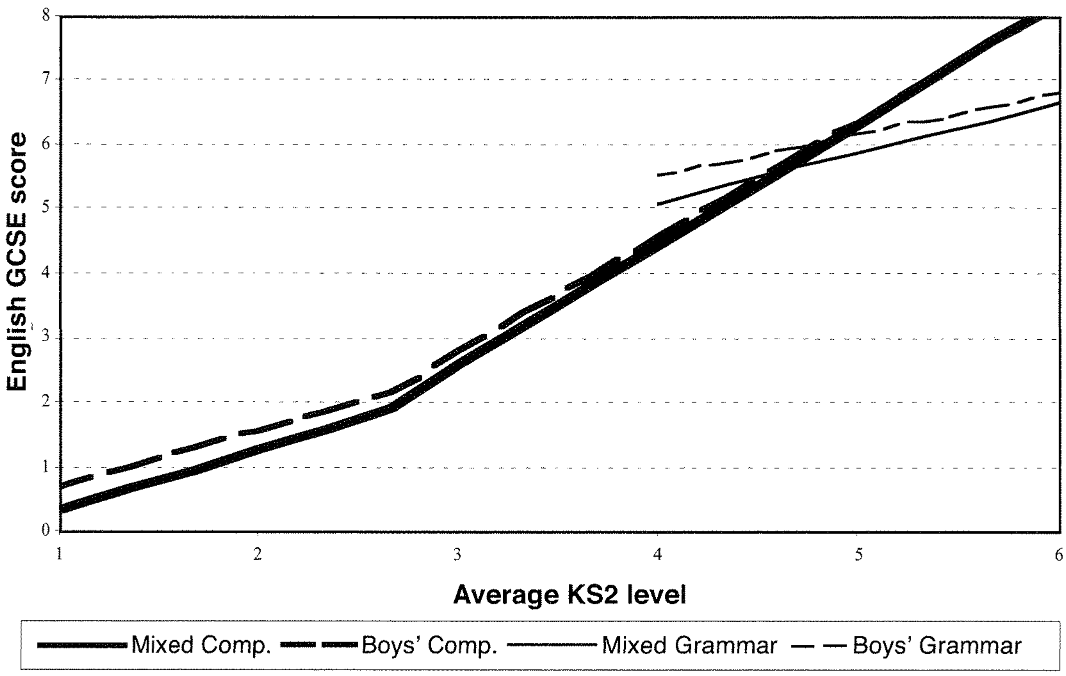


Figure A19 Relationship between average KS2 level and English GCSE score for girls in various types of schools

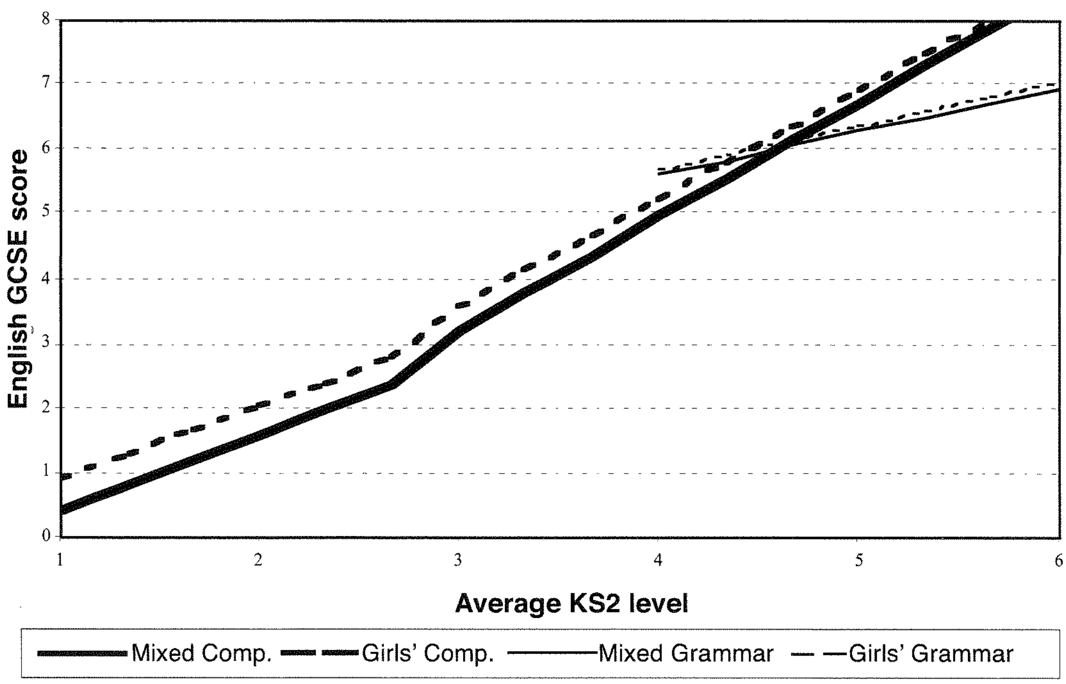


Figure A20 Relationship between average KS2 level and total science GCSE score for boys in various types of schools

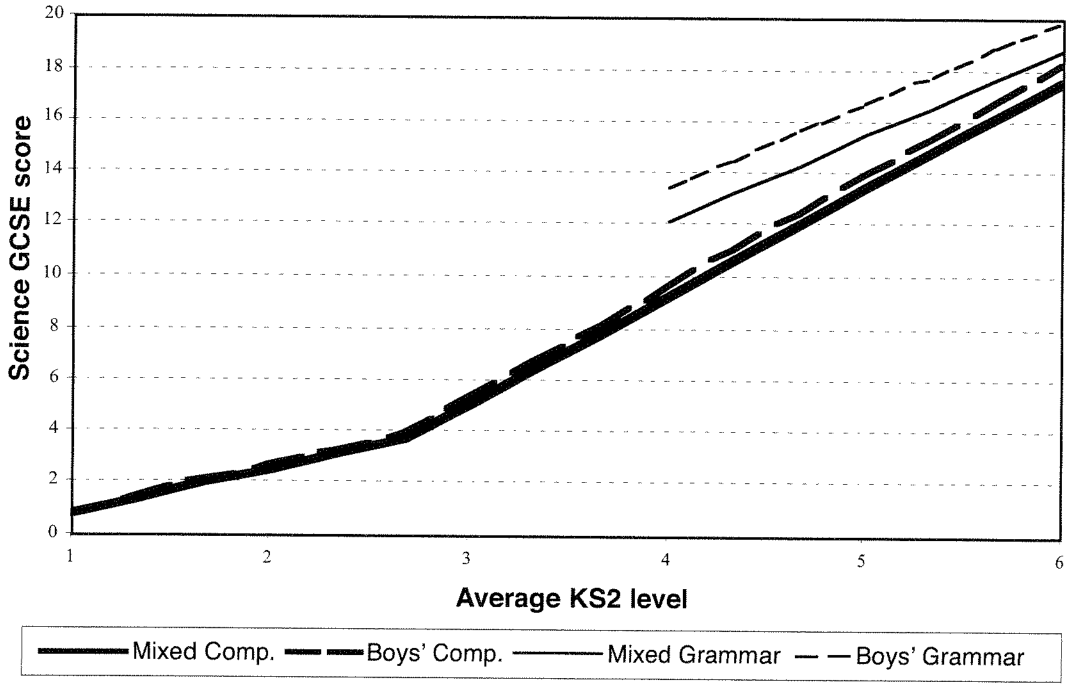


Figure A21 Relationship between average KS2 level and total science GCSE score for girls in various types of schools

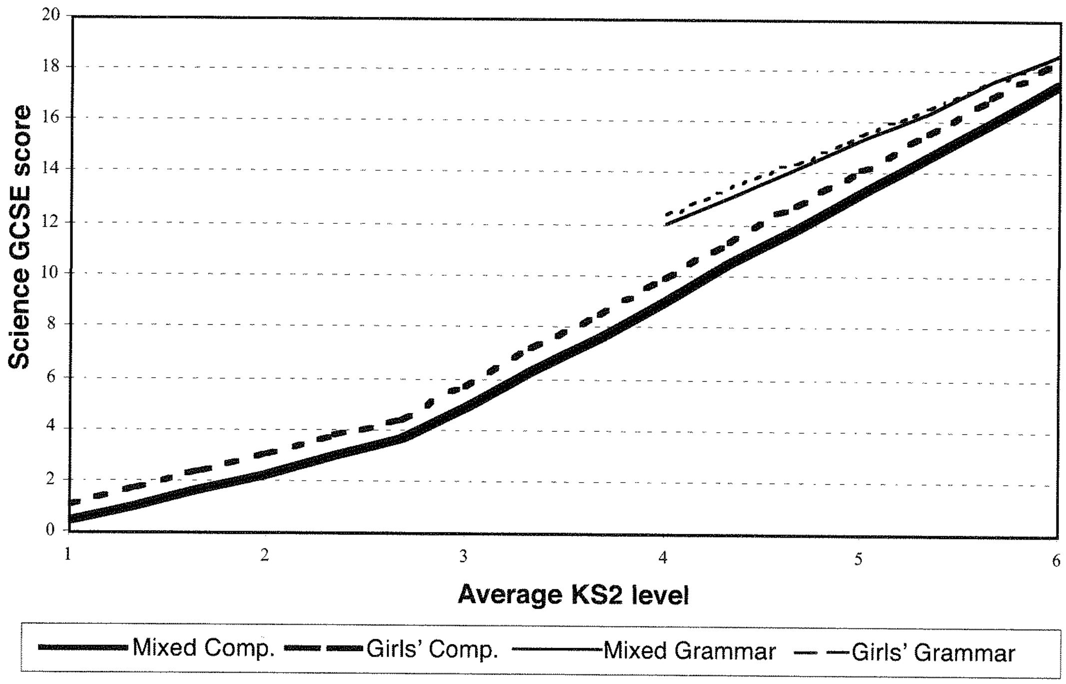


Figure A22 Relationship between average KS2 level and average science GCSE score for boys in various types of schools

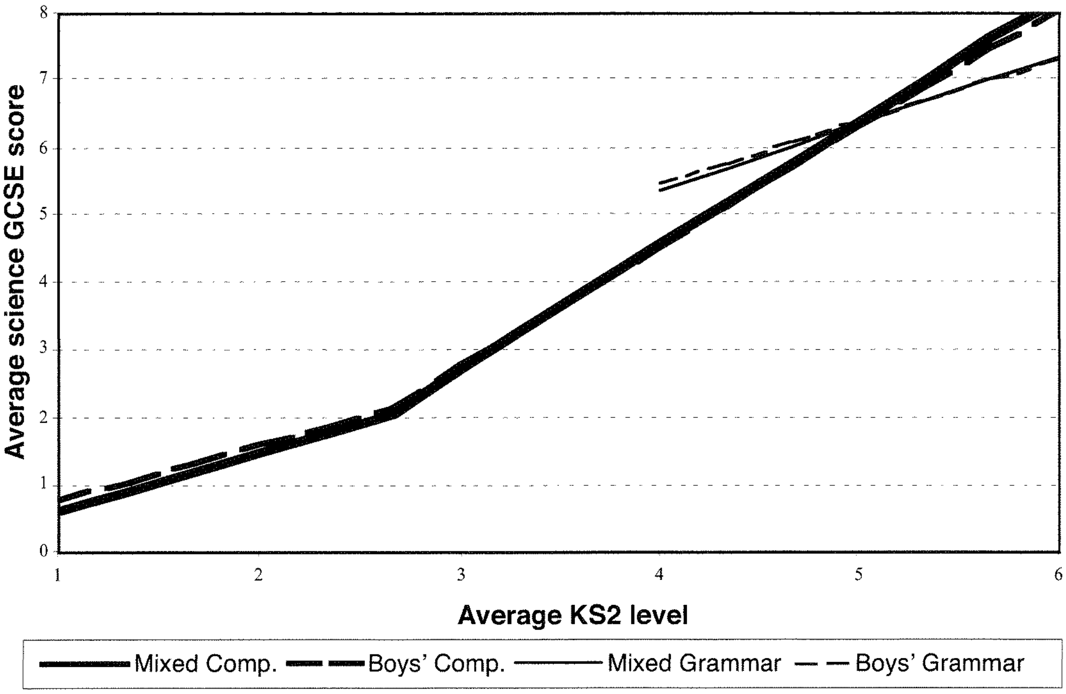


Figure A23 Relationship between average KS2 level and average science GCSE score for girls in various types of schools

