5. How predictable are age-16 competency levels?

In this chapter we start with correlations between the individual competency measures over time. We then present overall models using the measures grouped into two factors: the cognitive and attitudinal.

In the next chapter we look at the consistency of progress over time: whether those achieving low (or high) scores at earlier ages continued to do so.

Correlations between age-16 scores and earlier scores

At age 5 we measured *early literacy*, at age 6 we measured *BURT word recognition* and *invented spelling*, at ages 8, 10, and 12 we measured *PAT reading comprehension*, *BURT word recognition*, and *writing*, and at age 14 we measured *PAT reading comprehension* and *writing*. We look now at the correlations between these measures and the *literacy* score measured using the IALS test at age 16 (Table 14).

We also look at the measures of *early number knowledge* (age 5), *number knowledge* (age 6), *mathematics* as measured by a subset of PAT test items (ages 8–14), and *numeracy* as measured by the IALS test at age 16 (Table 15).

We have measures of *logical reasoning* at ages 5 and 6 using the coloured progressive matrices test, and from age 8 using the standard progressive matrices test. The measure used at age 16 is a composite, constructed from the age 12, 14, and 16 results. This has resulted in the correlation coefficients between the age-16 measure and the age-12 and -14 measures being higher than they otherwise would be (Table 16). A composite measure for *logical problem-solving* at age 16 corresponds with the age-16 *adult literacy and numeracy* scores: these are the scores that are our best measure of the young people's competencies as they finish their education.

As one would expect, correlations between age-16 scores are highest with the age-14 scores for the cognitive competencies: 0.71 with the PAT reading comprehension test at age 14 and the age-16 IALS literacy test, 0.77 between the scaled-down PAT maths test at age 14 and the age-16 IALS numeracy test, and 0.87 between the age-14 and composite measure for the logical problem-solving test used at age 16. The correlations of age-16 scores with age-5 scores are highest for mathematics/numeracy.

Table 14 ***Correlations between age-16 literacy and literacy scores ages 5–14***

Age	*Approximate n*[a]	*Literacy subtest*	*Literacy*
5	241	Early literacy	0.36
6	245	BURT word recognition	0.57
	245	Invented spelling	0.47
8	443	PAT reading comprehension	0.60
	444	BURT word recognition	0.55
	444	Writing	0.38
10	444	PAT reading comprehension	0.66
	444	BURT word recognition	0.58
	444	Writing	0.42
12	444	PAT reading comprehension	0.64
	444	BURT word recognition	0.54
	444	Writing	0.46
14	443	PAT reading comprehension	0.71
	440	Writing	0.50

[a] The exact sample size will lie within six students of the number given. The sample size varies between competency scores as we did not get a measure for each competency for each child in each round of data collection.

Table 15 ***Correlations for age-16 numeracy and logical problem-solving scores and corresponding scores for ages 5–14***

Age	*Approximate n*[a]	*Numeracy*[b]	*Logical problem-solving*
5	241	0.54	0.41
6	245	0.56	0.49
8	443	0.61	0.66
10	444	0.69	0.72
12	444	0.76	0.78
14	443	0.77	0.87

[a] The exact sample size will lie within six students of the number given. The sample size varies between competency scores as we did not get a measure for each competency for each child in each round of data collection.

[b] Measured by a test of early number knowledge at age 5, number knowledge at age 6, cut-down PAT mathematics tests at ages 8–14, and the cut-down IALS test at age 16.

There has been less consistency in the attitudinal measures.

At age 16 we have fewer attitudinal measures: our new measure of *thinking & learning* was constructed from some items that in the past have been used in the *curiosity* and *communication* competencies (Table 16); *focused & responsible* from some items that have been used in *communication* (a different subset of the items), *individual responsibility*, *self-management* (at age 14), and *perseverance* (0); and some items used to construct *social skills* and *social difficulties* were in the past used to construct *social skills with teachers/adults* and *social skills with peers* measures (Table 18).

At age 16 we have attitudinal competency measures for those still at school, but not those who have left school (as the measures are based on teachers' perceptions of the students), hence the smaller sample sizes for the attitudinal competencies.

Table 16 ***Correlations for thinking & learning scores ages 5–16***

Age	*Attitudinal subtest*	*Approximate n*	*Thinking & learning at 16*
5	Curiosity	227	0.09
	Communication	227	0.24
6	Curiosity	227	0.17
	Communication	227	0.34
8	Curiosity	412	0.11
	Communication	412	0.30
10	Curiosity	412	0.23
	Communication	412	0.40
12	Curiosity	411	0.39
	Communication	411	0.40
14	Curiosity	411	0.56
	Communication	412	0.59

Table 17 ***Correlations for focused & responsible scores ages 5–16***

Age	*Attitudinal subtest*	*Approximate n*	*Thinking & learning at 16*
5	Perseverance	227	0.18
	Communication	227	0.18
6	Perseverance	227	0.36
	Communication	227	0.27
	Individual responsibility	227	0.32
8	Perseverance	412	0.30
	Communication	412	0.22
	Individual responsibility	412	0.31
10	Perseverance	412	0.38
	Communication	412	0.31
	Individual responsibility	412	0.38
12	Perseverance	411	0.46
	Communication	411	0.33
	Individual responsibility	411	0.42
14	Perseverance	412	0.69
	Communication	412	0.61
	Self-management	412	0.67

Table 18 ***Correlations for social skills[a] and social difficulties scores ages 5–16***

Age	*Approximate n*	*Social skills at 16*	*Social difficulties at 16*
5	227	0.12	0.05
6	227	0.23	0.06
8	412	0.24	0.09
10	412	0.26	0.15
12	411	0.26	0.13
14	412	0.46	0.32

[a] Earlier social skill measures used to calculate the correlations were *adult social emotional* at age 5, and *social skills with adults* at ages 6–14.

Of the attitudinal scores, the first two, *thinking & learning* and *focused & responsible*, showed a moderate correlation across time from age 10 or 12, whereas the two social skills scores were weakly correlated with earlier scores, suggesting that the first two attitudinal scores measure attributes that are less subject to change: the things that the student enjoys (reflecting on the world around them, or focusing on the task in hand). The social skills scores may measure more how the young person is interacting with their environment at the time, and while this, too, will be largely influenced by the personality they are developing, it will also be changing in response to their environment, peer pressure, and even the relationship with the teachers who completed our forms.

Given the strong correlations between the competencies, both within a round of data collection, and between ages, we next investigate the extent to which it is possible to model the competencies at age 16 from the earlier competencies.

Modelling of competency factors over time

At ages 12 and 14 we have used combined competency measures to model later competencies from earlier measures. There are two main reasons for using the combined competency measures rather than the separate competencies. Firstly, the separate competencies are strongly correlated, and any model using them is likely to have problems with multicollinearity.[15] Multicollinearity is still a problem in some models using composite or combined competency measures. Secondly, having 200–400 observations limits the number of parameters that can be fitted in a model; models that incorporate factors based on the separate competency measures would require too many parameters for the number of observations, particularly models using age-5 or age-6 information.

We look first at the correlations between the composite competency measures over time, and then at the models fitted.

[15] Multicollinearity refers to the situation where the independent or predictor variables are highly inter-correlated (correlations greater than 0.7). In a linear model it is desirable to have the independent variables correlated with the dependent (outcome) variable, but not with each other. If the independent variables are strongly correlated with each other, then one or more of them is effectively redundant (does not add any new information to the model).
Multicollinearity can be detected in a model if the model as a whole has a low *p*-value, but some independent variables have high *p*-values; some regression coefficients have an estimate that does not make sense (too high or low or even the wrong sign); and the precision of the estimates in the model declines (this can be detected by looking at the variance inflation factors).

Correlations between the composite competencies over time

The composite cognitive and attitudinal competency measures are more strongly related over time than the individual measures are. The associations amongst the cognitive competencies (Figure 16) are stronger than those amongst the attitudinal competencies (Figure 17). This is true both between successive rounds of data collection (correlations of about 0.9 compared with 0.56–0.66), and going back over time. For the cognitive competencies, the correlation between the composite age-16 competency and the corresponding age-5 competency is 0.64, while the equivalent correlation for the attitudinal competencies is 0.28.

Figure 16 ***Linear associations across time in the cognitive competencies using normalised scores (n = 241 for age 5, 245 for age 6, 444 for ages 8–16)***

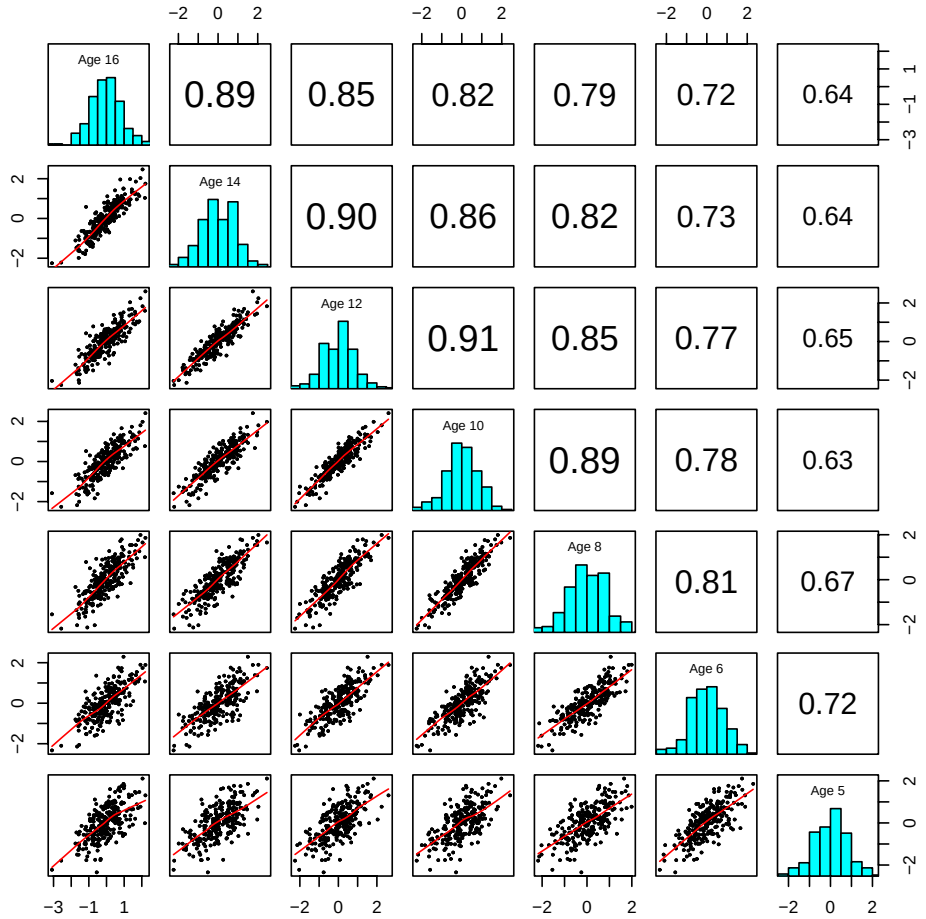
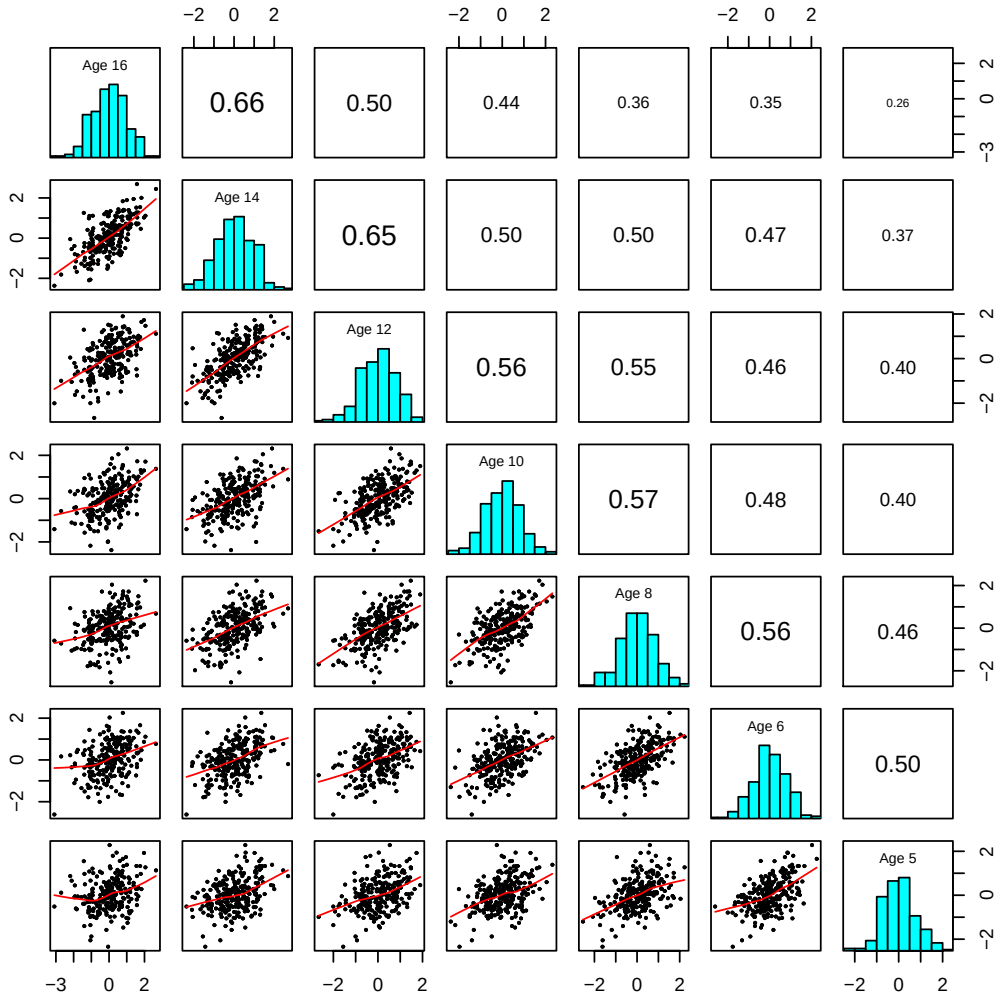


Figure 17 ***Linear associations across time in the attitudinal competencies (n = 227 for ages 5 and 6, 412 for ages 8–16)***



We fitted non-recursive path models to the data.[16] These models assume that the variables are multivariate normal. To meet this assumption we used the mean of normalised separate competency measures[17] as composite measures of the cognitive and attitudinal competencies at each age.

At age 14 we fitted models using data from age 8 on (a larger sample), and models using data from age 5 on (a smaller sample). This was repeated at age 16.

[16] Using SAS/STAT software (PROC CALIS).

[17] The data were normalised by taking the *z*-score (standard normal distribution) corresponding to the percentile of each observation.

Models for age-8 to age-16 data

The pattern found at age 12 and age 14 was one in which:

- attitudinal competencies are useful to predict:
- cognitive competencies at the same age, and
- attitudinal competencies at the next two ages; and
- cognitive competencies are useful to predict:
- attitudinal competencies at the next age, and
- cognitive competencies at the next two ages.

The strongest relationships are between successive competencies of the same type; relationships between earlier competencies of the same type are typically the next strongest; the relationships between attitudinal competencies and earlier cognitive competencies are almost as strong; and the weakest relationships are typically those between the attitudinal competencies and cognitive competencies at the same age.

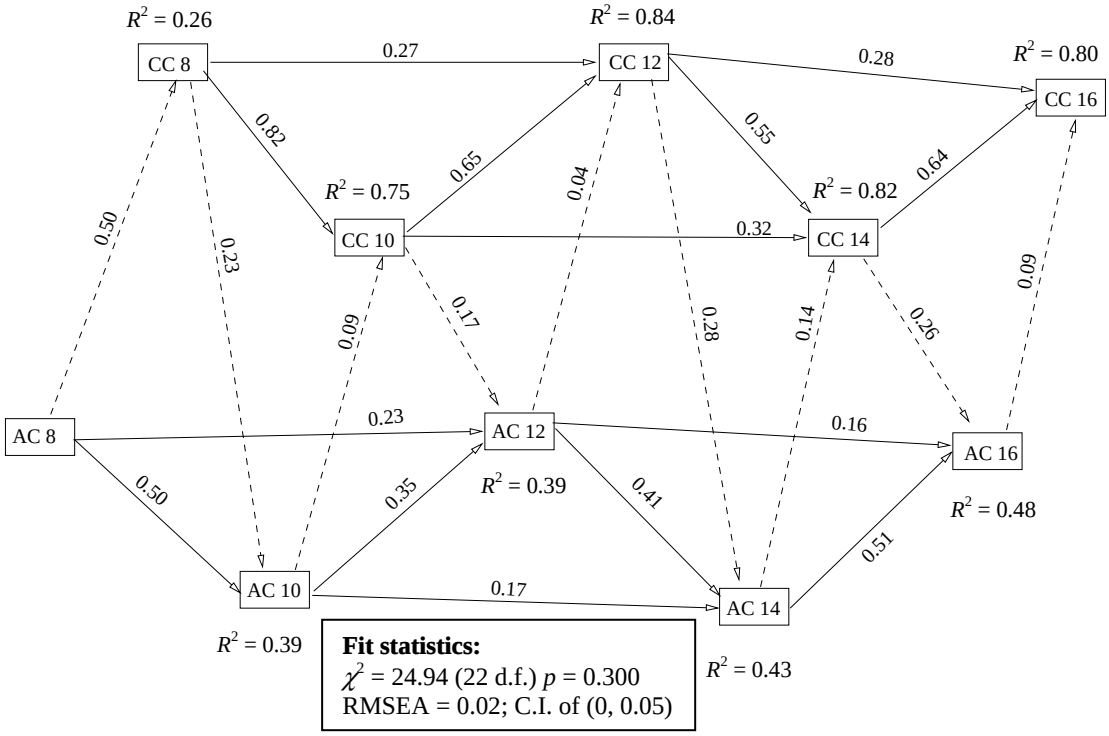
Around 80 percent of the variability in age-10–16 cognitive composite scores is accounted for (statistically predicted by), in decreasing order of influence: the previous age cognitive composite scores; the cognitive composite score before that (four years earlier); and the current attitudinal composite competency level.

