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Early childhood education and young adult competencies at age 16

Technical report 2 from the age 16 phase of the longitudinal Competent Children, Competent Learners study

Report to the Ministry of Education

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Technical report 2 from the age-16 phase of the longitudinal Competent Children, Competent Learners study

Edith Hodgen

NEW ZEALAND COUNCIL FOR EDUCATIONAL RESEARCH

TE RŪNANGA O AOTEAROA MŌ TE RANGAHAU I TE MĀTAURANGA

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1. Introduction

The role of early childhood education (ECE) in children's lives is a key focus for the Competent Children, Competent Learners study. When the study started, in 1992, the interest was on the effect on children while they were still in their last months of ECE. Since then, the interest has been on the long-term impact, if any, on the cognitive and attitudinal competencies measured.

This report covers any impact still discernible at age 16, and provides the technical details of the analysis. The main findings of this analysis are included in the companion summary report.

The Competent Children, Competent Learners study

Data collection for the first phase of this study took place over 1993–1994 in the wider Wellington region, usually within the last three months of a child's final ECE experience.[1] We collected full information on 307 children who were then attending kindergarten, education and care centres, playcentre, family day care, and aoga amata (Samoan language nests). This sample of 307 is referred to in this report as the "original sample". The information collected included ratings of centre quality taken from observations over a three-hour period, on at least three different days, usually a fortnight apart; observations of the study children (five times on each occasion when the centre rating was done); and information on structural aspects from interviews with centre staff. Parents gave us information on their child's ECE history, and their experiences with their child's first and last ECE service.

We also collected some information on an additional 767 children of the same age, which included the length of their early childhood education experience, and information on their current ECE centre, but not on the centre's quality. When the children were aged 8, we included 242 children from this additional data collection into the main sample that we have continued to follow at two-yearly intervals. The 549 children in the study at age 8, or those of them remaining in the study in later years, are referred to in this report as the "full sample". At age 16 we have a total of 448 participants still in the study.

Descriptions of the structural and process quality features of the ECE centres in our study, and observations of children's experiences in the centres, with some analysis of the relations between the structural and process quality aspects, and between children's observed experiences and competency levels can be found in Wylie, Thompson, and Kerslake Hendricks (1996).

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[1] The study does not include children who have no ECE experience. The pilot for this study found it difficult—and expensive—to identify and find such children, given that in New Zealand, the majority of children have had some ECE experience by the time they start school. A study that followed children from birth would be able to include those with no ECE experience more easily, though numbers would still be low.

Previous findings

The study participants' early childhood education experience was still contributing to their mathematics and reading comprehension scores at age 12.[2] At age 14[3], we found that aspects of the final early childhood education centre quality appear to have made some additional contribution to age-14 mathematics, reading comprehension, and attitudinal scores, after taking into account performance at the time of attending the final ECE centre, and family income or maternal qualifications. The difference between those with the most of a given aspect and others is a reasonable size, of around 9 percentage points on a scale of 100, warranting attention in policy and practice.

This contribution is generally not reduced much after taking age-5 performance into account, suggesting that ECE contributions to children's performance are not limited to the time they are attending. However, for many ECE quality measures the effect size was reduced somewhat after taking the social characteristics of the children into account: these generally have a more powerful effect than ECE experiences, partially because they are continuing elements in a child's life as they move through school.

The home environment and ECE environment both have long-term effects on learning outcomes. Some home and ECE variables were associated; for example, ECE centre socioeconomic mix and both family income and maternal qualifications. For these variables, the apparent ECE quality effect was markedly reduced when the home social characteristics were added to the models. However, we found slight, persistent positive effects of some ECE quality variables over and above the effects of the home environment. These effects were for attitudinal as well as cognitive competencies.

Generally, the associations found applied across the board—of general benefit to children's performance no matter what their social background. Children from low-income homes benefited more than others if they had experienced the highest quality in terms of staff guidance in their final ECE experience.

