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GCSE 1999: Added-value from schools adopting the CASE Intervention

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SUMMARY

This report presents data from the 1999 GCSE results of schools which started to use *Thinking Science,* the curriculum materials of the Cognitive Acceleration though Science Education (CASE) project, in 1994. CASE is delivered in Years 7 and 8, so this is the most recent opportunity there has been to investigate the long term effect of CASE on students' academic achievement.

Data from eleven schools were analysed. Selection of the sample is described and brief characteristics of the schools given. Unlike previous reports on the effects of CASE, this sample includes selective schools with relatively high-ability intakes.

The method of Value-Added analysis employed is to look at the mean ability of a school's intake to Year 7 and at the mean grades and percentage grade C and above obtained in GCSE examinations taken at the end of Year 11. For a set of control (non-CASE) schools it is possible to establish what mean GCSE grades would be expected from any level of intake. The extent to which the actual GCSE grades obtained by the CASE schools exceeded these expectations can then be measured.

The analysis is shown for GCSE science, mathematics, and English. In every subject and for every school CASE seems to have created real Added Value on academic achievement, and in the great majority of instances this reaches statistical significance.

The long-term far-transfer effect of CASE is once again confirmed, and is now extended to include selective schools with above-average ability students.

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Introduction

This report relates to the 1999 GCSE results of eleven schools whose science departments were trained in the use of the *Cognitive Acceleration through Science Education* (CASE) methods at King's College London. Most of these schools used the CASE *Thinking Science*[1] activities with their Years 7 and 8 classes in 1994 – 96. Grades attained in their 1999 GCSE examinations, taken three years after the end of the CASE intervention, provide evidence of the long-term effect CASE on students' academic achievement.

The 'Added-Value' approach

If we wish to assess how well a school is teaching its students, then we may simply look at their published GCSE results and compare those with the National Average. For example, the 1999 GCSE results for Science showed 50.8% of students across the country achieving C grade or above. If we find that a given school has 55% of their Year 11 getting C-grade or above in Science, do we say that is a good result? It all depends. If we know that the school intake in Year 7 was just on the National average (i.e. at the 50th* percentile) then we could say it is satisfactory: The school is doing a little better than average. But if we knew that the mean of the Year 7 intake was only at the 20th percentile (and there are many such schools in the big cities) then that result would be very good indeed. And if it were a selective school - say with a mean intake at the 70th percentile - then that result would indicate that the teaching was poor.

In order to assess whether a school's GCSE results are good or not it is necessary to compare them with the results of schools with similar Year 7 intakes. This means that we need some common measure of the ability of students entering the school. The way this is done for the CASE project is to administer a Piagetian Reasoning Task (PRT) to the whole school intake soon after they start Year 7. The particular PRT used at this level is *PRT II: Volume & Heaviness*[2]. From the mean score of this test the position of the school's intake relative to all other schools in England and Wales can be found.

PRTs were used in 1974 and 1975 in a survey of 14,000 ten to sixteen year-olds representative of the school population of England and Wales. It is on the basis of the norms established by that survey that a school can be placed on a national scale for the ability level of its intake. For example, a school's intake can be described as "average" (the mean at the 50th percentile), "considerably below-average" (say the mean at the 20th percentile) or, in the case of a grammar school which selects the top 20% and has a mean intake about the 88th percentile as "well above average".

PRTs have been shown to be good predictors of future learning in major school subjects, particularly in science and mathematics. Thus from the mean intake level for a school it is possible to estimate the most likely set of mean GCSE grades that will be obtained by that school. The method of analysis used here is to compare GCSE grades actually obtained by a school with those that would be expected from its mean intake level. The extent to which actual grades are higher than expected is a measure of the academic Value Added to the students by use of the CASE intervention.