Between 30–50 percent of the variability in the age-10–16 attitudinal composite competencies is predicted by, in decreasing order of influence: the previous attitudinal composite competency score; the attitudinal composite competency score before that (four years earlier); and the previous age cognitive composite score.

The model at age 16 was based on 412 observations, excluding young people for whom we missed one or more competency measures over the years, and all of those who had left school at age 16, as we have no teacher-based attitudinal competency measures for these young people.

The statistically significant paths are shown in Figure 18, where the attitudinal competencies are denoted by AC, and cognitive competencies by CC. Paths between competencies of the same type are shown as solid lines, and paths between competencies of different types are shown as dotted lines.

Figure 18 ***Path model of competencies ages 8–16***



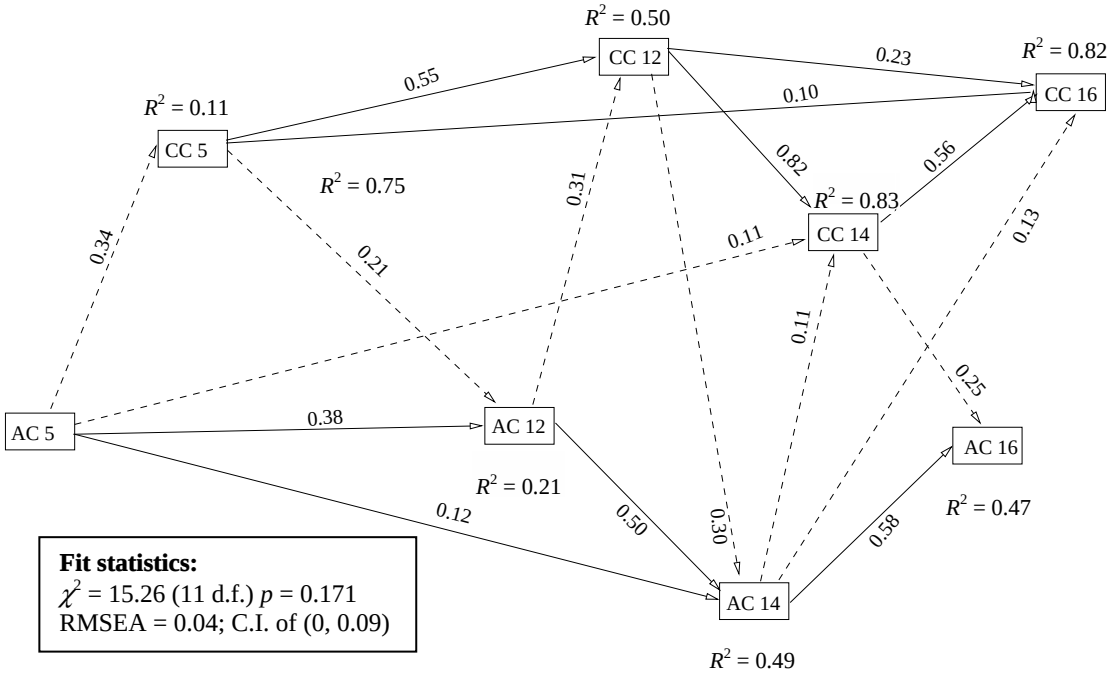
The pattern found at ages 12 and 14 has again given a good fit, and has extended to age 16. The path coefficients and R^2 values in this model are broadly similar to those found in the model at age 14, and the coefficients at age 16 are of the same order of size as those at age 14.

Model for age-near-5 to age-14 data

When we include competencies at ages 5 and/or 6, the sample size is greatly reduced (n = 226) as we exclude all those who joined the study at age 8.

At age 14 we used measures from both age 5 and 6 in a series of models. At age 16, the models were again "problematic", probably because of the high inter-correlations, and the small number of observations. However, a model using only age-5 data, together with ages 12, 14, and 16 gave an almost acceptable fit, and shows how the pattern shown above can be extended back in time to age 5.

Figure 19 ***Path model of competencies ages 5, 12, 14, and 16***



The main changes between this model and the previous one are that the age-5 competencies explain less of the variability in the age-12 competencies than the age-8 and -10 competencies did, but the amount of variability explained in the age-12–16 section of the model is much the same. Some of the paths that were just significant in the age-8–16 model were no longer significant in the age-5–16 model, but this probably does not mean much. There are several variations on the model that give almost equally good fits, and there is no strong reason to prefer one over another.

Summary

When we used the composite cognitive and attitudinal competency scores to represent the competencies at each age we found that all the cognitive competency scores (ages 5–16) were moderately to strongly correlated, and the attitudinal scores were weakly to moderately correlated. For both sets of competency, not surprisingly, the strongest correlations were between pairs of adjacent ages. These correlations in turn were stronger after age 8 for the cognitive competencies and after age 12 for the attitudinal competencies.

The implication here is that the young person's cognitive competencies were relatively stable from age 8, and age-8 competencies were relatively good predictors of age-16 competencies. However, the attitudinal competencies have varied more, and show greater response to the young people's environments: their home, school, and peer group being probably the most important influences. The attitudinal competencies became more "stable" after age 12, in other words from the start of secondary school, or just before the onset of puberty.

We obtained a good fit to models similar to those fitted at ages 12 and 14, in which each cognitive competency was predicted by the attitudinal competency at the same age, and the two preceding cognitive competencies, and the attitudinal competencies were predicted by the preceding cognitive competency and two preceding attitudinal

competencies. In other words, how you do now on a cognitive task is largely determined by how you have done on similar tasks before, and how you are feeling now. How you are feeling now is determined by how you were feeling before and how you did in cognitive tasks before.

6. Consistency of progress over time

We have established that there are associations between competencies over time. In this section we look at answering three slightly different questions:

- the extent to which individuals tend to achieve consistently in each of the competencies over time
- an attempt to determine differing patterns of achievement over time and
- the extent to which these tendencies are associated with the main social characteristics (gender, ethnicity, maternal qualifications, and family income) that we measure.

To answer the first question, we have again used quartile groups for each competency, and look at the extent to which the young people have stayed in the same quartile group or changed groups between the ages of 5 or 8 and 16.

To answer the second question, we follow average progress of subgroups in the top and bottom quartile group for the composite cognitive and attitudinal competencies. The subgroups are those who end up in the same quartile group in which they started, those who end up in the next group, and those who change more markedly over time.

To answer the third question, we have used the quartile groups defined for each age group to determine patterns over time. The patterns of achievement determined by stable or changing quartile group membership we used are: young people who were mainly in the group scoring less than the first quartile at each round of data collection; those mainly in the group scoring between the first quartile and the median; those mainly in the group scoring between the median and the third quartile; those mainly in the group scoring above the third quartile; those showing a tendency to achieve successively higher scores over time; and those showing a tendency to achieve successively lower scores over time. We then cross-tabulated these six categories with the social characteristics.

Starting and ending points

A quartile is a very thin "line in the sand" between groups, and it is to be expected that there would be quite a lot of movement between adjacent quartile groups between test rounds; those scoring at the top of the first group at age 5 are quite likely to be scoring at the bottom of the second group at age 6, for instance, and *vice versa*. Movement between non-adjacent groups is less likely, and can be part of a one-off-hop pattern (a test written on a very good or very bad day, perhaps) or part of a consistent trend.

Some of the movement between groups is attributable to regression to the mean: a group identified by its low scores in a test is expected on average to achieve higher scores on later tests because some of those in that group will have been placed there because of a worse than their own average performance. The same is true for a top-scoring group (they would be expected to do less well in future tests).

Most students achieved pretty similarly, with most or all of their test results putting them in one or two adjacent groups. A few had very variable results, with several "hops", and a minority showed a consistent trend either up or

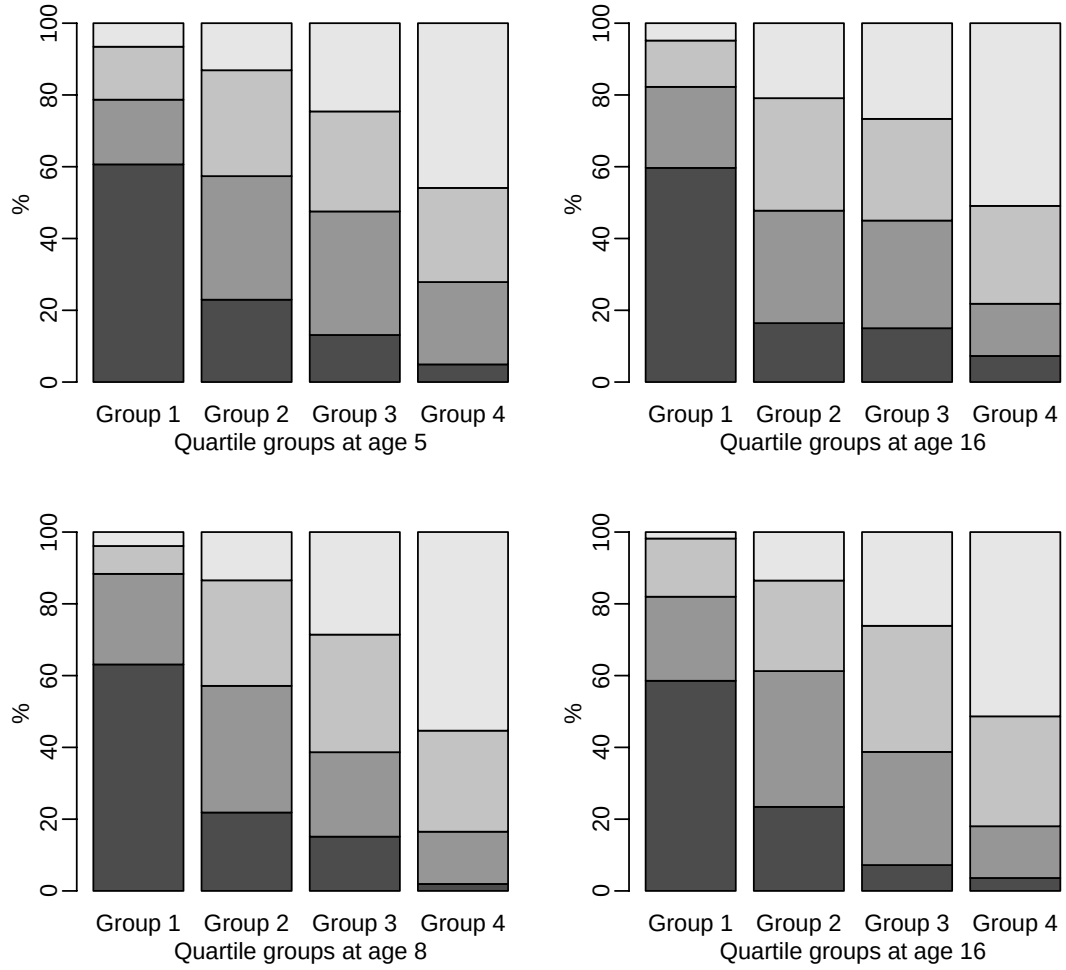
down. A "trend" was measured as a movement up from the lowest quartile group to the third or fourth group, or from the second to the fourth, or an equivalent movement down.

In the graphs that follow, the comparisons between age 5 and 16 are based on about 246 students for the cognitive competencies (this includes the young people no longer at a mainstream or other school) and 227 for the composite attitudinal competency (those still in a mainstream school); the comparisons between age 8 and 16 for the cognitive competencies on about 448 students (this includes the young people no longer at school), and those for the composite attitudinal competency on about 414 students (those still in a mainstream school).

Numeracy

The shifts in quartile group between age 5 and age 16 and between age 8 and age 16 are shown in Figure 20. The two figures on the left in the plots show the percentage of the age-5 and age-8 quartile groups that were in each of the quartile groups at age 16. The two figures on the right show the percentage of the age-16 quartile groups that were in each of the groups at age 5 or age 8. In each figure the black shading represents the percentage in Group 1 (those scoring less than the first quartile, or the bottom quarter of the young people), the lightest shading the percentage in Group 4 (those scoring above the third quartile, or the top quarter of the young people), with Groups 2 and 3 shaded dark and medium grey, respectively.

Figure 20 ***Retention in quartile groups between age 5 and 16 (top row) and age 8 and 16 (bottom row) in numeracy***



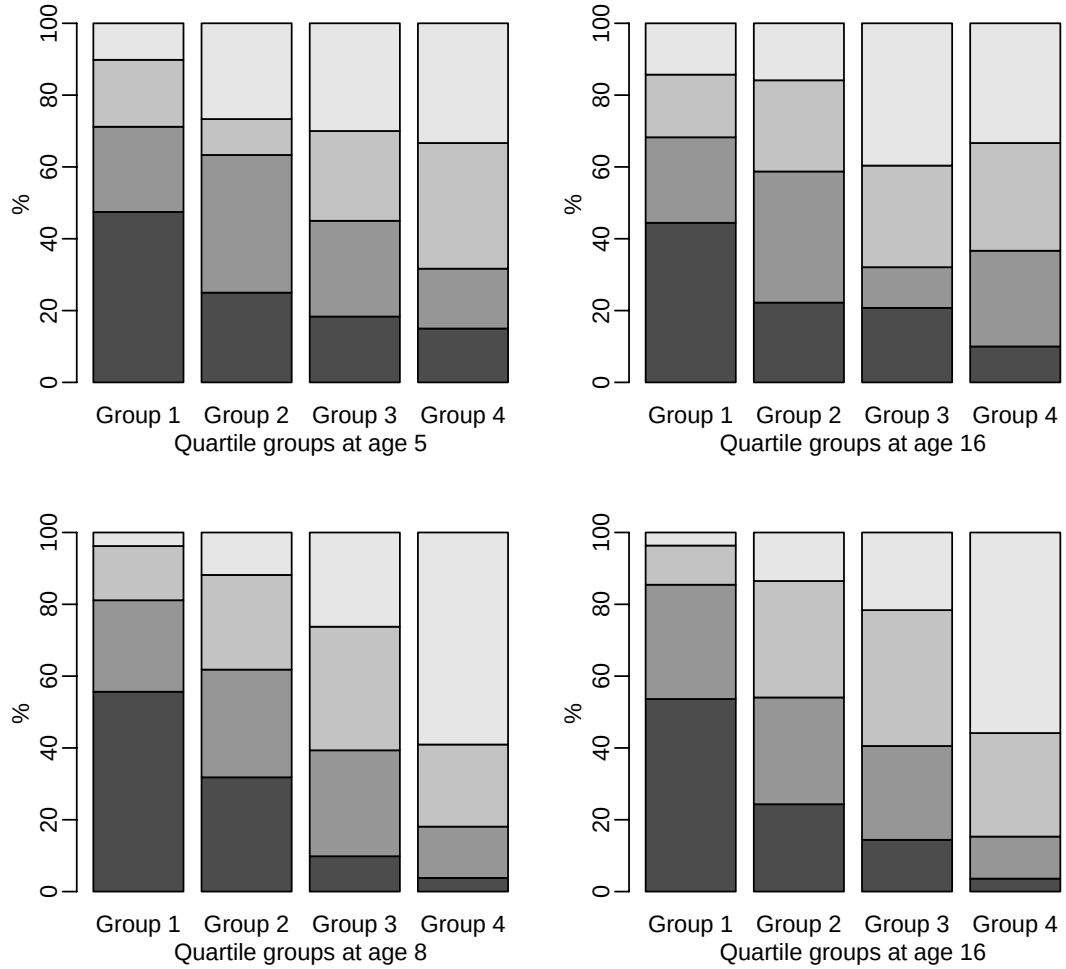
We can see from all four plots that the top and bottom quartile groups had the largest retention rate. Group 1 has about a 60 percent retention rate (the black section at the bottom of each of the Group 1 bars is about 60 percent), while the rate in Group 4 is between 45 and 55 percent (the lightest grey section at the top of each of the Group 4 bars). These rates are higher than the retention rates in the middle quartile groups, which range between 25 and 38 percent. This is to be expected, as the middle quartile groups each have two groups to exchange with, while the top and bottom groups have only one. Also, the range of scores achieved by each of the middle groups is narrower than the range of scores achieved by the extreme groups, so that a smaller difference in score is more likely to result in a change of quartile group membership in the middle two groups.

We can also see that movement from top group to bottom group or *vice versa* is less likely between ages 8 and 16 (between 2 and 4 percent) than between ages 5 and 16 (between 5 and 8 percent). The retention rates in the middle quartile groups are also slightly greater between ages 8 and 16. This could be because by age 8 children have acquired (or failed to acquire) the skills necessary in mathematics/numeracy, or it could be because the test at age 8 measured skills that better predicted long-term achievement in numeracy than the age-5 test did (or measured more similar skills).