The overall length of early childhood education experience did not make a marked independent contribution after age-5 scores and family resources to the cognitive competencies. However, overall ECE length of experience appeared to do so for the attitudinal competencies. There was a benefit to those who had 48 months or more ECE experience, compared with those who had less than 24 months, and a benefit to those who started ECE between the ages of 1 and 2, compared with those who started after age 3.

Other research findings

It has been suggested that one reason why ECE can have long term effects is that it also boosts non-cognitive skills (our attitudinal competencies), and thus can increase motivation levels (Cunha et al, 2005).

Non-cognitive skills have also been shown to be associated with the probability of dropping out of school, spending time in jail, smoking, and teen pregnancy. Each of these outcomes is most likely for those with low cognitive and non-cognitive skill levels, and is extremely unlikely for those with high levels (Heckman et al, 2004).

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[2] More detail is given in Wylie, Thompson et al. (2004).

[3] More detail is given in Wylie, Hodgen, Ferral, and Thompson (2006).

2. Description of the analysis and results presented

To answer the question: "Does an association between competency scores and early childhood education remain visible at age 16?" I have followed a procedure similar to that used at age 12 and age 14. I have tested the extent to which ECE experience and quality measures can be shown to have a statistically significant effect on the age-16 competency measures.

Measures of competency

The competency measures are:

Cognitive:

- *literacy*
- *numeracy*
- *logical problem-solving*
- *composite cognitive*

Attitudinal:

- *focused & responsible*
- *thinking & learning*
- *social skills*
- *social difficulties*
- *composite attitudinal*

and their characteristics and derivation are described in Hodgen (2006).

For all the age-16 reports I have put the competencies on a 0–10 scale. Each single increment on the scale is more or less equivalent to a 10 percentage point increase on a 0–100 scale such as those used in earlier reports for the competencies.

ECE measures

The ECE *experience* measures are those which have shown associations in previous analyses in the Competent Children, Competent Learners project:

- starting age at first ECE service
- total length of ECE experience
- socioeconomic mix of the final ECE centre attended

and the ECE *quality* measures are:

- ECE staff responsiveness to children
- ECE staff guide children in activities
- ECE staff asked children open-ended questions
- ECE staff joined children in their play
- ECE centre provided a print-saturated environment.

Note that starting age and total length of ECE experience are related, but not equivalent. Some children had breaks in ECE experience, and it is the length of experience rather than starting age that has in the past, and still at age 16, shown a stronger effect on the competency scores.

Process quality measures that showed no associations with our competency measures at age 16 were: staff model and encourage children to use positive approaches to behaviour; children can select from a variety of activities; children engage in imaginative play; stories are read; there is evidence of children's artwork and creativity; children work on maths/science problems themselves; children move freely between indoors and outdoors; there are enough age-appropriate resources; there are good safety practices; equipment and activities encourage fine motor skills; equipment and activities encourage gross motor skills; children can complete activities; children support one another; there is non-sex-stereotyped play; tikanga Mäori and/or te reo Mäori are evident; and recognition is given to children's cultures.

The relative size of measures of effect size for the ECE quality measures depends on the ranges of quality observed (NICHD ECCRN & Duncan, 2003). The median overall score on our rating scale was 7.1, with a range from 3.8 to 8.9. On average, then, the centres in the study were almost all judged to be between satisfactory and very good. In other words, most, if not all, of our centres were of relatively similar quality. This means that moderate effect sizes at best can be expected for our quality measures.

The ECE experience and quality measures are not linearly related to the competency measures, so, as has been done in the past, I have used the four quartile groups previously defined for each of these measures.

Sample size

At age 16 we have a total of 448 participants still in the study, 421 of whom are still at school. We have measures of the cognitive competencies for almost all of the 448 participants, and measures of the attitudinal competencies for most of those still at school (these measures are based on teachers' evaluations of the sample students in their class). We know the starting ages in ECE of all 448 students, but have information on all other ECE experience variables for the original sample students only (n = 246). In this report I concentrate on the results of the students for whom I have information on their ECE experience. I have cognitive competency measures for about 244 of the 246 students (one was not able to complete the tasks and one refused to), and attitudinal competency measures for about 228 participants (those still at school).