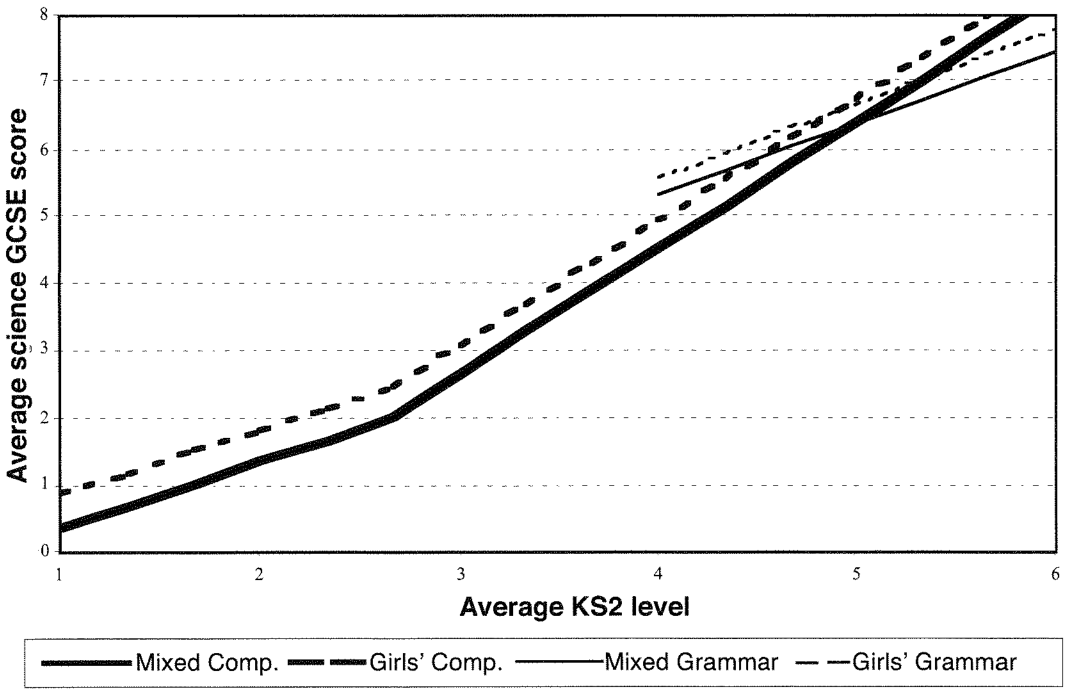


Figure A24 Relationship between average KS2 level and number of science GCSEs taken for boys in various types of schools

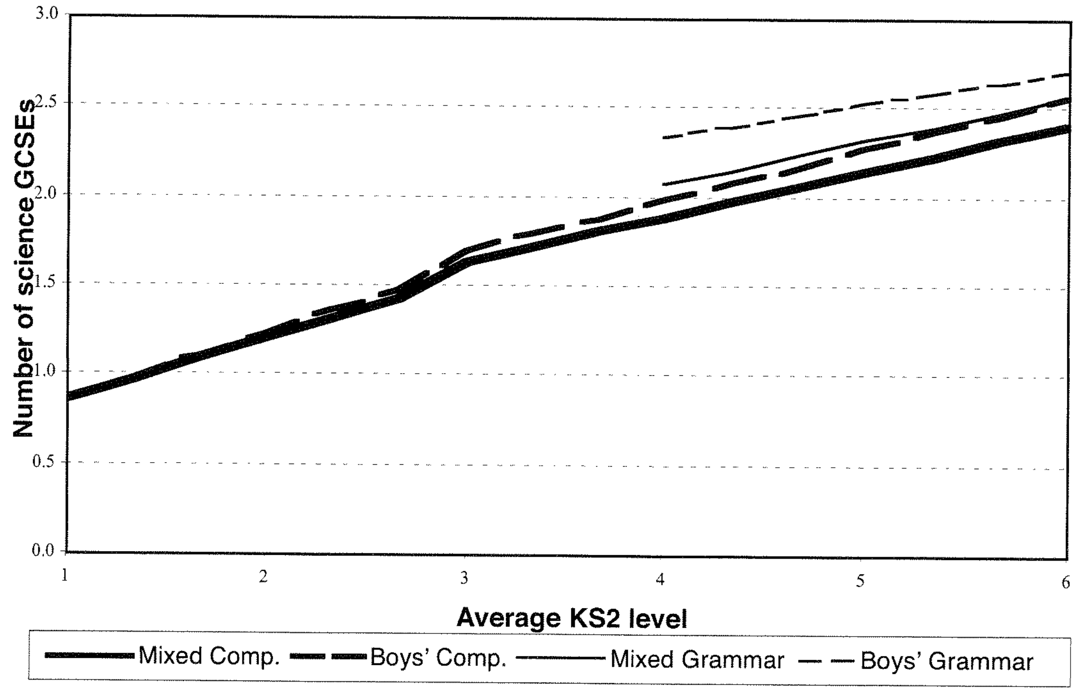


Figure A25 Relationship between average KS2 level and number of science GCSEs taken for girls in various types of schools

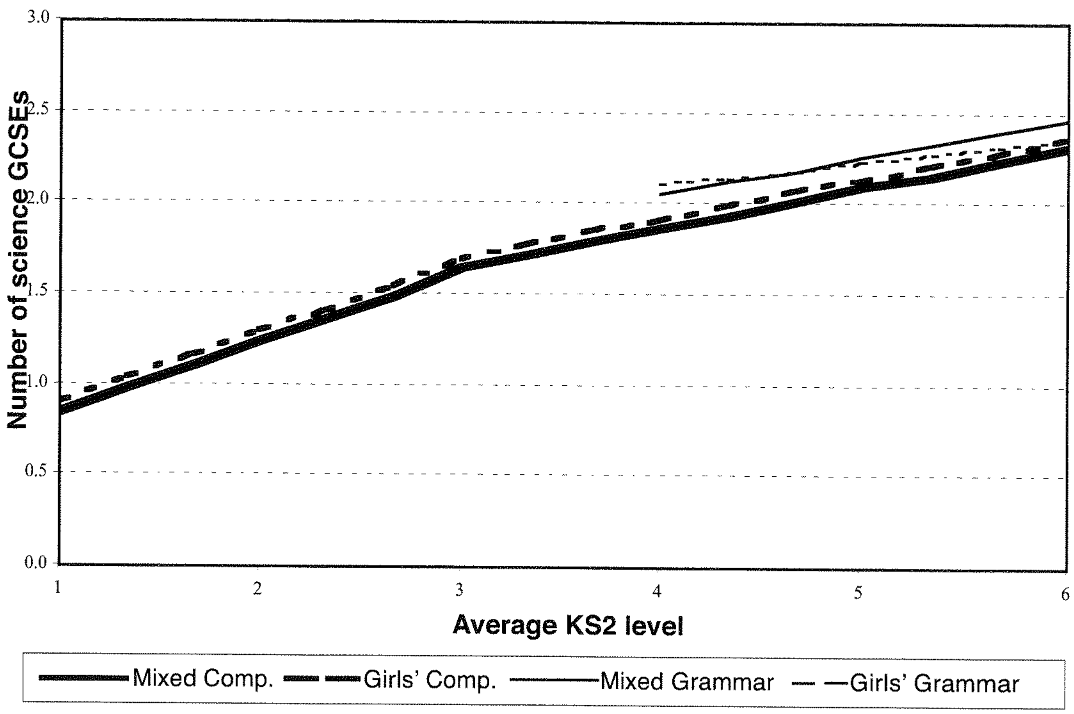


Table A5 Variables used in multilevel modelling

SPP	Variables defined for multilevel modelling			
		Range		
No.	Name	Min.	Max.	Description
1	LEA	202	938	LEA ID
2	SCHOOL	4000	6901	School ID
3	PUPIL	1	3.78E+05	Pupil ID
4	CONS	1	1	Constant term
5	TOTSCORE	0	138	Total GCSE points score
6	ENTRY	0	19	Number of GCSEs taken
7	AVSCORE	0	8	Average GCSE points score
8	MATHS	0	8	Maths GCSE score
9	ENGLISH	0	8	English GCSE score
10	SCIENCE	0	40	Total science GCSE score
11	AVSCI	0	8	Average Science GCSE score
12	NSCI	0	5	Number of science GCSEs taken
13	KS2AV	0	6	Average KS2 level
14	KS2M	0	6	KS2 Maths level
15	KS2E	0	6	KS2 English level
16	KS2S	0	6	KS2 Science level
17	SEX	1	2	Sex of pupil
18	AGE	189	200	Age of pupil
19	SEL	0	1	Grammar school indicator
20	PCSEL	0	38	Percentage of selection in LEA
21	PCFSM	0	84	Percentage of students eligible for FSM in school
22	BOYSCH	0	1	Boys' school indicator
23	GIRLSCH	0	1	Girls' school indicator
24	SIXTH	0	1	Indicator of sixth form availability
25	SIZE6TH	0	6.68	Size of sixth form (in hundreds)
26	SIZE	0.25	4.05	Number of Year 11s (in hundreds)
27	CLSIZE	14.4	43	Average size of one-teacher classes in school
28	LOWKS2	0	1	Indicator of whether KS2 average level is below 3
29	LOWKINT	0	2.667	Interaction of LOWKS2 and KS2AV
30	SELINT	-1.933	2.248	Interaction of SEL and KS2AV
31	SEXINT	-1.853	1.817	Interaction of SEX and KS2AV
32	SELPINT	-110.36	56.67	Interaction of PCSEL and KS2AV
33	FSMINT	-159.59	90.839	Interaction of PCFSM and KS2AV
34	SEL2INT	-48.466	54.686	Interaction of SEL, PCSEL and KS2AV
35	BOYSINT	-2.868	1.907	Interaction of BOYSCH and KS2AV
36	GIRLSINT	-3.126	1.871	Interaction of GIRLSCH and KS2AV
37	SIZEINT	-4.93	3.715	Interaction of SIZE and KS2AV
38	SEXLOW	-0.495	0.505	Interaction of SEX and LOWKS2
39	SXLOWINT	-1.32	1.347	Interaction of SEX, LOWKS2 and KS2AV
40	SELPCSEL	-3.792	32.878	Interaction of SEL and PCSEL
41	SEXSIZE	-1.044	1.066	Interaction of SEX and SIZE
42	BOYSIZE	-1.404	1.079	Interaction of BOYSCH and SIZE
43	GIRLSIZE	-1.518	0.806	Interaction of GIRLSCH and SIZE
44	FSMSIZE	-63.881	43.928	Interaction of PCFSM and SIZE
45	BOYSEL	-0.04	0.92	Interaction of BOYSCH and SEL
46	BOYSELI	-1.846	1.533	Interaction of BOYSCH, SEL and KS2AV
47	GIRLSEL	-0.06	0.9	Interaction of GIRLSCH and SEL
48	GIRLSELI	-1.209	1.805	Interaction of GIRLSCH, SEL and KS2AV
49	SELSIZE	-1.563	0.396	Interaction of SEL and SIZE
50	SIZE2	0.0625	16.4	Number of Year 11s (in hundreds) squared