Literacy

Similar plots of retention for *literacy* are shown in Figure 21.

Figure 21 ***Retention in quartile groups between age 5 and 16 (top row) and age 8 and 16 (bottom row) in literacy***



There is a bigger difference between the age-5 and -16 plots and the age-8 and -16 plots for *literacy* than there was for *numeracy*, both with respect to retention, and to movement from top to bottom (or bottom to top). Forty-seven percent of those in Group 1 at age 5 were still in Group 1 at age 16 (the black section of the Group 1 bar in the top left plot), but at age 8, the Group 1 retention rate was 56 percent (black section of the Group 1 bar in the bottom left plot). At the other end of the scale, for Group 4, a third in the top quartile group at age 5 were still in the same group at age 16, whereas for those in the top quartile group at age 8, 59 percent were still in the same group at age 16.

Ten percent of those starting in Group 1 at age 5 ended in Group 4 at age 16, compared with 4 percent making a similar shift between age 8 and 16. Even more moved downwards: 15 percent of those in Group 4 at age 5 ended in Group 1 at age 16, compared with 4 percent making a similar shift between age 8 and 16.

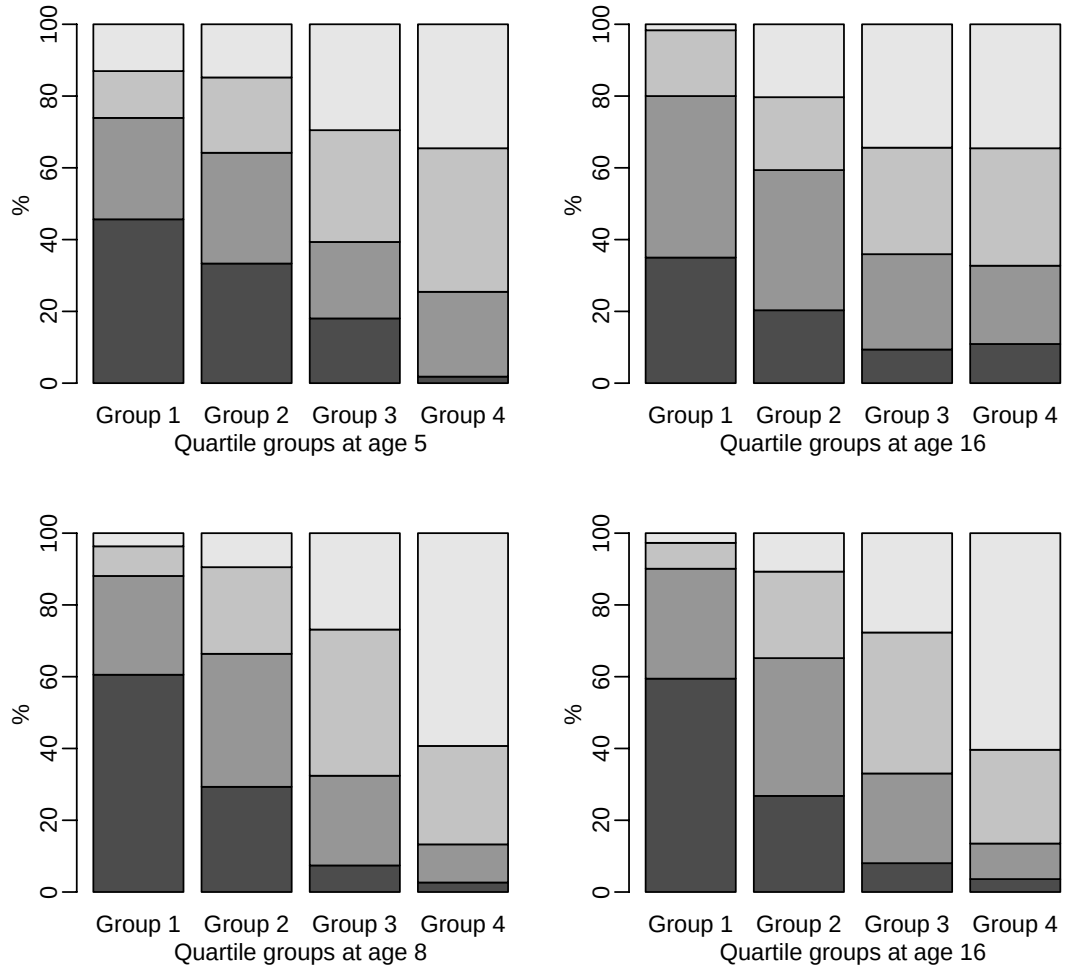
It would seem that our early literacy measure was not a good predictor of near-adult literacy, and/or that something happened between age 5 and age 8 for some students, and failed to happen for others. Either way,

relative achievement in *literacy* at age 8 was more closely associated with achievement in *literacy* at age 16 than the age-5 achievement was.

Logical problem-solving

Figure 22 shows the retention within quartile groups for *logical problem-solving* (called *logical reasoning* at age 5).

Figure 22 ***Retention in quartile groups between age 5 and 16 (top row) and age 8 and 16 (bottom row) in logical problem-solving***



The pattern of retention between ages 5 and 16 is more similar to that for *literacy* than for *numeracy*, while that between ages 8 and 16 is more similar to that for *numeracy* than for *literacy*.

At age 5, 46 percent of those in Group 1 were still in the same group at age 16, and 35 percent of those in Group 4 were still in the same group, compared with 61 and 59 percent, respectively, for age 8.

The top right-hand plot, of the age-5 quartile groups for each of the age-16 groups, shows that 33 percent of those in Group 4 at age 16 came from Group 4 at age 5, and 35 percent came from Group 3. Both plots in the top row indicate young people in Groups 3 and 4 at age 5 were about as likely to end up in Group 3 as Group 4 at age 16.

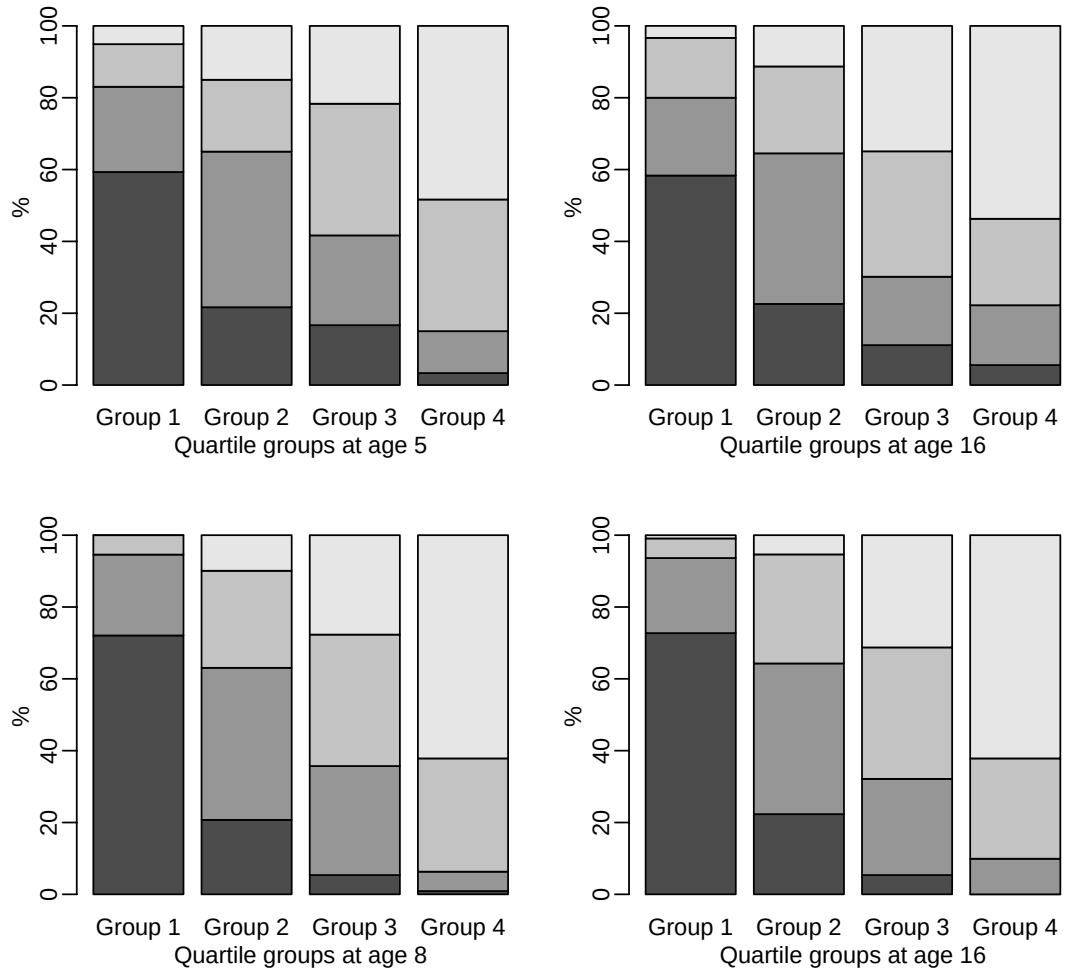
The reason for this lies at least in part in the distribution of the scores at age 5: there was a strong ceiling effect, with about a quarter of the children scoring over 90 percent. The distinction between Group 3 and Group 4 at age 5 is very slight. The distribution of scores at age 8 and age 16 was more symmetric and "lump-shaped", the distinction between quartiles is clearer, and the retention rates within each quartile group are higher.

Very few young people (under 4 percent) moved from Group 1 to Group 4, or the other way around, between ages 8 and 16.

Composite competency score

Retention within quartile groups was more marked for the *composite cognitive* score than for the individual scores (Figure 23), both between ages 5 and 16 and ages 8 and 16.

Figure 23 ***Retention in quartile groups between age 5 and 16 (top row) and age 8 and 16 (bottom row) in composite competency score***



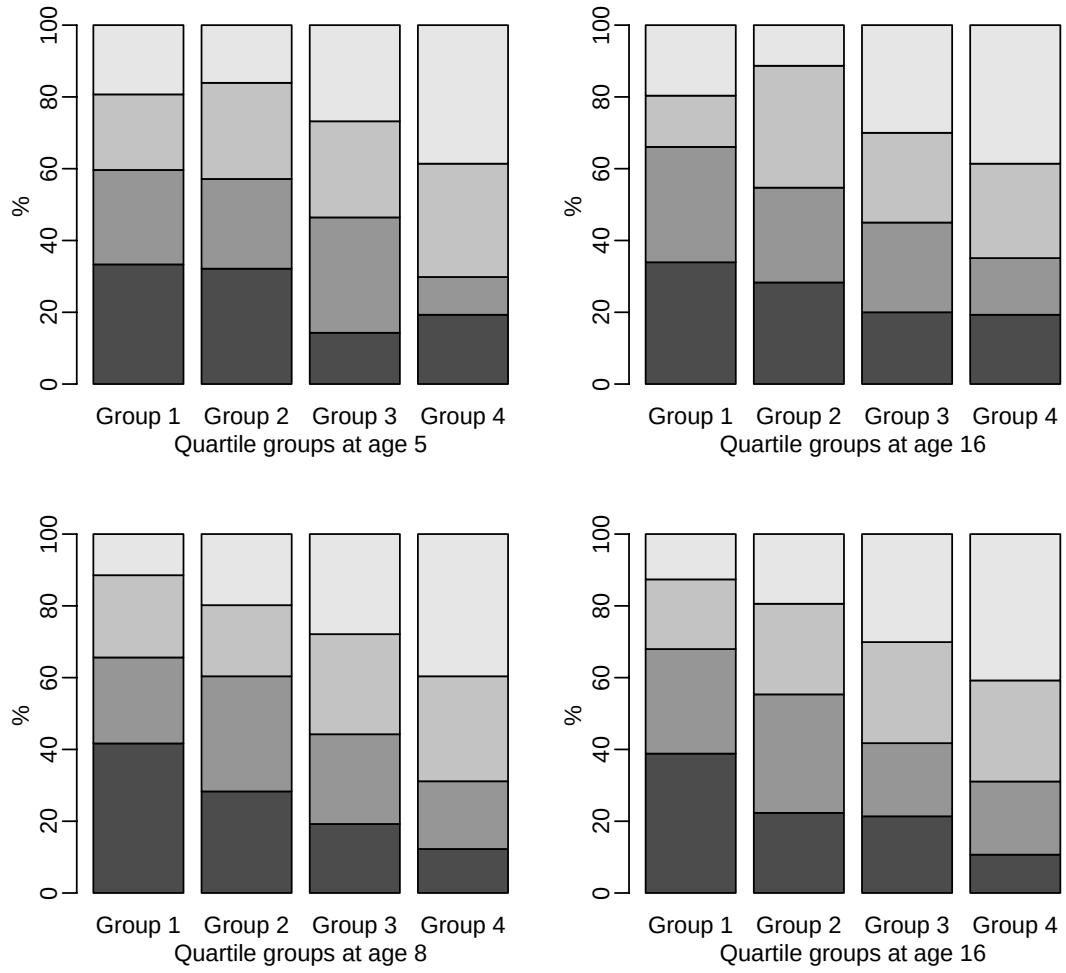
Retention rates between ages 5 and 16 were 59 percent for Group 1 and 48 percent for Group 4, and those between ages 5 and 16 and between ages 8 and 16 were 72 percent and 62 percent, respectively. Retention rates for Group 2 were also larger than for the individual competencies: between both ages 5 and 16 and between ages 8 and 16 they were 43 and 37 percent for Group 2 and 3, respectively. It would seem that it was harder to move up from Group 1 and 2 than it was to drop out of Group 3 or 4.

Very few students moved between Groups 1 and 4: 5 percent of those in Group 1 at age 5 and none of those in the same group at age 8 were in Group 4 at age 16; in the other direction, 3 percent of those in Group 4 at age 5 and 1 percent at age 8 were in Group 1 at age 16.

Composite attitudinal score

The individual attitudinal measures have changed more over time, with the greatest change being at age 16. For this reason we look only at the *composite attitudinal* score (Figure 24).

Figure 24 ***Retention in quartile groups between age 5 and 16 (top row) and age 8 and 16 (bottom row) in composite attitudinal score***



The retention rates for the composite attitudinal scores are lower than for any of the cognitive competency scores. A third of those in Group 1 at age 5 were still in the same group at age 16, while the same rate between ages 8 and

16 was 42 percent. Almost a fifth of those in Group 1 at age 5 had moved to Group 4 by age 16, and the same percentage had shifted from Group 4 to Group 1. At age 8 there was slightly greater retention: 42 percent and 40 percent for Groups 1 and 4, respectively, with correspondingly lower rates of about 12 percent shifting each way between Groups 1 and 4.

Much of the work we have done up to age 14 indicates that while the cognitive and attitudinal competencies are strongly associated, the cognitive competencies are also more strongly related to what was in place by age 5: innate aptitude and level of family advantage, reflected in opportunities for early learning and development of dispositions. The attitudinal competencies appear more strongly related to the students' current situation: the current family income, peer pressure, and school culture.

Paths to the ending points

We now follow those who began in the top or bottom quartile at either age 5 (if they were in the original sample) or age 8 (if they joined the study at this point), and trace their path to where they ended up at age 16. We do this for the two composite competencies, cognitive and attitudinal.

For each quartile group of interest, for example, the top quartile group (Group 4) for the cognitive competency, we follow the paths of the individuals in the sense that we plot the mean score for those who:

- are in the same quartile group at age 16 (Group 4)
- are in the next quartile group at age 16 (Group 3) and
- are scoring below the median at age 16 (Group 1 or 2).

For those in the bottom quartile group (Group 1), we plot the mean score of those in Group 1 at age 16, Group 2 at age 16, and those scoring above the median at age 16 (Group 3 or 4).

The mean scores calculated for ages 5 and 6 are for those in the original study group; those for ages 8–16 are for all students still in the study at age 16. This means that there is a slight discontinuity or bump in the plots at age 8, as at that age we add all those joining the study at age 8 and scoring in the quartile of interest at that age.

We have used normalised scores[18] so that the scores at each age have a mean 0 and standard deviation of 1, and the scores at different ages are easier to compare.

Figure 25 shows, in lighter grey, the paths of the individuals who were in the bottom quartile group for the composite cognitive competency at age 5, or when they joined the study at age 8. It is hard, if not impossible, to trace individual paths (they keep converging and diverging), but bits of paths can be traced (they jump up or down for one or more of the time points), and the overall spread gives an impression of the variability in scores, and how this variability increased over time.

The black dots are the median scores at each age (like the mean scores, all 0 because the scores are normalised). The thin, solid dark grey lines behind the lighter grey paths are plotted through the quartile values.

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[18] The data were normalised by taking the *z*-score (standard normal distribution) corresponding to the percentile of each observation.

The black dashed line shows the mean score for those who were in the bottom quartile at age 16. The line is almost flat, indicating that these students on average achieved remarkably constantly over time. The apparent rise in scores over their first year at school is probably largely due to regression to the mean, as we identified the groups by their performance at a single point in time.

The dotted line is the mean score of students who achieved in the second quartile group at age 16. The starting point at age 5 for this group is about the same as that of the bottom quartile group, but from age 6 this group scores more on average than the bottom quartile group, and the difference between these groups increases over time. The mean score at ages 14 and 16 is above the first quartile.

The dot-dashed line is the mean score of students who began in the bottom quartile group but scored above the median at age 16. The starting point at age 5 is above the other two black lines, indicating that at age 5 these students had on average relatively high scores for their quartile group. From there, their progress has been gradual but steady, with their mean scores increasing at each age, not reaching the median until age 10, and being between the median and third quartile at ages 14 and 16.