The Sample of Schools

Since 1991, King's College London has been offering two-year Professional Development (PD)

* The nth percentile is the score below which n% of the whole population lies. The 20th percentile is the score below which 20% of the population lies (and above which will be found 80% of the population).

courses to schools wishing to introduce CASE. These schools provide an obvious sample for investigating the long-term effects of CASE on academic achievement. To make the Value-Added estimate valid it was important to limit the analysis to those schools for which we had Year 7 PRT evidence for the same students who would sit GCSE in June 1999. We have reported previously on those schools which started the CASE PD programme in 1991[3]. No new schools started the course in 1992, and only three in 1993. The main source of schools for this survey is the fourteen schools which started in 1994. Pre-test data were available for only ten of the fourteen 1994 schools (not all schools which started the PD course in '94 actually started the testing and intervention programme in September of that year) and of these, we failed to get GCSE data from two. To the remaining eight 1994 schools were added one from the 1993 start, one of the 1991 start schools, and one Upper School which started CASE in its first Year (9) in 1995 (and subsequently in its feeder Middle Schools). This key identifies the schools in tables and figures which follow:

A	Clapton Girls (inner city Comprehensive)
B	Chatham Girls Grammar
C	St. Albans (boys Independent)
D	St. Edmunds Portsmouth (Catholic Comprehensive)
E	Downham Market (rural Comprehensive)
F	Downend (city comprehensive, Bristol)
G	Sion-Manning (girls inner city Catholic Comprehensive)
H	Rokeby (boys inner city Comprehensive)
I	South Camden (inner city Comprehensive)
J	George Abbott, Guildford (Comprehensive)
K	Sharnbrook Upper, Bedfordshire

To compare the performance of these schools with what would be expected from them without CASE, we also need a set of 'control' schools, similar to these eleven schools but whose students who sat GCSE in 1999 had not experienced CASE. Schools who are on the current (1999 start) King's PD course provide such a control set. All have administered PRTII which can be used to estimate the level of the school intake. These schools were asked for their 1999 GCSE results - which of course could not have been affected by the CASE intervention because their Year 7 students only began CASE some time in the last two years. By selecting a sample of those whose mean Year 7 percentile spans the range of intakes of our 1994 CASE schools, we can then relate those entry levels to the control schools' 1999 GCSE results. Note that for these control schools the Year 7 PRT and Year 11 GCSE data is not on the same students, so there is an assumption that the intake remains roughly constant – justifiable over a large number of schools.

Note also that these 'controls' are schools which have opted for CASE PD, and thus show the same level of enthusiasm for innovation as did the 1994 cohort.

Results for Science

An example of a complete analysis is shown in figure 1 on the next page. Each circle represents one school. Hollow circles are the mean percentiles of the control schools' Year 7 intakes, plotted against the mean of their 1999 GCSE results expressed on a scale from A* = 8 through C = 5 to G = 1. Not surprisingly, these fall near a straight line (the regression line predicting the science GCSE grades from school intake) showing that a school's performance at GCSE is directly related to the general ability of its intake. The fact that this line passes through the national average at the 50th percentile (shown as a triangle) suggests that this sample of control schools represents the national picture.

The solid circles represent the 1994 CASE schools. The extent to which these lie above their regression line for the controls is a measure of the added-value, that is, the extent to which their mean GCSE grades are higher than would be expected from their intake. In this case the added value averages approximately 1 grade, and this must be attributed to the CASE intervention as this is the only systematic difference between the 'CASE' and the control schools.

