No.385

Basic Competence in Mathematics: Swedish and English 16-year-olds

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Abstract

The transition to mass participation in post-16 education, which had occurred considerably earlier in other European countries, has finally taken place in England. However, high drop-out and failure rates persist, particularly on vocational qualification routes. Our hypothesis is that an important factor is the lack of basic competence of lower-achieving English students in the key skills **S** English language and Mathematics **S** required for success in further study. Our research addresses the validity of the argument by investigating whether any significant difference can be detected between the skills of English students entering post-compulsory education and those of students in countries where drop-out and failure rates are low. The country investigated in this study is Sweden where participation of 16-year-olds in post-compulsory education is currently over 90 per cent; and where some 90 per cent of those enrolling normally obtain an academic or vocational qualification. Some GCSE Maths questions were incorporated into the national test taken by Swedish 16-year-olds at the end of compulsory schooling; and significant differences were found in the scores of the lower 40 per cent of the cohort in the two countries. The results are consistent with the hypothesis; and also go beyond previous Swedish-English comparisons, which reflect the general emphasis in international studies on younger age groups (typically 9 and 13-year-olds).

This paper was produced as part of the Centre's
Human Resources Programme

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Series Editor: Graham Ingham

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

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ISBN 0 7530 1204 9

Individual copy price: £5

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The Centre for Economic Performance is financed by the Economic and Social Research Council

Acknowledgements

We wish to acknowledge the assistance provided by the Stockholm Institute of Education in making this research possible, and in providing data, comments and constructive criticism; and especially the contributions of Astrid Pettersson, Katarina Kjellström, Åsa Murray and Owe Liljefelt. We also thank the Associated Examining Board and especially Michael Cresswell for assistance in making available GCSE questions and pupil and item data. This research was supported by a grant from The Nuffield Foundation whose assistance is also gratefully acknowledged. All views are, of course, the authors' own.

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More than half of all 16-year-olds stayed on in post-compulsory full-time education in 1988 for the first time in the history of education in England. By 1994, participation for 16-year-olds had reached 71 per cent. This was slightly lower than the 73 per cent of 16-year-olds enrolled in the previous year, but compares with only 42 per cent in 1980, just fourteen years before (DES, 1981, 1982; DfEE, 1996, 1997). The transition to mass participation in post-16 education, which had occurred considerably earlier in other European countries (notably France, Italy, Germany and Sweden) had finally taken place in England. It brought with it the promise of improvements in the achievements of English students which would contribute to closing the qualifications gap that had opened up at post-compulsory level between England and other European states (Steedman and Green, 1996).

However, this promise has not as yet been realised as high drop-out and failure rates persist, particularly on vocational qualification routes. The two most important full-time vocational routes for English students are currently the one-year Intermediate and the two-year Advanced GNVQ (General National Vocational Qualification). In 1996 only half of Intermediate candidates and less than half of Advanced candidates completed their courses and qualifications successfully (FEDA, 1997; Payne *et al*, 1996).

Our hypothesis is that an important factor explaining the higher drop-out rate in England is the lack of basic competence of those who proceed to post-16 provision in England in the key skills **S** English language and Mathematics **S** required for success in further study. At post-compulsory levels, it is not only academic routes but also vocational and technical ones which demand written output in increasing quantities and with increasing emphasis on analytic and evaluative skills. The mathematical components of the vocational awards being started by increasing numbers of English young people are also an area in which it has been recognised for a long time that failure rates are high. Overall, success in post-compulsory studies tends to be associated with previous academic performance; and the link between mathematics performance in compulsory school and success in technical subjects is quite clear and direct (Choppin and Orr, 1976; Sutherland and Wolf, 1995).

The weakness in English and mathematics of post-compulsory students has already been identified in a number of studies (Audit Commission and OFSTED, 1993; Dearing, 1996). Nonetheless, there is very little information available which clarifies the substantive levels of achievement which students at this stage, and especially weaker students, actually attain. Our research addresses the validity of the argument that drop-out and failure rates are associated with students' low levels of basic or core skills. It does so by investigating whether any significant difference can be detected between the core skills of English students entering post-compulsory education and those of students in countries where drop-out and failure rates are low. The country investigated in this study is Sweden where participation of 16-year-olds in post-compulsory upper-secondary education has been 80 per cent or higher since the early 1970s and is currently over 90 per cent; and where some 90 per cent of those enrolling normally obtain an academic or vocational qualification.

In order to investigate this hypothesis we sought to devise a method of directly comparing the competence in basic skills of English and Swedish 16-year-olds about to transfer to post-secondary education. Our longer term aim is to find a way of measuring competence in both basic numeracy and in written communication. However, a start has been made with basic numeracy and this paper sets out the results of our comparison of basic numeracy skills, situates it within the wider context of international comparisons of Swedish and English Mathematics curricula and performance, and draws out some initial implications for improving the preparation of English 16-year-olds for further post-secondary study. In providing information about the performance of this age group it goes beyond previous Swedish-English comparisons, which reflect the general emphasis in international studies on younger age groups (typically 9 and 13-year-olds).

This paper is structured as follows. Section 1 provides a brief account of schooling provision in the two countries with particular reference to basic subjects and briefly compares subsequent post-16 provision. Section 2 describes the work and methods used to obtain the common performance measure. Section 3 presents an analysis of the performance of the Swedish and English students on the measures described in Section 2 and compares our findings with the Mathematics results for Sweden and England in the recent International Evaluation of Achievement; Section 4 explores the implications of the findings for our hypothesis and provides a conclusion.

1. Schooling in Sweden and England

Sweden is a country with an extremely long-standing commitment to the education of its whole population. It now has very high participation rates in the upper secondary school and has also recently implemented a major reform of upper secondary education, intended to integrate vocational and academic options more closely, and at the same time increase the general educational attainment of the whole age cohort. Both the three main academic options (which each has subdivisions) and the 13 vocational programmes offered at upper secondary level now have the same eight core subjects to which a minimum of just under one third (680/2400 hours) of total teaching time over the three year course must be devoted.