Table A6 Multilevel analysis of total GCSE scores

Total GCSE score		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	11.200	1.988	*	7.304	15.096	
School variance	88.630	2.448	*	83.832	93.428	
Pupil variance	320.600	0.749	*	319.132	322.068	Percent
Final model						reduction
LEA variance	1.817	0.329	*	1.173	2.461	84%
School variance	14.110	0.422	*	13.283	14.937	84%
Pupil variance	181.200	0.423	*	180.370	182.030	43%
Fixed coefficients						
CONS	11.540	1.704	*	8.200	14.880	
KS2M	6.087	0.044	*	6.001	6.173	
KS2E	7.569	0.044	*	7.483	7.655	
KS2S	4.824	0.047	*	4.732	4.916	
SEX	3.321	0.053	*	3.218	3.424	
AGE	-0.250	0.006	*	-0.263	-0.237	
SEL	9.941	1.507	*	6.987	12.895	
PCSEL	-0.046	0.017	*	-0.080	-0.012	
PCFSM	-0.162	0.008	*	-0.179	-0.146	
BOYSCH	0.851	0.536		-0.199	1.902	
GIRLSCH	2.459	0.403	*	1.669	3.249	
SIXTH	-2.159	0.284	*	-2.716	-1.602	
SIZE6TH	1.717	0.148	*	1.428	2.006	
SIZE	3.874	0.668	*	2.565	5.183	
CLSIZE	0.081	0.046		-0.009	0.171	
LOWKS2	25.900	0.515	*	24.890	26.910	
LOWKINT	-9.814	0.207	*	-10.219	-9.409	
SELINT	-9.590	0.773	*	-11.104	-8.076	
SEXINT	0.135	0.088		-0.037	0.307	
SELPINT	-0.068	0.005	*	-0.077	-0.059	
FSMINT	-0.044	0.003	*	-0.049	-0.039	
SEL2INT	0.097	0.028	*	0.041	0.152	
BOYSINT	-0.601	0.190	*	-0.973	-0.228	
GIRLSINT	-0.341	0.161	*	-0.657	-0.025	
SIZEINT	0.166	0.061	*	0.047	0.285	
SEXLOW	-6.241	0.999	*	-8.200	-4.282	
SXLOWINT	2.099	0.405	*	1.305	2.893	
SELPCSEL	-0.059	0.043		-0.142	0.024	
SEXSIZE	0.197	0.080	*	0.040	0.354	
BOYSIZE	-0.354	0.789		-1.899	1.192	
GIRLSIZE	-1.790	0.728	*	-3.217	-0.363	
FSMSIZE	0.028	0.011	*	0.006	0.050	
BOYSEL	2.690	1.156	*	0.424	4.956	
BOYSELI	1.074	0.787		-0.468	2.616	
GIRLSEL	-1.851	1.143		-4.091	0.389	
GIRLSELI	0.063	0.775		-1.456	1.582	
SELSIZE	-3.365	1.299	*	-5.911	-0.819	
SIZE2	-1.124	0.172	*	-1.460	-0.788	

Table A7 Multilevel analysis of average GCSE scores

Average GCSE score		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.108	0.018	*	0.072	0.143	
School variance	0.709	0.020	*	0.671	0.748	
Pupil variance	2.755	0.006	*	2.742	2.768	Percent
Final model						reduction
LEA variance	0.011	0.002	*	0.007	0.015	89%
School variance	0.089	0.003	*	0.084	0.095	87%
Pupil variance	1.609	0.004	*	1.602	1.616	42%
Fixed coefficients						
CONS	2.083	0.151	*	1.787	2.379	
KS2M	0.552	0.004	*	0.544	0.560	
KS2E	0.674	0.004	*	0.666	0.682	
KS2S	0.451	0.004	*	0.442	0.460	
SEX	0.295	0.005	*	0.285	0.305	
AGE	-0.024	0.001	*	-0.025	-0.023	
SEL	1.045	0.127	*	0.796	1.294	
PCSEL	-0.003	0.001	*	-0.006	-0.001	
PCFSM	-0.016	0.001	*	-0.017	-0.015	
BOYSCH	0.066	0.043		-0.019	0.151	
GIRLSCH	0.272	0.033	*	0.208	0.336	
SIXTH	-0.242	0.023	*	-0.287	-0.196	
SIZE6TH	0.152	0.012	*	0.128	0.175	
SIZE	0.334	0.054	*	0.227	0.441	
CLSIZE	0.002	0.004		-0.005	0.010	
LOWKS2	2.312	0.049	*	2.217	2.407	
LOWKINT	-0.878	0.019	*	-0.916	-0.840	
SELINT	-0.884	0.073	*	-1.026	-0.741	
SEXINT	0.033	0.008	*	0.017	0.049	
SELPINT	-0.005	0.000	*	-0.006	-0.005	
FSMINT	-0.002	0.000	*	-0.002	-0.001	
SEL2INT	0.008	0.003	*	0.002	0.013	
BOYSINT	-0.073	0.018	*	-0.108	-0.038	
GIRLSINT	-0.068	0.015	*	-0.098	-0.038	
SIZEINT	0.025	0.006	*	0.014	0.036	
SEXLOW	-0.490	0.094	*	-0.674	-0.305	
SXLOWINT	0.164	0.038	*	0.090	0.239	
SELPCSEL	-0.004	0.004		-0.011	0.003	
SEXSIZE	0.020	0.008	*	0.005	0.034	
BOYSIZE	-0.028	0.064		-0.154	0.098	
GIRLSIZE	-0.113	0.059		-0.230	0.003	
FSMSIZE	0.002	0.001	*	0.001	0.004	
BOYSEL	0.083	0.099		-0.111	0.276	
BOYSELI	0.073	0.074		-0.072	0.218	
GIRLSEL	-0.247	0.098	*	-0.438	-0.055	
GIRLSELI	0.092	0.073		-0.050	0.235	
SELSIZE	-0.203	0.106		-0.411	0.005	
SIZE2	-0.093	0.014	*	-0.121	-0.066	

Table A8 Multilevel analysis of number of GCSEs taken

Number of GCSEs taken		Multilevel results				
				95% confidence interval		
Parameter	**Estimate**	**Standard error**	**Sig.**	**Min.**	**Max.**	
Base case						
LEA variance	0.109	0.020	*	0.070	0.147	
School variance	0.895	0.025	*	0.845	0.945	
Pupil variance	6.193	0.014	*	6.165	6.221	Percent
Final model						reduction
LEA variance	0.039	0.008	*	0.024	0.055	63%
School variance	0.439	0.013	*	0.413	0.464	51%
Pupil variance	5.215	0.012	*	5.191	5.239	16%
Fixed coefficients						
CONS	10.550	0.292	*	9.978	11.122	
KS2M	0.300	0.007	*	0.285	0.314	
KS2E	0.570	0.007	*	0.556	0.585	
KS2S	0.276	0.008	*	0.260	0.291	
SEX	0.188	0.009	*	0.171	0.205	
AGE	-0.037	0.001	*	-0.039	-0.034	
SEL	0.143	0.262		-0.371	0.658	
PCSEL	-0.003	0.003		-0.008	0.003	
PCFSM	-0.015	0.001	*	-0.018	-0.012	
BOYSCH	0.035	0.094		-0.149	0.218	
GIRLSCH	0.098	0.071		-0.040	0.236	
SIXTH	-0.156	0.049	*	-0.253	-0.059	
SIZE6TH	0.142	0.026	*	0.091	0.192	
SIZE	0.590	0.117	*	0.361	0.818	
CLSIZE	0.017	0.008	*	0.001	0.033	
LOWKS2	-2.481	0.087	*	-2.652	-2.310	
LOWKINT	0.682	0.035	*	0.613	0.751	
SELINT	-0.803	0.131	*	-1.060	-0.546	
SEXINT	-0.246	0.015	*	-0.276	-0.217	
SELPINT	-0.004	0.001	*	-0.005	-0.002	
FSMINT	0.004	0.000	*	0.003	0.005	
SEL2INT	0.007	0.005		-0.002	0.017	
BOYSINT	-0.161	0.032	*	-0.224	-0.098	
GIRLSINT	-0.118	0.027	*	-0.172	-0.064	
SIZEINT	-0.041	0.010	*	-0.061	-0.020	
SEXLOW	-1.265	0.170	*	-1.597	-0.933	
SXLOWINT	0.546	0.069	*	0.411	0.681	
SELPCSEL	-0.003	0.007		-0.017	0.012	
SEXSIZE	-0.003	0.014		-0.029	0.024	
BOYSIZE	-0.060	0.138		-0.331	0.210	
GIRLSIZE	-0.179	0.127		-0.428	0.071	
FSMSIZE	0.005	0.002	*	0.001	0.009	
BOYSEL	0.568	0.201	*	0.175	0.961	
BOYSELI	-0.010	0.134		-0.271	0.252	
GIRLSEL	-0.005	0.198		-0.393	0.384	
GIRLSELI	0.071	0.132		-0.187	0.329	
SELSIZE	-0.490	0.227	*	-0.936	-0.044	
SIZE2	-0.152	0.030	*	-0.211	-0.093	

Table A9 Multilevel analysis of mathematics GCSE scores

Maths GCSE score		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.126	0.021	*	0.084	0.167	
School variance	0.852	0.024	*	0.806	0.898	
Pupil variance	3.442	0.008	*	3.426	3.458	Percent
Final model						reduction
LEA variance	0.010	0.002	*	0.006	0.015	91%
School variance	0.132	0.004	*	0.124	0.140	84%
Pupil variance	1.923	0.004	*	1.914	1.932	44%
Fixed coefficients						
CONS	2.602	0.171	*	2.268	2.936	
KS2M	0.972	0.005	*	0.964	0.981	
KS2E	0.514	0.005	*	0.505	0.523	
KS2S	0.433	0.005	*	0.423	0.442	
SEX	-0.030	0.005	*	-0.041	-0.020	
AGE	-0.029	0.001	*	-0.030	-0.028	
SEL	1.153	0.148	*	0.862	1.444	
PCSEL	-0.003	0.001	*	-0.006	0.000	
PCFSM	-0.016	0.001	*	-0.017	-0.014	
BOYSCH	0.075	0.052		-0.027	0.177	
GIRLSCH	0.323	0.039	*	0.247	0.400	
SIXTH	-0.229	0.027	*	-0.283	-0.175	
SIZE6TH	0.138	0.014	*	0.110	0.166	
SIZE	0.291	0.065	*	0.164	0.418	
CLSIZE	0.000	0.004		-0.009	0.008	
LOWKS2	2.694	0.053	*	2.590	2.798	
LOWKINT	-1.041	0.021	*	-1.083	-0.999	
SELINT	-1.100	0.080	*	-1.256	-0.944	
SEXINT	0.016	0.009		-0.002	0.033	
SELPINT	-0.005	0.000	*	-0.006	-0.004	
FSMINT	-0.001	0.000	*	-0.002	-0.001	
SEL2INT	0.010	0.003	*	0.005	0.016	
BOYSINT	-0.089	0.020	*	-0.128	-0.051	
GIRLSINT	-0.096	0.017	*	-0.128	-0.063	
SIZEINT	0.031	0.006	*	0.018	0.043	
SEXLOW	-0.356	0.103	*	-0.558	-0.154	
SXLOWINT	0.137	0.042	*	0.055	0.218	
SELPCSEL	-0.005	0.004		-0.013	0.004	
SEXSIZE	-0.002	0.008		-0.018	0.014	
BOYSIZE	-0.023	0.077		-0.173	0.128	
GIRLSIZE	-0.053	0.071		-0.191	0.086	
FSMSIZE	0.003	0.001	*	0.000	0.005	
BOYSEL	0.110	0.115		-0.115	0.334	
BOYSELI	0.068	0.081		-0.090	0.227	
GIRLSEL	-0.176	0.113		-0.397	0.046	
GIRLSELI	0.081	0.080		-0.075	0.237	
SELSIZE	-0.279	0.126	*	-0.527	-0.031	
SIZE2	-0.078	0.017	*	-0.111	-0.046	