Figure 1: GCSE 1999 Mean Science Grade Added-Value

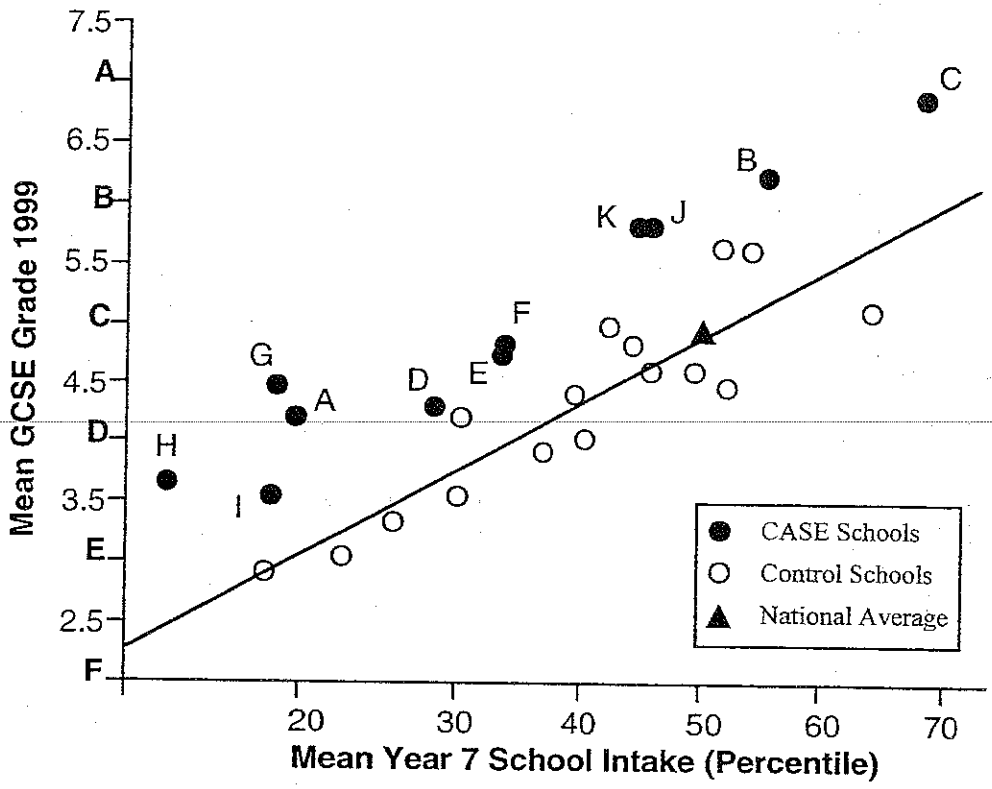


Table 1: GCSE 1999 Science Mean grades: Added-Value

School	predicted Mean	actual Mean	Added Value (Grades)	p	Effect-size (S.D.s)
A	3.06	4.24	1.17	<.01	0.69
B	5.20	6.26	1.06	<.01	0.63
C	5.92	6.91	0.99	<.025	0.59
D	3.68	4.31	0.63	n.s	0.38
E	3.99	4.77	0.78	<.05	0.46
F	4.00	4.84	0.84	<.025	0.50
G	2.99	4.50	1.51	<.005	0.89
H	2.49	3.69	1.20	<.01	0.71
I	2.96	3.57	0.61	n.s.	0.36
J	4.68	5.84	1.16	<.01	0.69
K	4.62	5.84	1.22	<.005	0.72
		Mean	**1.02**		**0.60**

n.s. – not statistically significant

The results are also presented in table 1. The predicted mean is read off from the control schools' regression line as being that which would have been obtained by a control school with the same Year 7 intake. Thus the added-value is simply the difference between this and the mean that was actually obtained. The p-value gives the probability that the result could be within the range of the control schools' variation. For example, p<.01 means that there is only 1 in 100 chance that that mean is not really different from the controls. The Effect-size gives the magnitude of the added-value in units of the standard deviation of the national results (1.69 grades in 1999). Effect sizes above 0.3 are normally considered useful, and above 0.5 are good.

The data can also be presented as the percentage of students achieving C-grade and above, as shown in figure 2 and table 2 on the next page. Again the percentage of those obtaining C-grade or above is entered in the graph against the mean Year 7 intake for the control schools. The added-value for any of the CASE schools can be assessed by inspecting the extent to which it lies above the control schools' regression line.