Since 1962, nine years of school (grades 1 through 9) have been compulsory for all Swedish students, and education up to this point takes place in comprehensive institutions. Children normally start school at seven, so the modal age at the end of ninth grade is 16. (While repeating years was quite common before the comprehensive reforms of 1962, it does not now occur.) There is also an extensive network of publicly funded day-care and kindergartens in Sweden, so most children will have had experience of these before starting compulsory schooling. Private schools make up only a tiny fraction of the system. Pupils are guaranteed a minimum of 1,490 hours of teacher-supervised instruction in Swedish over this period and 900 hours of Mathematics. As noted above, over 90 per cent of Swedish students currently (1997) proceed with full-time schooling beyond the end of compulsory schooling.

In England, full-time school attendance is compulsory between the ages of 5 and 16. A common curriculum is followed by all pupils until age 14 when pupils are directed towards different combinations of subjects. All pupils must follow courses in English, Mathematics and Science, and these will normally culminate in the pupils sitting for GCSE (General Certificate of Secondary Education) examinations in these subjects. While many students will study a wide range of academic subjects between ages 14 and 16, others will study a more restricted range while a third group may, from 1997, take vocational options (GNVQ Part 1) within compulsory schooling. By comparison with their Swedish contemporaries, English pupils will have had 11 **S** as opposed to 9 **S** years of compulsory schooling with no specification of the hours to be spent on English and Mathematics.

After the age of 16 all students in England are entitled to enter full-time further education on courses ranging from the academic A-levels or vocational Advanced GNVQ, both classified as ‘level 3’ courses, and both offering an entrance route to higher education, through to Intermediate (level 2) and Foundation (level 1) vocational courses. Courses are provided either in school sixth forms or in colleges of Further Education which take students of all ages from the age of 16. Students’ GCSE results are decisive in determining which course they enter, and particularly their grades in English and Mathematics. Most students who receive a C grade or higher in Mathematics will proceed to academic A-level courses; very few with less than a D in Mathematics will enter a level 3 course directly (FEU, 1994; FEDA, *op cit*); and conversely it is very rare for a student on a level 2/Intermediate course to have obtained a Maths grade higher than a D.

The Mathematics Curriculum

The Mathematics curriculum in the upper level of the Swedish compulsory school (grades 7-9) is largely a ‘core curriculum’ which is the same for all pupils. The main exceptions are English and Mathematics, where there is a choice between an advanced and a general course. In 1994-5, 58 per cent of the 9th grade pupils in regular schools took the advanced course in grade 9; 36 per cent the general course; 5 per cent were in schools which did not stream; and 0.6 per cent were following special ‘adjusted study courses’ with no Mathematics. The percentage taking the advanced course tends to be slightly higher in the 8th grade than in the 9th grade, when the formal assessments take place. Pupils experiencing difficulty with school subjects are also provided with special help. In 1989/90 over 40 per cent of pupils grade 6 (12 years old) had received remedial help at some point between grades 3 and 6 (Statistics Sweden, 1991).

The advanced Mathematics course is a prerequisite for admission into some of the upper secondary programmes. Admissions are decided by the local authorities on the basis of 9th grade results; but in recent years, as a result of smaller age cohorts, more places have been available in upper secondary schools, and therefore greater numbers have obtained their first choice of programme. The percentage of students taking the advanced Maths course is considerably higher than the percentage entering academic (or ‘theoretical’) programmes in the upper secondary school. This in turn means that a considerable number of the students starting vocational programmes will have completed the advanced Mathematics course beforehand.

This situation is markedly different from that obtaining in England, which has a three-tiered Mathematics syllabus in the final years of compulsory schooling. This involves the setting of students during the final two years of compulsory schooling, according to whether they are taking the upper, middle (intermediate) or lower (foundation) tier Mathematics papers. While there is overlap in content, and in the grades which it possible to obtain, there are significant differences in content among the three options.

The proportion of students attempting the more advanced tier has declined from 29 per cent to 17 per cent in recent years, following decisions on grading which make it possible to obtain a B grade on the intermediate syllabus. It is extremely uncommon for any student taking a vocational option to have completed the most demanding of the three syllabuses; conversely, only around half of those entering the academic A-level track will have done so, with the others generally having followed the intermediate Mathematics course. In the mid-1990s, the national candidate figures were 17 per cent Higher, 61 per cent Intermediate and 22 per cent Foundation (Joint Council for the GCSE statistics).

Evidence from the 1982 Second International Mathematics Study (SIMS) suggests that there are important differences between both the intended and the implemented Mathematics curriculum in England and Sweden (Travers and Westbury, 1989). Although the introduction of the National Curriculum in England since that date may have changed the situation to some extent, it seems unlikely that such marked differences in priorities and philosophy between the two countries could have changed so quickly. The 1982 study shows that the Swedish curriculum is less ambitious in its scope than the English *and* that Swedish teachers concentrate on fewer of the specified topics than do English teachers. An important explanation for the contrast between teachers' strategies in the two countries is provided by the pedagogic approach of the Swedish curriculum. The Swedish National Mathematics Curriculum (Skolverket, 1980) stresses that a pupil must not advance to a new section before she has enough basic knowledge and skills from earlier sections. This would imply that the amount of ground the teacher can cover with a class is determined by the speed of learning of the class. If indeed, Swedish teachers place more emphasis on mastery than English teachers, then this would help to explain the evidence on the contrast between English and Swedish Mathematics performance from the studies carried out by the IEA. Concentration on mastery would produce less variability in pupil performance and could lead to larger year on year pupil gains in learning (see Section 3 below) Such an emphasis would also restrict the amount of ground that the curriculum could aim to cover and that teachers could actually cover.

Table 1 is based on an analysis carried out for the International Evaluation of Achievement in 1982. For each area of Mathematics, a range of topics was identified as being taught by participating countries to the target age group (13/14 year olds). The table shows the percentage of the topics in each identified area of Mathematics that the curriculum in Sweden and in England and Wales specifies as needing to be covered by 13/14 year olds (the 'intended' curriculum). The 'implemented' curriculum is the proportion of the total topics identified that teachers in the sample schools stated that they had covered with those groups. In Arithmetic, Algebra and Geometry, the Swedish 'intended' curriculum covers fewer topics than that of England and Wales. In all areas, Swedish teachers state that they cover fewer topics than their English and Welsh counterparts. The difference is least striking in Measurement and Geometry, but nevertheless, the contrast supports the statement above taken from the Swedish National Mathematics Curriculum that Swedish teachers tend to concentrate more on mastery of basics than do English teachers.