Figure 25 ***Progress over time of those in the bottom quarter at age 5 and/or 8 in the composite cognitive competency***

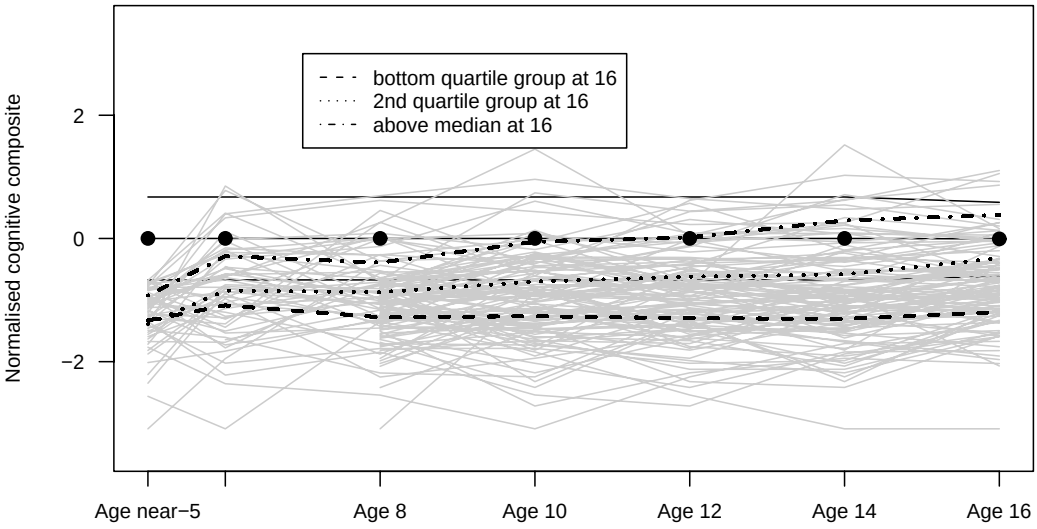
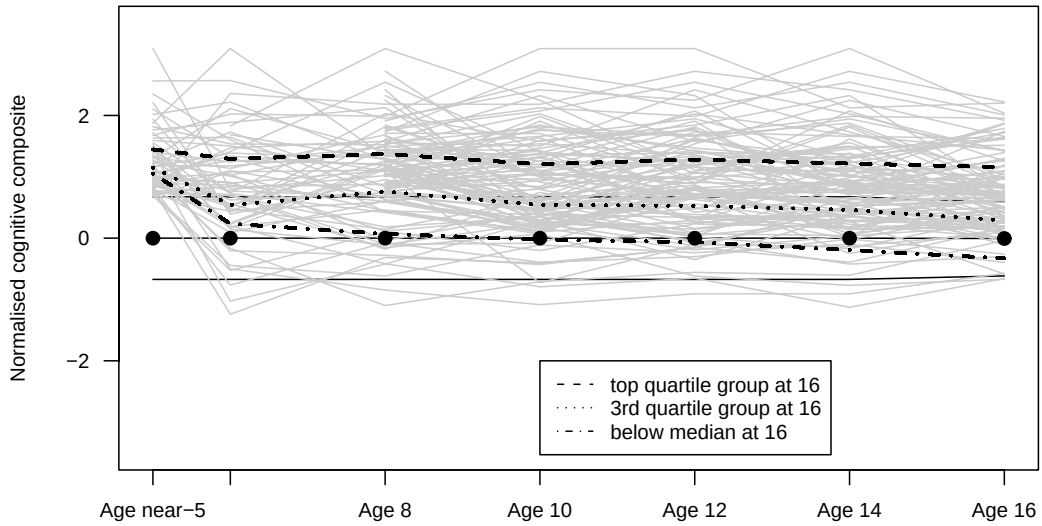


Figure 26 shows the corresponding patterns for those who were in the top quartile group at age 5 or who joined the study at age 8 and were in the top quartile group at that time.

Figure 26 ***Progress over time of those in the top quarter at age 5 and/or 8 in the composite cognitive competency***

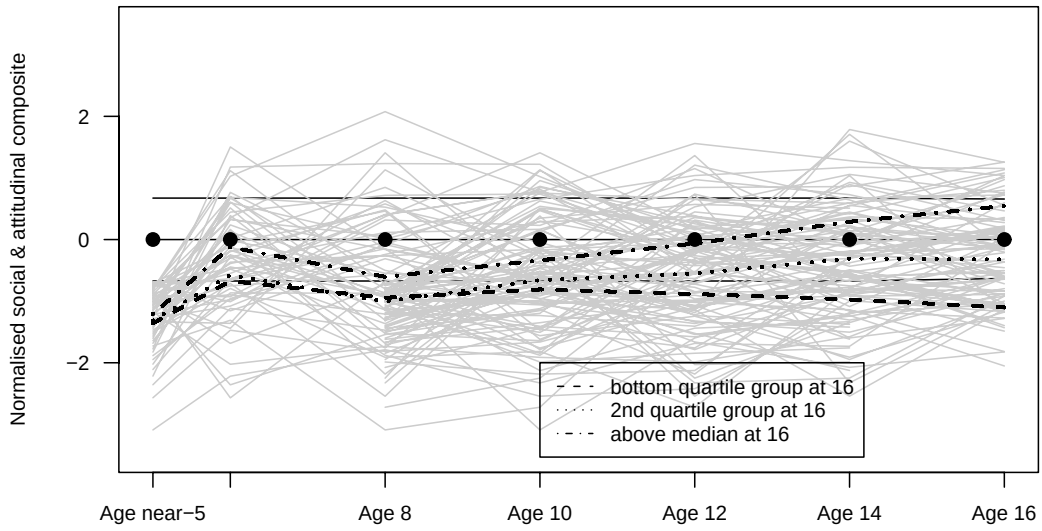


These three patterns have some similarities to those for the bottom quartile group:

- those scoring in the top quartile group at age 5 or 8 and 16 have an almost constant mean score, and this score is well above the third quartile
- those scoring in the third quartile group or below the median at age 16 had, on average, slightly lower scores to start with, and the difference between them and those in the top quartile group at age 16 increased over time (their average score decreased each time)
- those scoring in the third quartile group at age 16 had an average score that was below the third quartile from age 10 and
- those scoring below the median had mean scores that were below the median from age 10.

Figure 27 shows the pattern for those in the bottom quartile group for the composite attitudinal/social competency at age 5 or, if they joined the study at age 8, at that time.

Figure 27 ***Progress over time of those in the bottom quarter at age 5 and/or 8 in the composite attitudinal competency***

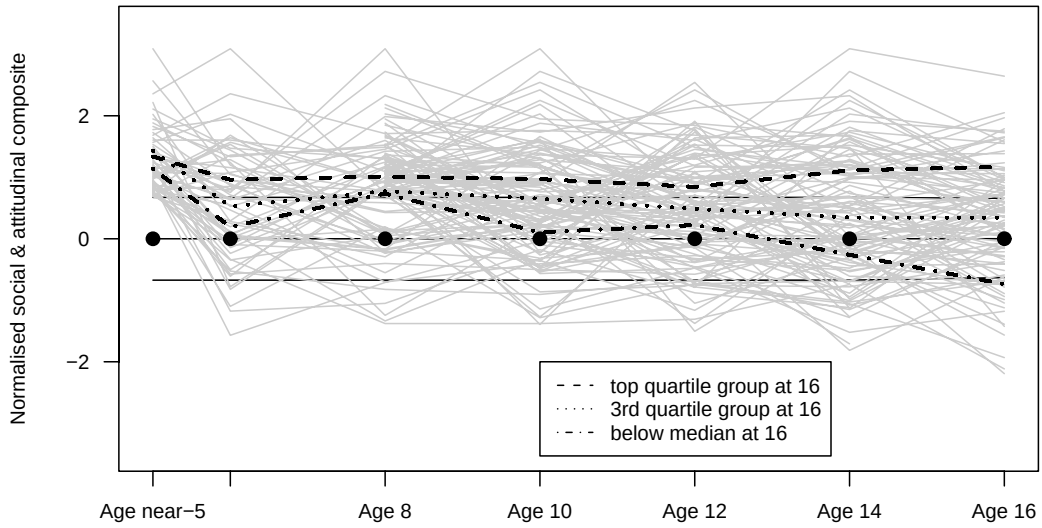


The pattern shown is largely the same as that shown for the bottom group in the cognitive competencies, but the there was greater divergence between those in the bottom quartile group at age 16 and those achieving higher scores at age 16. This is probably because the association between attitudinal scores over time was less strong than that between cognitive scores. On average:

- the starting points for the three groups were closer than for the composite cognitive competency;
- the average score for the group that began and ended in the lowest quartile groups decreased steadily over time from age 10—but the decline did not start with the transition to secondary school;
- the average score for the group that ended in the second quartile group increased slightly from age 10; and
- the average score for the group that ended scoring above the median increased steadily over time from age 8 (when it was depressed slightly by the scores of those joining the study at age 8), and ended only slightly below the upper quartile.

The last group we look at are those scoring above the upper quartile at age 5, or 8 (Figure 28).

Figure 28 ***Progress over time of those in the top quarter at age 5 and/or 8 in the composite attitudinal competency***



The pattern shown is similar to those seen before:

- those scoring above the upper quartile at age 5 or 8 and 16 have an almost constant mean score; this score is well above the third quartile and has increased slightly from age 12;
- all three groups tracked had similar average scores at age 5;
- the difference between those scoring in the third quartile group or below at age 16 and those in the top quartile group at age 16 increased over time (their average score decreased each time);
- those scoring in the third quartile group at age 16 had an average score that was below the third quartile from age 10; and
- those scoring below the median had mean scores that were below the median from age 14, suggesting that they could have been affected in the transition to secondary school, and their average scores dropped sharply from age 12, ending below the first quartile at age 16.

Paths by chance alone?

The background of individual paths in grey in Figures 25–28 shows that the students' scores did vary over time. The groups that we followed were defined by scores in a single test[19] (those above the top or below the bottom quartile at age 5). This means that any apparent change over time may just be due to chance, a phenomenon known as regression to the mean (Smith & Smith, 2005).

When the top (or bottom) 10 or 25 percent of students are selected on the basis of results in a single test and their progress is monitored over time, by chance alone some of the students will do "worse" (or "better") than in the first test because they were included in the group of interest only because they did better (or worse) in that test than in any other tests. Their apparent ability in the one test put them in the top (or bottom) 10 percent (or

[19] Strictly speaking, the scores we are concerned with here are the results of a battery of tests administered on one occasion, or derived from comments made by a teacher on a single occasion. If these tests and measurements were repeated later in the same year we would still expect to see regression to the mean.

whatever), although their true ability was not in the same group. The regression to the mean effect is marked between the test used to categorise the students, and later tests.

To what extent may this have been true for the students in the study? One way to get an approximate measure of this is to do a simulation. In this way we can get a picture of what happens under truly random variation, and can try to judge whether the effects seen for the study students are similar, or appear to be the result of random variation plus something else.

We simulated both cognitive and attitudinal competency scores. To conduct the simulations we:

- calculated the mean and standard deviation of the standardised composite scores for each student;
- used these individual means and standard deviations to generate a series of seven random "test results" for each student (we did not distinguish between the students in the original sample and those who joined the study at age 8);
- made graphs like Figures 25–28 using the simulated data, using the test results of the "first test" (the first simulated score) to define the three groups whose progress is tracked in the graphs;
- counted how many students stayed in the top quartile group, moved to the third quartile group, and moved to below the median, or, for the other graphs, stayed in the bottom quartile group, in the second quartile group, or moved to above the median, both in the "real" data and in repeated simulations; and
- determined how many students we would expect to stay or move as a result of random variation only. We used 200 simulations to establish empirical confidence intervals for these numbers.

The graphs for the simulations shown below are on first inspection similar to those for the "real" data, but there are some subtle differences.

Figure 29 ***Simulated progress over time for those in the bottom quarter at age 5 in the composite cognitive competency***

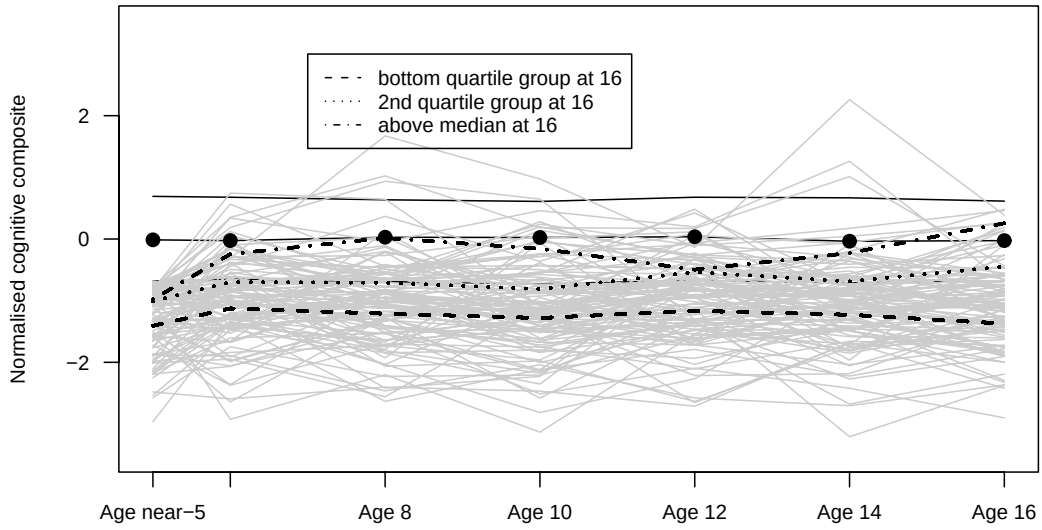


Figure 30 ***Simulated progress over time for those in the top quarter at age 5 in the composite cognitive competency***

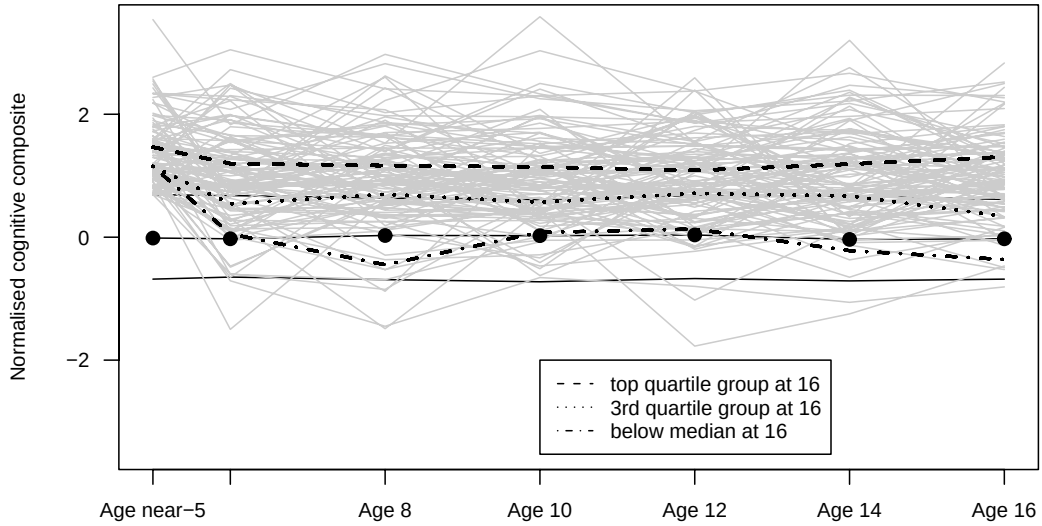


Figure 31 ***Simulated progress over time of those in the bottom quarter at age 5 in the composite attitudinal competency***