Figure 2: GCSE Science % at or above C-grade Added-Value

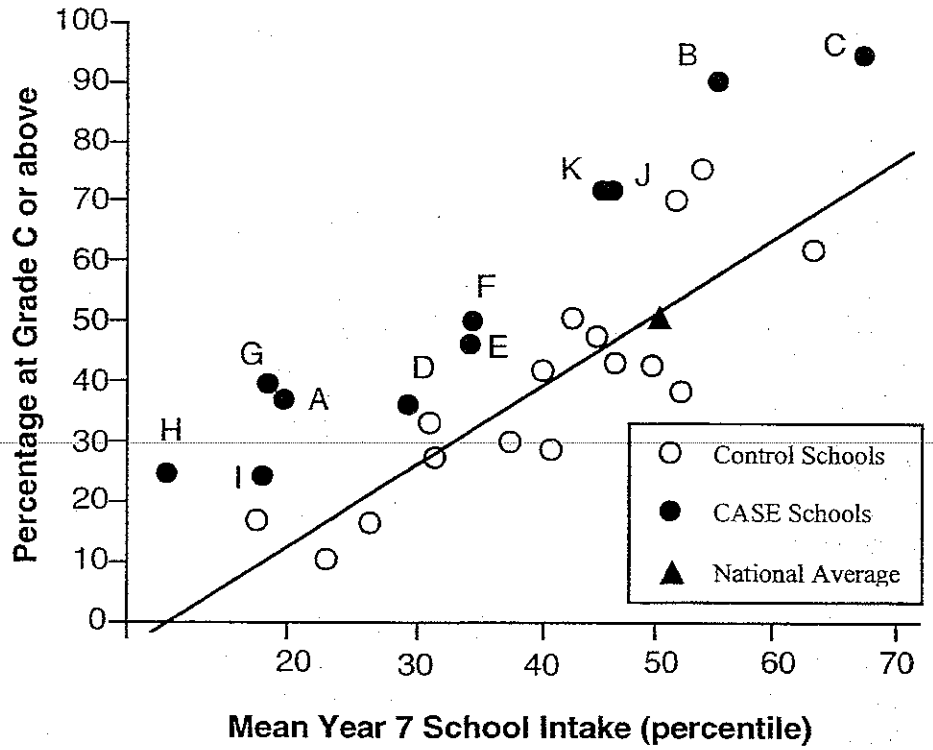


Table 2: GCSE 1999 Science: C-grade and above Added-Value

School	predicted %≥C	actual %≥C	Added Value %	p
A	13.8	36.8	23.0	<.01
B	59.6	90.5	30.9	<.0005
C	75.6	94.6	19.0	<.005
D	23.3	36.0	12.7	n.s.
E	29.5	46.3	16.8	n.s.
F	29.8	50.2	20.4	<.05
G	12.9	39.5	26.6	<.005
H	8.1	24.7	16.6	<.01
I	12.6	24.3	11.7	<.05
J	46.3	72.1	25.8	<.025
K	44.8	72.1	27.3	<.025
		mean	**21.0**	

If these results were repeated nationally the percentage at C-Grade and above would rise from 50.8% to 77.2%.*

Added-Value for GCSE Mathematics

Figure 3 and table 3 show the corresponding added-value data for mean grades in Mathematics GCSE. Note that these are the gains in Mathematics GCSE grades resulting from the Cognitive Acceleration through *Science* Education intervention. They show that there is transfer from thinking developed in a science context to increased academic achievement in maths.

* This differs from just adding 21% to the 1999 average because in handling differences between percentages it is necessary to convert them into Logits [Ln(%/(100-%))] to allow for the fact that below 35% they are no longer a linear scale (e.g. the result for School I is greater than it appears, compared with School K).