Table 1
Intended and implemented Mathematics curriculum in Sweden and England and Wales

	Sweden		England and Wales	
	%	%	%	%
	Intended	Implemented	Intended	Implemented
Arithmetic	75	50	88	88
Algebra	75	25	88	63
M'surement	100	75	100	100
Geometry	42	18	67	27
Statistics	100	0	80	60

Note: % all areas intended to be covered and actually covered by 60 per cent of the age group.
Source: K. J. Travers and I. Westbury (*eds*), *The IEA Study of Mathematics I: Analysis of Mathematics Curricula*, Chapters 4,5.

The Upper Secondary School in Sweden

Participation rates in a range of full-time post-compulsory education and training courses have been high in Sweden relative to England during the whole of the post-war period. By the end of the 1960s, no more than one quarter of leavers from compulsory education entered the labour market straight from school, the rest continued in some form of post-secondary academic or vocational education (Marklund and Bergendal, 1979)[1]. Until the 1970s, vocational and academic upper secondary courses were usually provided in separate establishments **S** Upper Secondary Colleges (*Gymnasien*) and Vocational Schools (*Yrkeskola*). The policy of bringing together academic and vocational upper secondary courses in a single institution called the Upper Secondary School *(Gymnasieskola)* was initiated in 1971. This was seen as a logical extension of the switch to a comprehensive compulsory school made in the 1960s. In 1974 the participation rate for 16-year-olds in all types of full-time post-compulsory education and training was around 73 per cent (Svensson and Stahl, 1996) and has increased since then to around 90-92 per cent of the age-group in 1994-5.

Almost all those who leave the compulsory school (*Grundskola*) at 16 apply for admission to the upper secondary school which offers a wide range of academic and vocational 3 or 4 year courses. (2 year courses have now been phased out). In a study conducted in 1991 surveying young people then aged 23-24 years, it was found that 9 per cent never entered upper secondary school, a further 9 per cent failed to finish, while 4 per cent attended only a special course which is not considered equivalent to a full upper secondary education. Thus of the cohort, which entered upper secondary education in or around 1983, some 80 per cent had completed upper secondary education and 20 per cent had failed to complete. Around 37 per cent of all boys and 48 per cent

1 By 1970, the existing upper secondary school (gymnasium) recruited around one third of all 16-year-olds, the new two-year continuation schools took an additional 20 per cent. Parallel to this, around one third of leavers from the compulsory school continued on to municipal vocational schools (Marklund and Bergendal, 1979).

of all girls aged 20 had completed 2, 3 or 4 year ‘theoretical’ or ‘academic’ courses of upper secondary education. Forty per cent of boys and 29 per cent of girls completed a two year vocational course (Murray, 1996). However, the worsening labour market situation of young people and higher skill demands from employers appear to have had the effect of increasing somewhat the proportions entering the upper secondary school. In 1993, 96 per cent of pupils leaving the compulsory school were admitted to the upper secondary school (Statistics Sweden, 1994a).

In spite of the fact that the 1944 Education Act bound English Local Education Authorities to provide further education (education after the school leaving age) for all those under the age of 19 who wished to participate, until 1988 less than half the age group chose to do so. One obvious point of contrast between the two countries which helps to explain the contrast in trends in participation is the existence in England of a tradition of apprenticeship. No such tradition existed in Sweden where, in the earlier part of the century, instruction in a trade or craft was most frequently provided in a trade school financed by the local authorities.

Because it was not, until the 1990s, formally regulated by government, precise figures for apprenticeships are difficult to establish;[2] but at its peak in the 1960s, British manufacturing industries enrolled nearly 250,000 male apprentices; equivalent to almost a quarter of all young men aged 16 and 17. By 1989 the figures were down to 50,000 **S** less than 5 per cent of the 16 and 17 year old male cohort. For females, totals were 5,000 and 4,000 respectively (Bosworth and Wilson, 1994). These figures are now higher again, in the context of the government’s ‘New Apprenticeship’ scheme which underwrites and regulates apprenticeships in a far wider range of industries than the traditional ones (Unwin, 1996); but in the meantime, as noted earlier, full-time enrolments have increased to levels much closer to, though still significantly short of Swedish levels.

Assessment and Certification

In both countries, there is an important formal assessment of students at the end of the compulsory phase of schooling. In England, this is the point at which the vast majority of students take centrally set and marked public examinations for the GCSE (see above). In Sweden, pupils are also graded at the end of the period of compulsory schooling on a five point scale. This is done on the basis of national tests in Swedish, Mathematics and English (for more details, see below) and on the basis of class work in the full range of subjects. In Sweden, as in England, students whose marks in the compulsory school are high enough to give a good chance of success in the academic stream (giving a chance of entering higher education) apply for those courses. Those entering academic upper secondary courses in Sweden have higher marks from the compulsory school than those entering vocational programmes. It can therefore be assumed that those taking vocational courses in Sweden are, as in England, drawn from the lower-attaining percentiles of the attainment spectrum. Of the age cohort born in 1972 and who entered upper secondary school in 1988, 43 per cent had an academic upper secondary education at the age of 20, and 42 per cent had a vocational upper secondary education (Statistics Sweden, 1994b).

The *ratio* of vocational to academic completion among Swedish upper secondary school leavers is similar to that in England where, in 1995, (based on full-time and part-time enrolments) the proportion of 17 year olds on A-level courses was 36 per cent, while 27 per cent of 17 year olds were on a variety of vocational courses. The point of contrast, and the one that we

2 Apprenticeship figures are normally given for the whole of the UK rather than for England separately.

particularly want to underline, however, is the *high absolute completion rate of all upper secondary education courses* in Sweden compared to England.[3]

For England, published statistics on completion rates on all the main further education courses are only available for recent years. However, it is clear that the numbers of students on vocational courses failing to complete a chosen course are high. As noted above, in 1996 only half of those on Intermediate GNVQ courses completed successfully; and for Foundation courses (level 1) the completion rate was less than one third.