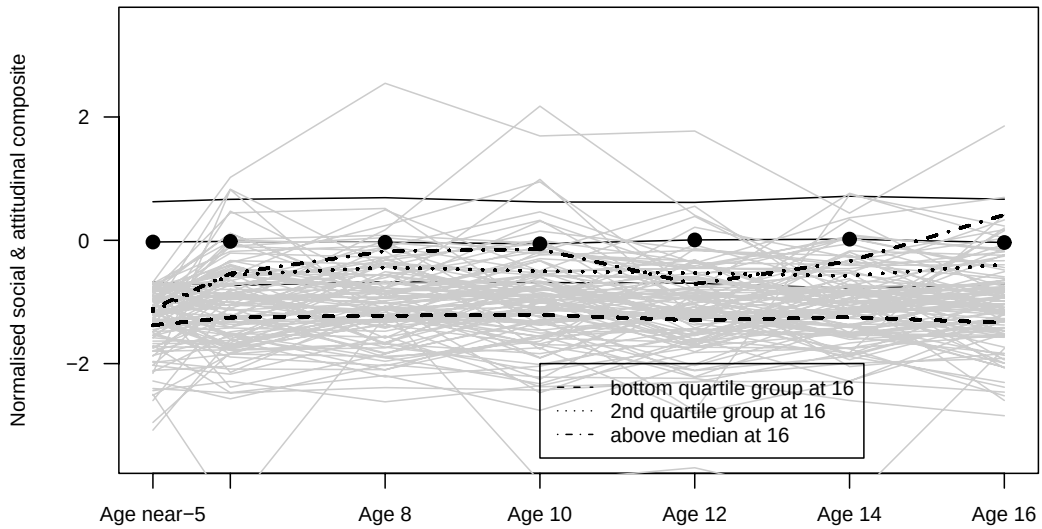
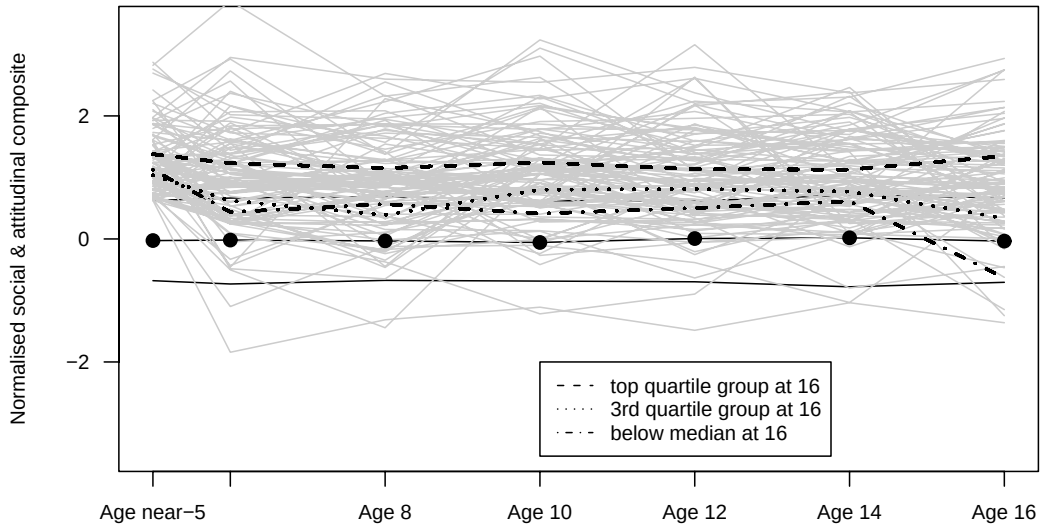


Figure 32 ***Simulated progress over time of those in the top quarter at age 5 in the composite attitudinal competency***



Both the "real" data graphs and the simulated data graphs have :

- widely varying individual paths (the grey lines)
- the lines for those ending in the three groups diverging early
- the larger the group, the smaller the variation in mean across ages (the sample sizes for those staying in the starting group were between 40 and 60; those for the groups shifting one quartile group were between 22 and 36; those ending on the other side of the median were between 5 and 30)
- an apparent "dip" in achievement median between ages 14 and 16 for those beginning in the top quartile and ending below the median, or an apparent "rise" at the same age for those beginning in the lowest quartile group and ending above the median and
- an apparent sharp drop (or rise) in achievement between ages near-5 and 6, which would largely be due to regression to the mean.

The differences are that:

- the start points and end points are determined largely by the selection criteria; however, in the "real" data the three groups tracked show more differentiation at the start
- the divergence takes place earlier in the real data, and is more marked
- the lines for the three groups never intersect in the real data, but do or almost do in the simulated data and
- the group that ended scoring below (or above) the median scored approximately at the median at age 10 in the real data, and below (or above) the median thereafter, but in the simulated group the mean score is at or above (or below) the median until age 16 and varies fairly randomly.

From the "real data" graphs, it would appear that there does seem to be a group in each category that is diverging slightly more and less randomly than would be expected by chance alone.

A further question that we can ask is whether the size of the groups is what would be expected or not.

To answer this question we looked at the number of students in each of the groups tracked. The numbers in the groups in the "real" data, and 95 percent confidence intervals for the numbers determined by repeated simulation

are shown in Tables 19 and 20. Approximately 112 students were in the group scoring above the upper quartile at age 5 (or 8 for some of the real data).

Table 19 ***Percentage of students scoring above the top quartile at age 5***

	Cognitive competency		***Attitudinal competency***	
Age-16 score group	***Real data (%)***	***95% confidence interval from simulation (%)***	***Real data (%)***	***95% confidence interval from simulation (%)***
Top quartile	57	63–73	39	45–56
Third quartile (above the median)	31	20–30	29	21–33
Below the median	10	4–11	34	33–29

Table 20 ***Percentage of students scoring below the bottom quartile at age 5***

	Cognitive competency		***Attitudinal competency***	
Age-16 score group	***Real data (%)***	***95% confidence interval from simulation (%)***	***Real data (%)***	***95% confidence interval from simulation (%)***
Bottom quartile	68	68–78	35	46–56
Second quartile (below the median)	23	17–26	25	21–32
Above the median	14	3–11	35	18–28

We have seen earlier (Figures 23 and 24) that retention within the top quartile group was greater for the composite cognitive competency than for the composite attitudinal competency, and that the rate of loss to the groups scoring below the median at age 16 was correspondingly greater for the attitudinal competency than the cognitive competency. The same story is told in Tables 19 and 20, for the real data.

The observed individual student mean achievement and individual variability was used to create the "population" for the simulations. Our simulation was as close to reality as possible, ignoring all other factors. Did these other factors appear to influence student scores to a detectable extent? The simulation suggests that of the approximately 112 students scoring above the top quartile at age 5, we would expect between 63 and 73 percent to still be scoring above the quartile at age 16 in the composite cognitive competency. However, only 57 percent of the real students did so. At the other end of the scale, we expect between 4 and 11 percent to be scoring below the median, and 10 percent did so. This is not outside the confidence interval, but is close to its upper limit.

Similarly, for the attitudinal competencies, we see fewer than expected students in the top quartile group at ages 5 or 8 still in that quartile group at age 16, and more than expected scoring below the median. A similar, but more marked pattern is seen (Table 20) for those scoring in the bottom quartile at age 8 for both competencies.

The simulations suggest that there were groups of students whose achievement was systematically better (or worse) than their age-5 or -8 achievement predicted, and that this change in performance was visible by age 10, and consistent and increasing at ages 12, 14, and 16.

Consistency of achievement over time and social characteristics

Having looked at where students tended to start and where they tended to end up, we now look at the related, but slightly different, question of how consistently they achieved between these end points, and relate this to their social characteristics.

The students were classified as being mainly in a particular quartile group if they were in that quartile group more often than they were in any other one, or if they were in that group or the groups on either side of it most of the time, and their earlier (age 5, 6, 8, 10) quartile groups were typically the same as, or next to their later (age 12, 14, 16) quartile groups. They were classified as having increasing scores if they moved on average two or more quartile groups between their typical early quartile groups and later quartile groups (from Group 1 to Group 3 or 4, or from Group 2 to Group 4). They were classified as having decreasing scores if they showed a similar shift down.

This classification is somewhat subjective, and depends slightly on whether a particular student was in the study from age 5 or joined at age 8. The results reported below are based on a classification including age-5 and age-6 results, but take into consideration an alternative analysis excluding them (not shown).

For any competency at any age we expect about a quarter of the students to be in each quartile group. Where the scores of several students were equal to a quartile, the percentage in the group with scores greater than or equal to the quartile will be slightly larger (and other groups correspondingly slightly smaller). When we look at typical groups over time, we again expect each quartile group to have about a quarter of the young people in it, but where we have marked movements either up or down we would expect slightly lower percentages in the mainly-first and mainly-fourth quartile groups, as most of the young people who "moved" would have moved from these groups into either the group with increasing scores, or that with decreasing scores.

For each of the competencies we look first at the characteristics the young people were born with (gender and ethnicity), and then at those they were surrounded by (maternal qualifications and family income).

Mathematics/numeracy

The percentage of young people in each of the mathematics/numeracy achievement groups for each of the gender and ethnicity groups is shown in Table 21.

Table 21 ***Consistency of mathematics/numeracy achievement over time by gender and ethnicity***

Quartile group	*Female (n = 217) %*	*Male (n = 229) %*	*Mäori/Pacific (n = 63) %*	*Päkehä/European & Asian (n = 371) %*
Mainly Group 1	19	21	37	18
Mainly Group 2	27	24	35	24
Mainly Group 3	18	21	21	25
Mainly Group 4	18	21	5	22
Decreasing	7	4	2	6
Increasing	3	6	2	5

From the table we can see that there were few gender differences. There may be a slightly greater tendency for males to do better over time, and for females to do worse. There are relatively marked differences between the ethnic groups: Mäori/Pacific young people were more likely to have been in the lower two groups, and to have stayed in or near their starting group. Those who shifted up or down groups were more likely to have been Päkehä/European or Asian.

The results for maternal qualifications and family income at age 5 are shown in Table 22.

Table 22 ***Consistency of mathematics/numeracy achievement over time by maternal qualification and age-5 family income***

	Maternal qualifications				***Age-5 family income***			
Quartile group	***None***	***Mid-secondary school/ Trade***	***Senior secondary school/ Tertiary***	***University***	***Under $30,000***	***$30,000–$60,000***	***$60,000–$80,000***	***$80,000 and over***
	(n = 58) %	***(n = 220) %***	***(n = 80) %***	***(n = 84) %***	***(n = 110) %***	***(n = 198) %***	***(n = 61) %***	***(n = 64) %***
Mainly Group 1	43	21	15	4	35	19	8	6
Mainly Group 2	31	31	18	14	36	25	16	19
Mainly Group 3	14	25	29	29	14	27	31	33
Mainly Group 4	5	15	24	38	10	20	26	28
Decreasing	5	5	10	4	4	6	8	5
Increasing	2	2	5	12	2	3	10	9

There were marked differences for both characteristics. Young people whose mothers had fewer qualifications tended to be in, and remain in, the lowest two quartile groups. Those whose mothers had more qualifications tended to be in, and remain in, the higher quartile groups, and this trend was stronger for those with mothers with university qualifications. Students whose scores showed a downward trend were more likely to have mothers with senior secondary school or tertiary qualifications, and those whose scores showed an upward trend were more likely to have university-educated mothers.

The pattern for family income was similar, but not quite as marked: those from low-income homes tended to be in, and remain in, the lower quartile groups, and those from higher-income homes to be in, and remain in, the higher quartile groups. Those from higher-income homes were more likely to have increasing scores than those from lower-income homes.

Literacy

The percentage of young people in each of the literacy achievement groups for each of the gender and ethnicity groups is shown in Table 23.

Table 23 ***Consistency of literacy achievement over time by gender and ethnicity***

Quartile group	*Female (n = 217) %*	*Male (n = 229) %*	*Mäori/Pacific (n = 63) %*	*Päkehä/European & Asian (n = 371) %*
Mainly Group 1	12	23	33	15
Mainly Group 2	26	31	41	26
Mainly Group 3	29	27	14	30
Mainly Group 4	23	12	6	19
Decreasing	5	3	2	4
Increasing	6	4	3	5

From the table we can see that there were some gender differences. Males were more likely to be in the lower quartile groups and remain there, and females to be in the highest group. There were no real differences in the tendency to achieve higher or lower scores over time.

There are relatively marked differences between the ethnic groups: Mäori/Pacific young people were more likely to have been in the lower two groups, and to have stayed in or near their starting group. Those who shifted up or down groups were slightly more likely to have been Päkehä/European or Asian.

The results for maternal qualifications and family income at age 5 are shown in Table 24.

Table 24 ***Consistency of literacy achievement over time by maternal qualification and age-5 family income***

	Maternal qualifications				*Age-5 family income*			
Quartile group	*None (n = 58) %*	*Mid-secondary school/ Trade (n = 220) %*	*Senior secondary school/ Tertiary (n = 80) %*	*University (n = 84) %*	*Under $30,000 (n = 110) %*	*$30,000–$60,000 (n = 198) %*	*$60,000–$80,000 (n = 61) %*	*$80,000 and over (n = 64) %*
Mainly Group 1	36	19	11	4	25	18	11	6
Mainly Group 2	47	30	28	13	42	29	16	16
Mainly Group 3	10	27	39	35	16	29	31	48
Mainly Group 4	3	13	18	38	8	15	31	25
Decreasing	0	5	3	4	4	4	7	3
Increasing	3	5	3	7	5	6	3	2

There were marked differences for both characteristics. Young people whose mothers had fewer qualifications tended to be in, and remain in, the lowest two quartile groups. Those whose mothers had more qualifications

tended to be in, and remain in, the higher quartile groups, and this trend was stronger for those with mothers with university qualifications. Students whose scores showed a downward trend were slightly more likely to have mothers with mid-secondary school or trade qualifications, and those whose scores showed an upward trend were more likely to have university-educated mothers.

The pattern for family income was similar, but not quite as marked: those from low-income homes tended to be in, and remain in, the lower quartile groups, and those from higher-income homes to be in, and remain in, the higher quartile groups. Those from moderately high-income homes were more likely to have decreasing scores than others, and those from high-income homes were slightly less likely to have increasing scores.

The patterns of increasing scores may be associated with the single university-educated mothers who would have had relatively low incomes when their children were aged 5.

Logical problem-solving

The percentage of young people in each of the logical problem-solving achievement groups for each of the gender and ethnicity groups is shown in Table 25.

Table 25 ***Consistency of logical problem-solving achievement over time by gender and ethnicity***

Quartile group	*Female* *(n = 217)* *%*	*Male* *(n = 229)* *%*	*Mäori/Pacific* *(n = 63)* *%*	*Päkehä/European & Asian* *(n = 371)* *%*
Mainly Group 1	17	17	24	16
Mainly Group 2	24	27	25	26
Mainly Group 3	26	24	21	26
Mainly Group 4	18	18	10	19
Decreasing	8	8	11	7
Increasing	7	6	10	6

From the table we can see that there were no gender differences. There are some marked differences between the ethnic groups: Mäori/Pacific young people were more likely to have been in the lowest group, and to have stayed in or near these starting groups. Those who shifted up or down groups were slightly more likely to have been Mäori/Pacific.

The results for maternal qualifications and family income at age 5 are shown in Table 26.

Table 26 ***Consistency of logical problem-solving achievement over time by maternal qualification and age-5 family income***

	Maternal qualifications				***Age-5 family income***			
Quartile group	***None***	***Mid-secondary school/ Trade***	***Senior secondary school/ Tertiary***	***University***	***Under $30,000***	***$30,000–$60,000***	***$60,000–$80,000***	***$80,000 and over***
	(n = 58) %	***(n = 220) %***	***(n = 80) %***	***(n = 84) %***	***(n = 110) %***	***(n = 198) %***	***(n = 61) %***	***(n = 64) %***
Mainly Group 1	29	20	10	4	25	18	8	6
Mainly Group 2	34	30	14	19	28	29	20	14
Mainly Group 3	19	21	38	30	23	24	28	31
Mainly Group 4	0	16	20	36	9	15	33	30
Decreasing	12	9	6	4	8	7	8	9
Increasing	5	4	13	8	7	7	3	9

There were marked differences for both characteristics. Young people whose mothers had fewer qualifications tended to be in, and remain in, the lowest two quartile groups. Those whose mothers had more qualifications tended to be in, and remain in, the higher quartile groups, and this trend was stronger for those with mothers with university qualifications. Students whose scores showed a downward trend were more likely to have mothers with no qualifications, and those whose scores showed an upward trend were more likely to have mothers with at least senior secondary school or tertiary qualifications.

The pattern for family income was similar: those from low-income homes tended to be in, and remain in, the lower quartile groups, and those from higher-income homes to be in, and remain in, the higher quartile groups. There were no real patterns with respect to increasing or decreasing scores.

Composite cognitive competency

The percentage of young people in each of the composite cognitive competency groups for each of the gender and ethnicity groups is shown in Table 27.

Table 27 ***Consistency of composite cognitive competency over time by gender and ethnicity***

Quartile group	*Female (n = 217) %*	*Male (n = 229) %*	*Mäori/Pacific (n = 63) %*	*Päkehä/European & Asian (n = 371) %*
Mainly Group 1	19	25	37	20
Mainly Group 2	24	25	32	23
Mainly Group 3	22	23	21	23
Mainly Group 4	24	19	6	24
Decreasing	2	4	2	4
Increasing	8	3	3	6

From the table we can see that there were few gender differences. There may be a slightly greater tendency to do better over time for females. There are relatively marked differences between the ethnic groups: Mäori/Pacific young people were more likely to have been in the lower two groups, and to have stayed in or near their starting group. Those who shifted up or down groups were more likely to have been Päkehä/European or Asian.

The results for maternal qualifications and family income at age 5 are shown in Table 28.

Table 28 ***Consistency of composite cognitive competency over time by maternal qualification and age-5 family income***

	Maternal qualifications				*Age-5 family income*			
Quartile group	*None (n = 58) %*	*Mid-secondary school/ Trade (n = 220) %*	*Senior secondary school/ Tertiary (n = 80) %*	*University (n = 84) %*	*Under $30,000 (n = 110) %*	*$30,000–$60,000 (n = 198) %*	*$60,000–$80,000 (n = 61) %*	*$80,000 and over (n = 64) %*
Mainly Group 1	43	24	14	7	32	24	11	8
Mainly Group 2	28	29	20	11	24	24	21	14
Mainly Group 3	14	22	25	30	16	22	30	30
Mainly Group 4	2	18	29	39	9	20	31	39
Decreasing	3	4	4	1	5	3	2	3
Increasing	0	4	9	12	4	7	5	6

There were marked differences for both characteristics. Young people whose mothers had fewer qualifications tended to be in, and remain in, the lowest two quartile groups. Those whose mothers had more qualifications tended to be in, and remain in, the higher quartile groups, and this trend was stronger for those with mothers with university qualifications. Students whose scores showed a downward trend were more likely to have mothers without university qualifications, and those whose scores showed an upward trend were more likely to have mothers with at least senior secondary school or tertiary qualifications.