Figure 3: GCSE 1999 Mean Mathematics Added-Value

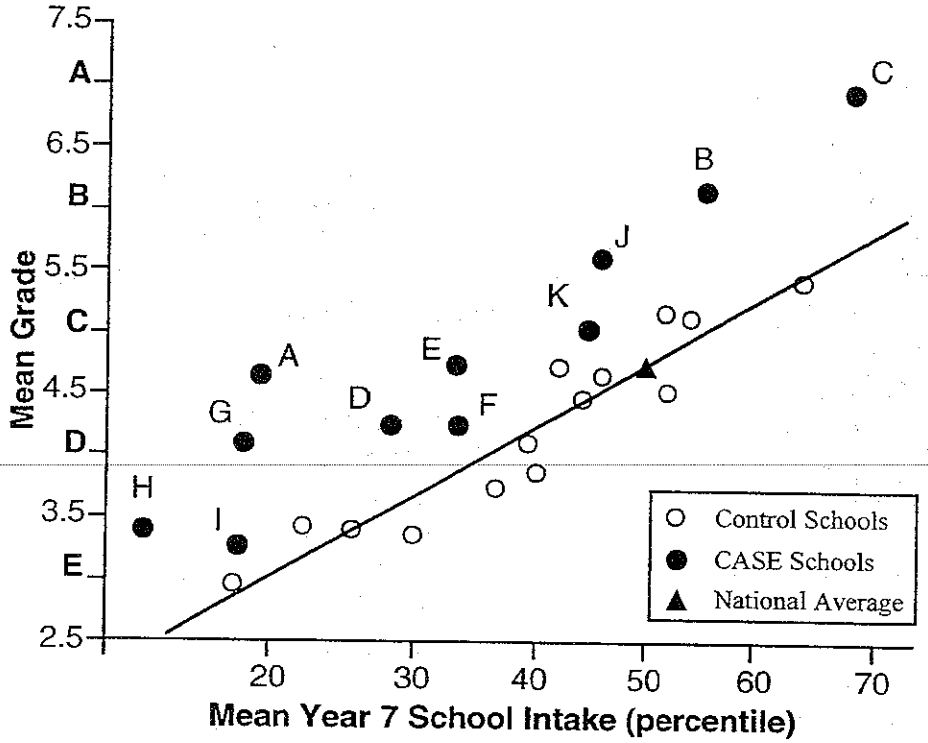


Table 3: GCSE 1999 Mathematics Mean grades: Added-Value

School	predicted Mean	actual Mean	Added Value (Grades)	p	Effect-size (S.D.s)
A	2.98	4.66	1.68	<.0005	0.89
B	4.96	6.17	1.22	<.0005	0.64
C	5.62	6.96	1.34	<.0005	0.71
D	3.55	4.23	0.68	<.01	0.36
E	3.84	4.73	0.89	<.005	0.47
F	3.85	4.24	0.40	n.s.	0.21
G	2.91	4.10	1.19	<.0005	0.63
H	2.45	3.39	0.94	<.005	0.50
I	2.89	3.26	0.38	n.s.	0.20
J	4.48	5.62	1.15	<.0005	0.61
K	4.42	5.04	0.62	<.025	0.33
		Mean	**0.95**		**0.5**

Table 4: GCSE 1999 Mathematics: C-grade and above Added-Value

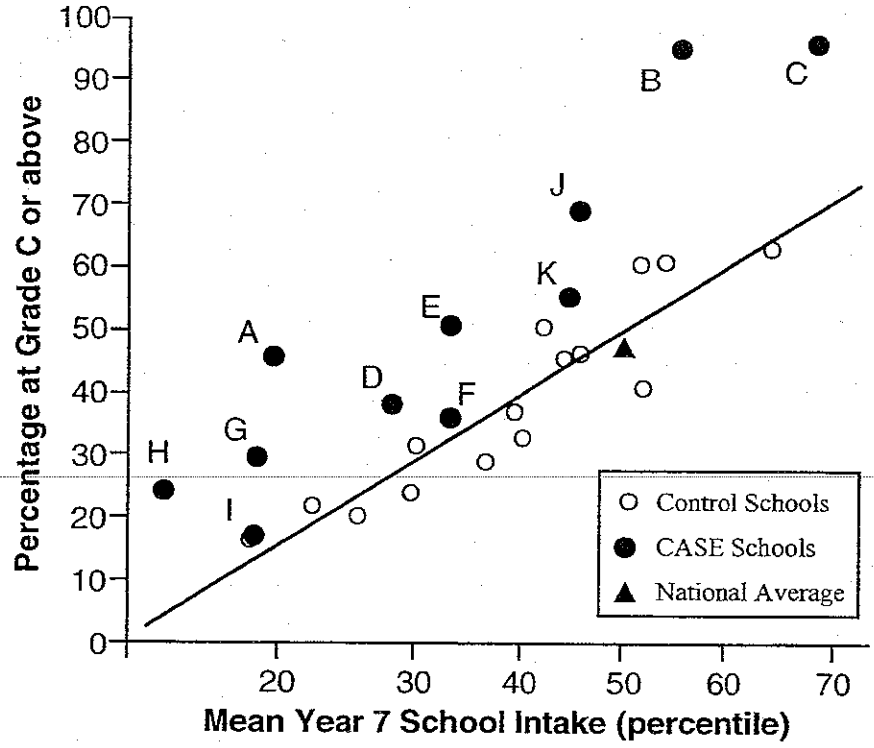
School	predicted %≥C	actual %≥C	Added Value %	p
A	15.4	46.1	30.7	<.0005
B	55.6	95.7	40.1	<.0005
C	69.1	96.4	27.3	<.0005
D	27.0	38.6	11.6	<.05
E	32.8	51.1	18.3	<.01
F	33.0	36.7	3.7	n.s.
G	13.9	30.3	16.4	<.025
H	4.6	24.7	20.1	<.005
I	13.4	17.6	4.2	<.01
J	45.8	69.6	23.8	<.005
K	44.7	55.9	11.2	0.05
		Mean	**18.8**	

The Added-Value in maths for the CASE schools is clearly similar to that for science

Table 4 and figure 4 give the same information in terms of percentage at C grade and above.