Table A10. Multilevel analysis of English GCSE scores

English GCSE score		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.088	0.017	*	0.056	0.121	
School variance	0.851	0.024	*	0.805	0.897	
Pupil variance	3.554	0.008	*	3.538	3.570	Percent
Final model						reduction
LEA variance	0.013	0.003	*	0.008	0.019	84%
School variance	0.177	0.005	*	0.167	0.187	79%
Pupil variance	2.086	0.005	*	2.076	2.096	41%
Fixed coefficients						
CONS	0.583	0.184	*	0.222	0.945	
KS2M	0.434	0.005	*	0.425	0.443	
KS2E	0.949	0.005	*	0.940	0.958	
KS2S	0.386	0.005	*	0.376	0.395	
SEX	0.539	0.006	*	0.528	0.550	
AGE	-0.021	0.001	*	-0.022	-0.020	
SEL	1.015	0.166	*	0.689	1.341	
PCSEL	-0.005	0.002	*	-0.008	-0.002	
PCFSM	-0.013	0.001	*	-0.015	-0.011	
BOYSCH	0.098	0.059		-0.019	0.214	
GIRLSCH	0.256	0.045	*	0.168	0.343	
SIXTH	-0.238	0.031	*	-0.299	-0.177	
SIZE6TH	0.157	0.016	*	0.125	0.189	
SIZE	0.440	0.074	*	0.295	0.584	
CLSIZE	0.008	0.005		-0.002	0.018	
LOWKS2	1.847	0.055	*	1.739	1.955	
LOWKINT	-0.747	0.022	*	-0.790	-0.703	
SELINT	-1.103	0.083	*	-1.266	-0.940	
SEXINT	-0.112	0.009	*	-0.130	-0.093	
SELPINT	-0.005	0.001	*	-0.006	-0.004	
FSMINT	-0.002	0.000	*	-0.003	-0.001	
SEL2INT	0.007	0.003	*	0.001	0.013	
BOYSINT	-0.082	0.020	*	-0.122	-0.042	
GIRLSINT	-0.083	0.017	*	-0.117	-0.049	
SIZEINT	-0.012	0.007		-0.025	0.000	
SEXLOW	-1.142	0.107	*	-1.352	-0.932	
SXLOWINT	0.359	0.043	*	0.274	0.444	
SELPCSEL	0.001	0.005		-0.008	0.010	
SEXSIZE	0.004	0.009		-0.013	0.021	
BOYSIZE	-0.109	0.088		-0.281	0.063	
GIRLSIZE	-0.137	0.081		-0.295	0.022	
FSMSIZE	0.002	0.001		0.000	0.005	
BOYSEL	0.262	0.127	*	0.013	0.511	
BOYSELI	-0.043	0.084		-0.209	0.122	
GIRLSEL	-0.240	0.126		-0.486	0.006	
GIRLSELI	0.106	0.083		-0.057	0.269	
SELSIZE	-0.318	0.144	*	-0.600	-0.035	
SIZE2	-0.118	0.019	*	-0.155	-0.081	

Table A11 Multilevel analysis of total science GCSE scores

Science GCSE score		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.629	0.114	*	0.407	0.852	
School variance	5.288	0.145	*	5.003	5.573	
Pupil variance	16.630	0.039	*	16.554	16.706	Percent
Final model						reduction
LEA variance	0.097	0.020	*	0.057	0.137	84%
School variance	1.166	0.034	*	1.100	1.232	78%
Pupil variance	10.210	0.024	*	10.163	10.257	39%
Fixed coefficients						
CONS	4.128	0.438	*	3.270	4.986	
KS2M	1.428	0.010	*	1.408	1.448	
KS2E	1.277	0.010	*	1.257	1.297	
KS2S	1.451	0.011	*	1.429	1.473	
SEX	-0.146	0.012	*	-0.171	-0.122	
AGE	-0.059	0.002	*	-0.062	-0.056	
SEL	3.214	0.411	*	2.408	4.020	
PCSEL	-0.018	0.004	*	-0.026	-0.009	
PCFSM	-0.038	0.002	*	-0.042	-0.033	
BOYSCH	0.212	0.151		-0.084	0.508	
GIRLSCH	0.715	0.114	*	0.492	0.937	
SIXTH	-0.583	0.079	*	-0.739	-0.428	
SIZE6TH	0.326	0.041	*	0.244	0.407	
SIZE	0.650	0.187	*	0.284	1.017	
CLSIZE	0.013	0.013		-0.013	0.038	
LOWKS2	6.306	0.122	*	6.066	6.546	
LOWKINT	-2.334	0.049	*	-2.430	-2.238	
SELINT	-0.887	0.184	*	-1.248	-0.527	
SEXINT	0.006	0.021		-0.035	0.047	
SELPINT	-0.016	0.001	*	-0.019	-0.014	
FSMINT	-0.010	0.001	*	-0.011	-0.009	
SEL2INT	0.030	0.007	*	0.017	0.043	
BOYSINT	0.096	0.045	*	0.008	0.185	
GIRLSINT	0.028	0.038		-0.048	0.103	
SIZEINT	0.136	0.014	*	0.108	0.164	
SEXLOW	-0.533	0.237	*	-0.998	-0.068	
SXLOWINT	0.227	0.096	*	0.039	0.416	
SELPCSEL	-0.045	0.011	*	-0.067	-0.023	
SEXSIZE	0.017	0.019		-0.020	0.054	
BOYSIZE	0.001	0.221		-0.433	0.434	
GIRLSIZE	0.027	0.205		-0.374	0.427	
FSMSIZE	0.007	0.003	*	0.000	0.013	
BOYSEL	0.983	0.310	*	0.375	1.591	
BOYSELI	-0.167	0.187		-0.534	0.199	
GIRLSEL	-0.287	0.307		-0.888	0.314	
GIRLSELI	-0.234	0.184		-0.596	0.127	
SELSIZE	-0.407	0.364		-1.120	0.307	
SIZE2	-0.176	0.048	*	-0.270	-0.081	

Table A12 Multilevel analysis of average science GCSE scores

Average science GCSE score	Multilevel results					
				95% confidence interval		
Parameter	**Estimate**	**Standard error**	**Sig.**	**Min.**	**Max.**	
Base case						
LEA variance	0.130	0.021	*	0.088	0.172	
School variance	0.794	0.022	*	0.751	0.837	
Pupil variance	3.343	0.008	*	3.328	3.358	Percent
Final model						reduction
LEA variance	0.018	0.003	*	0.011	0.025	86%
School variance	0.158	0.005	*	0.149	0.167	80%
Pupil variance	2.051	0.005	*	2.042	2.060	39%
Fixed coefficients						
CONS	2.977	0.180	*	2.624	3.330	
KS2M	0.612	0.005	*	0.603	0.621	
KS2E	0.578	0.005	*	0.569	0.587	
KS2S	0.625	0.005	*	0.615	0.635	
SEX	-0.040	0.006	*	-0.051	-0.029	
AGE	-0.029	0.001	*	-0.030	-0.027	
SEL	1.068	0.160	*	0.755	1.381	
PCSEL	-0.004	0.002	*	-0.008	-0.001	
PCFSM	-0.017	0.001	*	-0.019	-0.016	
BOYSCH	-0.068	0.057		-0.179	0.043	
GIRLSCH	0.350	0.043	*	0.266	0.433	
SIXTH	-0.219	0.030	*	-0.278	-0.160	
SIZE6TH	0.123	0.016	*	0.093	0.154	
SIZE	0.240	0.071	*	0.102	0.379	
CLSIZE	0.004	0.005		-0.006	0.013	
LOWKS2	2.371	0.055	*	2.264	2.478	
LOWKINT	-0.911	0.022	*	-0.954	-0.868	
SELINT	-0.827	0.082	*	-0.988	-0.666	
SEXINT	0.057	0.009	*	0.039	0.075	
SELPINT	-0.006	0.001	*	-0.007	-0.005	
FSMINT	-0.001	0.000	*	-0.002	-0.001	
SEL2INT	0.010	0.003	*	0.004	0.016	
BOYSINT	-0.074	0.020	*	-0.113	-0.034	
GIRLSINT	-0.042	0.017	*	-0.076	-0.008	
SIZEINT	0.025	0.006	*	0.012	0.037	
SEXLOW	-0.117	0.106		-0.325	0.092	
SXLOWINT	0.066	0.043		-0.018	0.151	
SELPCSEL	-0.008	0.005		-0.016	0.001	
SEXSIZE	0.014	0.009		-0.003	0.031	
BOYSIZE	-0.040	0.083		-0.204	0.123	
GIRLSIZE	-0.005	0.077		-0.156	0.146	
FSMSIZE	0.002	0.001		0.000	0.004	
BOYSEL	0.115	0.123		-0.125	0.355	
BOYSELI	0.022	0.084		-0.142	0.186	
GIRLSEL	-0.174	0.121		-0.411	0.064	
GIRLSELI	0.115	0.082		-0.046	0.277	
SELSIZE	-0.067	0.138		-0.337	0.203	
SIZE2	-0.067	0.018	*	-0.103	-0.032	

Table A13 Multilevel analysis of number of science GCSEs taken

Number of science GCSEs		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.005	0.001	*	0.003	0.007	
School variance	0.066	0.002	*	0.062	0.069	
Pupil variance	0.338	0.001	*	0.336	0.340	Percent
Final model						reduction
LEA variance	0.002	0.000	*	0.001	0.003	65%
School variance	0.039	0.001	*	0.037	0.041	41%
Pupil variance	0.303	0.001	*	0.302	0.305	10%
Fixed coefficients						
CONS	2.224	0.077	*	2.073	2.375	
KS2M	0.068	0.002	*	0.065	0.072	
KS2E	0.091	0.002	*	0.088	0.095	
KS2S	0.078	0.002	*	0.074	0.081	
SEX	-0.013	0.002	*	-0.017	-0.008	
AGE	-0.007	0.000	*	-0.007	-0.006	
SEL	0.211	0.074	*	0.066	0.355	
PCSEL	-0.002	0.001	*	-0.004	-0.001	
PCFSM	-0.003	0.000	*	-0.004	-0.003	
BOYSCH	0.052	0.027		-0.001	0.105	
GIRLSCH	0.031	0.020		-0.009	0.071	
SIXTH	-0.072	0.014	*	-0.100	-0.044	
SIZE6TH	0.028	0.007	*	0.013	0.042	
SIZE	0.117	0.034	*	0.051	0.183	
CLSIZE	0.002	0.002		-0.002	0.007	
LOWKS2	-0.422	0.021	*	-0.463	-0.380	
LOWKINT	0.120	0.008	*	0.103	0.136	
SELINT	-0.021	0.032		-0.083	0.041	
SEXINT	-0.035	0.004	*	-0.042	-0.028	
SELPINT	0.000	0.000	*	-0.001	0.000	
FSMINT	0.001	0.000	*	0.000	0.001	
SEL2INT	0.002	0.001	*	0.000	0.005	
BOYSINT	0.029	0.008	*	0.014	0.045	
GIRLSINT	-0.006	0.007		-0.019	0.007	
SIZEINT	0.016	0.002	*	0.011	0.021	
SEXLOW	-0.173	0.041	*	-0.253	-0.092	
SXLOWINT	0.078	0.017	*	0.045	0.110	
SELPCSEL	-0.004	0.002		-0.008	0.000	
SEXSIZE	-0.003	0.003		-0.009	0.004	
BOYSIZE	0.014	0.040		-0.064	0.092	
GIRLSIZE	0.019	0.037		-0.053	0.091	
FSMSIZE	0.001	0.001	*	0.000	0.002	
BOYSEL	0.192	0.055	*	0.084	0.301	
BOYSELI	-0.086	0.032	*	-0.149	-0.023	
GIRLSEL	0.040	0.055		-0.068	0.147	
GIRLSELI	-0.078	0.032	*	-0.140	-0.015	
SELSIZE	-0.108	0.066		-0.237	0.020	
SIZE2	-0.027	0.009	*	-0.043	-0.010	