The pattern for family income was similar, but not quite as marked: those from low-income homes tended to be in, and remain in, the lower quartile groups, and those from higher-income homes to be in, and remain in, the higher quartile groups. Those from the lowest-income homes were more likely to have decreasing scores than those from higher-income homes.

Composite attitudinal scores

The percentage of young people in each of the attitudinal competency score groups for each of the gender and ethnicity groups is shown in Table 29.

Table 29 ***Consistency of attitudinal competency score over time by gender and ethnicity***

Quartile group	***Female*** ***(n = 217)*** ***%***	***Male*** ***(n = 229)*** ***%***	***Mäori/Pacific*** ***(n = 63)*** ***%***	***Päkehä/European & Asian*** ***(n = 371)*** ***%***
Mainly Group 1	5	17	13	11
Mainly Group 2	23	34	44	25
Mainly Group 3	24	22	21	29
Mainly Group 4	17	8	0	15
Decreasing	13	9	14	10
Increasing	8	10	8	9

From the table we can see that there were some gender differences. Males were slightly more likely to be in Groups 1 or 2, and females to be in Groups 3 or 4. There are relatively marked differences between the ethnic groups: Mäori/Pacific young people were more likely to have been in the lower two groups, and to have stayed in or near their starting group.

There was more evidence of shifts over time, both up and down. But these shifts were not strongly associated with either gender or ethnic group.

The results for maternal qualifications and family income at age 5 are shown in Table 30.

Table 30 ***Consistency of composite attitudinal score over time by maternal qualification and age-5 family income***

	Maternal qualifications				*Age-5 family income*			
Quartile group	***None***	***Mid-secondary school/ Trade***	***Senior secondary school/ Tertiary***	***University***	***Under $30,000***	***$30,000–$60,000***	***$60,000–$80,000***	***$80,000 and over***
	(n = 58) %	***(n = 220) %***	***(n = 80) %***	***(n = 84) %***	***(n = 110) %***	***(n = 198) %***	***(n = 61) %***	***(n = 64) %***
Mainly Group 1	17	14	6	4	15	12	8	5
Mainly Group 2	40	31	24	19	42	27	15	23
Mainly Group 3	21	24	30	40	19	27	41	33
Mainly Group 4	0	10	20	21	5	12	23	19
Decreasing	9	13	13	5	14	11	7	9
Increasing	14	8	8	12	6	11	7	11

There were marked differences for both characteristics. Young people whose mothers had fewer qualifications tended to be in, and remain in, the lowest two quartile groups. Those whose mothers had more qualifications tended to be in, and remain in, the higher quartile groups. Students whose scores showed a downward trend were less likely to have mothers with university qualifications.

The pattern for family income was similar, but not quite as marked: those from low-income homes tended to be in, and remain in, the lower quartile groups, and those from higher-income homes to be in, and remain in, the higher quartile groups. Those from low-income homes were more likely to have decreasing scores than those from higher-income homes.

Summary

About 60 percent of the children doing well (or badly—they were in the top or bottom 25 percent of the sample) the first time we measured their numeracy, logical problem-solving, or cognitive composite scores were doing equally well (or badly) at age 16. Performance in the literacy tests was slightly less consistent, particularly when comparing age-5 and age-16 scores. Few young people moved between the top and bottom quartile groups in any of the cognitive competencies.

There was more movement in the attitudinal competency scores with around 40 percent doing as well at age 5 or 8 as at age 16, and 10–20 percent shifting from the bottom to top groups or vice versa.

When we looked at the paths followed by those in the lowest and highest quartile groups, we traced signs of a non-random movement from the starting quartile group. Typically, in both cognitive and attitudinal competencies, and for those moving from the top quartile group to below the median and those moving from the bottom quartile

group to above the median, the group average had crossed the quartile "line" defining the group by age 10, if not before, and had reached the median by age 12, if not before. Despite the often small group sizes, the "progress" of the average score was relatively steady. More of the original quartile group moved up (or down) than would have been expected by chance alone.

Because there were relatively few young people moving up or down it was difficult to get a clear picture of the characteristics of the groups, and these characteristics appeared to differ between competencies. Those doing increasingly well in cognitive competencies were male (in numeracy) or female (composite cognitive); Mäori/Pacific (logical problem-solving) or Päkehä/Asian (other competencies); have mothers with university or senior secondary or tertiary qualifications; and have come from families with age-5 incomes of at least $60,000 (particularly in numeracy). Those with decreasing cognitive competency scores were female (numeracy) or had mothers with few qualifications (logical problem-solving). For the attitudinal competencies, there were no clear trends for gender or ethnicity, but those with decreasing scores were more likely to have come from homes with non-university qualified mothers, and age-5 family incomes of under $60,000.

7. Attrition, school leaving by age 16, and competency patterns

A total of 549 young people have been part of the Competent Children, Competent Learners study sample, and by age 16, there were 448 participants (82 percent of the original sample), although we do not have complete data for all of these participants.

By age 16, 27 of the young people who were still in the study had left school, and a further five were still at school but no longer in a mainstream school.

In this chapter, we look at the differences between those still in the study and those who had left, and between those still in a mainstream school and those who had left school.

Leaving the study

Which young people and their families have left the study over the years? Family movements out of New Zealand have always been one of the main reasons for participants to leave the study. At ages 14 and 16 there have been young people who were reluctant to continue participation, and at age 16 there were a few parents who were impossible to contact, although the researchers could contact the corresponding young people (who remained in the study). At age 12 we found no statistically significant differences between the social characteristics of those who had left the study and those who were still in the study (Wylie et al. 2004). At age 14 we found the same, but that there were some differences in age-8 mathematics and logical problem-solving scores: those who left the study between age 12 and age 14 had slightly lower scores (Wylie, Ferral, Hodgen, & Thompson, 2006). Had these differences become more or less marked by age 16?

Social characteristics

At age 16, when we compared those still in the study with all of those who had left the study, the continuing participants were less likely to have come from homes with a family income of under $30,000 at age 5 (24 percent cf. 38 percent of those who had left the study), more likely to be Päkehä (80 percent cf. 68 percent), and less likely to be Pacific (4 percent cf. 12 percent) or Mäori (3 percent cf. 6 percent). More Mäori and Pacific students left between the age-14 and age-16 data collection rounds than between the age-12 and age-14 rounds. There were no statistically significant differences in gender, or maternal qualification.

Competency measures

We also compared the competency scores[20] at age 5 (n = 306), age 8 (n = 522), and age 14 (n = 472) of those in the study at age 16 with all those who had left by that time. All the mean age-5 competency scores of those

[20] The sample sizes given here are the number for whom we have competency measures at each age. The scores are measured in percentages, as they were in earlier reports, rather than the 0 or 1–10 scales used earlier in this report.

remaining in the study were higher than the scores of those who left (mean differences of between 1 and 9 percentage points, with the greatest difference for *early literacy*), although none were statistically significantly higher.[21] Similarly, all the mean age-8 competency scores of those remaining in the study were higher than the scores of those who had left. The competencies for which the age-8 scores were statistically significantly higher were *mathematics* (mean difference of 10 percentage points, $p = 0.0008$), *reading comprehension* (mean difference of 7 percentage points, $p = 0.015$), *individual responsibility* (mean difference of 6 percentage points, $p = 0.015$), *social skills with adults* (mean difference of 6 percentage points, $p = 0.003$), and *communication* (mean difference of 6 percentage points, $p = 0.0044$).

If difference in competency scores was detectable from age 5 (though not significant, the difference was consistently in the same direction for all competencies) or age 8 (where there were some statistically significant differences), what was the situation for the subset of young people who left between the age-14 and age-16 rounds of data collection? All the differences in age-14 competency levels were statistically significant, except for *logical problem-solving* (mean difference in scores of 3 percentage points). The largest differences were in *perseverance*, *mathematics*, *PAT reading comprehension*, *curiosity*, *communication*, and *self-efficacy* (mean differences of 16, 15, 14, 14, 13, and 13 percentage points, respectively, all *p*-values less than 0.002), and the other mean differences were between 6 and 11 percentage points (all *p*-values less than 0.05).

There appears to be a growing discrepancy between the competencies of those in the study and those who left, but the age-14 comparison is only between those who left between age 14 and age 16. Were there similar differences in score for the same students at ages 5 and 8, and if so, how large were these differences?

Some students joined the study at age 8, and some left the study at each round of data collection. If we wish to compare the competencies of those who left with those still in the study, the best ages at which to do it are age 5 (all of the original study group, but excluding those who joined at age 8); age 8 (excluding those who had left by age 8); and age 14 (excluding the relatively homogeneous group who left by age 12 and also those who left between ages 12 and 14).

How well do these earlier competencies predict age-16 competencies? Several of the age-5 scores have been shown to be relatively poor predictors of age-16 competencies; the age-8 competencies are moderately good predictors of the age-16 competencies, and the age-14 scores are even better.

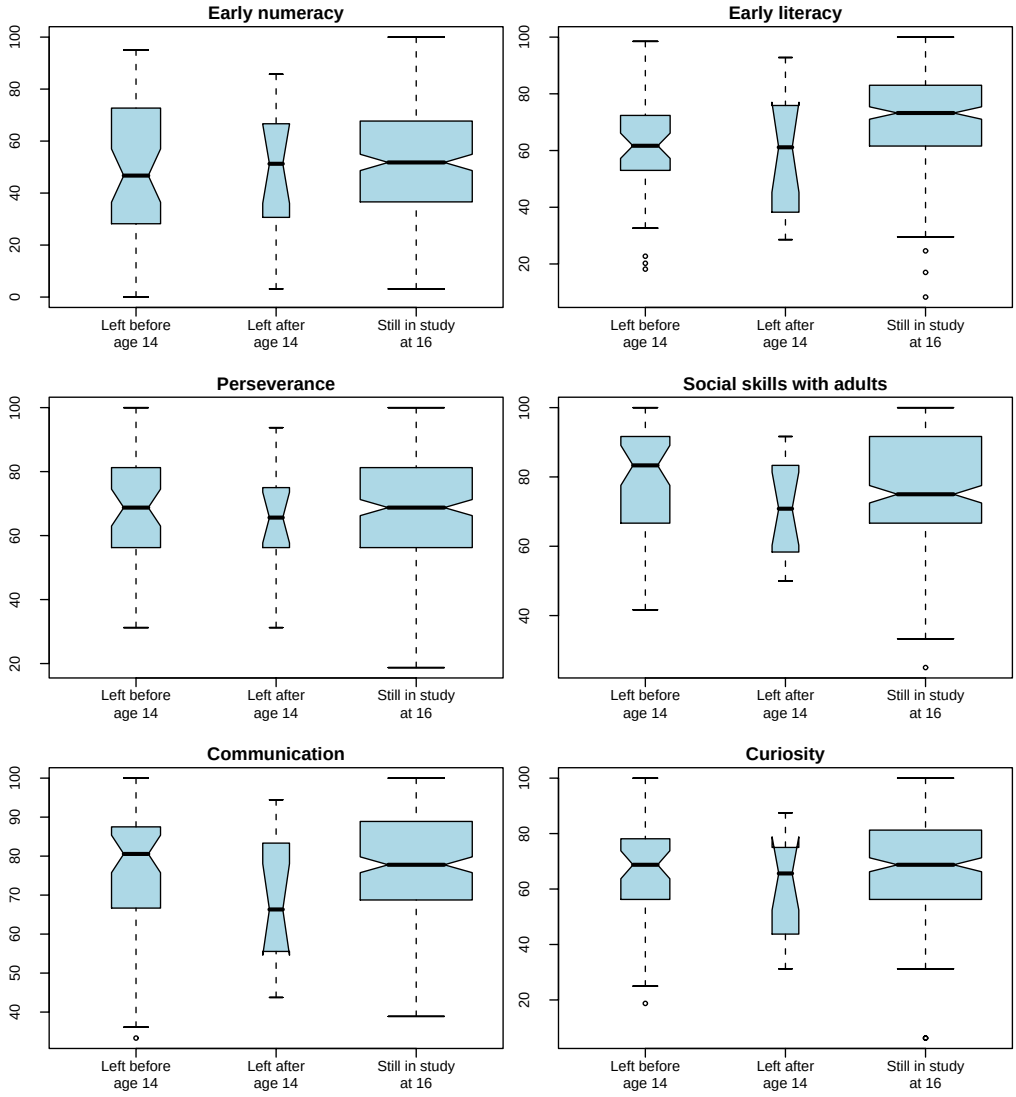
Figures 33–35 show the distribution of the scores for the competencies that showed the greatest mean difference between those in the study and those who left. *Logical problem-solving* scores in the two groups did not differ by much, and for this reason graphs for this competency are not shown.

Scores at age 5

Figure 33 shows the age-5 competency data for those in the original sample. There is a general tendency for those who left the study to have lower scores than those who remained in the study, but the differences are not great. They were most marked for *early literacy*. There seem to be differences between students who left before age 14 and those who left after age 14, particularly with respect to *social skills with adults* and *communication*.

[21] Using a *t*-test.

Figure 33 ***Age-5 scores for selected competencies for participants who left the study before age 14, those who left after age 14, and those still in the study at age 16 (n of 47, 14, and 246, respectively)***

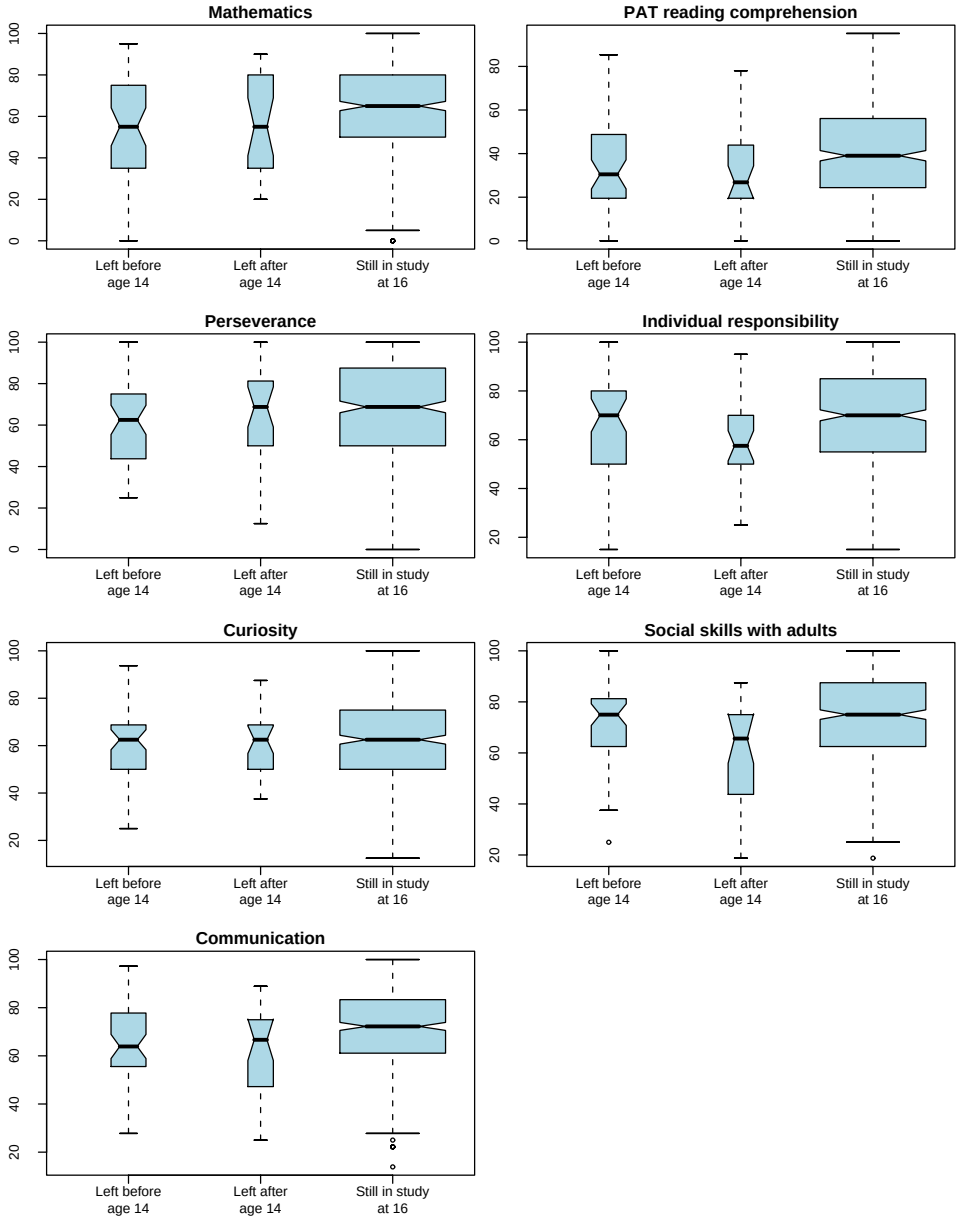


Scores at age 8

At age 8, the differences are more marked, as is shown in Figure 34. However, these patterns must be interpreted with a little care, as this is based on the data from the larger sample. There are increasing and statistically significant differences[22] for *mathematics*, *reading comprehension*, *individual responsibility*, *communication*, and *social skills with adults* (particularly for those who left after age 14).

[22] Analysis of variance, using 5 percent level of significance.