If these results were repeated Nationally the percentage at C-Grade and above in maths would rise from 48.0% to 76.6%

Figure 4: GCSE Maths % at C-Grade and above



Added-Value for GCSE English

Figure 5, and table 5 on the next page, show the corresponding added-value data for English.

Figure 5: GCSE 1999 Mean English Added-Value

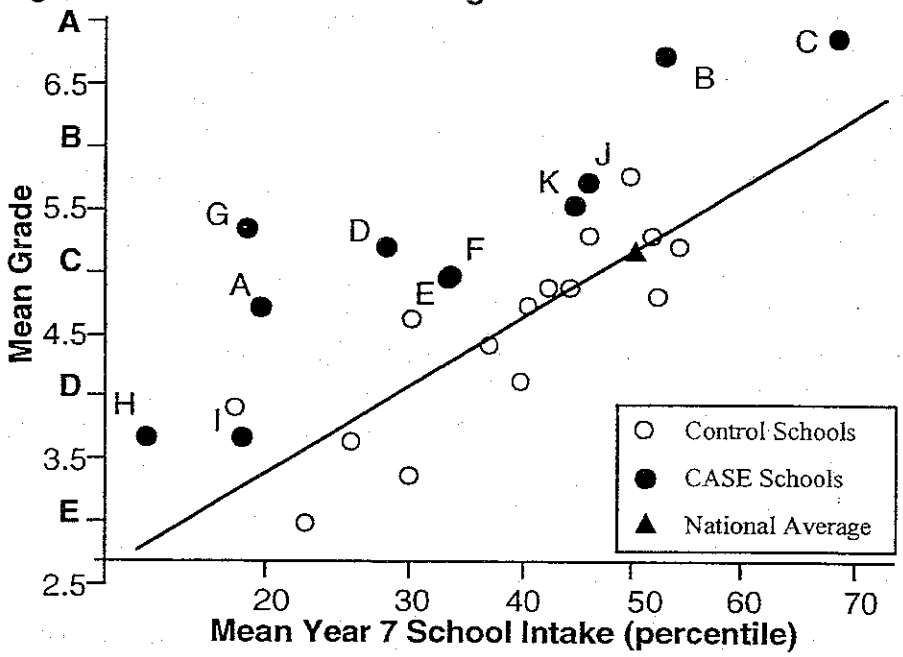


Table 5: GCSE 1999 English: Added-Value

School	predicted Mean	actual Mean	Added Value (Grades)	p	Effect-size (S.D.s)
A	3.57	4.74	1.17	0.025	0.74
B	5.38	6.65	1.27	<.01	0.81
C	5.98	6.89	0.91	<.05	0.58
D	4.09	5.22	1.13	<.025	0.72
E	4.35	4.98	0.63	n.s.	0.40
F	4.36	4.99	0.63	n.s.	0.40
G	3.51	5.37	1.86	<.005	1.18
H	3.09	3.69	0.60	n.s.	0.38
I	3.49	3.69	0.20	n.s.	0.13
J	4.94	5.74	0.80	<.05	0.51
K	4.89	5.57	0.68	n.s.	0.43
		Mean	**0.90**		**0.57**

The same data expressed as percentage C-grade or above is shown in table 6 and figure 6.