Table A14 Summary of multilevel modelling coefficients

	RESPONSE							
PREDICTOR	Totscore	Avscore	Entry	Maths	English	Science	Avsci	Nsci
KS2M	PPP	PPP	P	PPP	PP	PPP	PPP	P
KS2E	PPP	PPP	PP	PPP	PPP	PPP	PPP	PP
KS2S	PP	PP	P	PP	PP	PPP	PPP	P
SEX	P	P	p	n	PP	n	n	n
AGE	n	n	n	n	n	n	n	n
SEL	P	PP		PP	P	PP	P	P
PCSEL	n	n		n	n	n	n	n
PCFSM	NN	NN	N	N	N	NN	NN	N
BOYSCH								
GIRLSCH	p	p		p	p	p	p	
SIXTH	N	N	n	N	N	N	N	N
SIZE6TH	P	P	P	P	P	P	P	p
SIZE	PP	PP	PP	P	PP	P	P	PP
CLSIZE			p					
LOWKS2	PPP	PPP	NNN	PPP	PPP	PPP	PPP	NNN
LOWKINT	NNN	NNN	PP	NNN	NNN	NNN	NNN	PP
SELINT	N	N	N	N	N	n	N	
SEXINT		p	n		n		p	n
SELPINT	n	n	n	n	n	n	n	n
FSMINT	n	n	p	n	n	n	n	p
SEL2INT	p	p		p	p	p	p	p
BOYSINT	n	n	n	n	n	p	n	p
GIRLSINT	n	n	n	n	n		n	
SIZEINT	p	p	n	p		p	p	p
SEXLOW	N	n	N	n	N	n		n
SXLOWINT	p	p	P	p	P	p		p
SELPCSEL						n		
SEXSIZE	p	p						
BOYSIZE								
GIRLSIZE	n							
FSMSIZE	p	p	p	p		p		p
BOYSEL	p		p		p	p		p
BOYSELI								n
GIRLSEL		n						
GIRLSELI								n
SELSIZE	n		n	n	n			
SIZE2	NN	NN	NN	N	NN	N	N	NN

PPP	Significant Positive Coefficient with Normalised Coefficient % >20
PP	Significant Positive Coefficient with Normalised Coefficient % >10
P	Significant Positive Coefficient with Normalised Coefficient % >5
p	Significant Positive Coefficient with Normalised Coefficient % <=5
NNN	Significant Negative Coefficient with Normalised Coefficient % <-20
NN	Significant Negative Coefficient with Normalised Coefficient % <-10
N	Significant Negative Coefficient with Normalised Coefficient % <-5
n	Significant Negative Coefficient with Normalised Coefficient % >=-5
(Blank)	No Significant Effect

2. Analysis of the National Value-Added Dataset from Key Stage 1 1997 to Key Stage 2 2001

The national value-added dataset used contained the key stage 2 (2001) results of 31,748 pupils in 979 schools, linked to their key stage 1 performance in 1997. Progress from key stage 1 to key stage 2 was analysed to see if there were significant effects related to various aspects of school size.

Models fitted and background variables
Four key stage 2 outcomes were investigated:

- average level
- mathematics level
- English level
- science level.

The following background variables were included in the model:

pupil-level

- prior attainment (level achieved at key stage 1 in reading, writing, mathematics and spelling)
- whether spelling test was taken
- sex (girl or boy)
- age of pupil (in years and months)

school-level

- percentage of pupils eligible for free school meals
- whether school is a junior, middle or primary school
- number of Year 6 pupils in the school
- number of Year 4 pupils in the school.

In addition, extra variables were created which allow for interactions between these predictor variables. Some of these allowed for the fact that the relationship between prior attainment and outcome may be affected by background factors. Background variables that it was thought may affect the relationship between KS1 levels and KS2 levels were:

- sex of pupils
- percentage of pupils in school eligible for free school meals
- number of Year 6 pupils in school.

Table A15 provides a full list of all the variables used in the multilevel modelling.

Summary of results

Tables A16–A19 provide details of the multilevel analysis of each of the key stage 2 outcomes. Each table shows the variances at each level in the 'base case' (with no background variables), and the results for the final model. Coefficient signs and sizes for each outcome are summarised in Table A20.

Figures A26–A29 show normalised coefficients (also known as standardised coefficients or partial correlation) for each model. These measure the 'strength' of the relationship between each predictor and the relevant outcome given all the other background variables. It indicates how serious it would be to drop any one of the variables.

Gender differences were significant for all outcomes. Boys performed better than girls of similar prior attainment in mathematics, science, and on average, while girls performed better in English. There was some evidence of interaction between sex and prior attainment, with boys showing greater differentiation between differing levels of prior attainment than girls for mathematics, science and average level.

The main aim of the study was to assess the impact of school size. It can be seen in each of Figures A26–A29 that there is some uncertainty in the model over the size of the effects of each of the variables relating to school size. This is due to the relatively small size of the dataset (only nine LEAs, about 1,000 schools and around 32,000 pupils). Due to this uncertainty most of the variables relating to school size did not show significant effects for many outcomes.

There is a little evidence for a negative impact of junior and middle schools (as opposed to primary schools). Junior schools had a negative effect on mathematics, science and average key stage 2 levels. That is, pupils in junior schools appear to perform less well than those of similar prior attainment in primary schools. Middle schools had an even larger negative effect on mathematics and average levels attained.

There was some evidence of interactions relating to the number of Year 6 pupils in a school. For key stage 2 mathematics, there is a significant positive interaction between the number of Year 6 pupils and prior attainment. That is, in larger year groups there is a greater difference in mathematics achievement between pupils of differing prior attainment.

Although there were a few indications about effects relating to school size, no clear picture emerged. As mentioned above, this may be due to the relatively small size of the dataset being used.