The contrast between the two countries can be summarised as follows using the English National Foundation Targets 1 and 3, established by the government as objectives for given proportions of the population to reach by the late 1990s (NACETT, 1995). Target 1 involves obtaining 5 GCSE Grades A-C/NVQ2/GNVQ2; Target 3 is expressed in terms of percentages obtaining 2 or more A-levels/NVQ3/GNVQ3. If we accept that the range of outcomes in the Swedish upper secondary school covers are equivalent to the range covered in English upper secondary education, then we can compare the proportions of young people reaching at least the equivalent of the English National Foundation Target One or above in both countries.[4] In England, in 1995, 63 per cent of all 19 year olds were reported as having achieved at least the level of the government's Foundation Target One. In Sweden, for 1993, our estimate is that around *85* per cent had reached a similar standard by completing either a 3/4 year theoretical course in the upper secondary school or a 2/3 year vocationally oriented course.

2. Comparing Achievement in Sweden and England

There are two major points of assessment which affect a Swedish pupil's future path. The first is at the end of 9th grade, when all subjects that the pupil is studying are assessed by the relevant subject teacher, and given a mark: historically from 1 (lowest) to 5 (highest), although under current reforms this is being changed to a four-level scale. The number of subjects could total as many as 15 or 16 subjects, and all subjects count towards a student's final assessment and set of marks, which is simply an unweighted average. The second is at the end of 12th grade when the same procedures apply.

The assessment at the end of compulsory school (9th grade) determines admission to different courses within the upper secondary school, or affects labour market entry; and the assessment at the end of 12th grade determines admission to university, or, again, is important in making job applications. In 12th as in 9th grade, up to 15 subjects are taken and all count equally; thus, in formal terms, the mark for a one semester course in child care counts for as much as the mark for Maths or Swedish.

Although the recent reforms have made the vocational and academic options in upper secondary school the same length (three years) and much more similar than in the past, there is still

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3 Completion rate is c/p*100 where c= numbers completing a course for which enrolled and p=numbers enrolling.

4 A group of experienced lecturers drawn from a variety of vocational areas visited Swedish upper secondary schools in 1995 as part of this project. Their view, based on two days classroom observation with a Swedish opposite number working in the same vocational area was that the Swedish students were working at levels similar to their own GNVQ2/3 students. The Swedish students on 'individual courses' were thought to be at a similar level to English students working for GNVQ Foundation.

a clear distinction between them, related (among other things) both to Maths achievement at the end of 9th grade and to the Maths required of the student following the programme. As in most of the West, there has been a rapid increase in the number of students following academic programmes in the upper secondary school, from a little under 30 per cent in 1980 to over 40 per cent in 1990 (Svensson and Stahl, 1996; Statistics Sweden, 1994b).

Admission to both upper secondary programmes and university is made on the basis of the marks awarded by teachers (using a 1 to 5 scale) at the end of the 9th and 12th grades respectively. However, a number of national tests exist which are designed to ensure comparability of standards across the country. Under current arrangements (which will last until 1998) the first national test of students takes place in the first semester of grade 8. This covers English, and is followed by tests of Maths and Swedish in grade 9 (the end of compulsory school).

These centrally set tests are used by teachers to standardise their own marks. They do *not* override them. They work as follows. All students take the tests. Results are compiled centrally for the whole country on the basis of a sample of scripts, providing a mark distribution which can be divided up into 5 bands equivalent to the grading 1 through 5. This corresponds to the 5 level scale used for the official assessment by the teachers. (The use of a five-level scale dates back to 1962. Before that, 7 levels were used.)[5]

The bands or scale followed the normal distribution quite strictly in the early days, so that the percentage of pupils falling into each band nationally was as follows (Kilpatrick and Johansson, 1994):

Band	1	2	3	4	5
Percentage of Pupils	7	24	38	24	7

More recently the norming system for grade 9 was changed. Guidance states that the mean should be 3 for the country as a whole, and that there should be more 4s and 2s in a *class* (*sic*) than 5s and 1s respectively (Skolöverstyrelsen, 1980: quoted in Kilpatrick and Johansson, 1994). Nationally, about 40 per cent do indeed get a 3; 30 per cent get a 1 or a 2; and 30 per cent a 4 or a 5. No information is published on the breakdown between 1s and 2s and 4s and 5s. However, there was a lot of unhappiness about giving low grades **S** particularly 1s **S** and this affected the move away from the clear national norm-referencing described above. In Maths at least there has been a trend towards fewer 1s than a normal distribution would imply (personal communication).

The purpose of the national tests is, as noted above, to help the teachers standardise their own marking when using this 5 point scale. They mark the tests themselves, and so know exactly what raw scores each child has obtained; but there is no direct link between an individual child's test and end-of-year score. Results from the tests are compiled centrally (on an item by item basis), and from this, national results are calculated and the range of marks corresponding to different bands is derived. In the past, teachers were told which raw test scores corresponded to which grades for all 5 of the latter, and so could align their mark distribution exactly with that suggested by the national test results. More recently, in line with the more permissive (some would say ambiguous) marking guidance, they have been told only which set of scores covered the middle grade (grade 3)

If the information that a school is given indicates that, say, 40 per cent of their students fall in band 3, then they must stick to that in their final grades. Their distribution of grades for, say, Maths or Swedish **S** the standardised subjects **S** should also have 40 per cent of grade 3s. (None

5 This discussion is in terms of the current system, not the arrangements envisaged for 1998 onwards.

of this comes down to the level of individual students, where teachers can and do depart a long way from the national test score.) However, as noted above, no guidance is given on where the mark cut-off between grade 2 and grade 1 lies, or the one between 4 and 5. If 30 per cent of the school's cohort scored higher than the grade 3 band of marks it is up to the school where it puts the higher boundary, and how it allocates that 30 per cent to the two groups.[6] This process is quite straightforward for teachers in subjects with a national test. In others they have to use other methods; e.g. comparing Science results with those in Maths, on the assumption there should be some relationship. There is group discussion of the grades in many schools; and the head, who has ultimate responsibility, will ask for grades to be justified.

Secondary education in England and Wales is also organised to provide two major assessment points, but they are very different, since each involves major sets of public examinations. The first of these is taken, typically, at the end of the period of compulsory schooling when the modal age of students is 16. Under the National Curriculum introduced in the 1980s this is Year 11 (although many students will in fact have been in school for over 11 years, having started in the term when their 5th birthday falls). The system in Scotland is different although it also involves two main sets of public examinations.