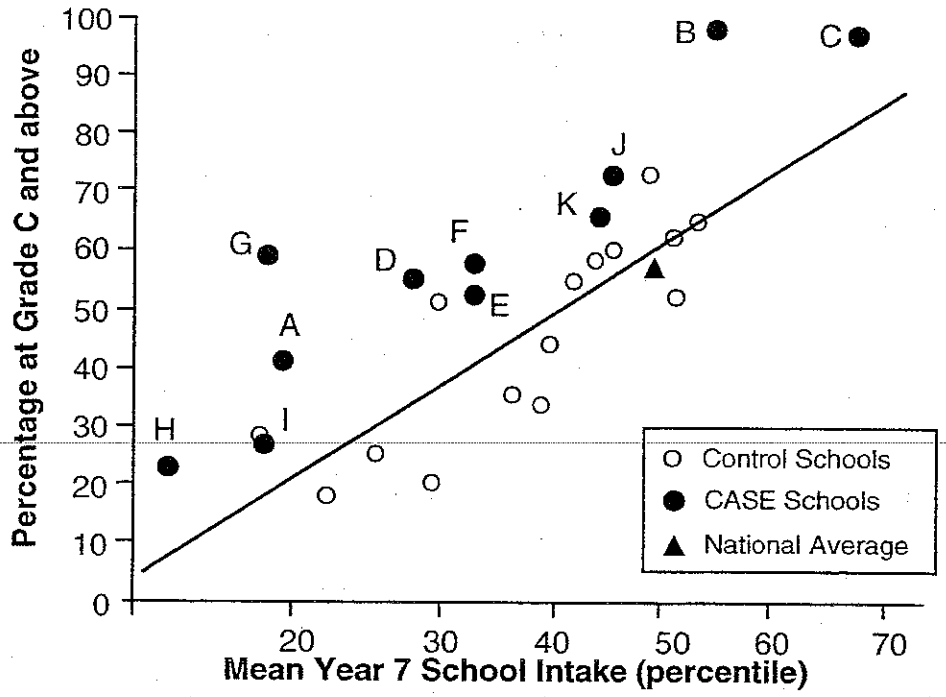
Table 6: GCSE 1999 English: C-grade and above Added-Value

School	predicted %≥C	actual %≥C	Added Value %	p
A	20.8	42.1	21.3	<.025
B	63.9	99.1	35.2	<.005
C	78.4	98.2	19.8	<.05
D	33.2	56.1	22.9	<.025
E	39.4	58.6	19.2	<.05
F	39.7	53.1	13.4	n.s.
G	19.2	59.6	40.4	<.005
H	9.2	23.3	14.1	n.s.
I	18.7	27.7	9.0	n.s.
J	53.4	73.6	20.2	<.05
K	52.3	66.5	14.2	n.s.
		Mean	**20.9**	

If these results were repeated nationally the percentage at C-Grade and above would rise from 57.7% to 79.7%.

The statistical significance of these results for English is lower because of the greater variation of the control schools' mean results, as can be seen in Figs. 5 & 6. This is a reflection of the lower precision obtainable in assessing English, compared with science or mathematics. Nevertheless it can again be seen that the English added-values are of the same order as those for Science.

Figure 6: GCSE English % at C-Grade and above



Conclusion

The data presented in this report confirms the substantial effect of Cognitive Acceleration (CA) methods on students' academic achievement. There is a long-term effect -it lasts at least three years after the end of the CA intervention. There is also a far transfer effect: although the CA reported here was delivered by science teachers in science lessons with activities set in a science context, the students who experienced the activities attained significantly higher grades in English GCSE.

By far the most likely mechanism by which this happens is that the CA activities have a fundamental effect on students' general ability to learn, and that they can then turn this generally enhanced learning ability to bear on all school subjects.

But these data are more than just the latest in a long line of evidence for the long-term far-transfer effect of CA (see endnotes [3] and [4]). For the first time, data from two selective schools have been obtained and although the sample is not large, it is sufficient to falsify the hypothesis that 'CA only works with less able students'. If you look back over the figures and tables presented in this report, you will see that school B, a girls' grammar school, and school C, a boy's independent school, have consistently made amongst the largest gains in GCSE grades, beyond those even they would have expected.

The data of this report add significantly to the already strong evidence for the consistency and generalisability of the effect of Cognitive Acceleration.

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[1] *Thinking Science: The curriculum materials of the CASE project.* by Philip Adey, Michael Shayer, and Carolyn Yates. 2nd edition published by Thomas Nelson & Sons, 1995

[2] Piagetian Reasoning Tasks are available form Science Reasoning, 16 Fen End, Over, Cambs, CB4 5NE. phone 01954 231814

[3] *The long-term effects of Cognitive Acceleration on students' school achievement, November 1996.* by Michael Shayer. Centre for the Advancement of Thinking, King's College London, 1997

[4] *Really Raising Standards* by Philip Adey and Michael Shayer, Routledge, 1994