Effect size measures

There are three commonly used measures of effect size used with ANOVA: η^2 which is the proportion of the total variance that is attributed to an effect in the sample; η_p^2 which is the proportion of the effect plus residual variance

that is attributable to the effect in the sample; and ω^2 which is an estimate of the total variance attributable to an effect in the population. Where more than one explanatory variable is included in a model, η_p^2 or ω^2 are more appropriate. Software such as SPSS produces η_p^2 by default. In general the value of η_p^2 is about twice that of ω^2 (the former is the estimate for the sample, the latter for the population). Where there is a single explanatory variable, unadjusted R^2 and η^2 are of the same order of size, as are adjusted R^2 and η_p^2.

According to Cohen's guidelines, a "large" effect size would be one where at least 14 percent of the variance was accounted for, a "moderate" or "medium" effect one where between 6 and 14 percent of the variance was accounted for, and a "small" effect one where between 2 or 3 and 6 percent of the variance was accounted for.

A more commonly used measure of effect size, Cohen's *d*, is less appropriate for use with linear models. This effect size measures the difference between the means of (typically) an experimental group and a control group relative to the standard deviation of the variable. For this measure, the cut-off values for large, medium, and small effects are 0.8, 0.5, and 0.2.

How do effect sizes and significance inter-relate? The reason why effect size measures have become popular is because they offer a means of judging the importance (size) of an effect that is not as dependent on sample size as a test of hypothesis. In a test of an hypothesis, the power of the test (the ability of the test to detect a "true" departure from the null hypothesis) is heavily dependent on the size of the sample. A small sample will only detect large differences between groups (departures from the null hypothesis), and a very large sample will detect very small differences between groups—differences that may not be meaningful in a real-world (or policy) sense. This makes comparing *p*-values[4] from different studies difficult, particularly when one study was based on 50 participants and another on 10,000. However, comparing *effect sizes* from the studies would be more meaningful[5]. In this report both effect sizes and *p*-values are presented so that the reader can judge both whether the effects were statistically significant or not and the relative size and importance of the different effects.

Analysis in this report

I explored both the effect of each ECE measure on its own, and the effect of the measures after accounting for age-5 achievement in a similar competency, maternal qualifications, and age-5 family income and, where the effect may be significant, gender and ethnicity effects for some of the competencies (Hodgen, 2006).[6] Inclusion of the other variables in the model shows the effect of the ECE measure *after accounting for the variability in the other variables*. This is particularly important where attendance at an ECE centre, and the quality of the ECE centre selected, will be associated with social characteristics, like maternal qualifications and family income, which in turn have been shown to be associated with competency measures.

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[4] A *p*-value is the probability of observing a result as marked (for example as strong a correlation, or as big a difference between groups) by chance alone. The test statistic is calculated under the assumption of no differences (the *null hypothesis*), and a large *p*-value indicates that this assumption is, if not exactly likely to be true, then at least unlikely to be false. A small *p*-value (traditionally, 0.05 or 0.01 are taken as cut-off values) indicates that the sample result is *unlikely to be true* by chance alone, allowing the conclusion that the null hypothesis is false (for example, the variables *are* correlated, or the groups *do* differ).

[5] Effect sizes are, like all statistics, subject to sampling variation, and the extent of this variation is partly dependent on sample size. For this reason some authors (Thompson, 2002, for example) recommend that confidence intervals for effect sizes be given. Direct comparisons of effect sizes alone can still be misleading, particularly those calculated on smaller data sets.

[6] I used the R software package (R Development Core Team, 2006) for the analysis.