The public examinations taken at this point are known as the General Certificate of Secondary Education, GCSE. Students can take as many individual subjects as they and their school agree, and each subject is separately certificated. A large majority of students will take between six and ten subjects, usually Mathematics, English, Science, and a modern foreign language, followed in popularity by Art, Technology, History and Geography. This pattern reflects the National Curriculum; but there is also a large number of subjects which are taken by smaller proportions of the age cohort, such as music, business studies, religious studies, classical languages. Grades awarded for a GCSE run from A* (the top) to G. Papers which do not merit a grade are labelled as U (ungraded). As noted above, a C grade has particular significance; public statistics, and entry requirements for further study, are often phrased in terms of this boundary.

Each GCSE examination is set and marked, and the qualification awarded by, one of five examination boards. These are independent, though government-regulated, bodies which had their origins in organisations set up by the universities in the 19th century to offer public examinations. Schools decide which board to use for a given subject, and although there is a broadly geographical element to this **S** schools in the north of England generally use the Northern board, Welsh schools the Welsh one **S** this is far from universal. A given school may use several different boards for different subjects, depending on how much they like the particular syllabus and examination papers and requirements. Within general parameters set by the government, there is room for considerable variation in both specific content and mode of assessment (just as, of course, there is in the teacher assessments characteristic of Swedish schools).

In most subjects, all candidates will sit the same paper, but a number of subjects use 'tiered' papers, which cover different amounts of subject-matter, and are of differing difficulty. Mathematics is one such subject, with the examinations reflecting and determining a three-tiered Mathematics syllabus during the final years of compulsory school.[7] Candidates are entered for Foundation, Intermediate or Higher tier papers according to their teachers' judgement of their achievement and how much Mathematics they have covered. The grades which a student can obtain depend on which level is taken. At Foundation level, grades D through G are available. Until 1993, grades C and below could be obtained on the Intermediate paper; but from 1994 on, it became possible to obtain a B on the Intermediate papers. It remains the case that an A and an A*

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6 In fact in Maths the way results are reported makes it possible for teachers to calculate the marks for each band quite easily, should they wish.

7 Not all the Mathematics syllabuses offered by boards are tiered, but the vast majority are.

can be gained only by higher tier candidates; and very few students entered for these papers will obtain less than a C. In order to maintain comparability of standards in a system where a given grade can be obtained from different tiers, it is common practice to have common items. Some questions will appear in Foundation and Intermediate papers, or in Intermediate and Higher.

The national tests for 9th and 12th grade Mathematics are set and analysed by the Stockholm Institute of Education (the *Lärarhögskolan i Stockholm*) on behalf of the government. In common with other countries, Sweden is concerned to monitor not only standards within Sweden, but also the educational standards of its schools as compared to those elsewhere. The Stockholm team was therefore very interested to be approached with the idea of including some GCSE questions in its 9th grade tests.

The Southern Examining Group (SEG) kindly agreed to allow individual questions from its summer 1994 GCSE papers to be passed on to the Swedish team for them to use when constructing their 1994-5 grade 9 test (which is taken by students in the Spring at the age of 16) and to carry out a special analysis in order to make examination statistics available on candidates' responses to individual questions. The final choice of GCSE questions to be included in the Swedish tests was made by a specially convened panel of teachers and experts from the Stockholm Institute. Three questions were selected. These are set out in full in Figure 1 and referred to hereafter as the 'temperature question', the 'milk question' and the 'number question'.

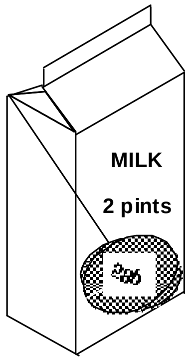
Figure 1
GCSE Foundation/Intermediate tier questions selected for inclusion in Swedish national tests

The temperature was recorded inside a house and outside a house:

Inside temperature	Outside temperature
16EC	-8EC

How many degrees warmer was it inside the house than outside?

Answer .... EC (1 mark)



Two pints of milk cost 58p. What is the cost of 5 pints of milk at the same price per pint?

Answer .... (2 marks)
(Foundation tier only)

Adrian thinks of a number. He doubles it and then adds 5. The answer is 17. What was his number?

Answer .... (1 mark)

All three questions appeared in the papers set for the lowest tier GCSE in the summer of 1994; and two (the milk and the temperature ones) were also included in the Intermediate paper, as two of the common questions used in securing grade comparability across tiers. All three were included in the Swedish grade 9 test for all pupils in the higher forms of the compulsory schools. This test in fact takes three forms: one test for those following the general course, one paper for those taking the advanced course, and one test for students in unstreamed schools. All three groups were given the three English items.

The Swedish Sample

In 1995 0.6 per cent of Swedish pupils left lower secondary school without a leaving certificate and 0.7 per cent left without a mark in Mathematics (Swedish National Agency of Education, 1996). We have assumed that they come from the bottom of the achievement spectrum in Sweden, just as we assume this for those who do not sit a GCSE in England. These figures provide us with the estimate that 98 per cent of the age cohort attend the Mathematics teaching and should take the test. Results were collected from over 98 per cent of these pupils in the Swedish national survey in 1995. Thus 96 per cent of the Swedish age cohort actually participated in the test.

The English Sample

In England, there is no Mathematics examination at age 15+ which is taken by all students, or by a representative cross-section. The tiered system means that students follow different courses for the final two years of compulsory schooling; and their institutions have a choice between not only boards but examination papers and syllabuses within boards. A major advantage of SEG papers is that the group has the largest entry for Mathematics, and one which was not confined to a particular geographical area. However, its distribution of final grades, and of candidates for the different tiers, is not identical to that for the country as a whole. Some calculations and adjustments are therefore necessary in order to determine what part of the school population is represented by the SEG entry for the papers containing the selected questions. The data used are taken from examination statistics published by the DfEE and the Joint Council for the GCSE.

In 1994 there were 532,273 students in the relevant age cohort in English and Welsh schools. 46050 were in independent and 486223 in maintained schools: both categories include special schools. The total number of 15/16-year-olds in maintained schools who took Maths GCSE was 437005, or 90 per cent. 2.2 per cent of these were ungraded, i.e. did not achieve a grade. That year, 6 per cent of the maintained school cohort was not entered for any GCSEs and a further 2 per cent did not pass any; so 8 per cent of the total maintained school cohort (including students in special schools) achieved no GCSE passes at all. However, few of those students will have been entered for the Mathematics examination. We have therefore assumed, for the purposes of this paper, that the 90 per cent entry figure can be taken to represent the upper 90 per cent of the achievement distribution in maintained schools.