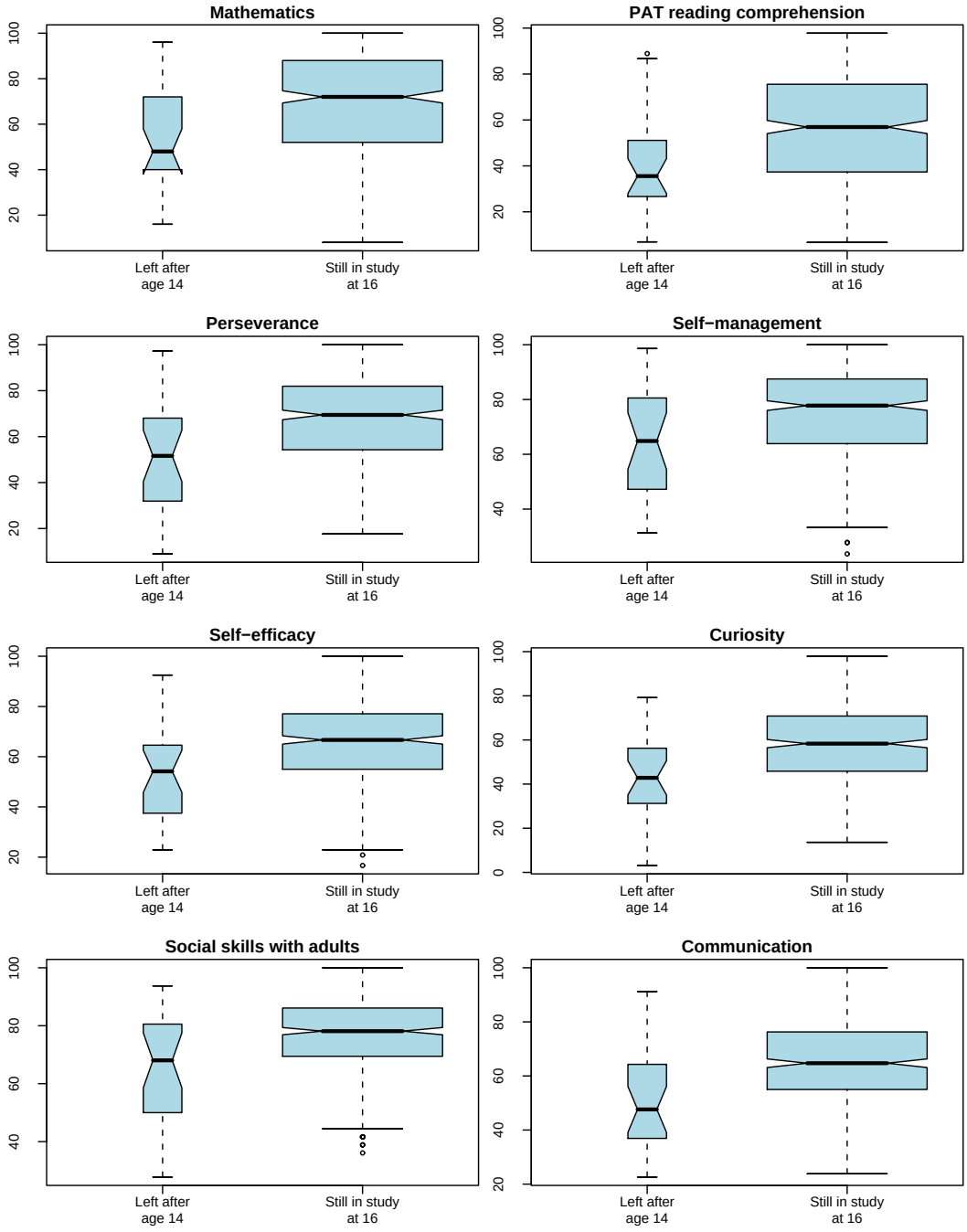
Figure 34 ***Age-8 scores for selected competencies for participants who left the study before age 14, those who left after age 14, and those still in the study at age 16 (n of 49, 26, and 448, respectively)***



Scores at age 14

Figure 35 shows similar data at age 14, at which stage, of course, there are no data for those who left *before* age 14. The differences between those who left at age 14 and those who did not are considerably more marked (and are all statistically significant).

Figure 35 ***Age-14 scores for selected competencies for participants who left the study after age 14 and those still in the study at age 16 (n of 28 and 446, respectively)***



So, overall, we see a pattern of increasing differentiation over time, both for the group of participants who left the study as a whole, and for those who did not participate after age 14. We also see that those who left the study before age 12 were less different from those who stayed in than was the case for those who left after age 12. After the age of 12 more *students* decided that they no longer wished to take part, and these students tended to be from less-advantaged homes, and to have had lower competency scores at ages 12 and 14. However, while on average the students who left after age 12 had lower competency scores (and for some competencies included the students achieving the lowest score/s), this group included some students whose scores were above the upper quartile, too, for every competency.

Leaving school at 16

By age 16 our original study group has divided, not only into those still in the study and those who have left, but also into those still in a mainstream school (414), those studying through The Correspondence School or home schooled (5), and those who have left school (27). There are a further three students for whom we have incomplete competency data, for various reasons (one was overseas and completed some, but not all the tasks, one was unable to complete the tasks, one refused to do so).

Does the group of students who have left school differ from those still at school, and if so how far back can we trace those differences? In the comparisons that follow, we compare only the 414 who are still in a mainstream school with the 27 who have left school.

Social characteristics

If we look first at family characteristics, we see that, like the students who left the study after age 12, the students who have left school at age 16 are more likely to come from a family with an income under $30,000 at age 5 (70 percent cf. 22 percent of those still at a mainstream school), and the difference in family income was, if anything, more marked at age 14, when 44 percent of those who had left school came from families with a current income of under $30,000, compared with 10 percent of those in a mainstream school. A third of the students who left school had mothers with no formal qualification, compared with 12 percent of those still at a mainstream school. There were no statistically significant differences based on ethnicity or gender.

Competency measures

If we look at the competency scores at age 14, the group that left school had statistically significantly lower scores for *all* competencies. How far back can we track this?

We have age-5 data on 236 students still in the study at age 16. The group that left school at 16 (n = 14) had approximately equal or lower scores than those who were still at a mainstream school (n = 222) across the range of measures, and there were statistically significant differences for *early number knowledge* (scores were 16 percentage points lower, $p = 0.005$) and *early literacy* (scores were 12 percentage points lower, p = 0.009, respectively). These two differences were the start of a consistent pattern that was particularly clear for ages 8–14.

We have age-6 data on 242 students still in the study. The differences were more consistent with the pattern that subsequently developed in their school years in that the mean scores of those who left school at 16 (n = 14) were all lower than those of the students who stayed in school (n = 228). However, at age 6 none of the differences were statistically significant at the 5 percent level. One reason fewer differences were statistically significant at ages 5 and 6 than at ages 8–14 was the smaller sample sizes at ages 5 and 6, particularly for the students who left school.

By age 8, for the larger sample (27 who had left school at age 16, and 414 in a mainstream school), the differences in mean score were more marked for all competencies, and were statistically significant for *mathematics* (19 percentage points, $p < 0.0001$), *PAT reading comprehension* (15 percentage points, $p = 0.0006$), *perseverance* (14 percentage points, $p = 0.0008$), *individual responsibility* (10 percentage points, $p = 0.0009$), *Burt reading test* (8 percentage points, $p = 0.0124$), *logical problem-solving* (8 percentage points, $p = 0.0066$), and the composite scores (cognitive and attitudinal, 11 percentage points, $p = 0.0001$ and 7 percentage points, $p = 0.0087$, respectively).

The position at age 10 was similar, with the statistically significant differences for *PAT reading comprehension* (19 percentage points, $p < 0.0001$), *mathematics* (13 percentage points, $p = 0.0035$), *Burt reading test* (11 percentage points, $p = 0.0009$), *writing* (9 percentage points, $p < 0.0001$), *logical problem-solving* (8 percentage points, $p = 0.0064$), and the cognitive (9 percentage points, $p = 0.0012$), but not the attitudinal composite (3 percentage points, $p = 0.280$).

It is not clear why the differences should be more marked at age 8 than at age 10. However, by age 12, the differentiation between groups was more noticeable: there were strong and consistent differences between the groups, and the differences were statistically significant for all competencies other than writing (where they were indicative). The greatest differences were for *mathematics* (18 percentage points, $p < 0.0001$), *perseverance* (17 percentage points, $p < 0.0001$), *PAT reading comprehension* (16 percentage points, $p = 0.0002$), and *individual responsibility* (15 percentage points, $p < 0.0001$).

At age 14, all the differences in competency were statistically significant. The greatest differences were for *perseverance* (24 percentage points, $p < 0.0001$), *mathematics* (22 percentage points, $p < 0.0001$), *self-efficacy* (21 percentage points, $p < 0.0001$), *PAT reading comprehension* (20 percentage points, $p < 0.0001$), and *self-management* (19 percentage points, $p < 0.0001$).

The percentage point differences quoted above do not give truly meaningful comparisons, as the means for the competency measures are all different, as are the standard deviations. Table 31 gives the difference between the mean standardised scores of those still at school at age 16 and those who have left school. The standardised scores all have a mean of 0 and standard deviation of 1, so these mean differences correspond to Cohen's *d* effect sizes. A mean difference in the table of around 0.2 would be regarded as small, that of around 0.5 as medium, and one of 0.8 or more as large.

Table 31 ***Effect sizes for mean differences in age 5–8 competency scores between age-16 school-leavers and those still in mainstream education***

Age 5		***Age 6***		***Age 8***	
Competency	***Difference***	***Competency***	***Difference***	***Competency***	***Difference***
Cognitive composite	***0.824***	***Cognitive composite***	***0.609***	***Mathematics***	***0.819***
Early number knowledge	***0.765***	Invented spelling	0.582	***Cognitive composite***	***0.760***
Early literacy	***0.715***	Independence	0.535	***PAT reading***	***0.672***
Logical problem-solving	0.509	***BURT word recognition***	***0.517***	***Perseverance***	***0.664***
Social skills with peers	0.265	Perseverance	0.440	***Logical problem-solving***	***0.539***
Motor skills	0.256	Number knowledge	0.419	***Attitudinal composite***	***0.521***
Social skills with adults	0.198	Attitudinal composite	0.396	***Individual responsibility***	***0.516***
Curiosity	0.133	Logical problem-solving	0.342	***BURT word recognition***	***0.494***
Attitudinal composite	0.019	Communication	0.332	Social skills with peers	0.395
Perseverance	-0.096	Social skills with adults	0.307	Writing	0.369
Self social-emotional	-0.169	Social skills with peers	0.120	Curiosity	0.294
Communication	-0.328	Curiosity	0.106	Social skills with adults	0.278
		Fine motor skills	0.002	Communication	0.244
				Fine motor skills	0.026

Effect sizes shown in bold were statistically significant. Smaller effect sizes were significant at age 8 as the sample size was larger.

Similar results for ages 10–14 are given in Table 32. Up to age 10, the relatively larger differences were all cognitive competencies, and at least half of the attitudinal competencies had relatively small effect sizes (under 0.3). Some were even negative, indicating that the left-school group had slightly higher scores. However, by age 12 this had changed, and the change became more marked at age 14: the larger effect sizes were for the attitudinal competencies, which had increased between two- and four-fold from the age-10 levels, and the effect sizes for the cognitive competencies had also increased, but only slightly. At all ages the cognitive competencies with the smallest effect sizes were *writing* and *logical problem-solving*. If *logical problem-solving* can be taken to be the closest measure we have of students' "intelligence", or combined innate perceptual and logical abilities, it would seem that the two groups were least differentiated in this respect. The differences, such as they were, were far greater in the young people's ability to read, to understand what they read, and in their knowledge of mathematics—skills they learnt at school, and reinforced (or not) by use outside school in their home and leisure activities, rather than had "built-in".

Table 32 ***Effect sizes for mean differences in age 10–14 competency scores between age-16 school-leavers and those still in mainstream education***

Age 10		Age 12		Age 14	
Competency	***Difference***	***Competency***	***Difference***	***Competency***	***Difference***
PAT reading	***0.861***	***Attitudinal composite***	***0.940***	***Self efficacy***	***1.393***
Writing	***0.781***	***BURT word recognition***	***0.817***	***Attitudinal composite***	***1.319***
Cognitive composite	***0.667***	***Perseverance***	***0.809***	***Perseverance***	***1.260***
BURT word recognition	***0.657***	***Social skills with peers***	***0.787***	***Social skills composite***	***1.179***
Mathematics	***0.580***	***Social skills with adults***	***0.787***	***Self-management***	***1.174***
Logical problem-solving	***0.540***	***Cognitive composite***	***0.786***	***Social skills with peers***	***1.111***
Social skills with peers	0.306	***Individual responsibility***	***0.779***	***Communication***	***1.107***
Communication	0.242	***PAT reading***	***0.776***	***Social skills with adults***	***1.095***
Attitudinal composite	0.215	***Mathematics***	***0.776***	***Curiosity***	***1.017***
Perseverance	0.200	***Logical problem-solving***	***0.740***	***Cognitive composite***	***0.960***
Fine motor skills	0.198	***Communication***	***0.728***	***Mathematics***	***0.909***
Social skills with adults	0.171	***Curiosity***	***0.655***	***PAT reading***	***0.880***
Individual responsibility	0.121	Writing	0.437	***Writing***	***0.778***
Curiosity	0.051			***Logical problem-solving***	***0.707***

Effect sizes shown in bold were statistically significant.

It would appear that children who made the decision to leave school at age 16 had a long-term pattern of below average achievement in the cognitive competencies, particularly those learnt at school, and this difference increased after age 10. Their engagement in school changed far more dramatically. This attitudinal change was not only with respect to work and how they behaved in class (perseverance, self-management, etc.), but also affected their relationships with their peers and adults (the social skills and communication).

Graphs of the differences for the three main cognitive competencies and five attitudinal competencies most strongly associated with cognitive outcomes give a remarkably consistent picture of the changes over time. The plots in Figures 36–43 show the mean score for each group, and a bootstrapped 95 percent confidence interval[23] for the score. The scores described as statistically significant above should not have overlapping confidence intervals.

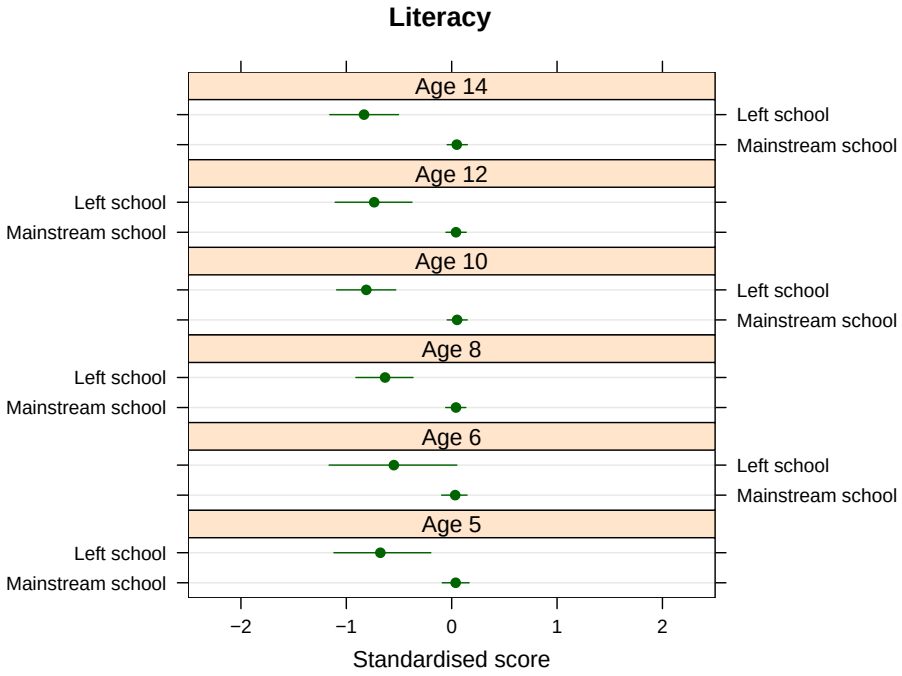
Figure 36 shows the data for *literacy* (*early literacy*, *invented spelling*, or *PAT reading comprehension*). At age 5, in the bottom panel, it is clear that the confidence intervals for those who left school and those in mainstream school were different. From that age on, each pair of dots (those still at school versus those who have left school) becomes wider apart, indicating the increasing difference in reading ability.[24] The mean of those still at school sits

[23] A bootstrapped confidence interval is a non-parametric confidence interval for an estimate. As in any 95 percent confidence interval, we expect the true mean to lie between the limits of the interval 95 percent of the time.

[24] To make the scores easier to compare across the years, the original percentage point scores have been standardised to have a mean of 0 and standard deviation of 1. This also means that comparing differences across different scores is more meaningful (all have the same mean and are equally variable).