I fitted a series of models that included the:

- corresponding age-5 competency (e.g. early number knowledge at age 5 for numeracy at 16);
- age-5 competency and maternal qualifications;
- age-5 competency and family income at age 5[7]; and
- age-5 competency, maternal qualifications, family income at age 5, gender, and ethnicity (where these previously were significant).

Why fit a series of models? We have established that there is an association between maternal qualifications and family income and the competencies (Hodgen, 2006; Wylie et al, 2004; Wylie et al, 1996). There are also associations, to at least some extent between social characteristics and ECE quality or experience. Families with more resources, or who value education more highly, are more likely to select a high-quality ECE centre. It is therefore important to account for the variability explained by the social characteristics before exploring any effects of ECE quality.

There are also some associations between cognitive skills and the social characteristics. It is therefore important to account for differing inherent skill levels before exploring the effects of ECE experience or quality. In an ideal world, we would have a measure taken before the child began ECE. In this study, we have measures taken towards the end of their ECE experience, so the age-5 competency measures include the effects of the children's ECE experiences. Examining the effect of ECE experience or quality *after* accounting for variations in age-5 competency allows us to estimate the long-term effects of ECE that are over and above any short-term effects captured in the age-5 competency measure and over and above what difference in competency were measured at age 5.

I present the results for all of the competencies for each of the ECE experience and quality measures in turn, so that a comparison across age-16 competencies is easier for each ECE measure.

I first present the results from fitting simple models (one-way analysis of variance or ANOVA models) for each of the competency measures. The mean competency scores in the four quartile groups for each ECE quality measure are presented[8], together with the *p*-value for the ANOVA, and the percentage of variance in the competency score that is accounted for by the ECE quality measure (R^2). In these tables the unadjusted R^2 is quoted, and it is in the same order of size as the effect size would be if η^2 was used to measure effect size.

I report on the contrasts that were still statistically significant when the age-5 competency and social characteristics were added to the models. I report the adjusted R^2 for the overall model, and the η_p^2 values for each of the variables included in each of the models. Both R^2 and η_p^2 are reported as the percentage of variability accounted for. Full results are in the appendix.

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[7] I use family income at age 5 rather than current family income because this indicates the resources and opportunities that may have been available in the early years, when the study participants were attending ECE.

[8] The quartile groups have been used for consistency with previous reports. However, the results suggest that a more useful (but less even) division may be between those scoring 4 or more, and those scoring less. Those scoring 4 or more usually correspond to the highest quartile group, or to those scoring well over the median. ECE staff responsiveness to children is an example of a quality measure where the both highest-scoring quartile groups score over 4 on average, and there are slight differences between these groups in the one-way ANOVAs.

Where there is a strong and consistent effect across time in one or more of the cognitive competencies I present the means for the first three (combined) and highest quartile groups from age 5 to age 16, the *p*-value for the one-way ANOVA, R^2, the difference between the highest and lowest quartile group means, and the difference between the group means presented in the table. Combining the first three quartile groups makes sense in these instances, as the greatest difference is usually between the highest quartile group and the rest.

I describe as "significant" results where $p < 0.01$, as "indicative" those where p is between 0.01 and 0.05, and as "no longer notable" those where $p > 0.05$.

3. ECE experience and competencies at age 16

I look at the effect of each of the aspects of ECE experience in turn, across all the age-16 competencies.

Starting age

Of the 448 students still in the study at age 16, 29 percent started ECE before they were a year old, 16 percent started before they turned two, 23 percent started in their third year, and 32 percent started after they turned three.