Identifying the characteristics of candidate numbers is complicated, in England, by the existence of a large independent sector which enrols 8.7 per cent of the relevant age-group. These students are not representative of the age-cohort in achievement terms; and nor do their schools select among papers and syllabuses in the same ratios as the maintained sector. Examination of award statistics indicates that very few independent school entries receive low grades or fail their Mathematics GCSE: for example, in the SEG papers used for this study, no candidates from the independent sector received a U (ungraded=fail) in 1994. Of the total independent school entry of 3516 for this award, only 4 (.01 per cent) received a G compared to 5.7 per cent of maintained school candidates.

It therefore seems reasonable to treat the proportion of the cohort *not* taking GCSE Maths as equivalent to the bottom 9 per cent: i.e. to assume that independent school pupils are not included in this bottom part of the achievement range[8], and that it is therefore equivalent to the 10 per cent of maintained students who do not sit Mathematics. (0.1 x 91.3 = 9.1, the 91.3 per cent figure representing the proportion of the age-group in maintained schools.) [9]

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8 We have also made the assumption that the numbers of independent school pupils never entered for Maths GCSE at all is very small and can be ignored. This is consistent with their achievement profile overall, and with the tendency **S** documented in correspondence between the Headmasters' Conference and DfEE **S** for independent school pupils who do not appear in the 15 year old statistics to be largely early entries (see footnote 9). There are no reliable data available on independent sector non-entry figures; and given the large groups being compared here, we do not think that their omission can affect the overall results.

9 We can also arrive at this figure by a different route as follows. In 1993 there was a total of 549,000 15 year olds in England. A total of 487,534 15 year old entries were registered in the academic year 1993/4.

In determining how best to align the Swedish and English samples, a further complication is introduced by the freedom of English schools to select different GCSE boards and syllabuses. This is not a random affair. Some syllabuses are more popular with independent schools than others; and some parts of the country **S** notably London and the county of Kent **S** enter most of their students for syllabuses which they have themselves helped to develop over the years.

The syllabus selected for this study had the largest entry nationally in 1994. In 1994, among students sitting syllabuses for which data are published by tier, 53 per cent took a SEG syllabus, 18 per cent a MEG one, 22 per cent a NEAB one and 8 per cent a WJEC one. 29 per cent of all students in this population (106,110 individuals, and 55 per cent of SEG entries) took the 'SEG 2410 Version 1' syllabus from which the questions used in Sweden were drawn.[10]

The size of the SEG 2410 entry made it the most obvious choice as a proxy for the age cohort overall; but in a number of ways, it departs from the national average. As shown below, the percentages of candidates entered for the respective tiers is somewhat different from the national average:

% of candidates in:	Higher tier	Intermediate tier	Foundation tier
SEG 2410 version 1	19.7	55.5	24.7
National average	16.5	61.6	21.8

The paper also 'under-recruits' from the independent sector. The negligible proportion of independent school candidates for the Foundation tier reflects entry patterns for that sector; but for the Intermediate papers (independent sector candidates = 3 per cent) and Higher tier paper (independent sector candidates = 8 per cent) the figures are lower than the national average. However, given that this study focused on Foundation, and, to a lesser degree, Intermediate candidates, it is unlikely that this creates any significant bias.

In comparing the performance of the English and Swedish students, the best approach was to use the different proportions obtaining particular grades as a way of identifying points corresponding to percentile cut-offs in the Swedish data. This is also not quite as simple as it seems. As Table 2 demonstrates, grade distributions also markedly vary according to which population and syllabus one examines. Such variation does not mean that standards necessarily vary: on the contrary, given the differences between papers and boards in the characteristics of candidate entry, one would expect differences in grade distributions. However, it further complicates decisions about how best to compare English and Swedish performance.

From this we calculate that 11.29 per cent of the cohort was not entered. However, we must allow for those who had been entered for GCSE Mathematics before the age of 15. We assume they are not entered again at 15. The GCSE entries (entered for one or more any subject) of those aged <15 years in 1993/4 amounted to 5.37 per cent of all 15 year olds (strictly speaking we should take the 1992/3 figure but in practice it probably does not make much difference). We do not know how many of those entered aged <15 were entered for Maths but it seems reasonable to assume that all those obtaining 4 or more passes at Grades A-C were entered. These account for the vast majority of the <15 year olds. 4.6 per cent passed 4 or more; so we assume that 4.6 per cent of those aged <15 were entered for GCSE Maths. Subtracting from 11.29 this gives us 6.69 per cent. We therefore have an estimate in the range 7-9 per cent for the percentage of the cohort not entered for GCSE Maths.

10 ULEAC data are not published by tier; but none of their syllabuses had a larger entry than SEG 2410.

Table 2
Grade distributions, GCSE Maths

	SEG 2410 entries 1994	SEG 2410 entries schools only 1994		Maintained school candidates age 15 at start of 1993-4 school year	All candidates, all ages 1994
	%	%		%	%
		All	Maintained		
A + A*	7.9	11.3	10.4	7.7	8.4
B	19.8	21.5	20.9	14.8	15.8
C	19.3	16.7	16.8	19.8	22.0
D	19.7	17.2	17.6	15.4	17.2
E	15.7	15.4	15.9	16.1	15.5
F	11.4	11.1	11.4	13.7	12.5
G	5.1	5.5	5.7	7.4	6.3
U	1.1	1.3	1.3	2.2	2.2

As explained above, in Sweden, among those enrolled in school following the course, 57 per cent take the 'special', more advanced, course in Maths, and 38 per cent the less advanced, 'general' course. 5 per cent are unstreamed (Swedish National Agency of Education, 1996). The performance of the unstreamed group is entirely comparable on the experimental questions with that of the combined special and general groups, and we can therefore allocate their numbers between these two groups in the same proportion as for the general school population. These gives us the following calculations and results:

'Special course': of those in school, equivalent to 57% + (0.62 x 5.0)% = 60.1%
'General course': of those in school, equivalent to 38.0 + (0.38 x 5.0)% = 39.9%

Adjusting this to allow for the 1.3 per cent of the population who do not obtain a certificate (and who include most of the 0.6 per cent who are taking 'adjusted' courses without Maths), we can calculate that non-participants plus students at 'general' course level are equivalent to 41 per cent of the Swedish age-cohort.