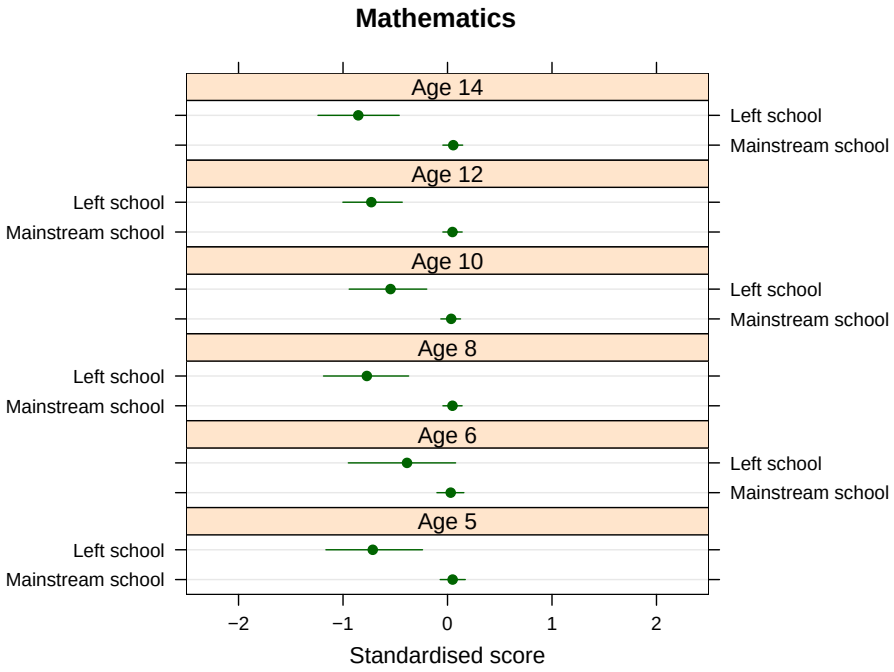
just above 0 (the overall mean is 0), while the mean of those who have left school "drifts" to the left over time (below 0). The actual differences between the pairs of means are given in Table 31 (ages 5–8) and Table 32 (ages 10–14).

Figure 36 ***Increasing differences in literacy score between those in school at 16 and those who have left school***



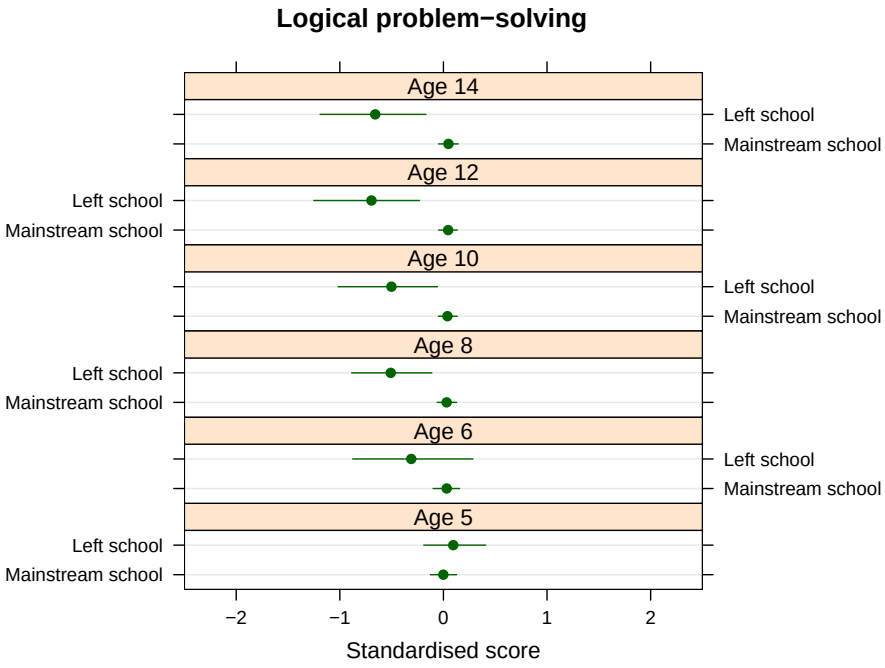
A similar picture is given for *mathematics*, in Figure 37, although the divergence was stronger and from an earlier age. Difficulty in reading may have compounded difficulties in mathematics for weaker students, and several of those who left school at 16 would have belonged to this group.

Figure 37 ***Increasing differences in mathematics score between those in school at 16 and those who have left school***



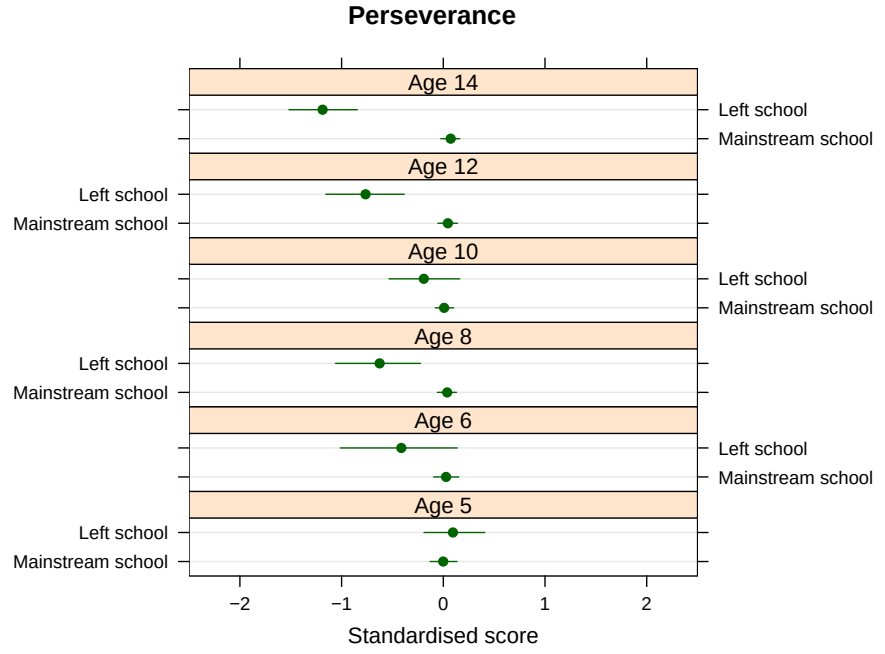
The same pattern is evident with *logical problem-solving*, but with smaller differences between scores for the group who have left school, and those who remain. This difference between *logical problem-solving* and the other two cognitive competencies was also evident in our investigations at age 14: for example, *mathematics* score was strongly associated with engagement in school, but the association with *logical problem-solving* was far less strong; and its associations with maternal qualification and family income were along the same gradient, but not as steeply as found for *mathematics*. The reasons may be that the *logical problem-solving* test was non-verbal, and did not involve any reading, or that the skills measured are not as explicitly taught in school (though they may be more so with the new curriculum framework currently in draft form), so any initial differences are not consolidated and increased by differences in school experience. The *logical problem-solving* scores for those who left school and are still at school are shown in Figure 38.

Figure 38 ***Increasing differences in logical problem-solving score between those in school at 16 and those who have left school***



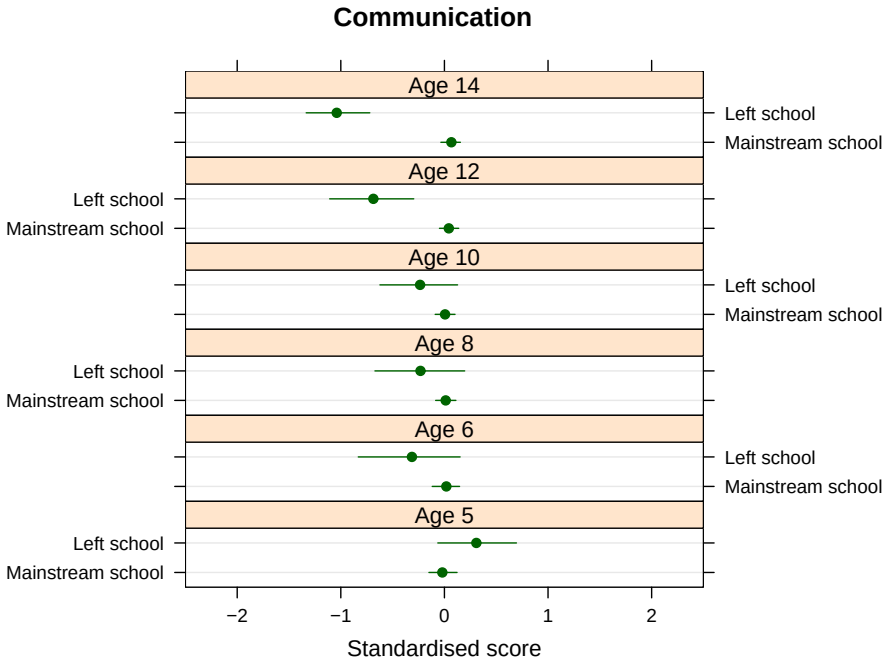
Not only are the students who left school at age 16 falling behind in their cognitive competencies, but their attitudinal scores (derived from teacher comments) are also diverging from those of their peers. This may be as a result of their increased disengagement from school: they are less co-operative, try less hard, and care considerably less than the rest of the class who stayed in school. These changes are most marked from age 12. Figure 39 shows the scores for *perseverance*, where the decrease in the scores for those who left school accelerates after age 12.

Figure 39 ***Increasing differences in perseverance score between those in school at 16 and those who have left school***



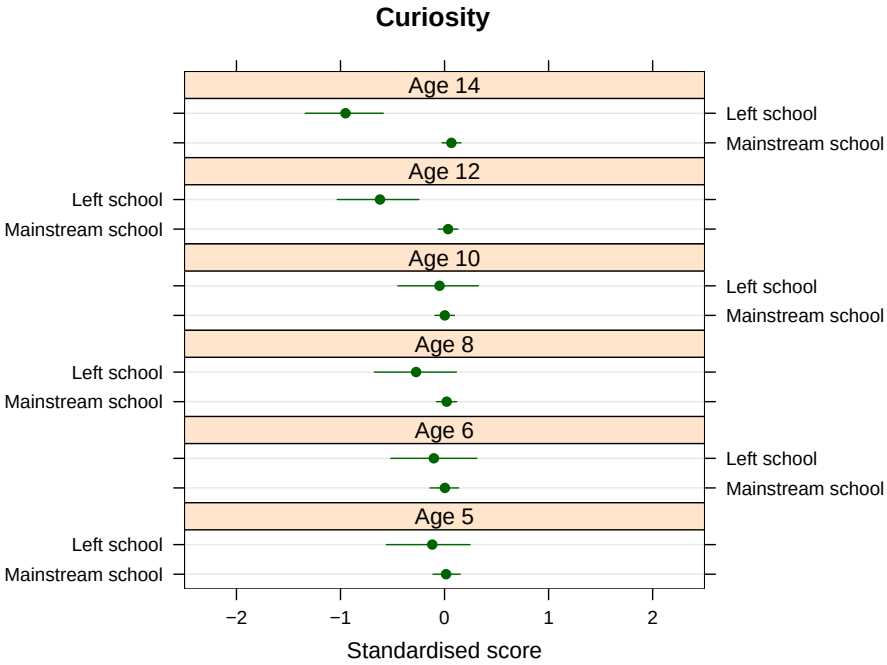
The divergence in *communication* score, too is marked from age 12 on (see Figure 40).

Figure 40 ***Increasing differences in communication score between those in school at 16 and those who have left school***



For *curiosity*, too, there are no real differences in score up to age 10, but after that the differences increase markedly (see Figure 41).

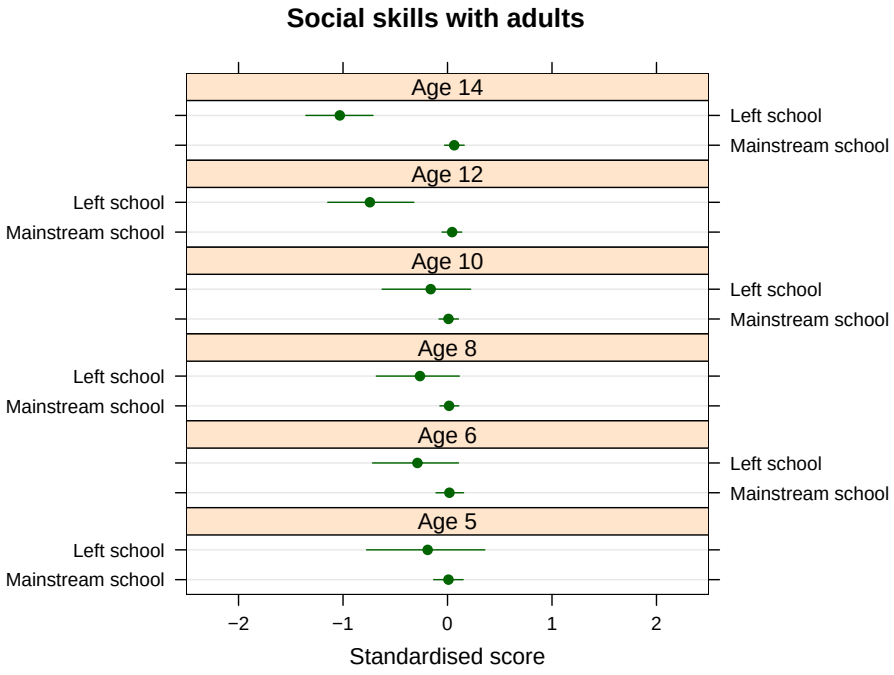
Figure 41 ***Increasing differences in curiosity score between those in school at 16 and those who have left school***



A similar pattern is also seen for *individual responsibility/self-efficacy* (Figure 42) and *social skills with adults* (0).

Figure 42 ***Increasing differences in individual responsibility/self-efficacy score between those in school at 16 and those who have left school***

Figure 43 ***Increasing differences in social skills with adults score between those in school at 16 and those who have left school***



Those who left school by 16 not only were more likely to have started school with disadvantages identified by their social characteristics (their mothers were more likely to have no/low levels of qualification, their family

income was low), but also with lower-than-average early number knowledge, early literacy scores, and slightly lower logical reasoning scores. They found pattern finding (logical problem-solving), symbol recognition (early number knowledge), and pre-literacy skills more challenging than other children did.

By the time they were 8, and when they were 10, they were more likely to give up easily (perseverance), not to take responsibility for themselves and their actions, and were behind in all their cognitive competencies. Their fine motor skills were as good as those of their peers, and their social and communication skills were not much worse than those of their peers.

Between the ages of 10 and 12 something happened. Some of the changes may well have been in what was expected of them in the classroom, and in how their behaviour was evaluated by their teachers in response to our questions (which modified as the children got older). But the differences recorded in our statistics at age 12 tell of increased disparity in the cognitive competencies, and now a much more marked disparity in the attitudinal competencies. At 12, the young people who left school by 16 were giving up, playing up, and increasingly alienated (lower social skills with both adults' and peers' scores), and this trend was even more marked at age 14.

Anecdotal evidence from the field researchers suggests that for several of the boys, leaving school was a means to find more meaningful and purposeful ways to fill the day, or to realise a long-held ambition (an apprenticeship). School had not satisfied their needs, and starting work was seen as a positive step towards their adult life. Several of the girls who left school, however, did so "aimlessly". They got into "bad company" and/or developed "bad habits", lost purpose and direction, and left school with no definite aim or plans. Some had become pregnant.

The transition from school will be examined in more detail in a later report in this series. For now, we note that, on average, the differences between those leaving school at 16 and those continuing in education began at birth, but appeared to "crystallise" between the ages of 10 and 12.

Not all students who left school early had lower-than-average competency scores (some had scores above the upper quartile in some or all competencies), but on average, students leaving school by age 16 started school with a disadvantage in literacy and numeracy, and possible slight disadvantages in social and attitudinal competencies. Their disadvantage became more consistent across competencies between the ages of 8 and 10. The disadvantage was most marked in literacy, numeracy, and individual responsibility. The extent of the disadvantage increased at age 12 and again at age 14, by which time very little at school was going well for them: they were behind their classmates in literacy and mathematics, and their behaviour in class, attitude to schoolwork, and effort put in caused their teachers to give them ratings that gave them markedly lower attitudinal competency scores.

Summary

Up to age 12, those young people withdrawing from the study were no different from those still in the study with respect to either their competency measures or their social characteristics. However, the students who have withdrawn after age 14 have a distinct profile. They are more likely to be Mäori or Pacific, to come from families that had a low income when they were 5, and to have achieved lower-than-average scores in all competencies at age 14. Some of the differences in competency were there at age 5. Those who left the study after age 14 had lower scores in early literacy (which may have compromised their academic school career), social skills with adults, and communication. They started school under-prepared, and by age 8 their literacy and numeracy, individual responsibility, social skills, and communication were below average. The difference for logical problem-solving was less marked.

The net effect of this is that the young people remaining in the study are probably less representative of the wider New Zealand population than the initial sample was, and that any comparisons between age-16 competency scores and earlier measures need to be based on the same individuals, rather than the "whole sample" at the earlier age. However, longitudinal comparisons of characteristics and achievements within the rich data of the study are still very useful.

Somewhat similarly, we find that those who left school have, on average, a different profile by age 14. Early school-leavers were more likely to come from families that had a low age-5 income and that were still low-income when the young people were aged 14. They were also more likely to have mothers with no formal qualifications; to have had slightly lower-than-average cognitive competencies at age 5, but average attitudinal competencies.

The cognitive differences between those at school and those who left school became successively more marked from age 8. This difference was slow and steady for the cognitive competencies, but for the attitudinal competencies it escalated rapidly after age 10.

The feedback loop of attitude affecting cognitive competency levels, affecting attitude levels, affecting cognitive levels, and so on, described in Chapter 5 would appear to be at work here. Having started with some disadvantage at age 5, and coming from families without strong traditions of education, by late primary school their attitude to and engagement in school decreased along with their cognitive achievement, to the point where they chose to leave school as soon as possible.

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