Table 1 ***Starting age at ECE and students' competencies at age 16***

Starting age → ***Age-16 competency ↓***	***< 12 months (n = 130)****	***12–23 months (n = 71)***	***24–35 months (n = 103)***	***≥ 36 months (n = 144)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	6.10	***6.29***	*5.80*	5.85	0.088	1.5
Literacy	6.89	***7.38***	*6.64*	6.70	***0.008***	***2.7***
Logical problem-solving	5.72	***5.72***	*5.19*	5.23	0.030	2.0
Cognitive composite	6.24	***6.46***	5.85	5.91	***0.007***	***2.7***
Focused & responsible	6.84	***6.96***	*6.78*	6.83	0.916	0
Thinking & learning	6.32	***6.39***	*6.26*	6.32	0.949	0
Social skills	*6.23*	***6.42***	6.28	6.27	0.836	0.2
Social difficulties	*6.06*	***6.47***	6.32	6.14	0.573	0.5
Attitudinal composite	6.46	***6.59***	*6.44*	6.47	0.910	0.1

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 122, 67, 95, 130, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

\# Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

There were statistically significant differences in *literacy* and the *cognitive composite* between those who began ECE in their second year and those who began either earlier or later.

When the age-5 equivalents of *literacy*, *logical problem-solving*, and *cognitive composite* scores, maternal qualifications and age-5 family income, and gender and ethnicity where relevant were added to the respective models, starting age at ECE was no longer statistically significant (see Table 18 and Table 19 in the appendix).

Length of ECE experience

Of the 246 students still in the study at age 16 for whom we have data on their length of ECE experience, 13 percent had a total of under two years' ECE experience, 22 percent had between two and three years', 25 percent had between three and four years', and 40 percent had more than four years' ECE experience.

Table 2 ***Total length of ECE experience and students' competencies at age 16***

Length of ECE experience → ***Age-16 competency ↓***	***< 24 months (n = 32)****	***24–35 months (n = 53)***	***35–47 months (n = 62)***	***≥ 48 months (n = 99)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	5.53	*5.47*	5.90	***6.29***	0.004	5.3
Literacy	*6.59*	6.62	6.81	***6.95***	0.534	0.9
Logical problem-solving	*4.66*	5.03	5.26	***5.97***	***0.0003***	***7.6***
Cognitive composite	*5.59*	5.71	5.99	***6.40***	***0.003***	***5.5***
Focused & responsible	*6.70*	6.80	6.82	***6.98***	0.813	0.4
Thinking & learning	6.24	6.26	*6.17*	***6.48***	0.602	0.8
Social skills	***6.31***	*6.18*	6.20	6.31	0.934	0.2
Social difficulties	*6.03*	6.06	***6.48***	6.08	0.703	0.6
Attitudinal composite	6.42	6.41	*6.40*	***6.59***	0.806	0.4

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 30, 48, 55, 95, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

For *numeracy* and the *cognitive composite* scores, there were statistically significant differences between those who had less than 36 months' ECE experience, and those who had over 48 months'. For *logical problem-solving*, there were statistically significant differences between those who had over 48 months' experience and each of the other categories.

The length of ECE experience did not remain significant for any of the competencies once maternal qualifications and the relevant age-5 competency measure had been added to the model (see Table 20 and Table 21 in the appendix).

Thus, it would seem that in our study the benefits of longer ECE experience make most of their visible contribution to age-5 scores, with a separate contribution still visible at age 14, but no longer visible by age 16.

Early childhood centre socioeconomic mix

We have consistently found that children whose ECE centre served mainly middle-class[9] families (as categorised by teachers) had higher average scores for the cognitive competencies. At age 16, that continued to be the case.

Table 3 ***ECE socioeconomic mix and students' competencies at age 16***

Socioeconomic mix of ECE → ***Age-16 competency ↓***	***Middle class*** ***(n = 102)****	***Low to middle income*** ***(n = 48)***	***Wide range*** ***(n = 69)***	***Low income*** ***(n = 25)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	***6.51***	5.56	5.59	*5.26*	***< 0.0001***	***11.3***
Literacy	***7.37***	6.57	6.38	*5.98*	***< 0.0001***	***10.6***
Logical problem-solving	***6.12***	5.11	5.07	*4.18*	***< 0.0001***	***13.5***
Cognitive composite	***6.66***	5.75	5.68	*5.14*	***< 0.0001***	***15.9***
Focused & responsible	***7.29***	6.81	6.42	*6.33*	***0.002***	***6.5***
Thinking & learning	***6.68***	6.39	*5.81*	6.02	***0.002***	***6.4***
Social skills	***6.52***	6.33	*5.87*	6.04	0.032	3.9
Social difficulties	***6.73***	6.04	5.83	*4.64*	***0.0003***	***8.0***
Attitudinal composite	***6.83***	6.51	*6.04*	6.13	***0.002***	***6.3***