To find the equivalent part of the English population, the figures for grade distributions need to be adapted to allow for the fact that they represent only 91 per cent of the age cohort. Non-participants are assumed, as for Sweden, to represent the bottom of the achievement distribution. The national distribution of marks (see Table 2) gives us 2.2 per cent of candidates ungraded; 6.3 per cent at grade G; 12.5 per cent at F, and 15.5 per cent at grade E. Adjusted, this gives us a total of 33.2 per cent of the cohort taking GCSE and obtaining these grades; adding non-participants gives a total of 42.2 per cent, a group size very similar to the Swedish comparison group.[11] In this case, the non-participants plus the lower grades provide an estimated 38.5 per cent of the cohort, or slightly less than the Swedish equivalent. Overall, the closeness of the percentages makes it reasonable to compare the Swedish group taking the general course with those English candidates scoring a grade E or below.

3. The Performance of Swedish and English Students

Table 3 summarises the success rates of the relevant groups on the three common questions. The samples used consisted of a random sample of 1000 Swedish students from the ‘General course’ group; 1000 Swedish students from the ‘Special course’ group; 997 randomly selected Foundation tier SEG candidates; and 1000 randomly selected Intermediate tier SEG candidates.

The most relevant comparisons are between the 2nd and 3rd columns. In the second, candidates from the Foundation paper (who all obtain E or below) have been combined with candidates from the Intermediate paper who obtained grade E or below in order to obtain the full equivalent sample.

Table 3
Percentages correct by country

	Foundation group n=997	Foundation plus Intermediate at grade E and below n=1131	Swedish ‘General’ group (valid sample) n=1000
Temperature question	62	65	73
Milk question	59	57	75
Number question	86	n/a	87

A significantly higher proportion (at the 1 per cent significance level) of the Swedish ‘General’ group answered the temperature and milk questions than did either the Foundation group or the combined Foundation and Intermediate Group in England. The difference in the proportion answering the number question correctly in the two countries is insignificant.

These results suggest that, at the lower levels of the achievement distribution, English students are performing less well than their Swedish contemporaries. Moreover, it must be remembered that the Swedish group includes all but the bottom 4 per cent of the cohort. The English, although the cut-off point is at approximately the same level, excludes a far larger group **S** *9 per cent of the age cohort. It seems likely, therefore, that the comparison overstates English performance relative to the Swedish.*

11 As one would expect from the breakdown of entries by tier, SEG 2410 grades are rather higher on average than the national distribution. However, this does not imply any difference in standards — quite the opposite — and we therefore treat those at grades G, F and E and representative of the national population obtaining those grades.

Table 4 below unpacks the performance of English students in more detail by analysing the performance on the three questions by grade achieved. It suggests that there is a major difference between the lowest-achieving and the higher-achieving even within this group separated only by 2 grade levels. Over 80 per cent of candidates who obtain grade E on the more demanding Intermediate tier papers complete the two common questions successfully. Grade E Foundation paper candidates reach 93 per cent facility rates on the number questions (close to a ceiling) and over 70 per cent on the other two questions. By contrast, the score of candidates from the Foundation Tier passing with a G grade on the number question is 76 per cent and their average for the two other questions is only 39 per cent. These figures are consistent with the conclusion drawn in a number of recent studies: namely that it is because of a long tail of under-achievers at the bottom of the achievement distribution that English students compare badly with overseas contemporaries.

Table 4
Percentages answering correctly: comparison of English groups with lower grades

	Temperature question	Milk question	Number question	Number of cases
All Foundation plus Intermediate at E and below	65	57	n/a	1131*
All Foundation paper candidates	62	59	86	997
All Intermediate at E and below	75	72	n/a	134
Intermediate and Foundation: Grade E				
Intermediate	85	81	n/a	84
Foundation	76	73	93	257
Intermediate and Foundation Grade F				
Intermediate	66	62	n/a	45
Foundation	61	56	91	337
Foundation Grade G	43	35	76	214
Foundation Grade U	29	16	34	38

* excludes X graded candidates on Intermediate paper who missed part of the exam.

Table 5 confirms this general conclusion. In this case, the comparisons are between the upper 60 per cent of the Swedish age cohort (who take the ‘Special course’) and the group of

English Intermediate tier students who obtain B, C or D grades. The latter excludes the 15 per cent of the cohort who take the upper tier papers and who mostly obtain A or B grades. In other words, the comparison is, roughly, between the top 60 per cent in Sweden and the group falling between the 40th and 85th percentiles in England. While there is clearly a strong possibility of a ceiling effect here, the English candidates perform at a level which, overall, is only slightly below that of the Swedish group. Since the English sample excludes the highest achieving pupils, these results are consistent with the view, expressed in previous studies, that the top English pupils achieve at a high level compared to equivalent groups elsewhere.

Table 5
Percentages answering correctly: comparison of English upper grade Intermediate students and Swedish students

	England: B Grade on Intermediate	England: C Grade on Intermediate	England: D Grade on Intermediate or Foundation	Swedish 'General'	Swedish 'Special'
Temperature	91	88	85	73	92
Milk	95	92	85	75	93
Number			98 (Foundation only)	87	97
N	134	236	604 (Number question: 122)	1000	1000

The Performance of England and Sweden on International Tests of Mathematics Achievement

English and Swedish performance in Mathematics has been measured on a common test on three occasions, in 1964, 1982 and 1995. In the First International Mathematics Study conducted in 1964 (FIMS), Sweden performed less well than England and Wales in Mathematics, being ranked 12/12 compared to England which ranked 6/12 on the performance of the group in the 13 year grade (Reynolds and Farrell, 1996). In the Second International Mathematics Study (SIMS, 1980-82) Sweden again ranked well behind England and Wales **S** 17/20 compared to 11/20 for England (Reynolds and Farrell, *op cit*). In the Third International Mathematics and Science Study (TIMSS, 1995) Sweden's score on the TIMSS items for the International 7th Grade (*I7Gr* ages 12/13)was not significantly different from that of England. At the International 8th Grade (*I8Gr* ages 13/14) Sweden scored significantly *higher* than England (Keys, Harris and Fernandes, 1996). Swedish pupils registered much larger gains in mathematical competence than did English pupils between *I7Gr* and *I8Gr*.