Figure A26 Normalised coefficients for average KS2 level

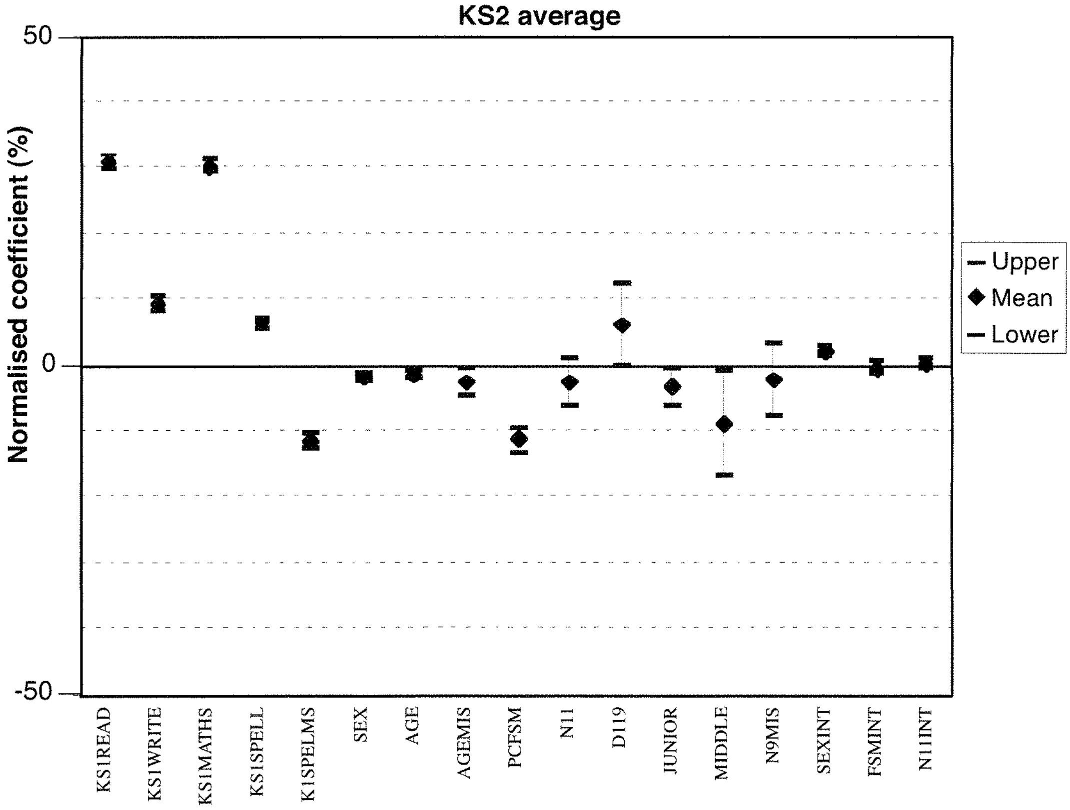


Figure A27 Normalised coefficients for KS2 mathematics level

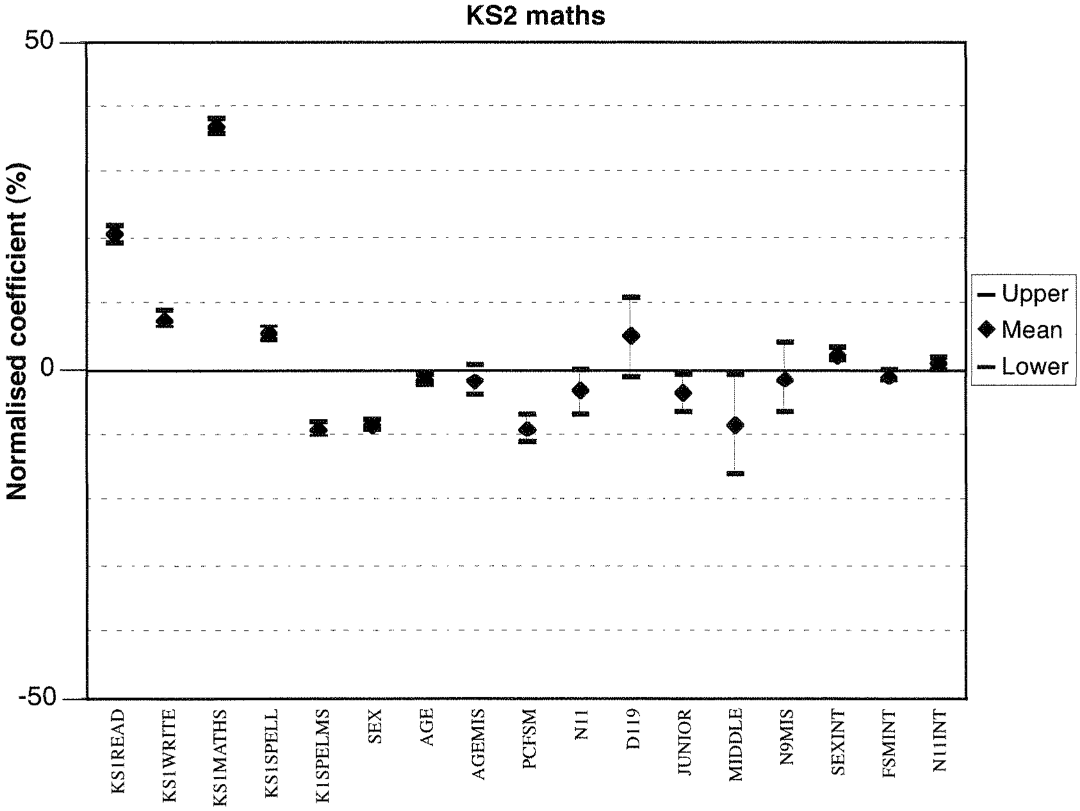


Figure A28 Normalised coefficients for KS2 English level

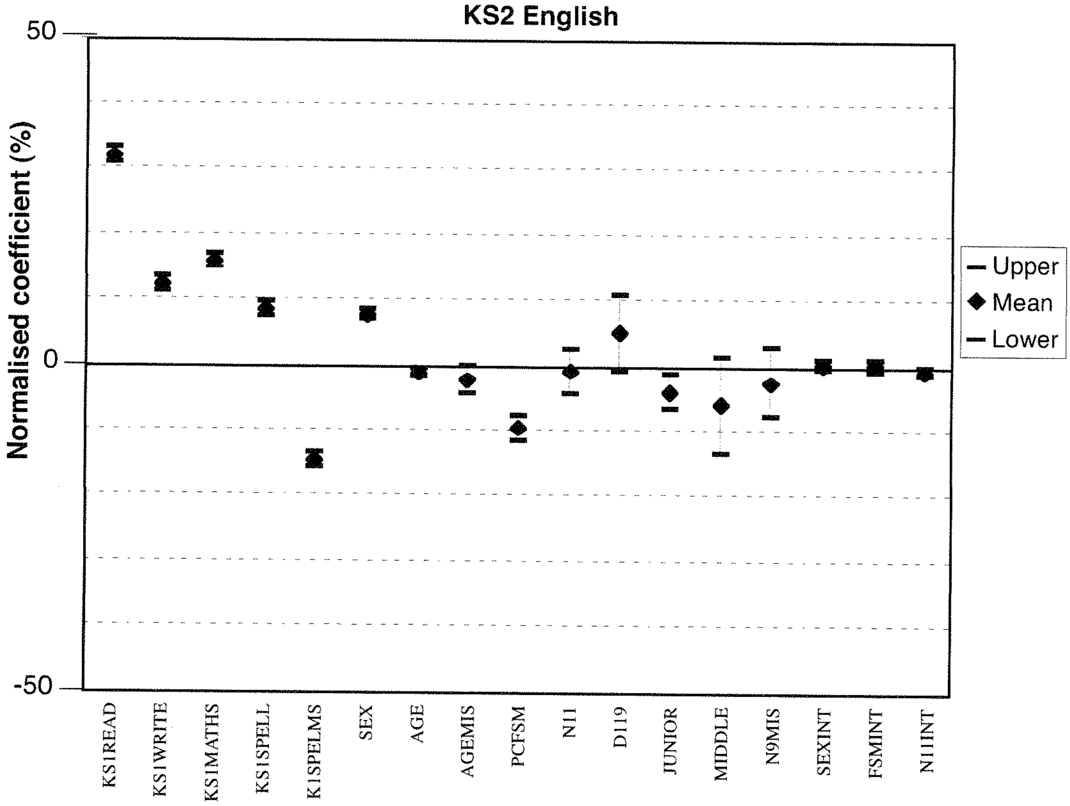


Figure A29 Normalised coefficients for KS2 science level

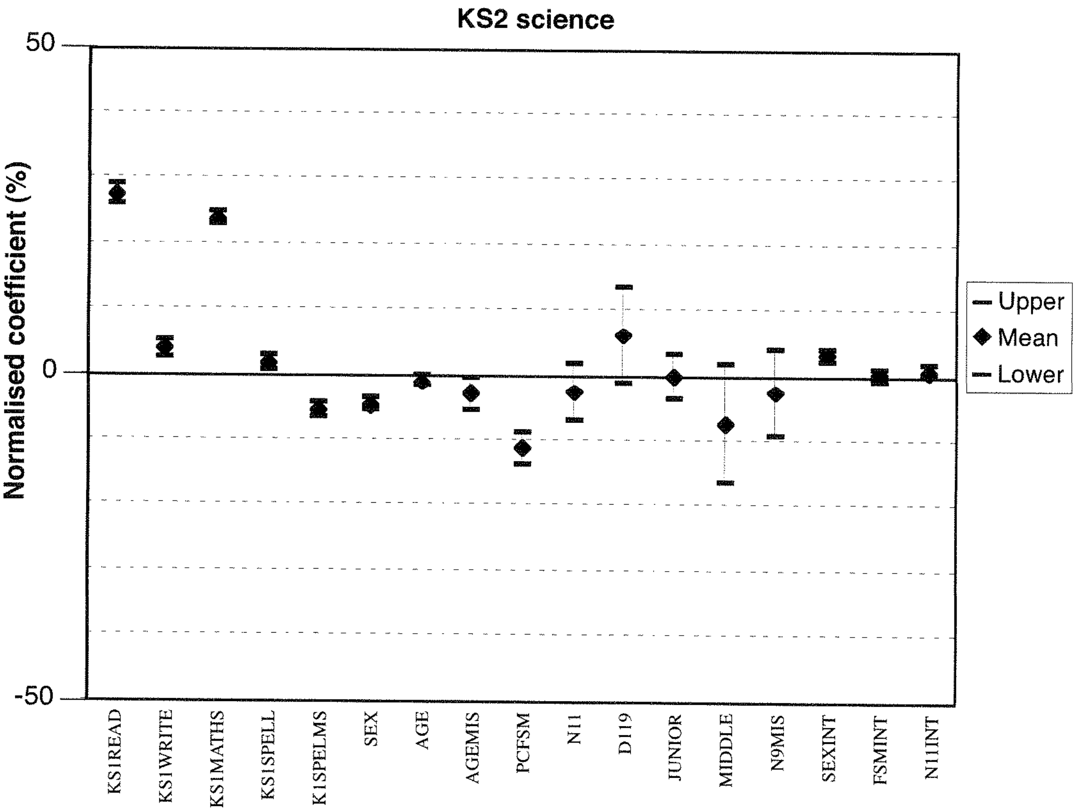


Table A15 Variables used in multilevel modelling

SPP	Variables defined for multilevel modelling			
		Range		
No.	Name	Min.	Max.	Description
1	LEA	207	937	LEA ID
2	SCHOOL	2000	5403	School ID
3	PUPIL	1	32139	Pupil ID
4	CONS	1	1	Constant
5	KS2AV	1	6	KS2 average level
6	KS2M	1	6	KS2 maths level
7	KS2E	1	6	KS2 English level
8	KS2S	1	8	KS2 science level
9	KS1AV	0	4	KS1 average level
10	KS1READ	0	4	KS1 reading level
11	KS1WRITE	0	4	KS1 writing level
12	KS1MATHS	0	4	KS1 maths level
13	KS1SPELL	0	4	KS1 spelling level
14	K1SPELMS	0	1	Indicator of whether KS1 spelling is missing
15	SEX	1	2	Sex of pupil
16	AGE	117	148	Age of pupil in months
17	AGEMIS	0	1	Indicator of whether AGE is missing
18	PCFSM	0	89	Percentage FSM in school
19	N11	0.2	22.4	Number of 11 year olds in school (in tens)
20	N9	0.3	19.2	Number of 9 year olds in school (in tens)
21	D119	-4.8	16.9	Difference between N11 and N9
22	JUNIOR	0	1	Junior School
23	MIDDLE	0	1	Middle School
24	N9MIS	0	1	Indicator of whether N9 is missing
25	SEXINT	-1.03	1.03	Interaction of SEX and KS1AV
26	FSMINT	-124.77	41.896	Interaction of PCFSM and KS1AV
27	N11INT	-31.394	22.558	Interaction of N11 and KS1AV

Table A16 Multilevel analysis of average KS2 level

KS2 average		**Multilevel results**				
				95% confidence interval		
Parameter	**Estimate**	**Standard error**	**Sig.**	**Min.**	**Max.**	
Base case						
LEA variance	0.009	0.004		0.000	0.017	
School variance	0.057	0.003	*	0.051	0.064	
Pupil variance	0.344	0.003	*	0.338	0.349	Percent
Final model						reduction
LEA variance	0.009	0.005	*	0.000	0.018	-5%
School variance	0.028	0.002	*	0.025	0.031	51%
Pupil variance	0.171	0.001	*	0.169	0.174	50%
Fixed coefficients						
CONS	3.753	0.279	*	3.206	4.300	
KS1READ	0.293	0.006	*	0.283	0.304	
KS1WRITE	0.117	0.006	*	0.105	0.130	
KS1MATHS	0.328	0.005	*	0.317	0.338	
KS1SPELL	0.075	0.006	*	0.064	0.086	
K1SPELMS	-0.157	0.007	*	-0.170	-0.144	
SEX	-0.024	0.005	*	-0.033	-0.014	
AGE	-0.008	0.002	*	-0.012	-0.004	
AGEMIS	-0.050	0.023	*	-0.096	-0.005	
PCFSM	-0.005	0.000	*	-0.006	-0.004	
N11	-0.005	0.003		-0.011	0.002	
D119	0.016	0.008		0.000	0.032	
JUNIOR	-0.049	0.024	*	-0.095	-0.003	
MIDDLE	-0.238	0.111	*	-0.456	-0.021	
N9MIS	-0.056	0.074		-0.201	0.089	
SEXINT	0.056	0.009	*	0.038	0.075	
FSMINT	0.000	0.000		-0.001	0.001	
N11INT	0.001	0.001		-0.002	0.004	

Table A17 Multilevel analysis of KS2 mathematics level

KS2 maths		Multilevel results				
				95% confidence interval		
Parameter	**Estimate**	**Standard error**	**Sig.**	**Min.**	**Max.**	
Base case						
LEA variance	0.009	0.005		0.000	0.018	
School variance	0.073	0.004	*	0.064	0.082	
Pupil variance	0.585	0.005	*	0.576	0.594	Percent
Final model						reduction
LEA variance	0.011	0.005	*	0.000	0.021	-18%
School variance	0.040	0.002	*	0.035	0.044	46%
Pupil variance	0.346	0.003	*	0.341	0.352	41%
Fixed coefficients						
CONS	3.870	0.395	*	3.096	4.644	
KS1READ	0.250	0.008	*	0.235	0.265	
KS1WRITE	0.122	0.009	*	0.104	0.140	
KS1MATHS	0.514	0.008	*	0.499	0.529	
KS1SPELL	0.081	0.008	*	0.065	0.096	
K1SPELMS	-0.158	0.009	*	-0.177	-0.140	
SEX	-0.136	0.007	*	-0.149	-0.123	
AGE	-0.011	0.003	*	-0.016	-0.005	
AGEMIS	-0.045	0.030		-0.104	0.015	
PCFSM	-0.005	0.001	*	-0.006	-0.004	
N11	-0.008	0.004		-0.016	0.000	
D119	0.016	0.010		-0.003	0.036	
JUNIOR	-0.072	0.029	*	-0.129	-0.016	
MIDDLE	-0.293	0.136	*	-0.560	-0.026	
N9MIS	-0.043	0.092		-0.224	0.138	
SEXINT	0.076	0.013	*	0.049	0.102	
FSMINT	-0.001	0.000	*	-0.002	0.000	
N11INT	0.004	0.002	*	0.000	0.008	

Table A18 Multilevel analysis of KS2 English level

KS2 English		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.010	0.005		0.000	0.020	
School variance	0.067	0.004	*	0.059	0.075	
Pupil variance	0.525	0.004	*	0.517	0.533	Percent
Final model						reduction
LEA variance	0.008	0.004	*	0.000	0.016	24%
School variance	0.033	0.002	*	0.029	0.037	51%
Pupil variance	0.298	0.002	*	0.293	0.303	43%
Fixed coefficients						
CONS	3.352	0.364	*	2.638	4.066	
KS1READ	0.371	0.007	*	0.357	0.385	
KS1WRITE	0.182	0.008	*	0.166	0.199	
KS1MATHS	0.210	0.007	*	0.196	0.224	
KS1SPELL	0.122	0.007	*	0.108	0.137	
K1SPELMS	-0.237	0.009	*	-0.254	-0.220	
SEX	0.124	0.006	*	0.112	0.137	
AGE	-0.008	0.003	*	-0.013	-0.002	
AGEMIS	-0.054	0.028		-0.109	0.000	
PCFSM	-0.005	0.001	*	-0.006	-0.004	
N11	-0.002	0.004		-0.009	0.006	
D119	0.015	0.009		-0.002	0.033	
JUNIOR	-0.074	0.026	*	-0.125	-0.022	
MIDDLE	-0.200	0.124		-0.443	0.043	
N9MIS	-0.078	0.084		-0.244	0.087	
SEXINT	0.014	0.013		-0.010	0.039	
FSMINT	0.000	0.000		-0.001	0.001	
N11INT	-0.003	0.002		-0.007	0.000	

Table A19 Multilevel analysis of KS2 science level

KS2 science		Multilevel results				
				95% confidence interval		
Parameter	Estimate	Standard error	Sig.	Min.	Max.	
Base case						
LEA variance	0.009	0.004		0.000	0.017	
School variance	0.058	0.003	*	0.051	0.064	
Pupil variance	0.332	0.003	*	0.326	0.337	Percent
Final model						reduction
LEA variance	0.010	0.005	*	0.000	0.020	-17%
School variance	0.036	0.002	*	0.032	0.041	37%
Pupil variance	0.238	0.002	*	0.235	0.242	28%
Fixed coefficients						
CONS	4.049	0.330	*	3.402	4.696	
KS1READ	0.260	0.006	*	0.247	0.273	
KS1WRITE	0.047	0.008	*	0.032	0.062	
KS1MATHS	0.256	0.006	*	0.243	0.268	
KS1SPELL	0.022	0.007	*	0.009	0.035	
K1SPELMS	-0.073	0.008	*	-0.088	-0.058	
SEX	-0.059	0.006	*	-0.070	-0.048	
AGE	-0.005	0.002	*	-0.010	-0.001	
AGEMIS	-0.058	0.027	*	-0.110	-0.005	
PCFSM	-0.005	0.001	*	-0.006	-0.004	
N11	-0.004	0.004		-0.012	0.003	
D119	0.016	0.009		-0.003	0.034	
JUNIOR	-0.001	0.027		-0.054	0.052	
MIDDLE	-0.199	0.127		-0.448	0.051	
N9MIS	-0.063	0.085		-0.230	0.104	
SEXINT	0.080	0.011	*	0.058	0.101	
FSMINT	0.000	0.000		-0.001	0.001	
N11INT	0.003	0.002		0.000	0.006	

Table A20 Summary of multilevel modelling coefficients

	RESPONSE			
PREDICTOR	KS2AV	KS2 Maths	KS2 English	KS2 Science
KS1READ	PPP	PPP	PPP	PPP
KS1WRITE	P	P	PP	p
KS1MATHS	PPP	PPP	PP	PPP
KS1SPELL	P	P	P	p
K1SPELMS	NN	N	NN	N
SEX	n	N	P	n
AGE	n	n	n	n
AGEMIS	n			n
PCFSM	NN	N	N	NN
N11				
D119				
JUNIOR	n	n	n	
MIDDLE	N	N		
N9MIS				
SEXINT	p	p		p
FSMINT		n		
N11INT		p		

PPP	Significant Positive Coefficient with Normalised Coefficient % >20
PP	Significant Positive Coefficient with Normalised Coefficient % >10
P	Significant Positive Coefficient with Normalised Coefficient % >5
p	Significant Positive Coefficient with Normalised Coefficient % <= 5
NNN	Significant Negative Coefficient with Normalised Coefficient % <-20
NN	Significant Negative Coefficient with Normalised Coefficient % <-10
N	Significant Negative Coefficient with Normalised Coefficient % <-5
n	Significant Negative Coefficient with Normalised Coefficient % >= -5
(Blank)	No Significant Effect

Appendix II Logistic Regression Analysis

Logistic regression is a form of regression analysis in which the outcome of interest is binary, i.e. just takes two values – for example: passing an exam or not; going into further education or not; entering a higher tier or not, etc. A set of background variables can be used to predict the probabilities of the binary outcome, as in conventional regression analysis, but the coefficients relate to increasing or decreasing the probability that an outcome occurs.

Logistic regression deals with the relative *odds* associated with an event, which are equal to:

$$\frac{\text{Probability of event occurring}}{\text{Probability of event not occurring}}$$

The procedure gives an *odds ratio,* which compares the odds of an event (e.g. being entered for a particular examination) associated with one group of students, with the odds for another group. An odds ratio close to one shows there is little difference between two groups, whereas an odds ratio significantly greater or less than one indicates differences in application rates between the groups.

The following data was included in the analysis:

pupil-level

- prior attainment (level achieved at KS2 in mathematics, English and science, average level and an indicator for pupils with average level below 3)
- sex (girl or boy)

school-level

- grammar or comprehensive
- percentage of pupils eligible for free school meals
- boys', girls' or mixed school
- average size of one-teacher classes in the school
- small, medium or large school[4]
- whether school has a sixth form.

Note that because the analysis was not multilevel, the coefficients relating to school-level factors may appear more significant than they should be. The significance levels for these factors are therefore shown in italics. Multilevel logistic analysis on one example showed largely the same results, but with less significance for the school factors.

[4] School size was based on the number of pupils in Year 9, and was coded into three approximately equal categories: small (up to 180), medium (181 to 230) and large (231 or more). For this analysis the medium category was taken as the default.

1. Probabilities of Entry to Higher Tiers at Key Stage 3

The national value-added dataset used contained 2001 key stage 3 results, linked to key stage 2 performance in 1998. Logistic regression was used to explore the impact of school-level factors on entry to higher-tier examinations in mathematics and science.

1.1 Entry to higher tiers in mathematics

For this analysis, the binary outcome was taken as being entered for Tier 5–7 or above in mathematics at key stage 3. Clear data was available on this for 442,438 students, who were included in the analysis. The analysis was run in a 'step-up' mode, with additional background variables being added to the regression until no further statistically significant variables could be added.

The results are shown in Table A2.1 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance. The latter can be regarded as the probability that the given odds ratio could have occurred by chance, with no real association being present.

Table A2.1 Significant variables related to chance of being entered for a higher tier in mathematics at KS3

Variable	Odds ratio	Significance
KS2 mathematics level	4.15	0.0%
KS2 average level	9.74	0.0%
KS2 average level < 3	1.373	0.3%
Sex (girls v. boys)	1.069	0.0%
% eligible for free school meals	0.988	0.0%
Boys' school	1.260	0.0%
Girls' school	1.064	0.2%
Small school	1.026	0.6%
School with sixth form	1.098	0.0%
Grammar school	17.54	0.0%
Girls' grammar school	1.303	4.8%
Boys' grammar school	2.089	0.0%
Small grammar school	0.558	0.7%

Other background variables, including average size of one-teacher classes and large schools, were not statistically significant at the five per cent level.

The 'base case', against which other probabilities are measured, is a boy in a medium-sized mixed comprehensive school. Thus attendance at a boys' rather than a mixed school would increase the chances of being entered for a higher tier by a factor of 1.260. The odds ratios are multiplicative; hence girls in a girls' school have an odds ratio of 1.069 x 1.064 = 1.137 (relative to boys in a mixed school). Grammar schools are over 17 times more likely than others to enter pupils for higher tiers, but for small grammar schools this ratio is reduced to 17.54 x 1.026 x 0.558 = 10.04. Girls in a girls' grammar school would have an overall odds ratio of 1.069 x 1.064 x 17.54 x 1.303 = 26.0 (relative to boys in a mixed comprehensive school).

1.2 Entry to higher tiers in science

For this analysis, the binary outcome was taken as being entered for Tier 5–7 or above in science at key stage 3. Clear data was available on this for 441,710 students, who were included in the analysis. The results are shown in Table A2.2 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.2 Significant variables related to chance of being entered for a higher tier in science at KS3

Variable	Odds ratio	Significance
KS2 science level	1.223	0.0%
KS2 average level	18.01	0.0%
KS2 average level < 3	1.279	0.4%
Sex (girls v. boys)	0.873	0.0%
Average size of one-teacher classes	0.994	1.2%
% eligible for free school meals	0.990	0.0%
Boys' school	1.215	0.0%
Girls' school	1.391	0.0%
School with sixth form	1.093	0.0%
Grammar school	9.68	0.0%
Boys' grammar school	1.399	0.1%

Other background variables, including small and large schools, girls' grammar schools and small grammar schools, were not statistically significant at the five per cent level.

In this case, girls were significantly less likely than boys to be entered for higher tiers in science (odds ratio = 0.873). However, in girls' schools, the odds ratio was 0.873 x 1.391 = 1.214, about the same as for boys in boys' schools. Compared with the effect of boys' schools and grammar schools separately, there was an extra impact of boys' grammar schools equivalent to a total odds ratio of 1.215 x 9.68 x 1.399 = 16.45, compared with boys in mixed comprehensive schools.

2. Probabilities of Taking Various Subjects at GCSE

The national value-added dataset used contained 2001 GCSE results, linked to key stage 2 performance in 1996. Logistic regression was used to explore the impact of school-level factors on entry to various GCSE subjects.

The dataset contained information on students' grades in (and hence entry to) a list of 23 different subjects. Certain subjects and subject combinations were analysed, to explore the impact of school-level factors on entry. The analysis focused on science, language and design technology subjects, as these are areas which are traditionally male- or female-dominated, to see whether single-sex schools helped to counter or reinforce the stereotypes. More specifically, the outcomes investigated were:

- Double award versus single award science (for those who did one or the other)
- D & T – Food
- D & T – Graphics
- D & T – Resistant Materials
- Physics
- Chemistry
- Biology
- French plus German (NB: data on Spanish was not available).

2.1 Entry to double rather than single science

For this analysis, the binary outcome was taken as being entered for double science rather than single science. Clear data was available on this for 325,229 students entered for either double or single science, who were included in the analysis. The results are shown in Table A2.3 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.3 Significant variables related to chance of being entered for double rather than single award science

Variable	Odds ratio	Significance
KS2 English level	1.444	0.0%
KS2 mathematics level	1.429	0.0%
KS2 science level	1.458	0.0%
KS2 average level < 3	1.111	0.0%
Sex (girls v. boys)	0.865	0.0%
Average size of one-teacher classes	1.032	0.0%
% eligible for free school meals	0.992	0.0%
Boys' school	0.747	0.0%
Small school	0.895	0.0%
Large school	1.077	0.0%
School with 6th form	0.842	0.0%
Girls' grammar school	4.079	0.0%

Other background variables, including girls' schools, grammar schools, boys' grammar schools and small grammar schools, were not statistically significant at the five per cent level.

Although girls in mixed schools are less likely than boys to do double science (odds ratio = 0.865), in a girls' grammar school the odds ratio becomes 0.865 x 4.079 = 3.528, relative to boys in mixed schools. However, boys in boys' schools had an odds ratio of 0.747, below that for girls in mixed schools.