A possible explanation may be simply that Swedish pupils were at a different stage of Mathematics learning from English pupils **S** Swedish pupils were in their 6th year of full-time compulsory schooling in *I7Gr* while English pupils were in their 8th year **S** if we had been able to look at the progress of English pupils between their 6th and 7th years of full-time schooling we might have observed the same degree of progress. Whatever the reason for the more rapid Swedish progress between *I7Gr* and *I8Gr,* Sweden improved its position in the rank order of the TIMSS

Mathematics test relative to SIMS while England's position deteriorated. In TIMSS at *I7Gr* Sweden was ranked 15/20 **S** 14/20 at *I8Gr* (17/20 for SIMS) **S** above England which was ranked 16/20 in *I7Gr* and *I8Gr*.

The Performance of Pupils in England and Sweden on Selected Mathematics Topics in the Standard TIMSS Test

The results of the TIMSS Mathematics test for 13 year olds were reported under 6 categories for all countries[12]. The TIMSS data can therefore also be used to compare the performance of Swedish pupils in the basic skill areas of a) fractions and number sense and b) measurement. This information should also enable a further test of our findings from the GCSE questions to be carried out.

Table 6
Average percentage of correct answers for *Fractions and number sense* in England and Sweden (51 items)

	International Seventh Grade Pupils (*I7Gr*) %	International Eighth Grade Pupils (*I8Gr*) %
England	48 (1.0)	54 (0.8)
Sweden	51 (0.8)	62 (0.8)

(Standard errors in brackets)

Table 7
Average percentage of correct answers for *Measurement* in England and Sweden (18 items)

	International Seventh Grade Pupils (*I7Gr*) %	International Eighth Grade Pupils (*I8Gr*) %
England	43 (0.9)	50 (0.9)
Sweden	47 (0.7)	56 (0.9)

(Standard errors in brackets)

Source for Tables 6 and 7: Beaton A.E., Mullis I.V.S *et al*, *Mathematics Achievement in the Middle School Years*, Boston College 1997 Tables 2.1 and 2.2.

In both these areas of mathematics, there is only a small, though statistically significant

12 These categories were: Fractions and number sense, Geometry, Algebra, Data representation, analysis and probability, Measurement and Proportionality.

difference between the countries in *I7Gr*. In *I8Gr*, by contrast, the Swedish pupils perform considerably better than the English pupils. These were not the only areas in which Swedish pupils performed better than English at *I8Gr* **S** Swedish pupils were also ahead in data representation and proportionality. English pupils consistently performed better only in geometry and algebra.

The stronger performance of the Swedish pupils in this area points in the same direction as the results of the performance of 16-year-olds on GCSE Mathematics questions in both. Both the GCSE questions and the Test B items, on which the Swedish students did better than the English, tested simple basic skills of mathematical logic and arithmetical manipulation. We would therefore expect that Swedish pupils would out-perform English pupils on the questions in the TIMSS Mathematics test in these areas and this is indeed shown to be the case.

4. Summary and Conclusions

This study reports the results of an investigation into the differences in prior attainment between Swedish and English 16-year-olds enrolling in full-time courses of vocational education and training. Swedish participation rates and success rates on these courses are markedly higher than in England **S** over 80 per cent gain a qualification in Sweden compared with 63 per cent in England. Evidence from studies organised by the International Association for Educational Achievement indicated important differences in the teaching of Mathematics at age 13 to pupils in England and Sweden. Swedish teachers appeared to place emphasis in their teaching on trying to ensure mastery of topics for a majority of pupils rather than on covering a wide range of topics.

This study seeks to test the view that emerges from these international studies that Swedish students in the lower half of the attainment range are better prepared at age 16 in the key skill areas (application of number and communication) that underpin further education and training than English students. The study examines Mathematics; the feasibility of attempting a similar review of communication key skills at 16 is under review. In our study, the performance in Mathematics of 16-year-old Swedish and English students of below average ability was directly compared as a result of a unique experiment. This experiment involved incorporating into Mathematics tests taken by almost all Swedish pupils in 1995 in their last year of compulsory schooling (aged 15/16) three questions taken from Mathematics papers sat by English candidates for the GCSE Mathematics examination in 1994. The questions chosen tested basic mathematical skills and because of the way in which students both in England and Sweden are divided into groups of different ability levels for the teaching of Mathematics prior to testing, we were able to compare the performance of a sample of 16-year-old pupils previously classified as from the lower-attaining 40 per cent of pupils in each country. This gave a more useful indication of the level of preparation of the students who normally proceed to vocational courses than had been available from international studies where students are normally younger (13/14), there is no independent estimate of prior attainment and results are given for the average of the whole ability range.

Taking 16-year-olds in the two countries, we were able to compare the attainments of the group taking the less difficult Mathematics syllabus in Sweden (‘General’ group) and the lowest third of the English group entered for the Intermediate Mathematics GCSE together with the whole group entered for the Foundation paper (approximately 40 per cent of the age group in both countries). When the English students’ performance was compared to the Swedish students on the three questions, a significantly higher proportion of the Swedish ‘General’ group answered the temperature and milk questions correctly, compared to the combined Foundation and lower Intermediate group in England. The difference in the proportion answering the number question in the two countries was insignificant.

The result of our own experiment was consistent with results for Mathematics of the Third International Mathematics and Science Study (TIMSS) which showed the average performance of the older of the two Swedish classes tested to be significantly higher than that of the corresponding English class. Swedish pupils also out-performed English pupils in the Mathematics topic areas, fraction and numbers sense, measurement, data representation and proportionality. The only areas in which English pupils performed better than Swedish pupils at International Grade 8 were geometry and algebra.

If no significant difference had been detected in the performance of Swedish and English 16-year-olds, the hypothesis of higher Swedish key skills would have had to be ruled out. The significant differences that have been found mean that that hypothesis cannot be excluded. While we have not sought to establish a direct causal link between the level of prior preparation in the key skills and the outcomes of further education and training, the evidence now points more strongly to the conclusion that greater success in education and training in Sweden may result in part from higher proportions reaching threshold levels of key skills on entry. The challenge now is to further investigate this and other factors involved in success after compulsory school.

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