2.2 Entry to D & T Food GCSE

For this analysis, the binary outcome was taken as being entered for D & T Food. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.4 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.4 Significant variables related to chance of being entered for D & T Food GCSE

Variable	Odds ratio	Significance
KS2 English level	1.081	0.0%
KS2 mathematics level	0.865	0.0%
KS2 science level	0.890	0.0%
KS2 average level < 3	0.777	0.0%
Sex (girls v. boys)	3.676	0.0%
Average size of one-teacher classes	1.007	0.6%
% eligible for free school meals	0.992	0.0%
Boys' school	0.509	0.0%
Girls' school	0.554	0.0%
Small school	1.136	0.0%
School with 6th form	0.962	0.1%
Grammar school	0.490	0.0%
Girls' grammar school	1.171	1.3%
Boys' grammar school	0.376	0.0%
Small grammar school	1.437	0.0%

The other background variable, large schools, was not statistically significant at the five per cent level.

Girls are much more likely than boys to be entered for this subject (odds ratio = 3.676). However, in a girls' school this reduces to 3.676 x 0.554 = 2.037. In a girls' grammar school, the odds ratio becomes 3.676 x 0.554 x 0.490 x 1.171 = 1.169, relative to boys in a mixed non-grammar school.

2.3 Entry to D & T Graphics GCSE

For this analysis, the binary outcome was taken as being entered for D & T Graphics. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.5 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.5 Significant variables related to chance of being entered for D & T Graphics GCSE

Variable	Odds ratio	Significance
KS2 English level	1.237	0.0%
KS2 mathematics level	1.099	0.0%
KS2 science level	1.100	0.0%
KS2 average level < 3	0.785	0.0%
Sex (girls v. boys)	0.718	0.0%
Girls' school	1.127	0.0%
Small school	0.928	0.0%
Grammar school	0.617	0.0%
Girls' grammar school	0.711	0.0%
Boys' grammar school	0.660	0.0%
Small grammar school	1.376	0.0%

The other background variables, including average class size, % FSM, boys' schools, large schools and schools with 6th forms, were not statistically significant at the five per cent level. Girls were less likely than boys to take this subject (odds ratio = 0.718); however, in girls' schools, the odds ratio becomes 0.718 x 1.127 = 0.809.

2.4 Entry to D & T Resistant Materials GCSE

For this analysis, the binary outcome was taken as being entered for D & T Resistant Materials. Clear data was available on this for 369,341 students, who were included in the analysis. The analysis was run in a 'step-up' mode, with additional background variables being added to the regression until no further statistically significant variables could be added.

The results are shown in Table A2.6 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

The other background variables, including boys' schools, large schools, schools with sixth forms and girls' and boys' grammar schools, were not statistically significant at the five per cent level. Girls were much less likely than boys to take this subject (odds ratio = 0.237); however, in girls' schools, the odds ratio becomes 0.237 x 1.591 = 0.377.

Table A2.6 Significant variables related to chance of being entered for D & T Resistant Materials GCSE

VariableOdds ratio	Significance	
KS2 English level	0.832	0.0%
KS2 mathematics level	0.975	0.2%
KS2 science level	1.054	0.0%
KS2 average level < 3	0.742	0.0%
Sex (girls v. boys)	0.237	0.0%
Average size of one-teacher classes	1.008	0.1%
% eligible for free school meals	0.999	4.6%
Girls' school	1.591	0.0%
Small school	1.168	0.0%
Grammar school	0.364	0.0%
Small grammar school	2.280	0.0%

2.5 Entry to physics GCSE

For this analysis, the binary outcome was taken as being entered for physics. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.7 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.7 Significant variables related to chance of being entered for physics GCSE

Variable	Odds ratio	Significance
KS2 English level	1.435	0.0%
KS2 mathematics level	2.008	0.0%
KS2 science level	1.924	0.0%
KS2 average level < 3	0.768	4.0%
Sex (girls v. boys)	0.802	0.0%
Average size of one-teacher classes	0.988	3.2%
% eligible for free school meals	0.982	0.0%
Boys' school	2.894	0.0%
Girls' school	1.394	0.0%
Small school	0.747	0.0%
Large school	1.070	0.3%
School with 6th form	0.875	0.0%
Grammar school	4.835	0.0%
Girls' grammar school	0.526	0.0%
Boys' grammar school	0.713	0.0%

The other background variable, small grammar schools, was not statistically significant at the five per cent level. Girls were less likely than boys to be entered for this subject (odds ratio = 0.802); however, in girls' schools, this became 0.802 x 1.394 = 1.118, relative to boys in mixed schools. For boys in boys' schools, though, the odds ratio was 2.894 relative to boys in mixed schools.

Mixed grammar schools had an overall odds ratio of 4.835, showing that their pupils were much more likely than others to be entered for physics, taking other factors into account. For boys in boys' grammar schools, the odds ratio was 4.835 x 2.894 x 0.713 = 9.977, relative to boys in mixed non-grammar schools. For girls in girls' grammar schools, the odds ratio was 4.835 x 1.394 x 0.526 = 3.545, relative to girls in mixed non-grammar schools.

2.6 Entry to chemistry GCSE

For this analysis, the binary outcome was taken as being entered for chemistry. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.8 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.8 Significant variables related to chance of being entered for chemistry GCSE

Variable	Odds ratio	Significance
KS2 English level	1.436	0.0%
KS2 mathematics level	2.000	0.0%
KS2 science level	1.928	0.0%
Sex (girls v. boys)	0.808	0.0%
Average size of one-teacher classes	0.986	1.3%
% eligible for free school meals	0.983	0.0%
Boys' school2.803	0.0%	
Girls' school1.329	0.0%	
Small school0.772	0.0%	
Large school1.085	0.0%	
School with 6th form	0.856	0.0%
Grammar school	4.773	0.0%
Girls' grammar school	0.549	0.0%
Boys' grammar school	0.732	0.0%

The other background variables, low KS2 average level and small grammar schools, were not statistically significant at the five per cent level. The patterns of relationships were very similar to those for physics, above.

2.7 Entry to biology GCSE

For this analysis, the binary outcome was taken as being entered for biology. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.9 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.9 Significant variables related to chance of being entered for biology GCSE

Variable	Odds ratio	Significance
KS2 English level	1.424	0.0%
KS2 mathematics level	1.956	0.0%
KS2 science level	1.880	0.0%
Sex (girls v. boys)	0.822	0.0%
Average size of one-teacher classes	0.983	0.3%
% eligible for free school meals	0.984	0.0%
Boys' school	2.800	0.0%
Girls' school	1.314	0.0%
Small school	0.784	0.0%
Large school	1.065	0.5%
School with 6th form	0.834	0.0%
Grammar school	4.450	0.0%
Girls' grammar school	0.644	0.0%
Boys' grammar school	0.869	3.1%
Small grammar school	0.891	4.8%

The other background variable, low KS2 average level, was not statistically significant at the five per cent level. The pattern of relationships was very similar to those for physics and chemistry, above.

2.8 Entry to both French and German GCSE

For this analysis, the binary outcome was taken as being entered for two foreign languages – French and German. Clear data was available on this for 369,341 students, who were included in the analysis. The results are shown in Table A2.10 below, with the significant variables indicated, together with the odds ratio associated with each and its level of statistical significance.

Table A2.10 Significant variables related to chance of being entered for both French and German GCSE

VariableOdds ratio	Significance	
KS2 English level	1.771	0.0%
KS2 mathematics level	1.497	0.0%
KS2 science level	1.243	0.0%
KS2 average level < 3	0.442	0.0%
Sex (girls v. boys)	1.828	0.0%
Average size of one-teacher classes	0.965	0.0%
% eligible for free school meals	0.954	0.0%
Girls' school	0.797	0.0%
Large school	0.905	0.0%
School with 6th form	0.904	0.0%
Grammar school	1.256	0.1%
Boys' grammar school	1.524	0.0%
Small grammar school	1.169	2.5%

The other background variables, boys' schools, small schools and girls' grammar schools, were not statistically significant at the five per cent level.

Although girls are more likely than boys to take both languages (odds ratio = 1.828), this is reduced in girls' schools, where the odds ratio become 1.828 x 0.797 = 1.457. Grammar school students are more likely to take both languages (odds ratio = 1.256) and for boys in boys' grammar schools, the odds ratio becomes 1.256 x 1.524 = 1.914, similar to that for girls in mixed non-grammar schools.

The LGA Educational Research Programme is carried out by the NFER. The research projects cover topics and perspectives that are of special interest to LEAs. All the reports are published and disseminated by NFER, with separate executive summaries.

The summaries are available free of charge both on paper and on the NFER website – **www.nfer.ac.uk**

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The LEA Role in Data Collection, Analysis and Use and Its Impact on Pupil Performance (LGA Research Report 29)
Peter Rudd and Deborah Davies

In recent years, the use of pupil performance data for target setting and raising standards of attainment in schools has become increasingly important. The report examines how schools and LEAs can work together to make best use of pupil performance data, while giving examples of good practice. It makes a number of recommendations for both LEAs and school staff.

Published in 2002 ISBN 1 903880 20 3 Price: £12.00

The Impact of Specialist and Faith Schools on Performance (LGA Research Report 28)
Sandie Schagen, Deborah Davies, Peter Rudd and Ian Schagen

Specialist and faith schools tend to be a popular choice with parents, obtaining good results in national league tables. Questions are sometimes asked as to whether this is due to their status as specialist/faith schools, or to other factors. This study provides a clear and comprehensive critical review of the relevant literature and assesses the effectiveness (in value-added terms) of specialist and faith schools.

Published in 2002 ISBN 1 903880 19 X Price: £10.00

Multi-agency Working: A Detailed Study (LGA Research Report 26)
Mary Atkinson, Anne Wilkin, Alison Stott, Paul Doherty and Kay Kinder

This report gives the findings from the final phases of a study of multi-agency working. It includes different models: their rationale and development; their impact; and the challenges and key factors in the success of multi-agency initiatives.

This research is clearly linked to the current Government agenda on 'joined-up thinking', and is therefore of particular interest to personnel within Education, Health and Social Services agencies.

Published in 2002 ISBN 1 903880 13 0 Price: £19.50

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Sandra Brown, Suzanne Edmonds and Barbara Lee

An investigation into the current and potential role of the LEA in supporting schools to provide professional development for their staff, as part of their efforts to raise achievement, formed the basis of this report.

Published in 2001 ISBN 1 903880 09 2 Price: £15.50

Evaluating School Self-evaluation (LGA Research Report 21)
Deborah Davies and Peter Rudd

School self-evaluation, supported by local education authorities, can be a major influence upon teachers' professional development and on the quality of teaching and learning. This NFER study shows that school self-evaluation takes many forms and can have a variety of purposes, but when it is implemented strategically and purposefully, it can be a central driving force for school improvement.

Published in 2001 ISBN 1 903880 03 3 Price: £12.00

Making a Difference: Early Interventions for Children with Autistic Spectrum Disorders (LGA Research Report 22)
Jennifer Evans, Frances Castle, Shanee Barraclough and Glenys Jones

This report attempts to ascertain the level of identification of autistic spectrum disorders for younger children and their types of provision, focusing on: parental support; inter-agency communication and collaboration. It also looks at specific interventions offered by LEAs and health authorities and the ways in which children's progress was tracked and decisions made about the effectiveness of the interventions offered. Recommendations concerning inter-agency communication and collaboration between providers of care for these children are included.

Published in 2001 ISBN 1 903880 05 X Price: £16.00

For further information on any of the above projects or the publications, please contact:

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