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 101, 40, 63, 22, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

Unadjusted R^2.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

For *numeracy*, *literacy*, *logical problem-solving*, and the *cognitive composite*, there were statistically significant differences between the scores of those attending an ECE centre that served middle-class families and all other types of centre. For *focused & responsible* and *social difficulties* there were statistically significant differences between the scores of those attending an ECE centre that served middle-class families and those serving either a wide range or those serving low-income families. For *thinking & learning*, *social skills*, and the *attitudinal*

[9] The data here come from ECE centre managers' response to a closed question on their centre profile, asking them "What is the socioeconomic profile of the children at this centre?" and offering the categories: wide range, mainly middle class, mainly low-middle income, mainly low-income and/or on benefits, and other. A combination of "class" and "income" terms was used because of previous experience in other surveys, which showed that while "middle-class" was a term that made sense, "working class" did not.

composite, there were statistically significant differences between the scores of those attending an ECE centre that served middle-class families and those serving a wide range.

ECE socioeconomic mix remained statistically significant for *social difficulties* (p = 0.004, η_p^2 = 6.6) once the age-5 social composite score, gender, maternal qualifications, and age-5 family income had been added to the model. None of the other competencies remained statistically significant (see Table 22 and Table 23 in the appendix). Again, the contribution made to competencies by socioeconomic mix is likely to be subsumed in the age-5 performance level (and to reflect differences in individual socioeconomic resources) with a separate contribution remaining evident only for attitudinal competencies at age 14, and for social difficulties at age 16.

Summary of findings on ECE experience

It would appear that there is no separate long-term association for our young people between when a child started ECE, how long they were in ECE, or the socioeconomic mix of the ECE centre, and any of the competency measures, apart from a tendency to mix with anti-social peers, be influenced negatively by peers, or to be involved in bullying (that is, to get a low score in *social difficulties*). Students who had a score indicating some "social difficulties" were slightly more likely to be from ECE centres with children from a wide range of backgrounds or from low-income families.

Any apparent associations seen in the one-way ANOVAs are most probably the result of an association between the ECE experience variables and the child's other experiences, mainly maternal qualifications and age-5 competency, with the latter likely to have some association with ECE experience and quality. Mothers with higher qualifications may return to work earlier, remain in work more consistently, and be more willing and able to pay for a more "middle-class" centre than mothers with fewer (or no) qualifications.

However, the direction of the differences in competency score between the quartile groups has been consistent over the years. Between age 14 and age 16 the study has lost about 30 young people, and those with mothers with fewer qualifications, from lower-income homes, and those who were less engaged at school and who had lower competency scores (Hodgen, 2006) were slightly more likely to decline to continue to participate in the study. In addition, at age 16 we do not have attitudinal scores for those who have left school (these young people, like those who have left the study, have tended to be those with fewer "advantages" in life). I have not investigated the extent to which finding fewer long-term effects of ECE experience at age 16 than at age 14 was a consequence of non-random sample attrition.

4. Early childhood education quality and competencies at age 16

Aspects of quality provision in the study participants' final ECE centre showed associations with the sample's competency levels between ages 8 and 14. The strongest associations were with mathematics and the PAT reading comprehension test. The aspects of quality that showed a continuing contribution were mainly related to teacher–child interaction.

I have analysed the aspects of quality separately because many of the correlations between items are weak (r = 0.30 or less), indicating that the participants were attending ECE centres that could have strengths in some areas but not across the board. The correlations between the staff–child interaction measures (providing guidance, joining children in their play, asking open-ended questions, and being responsive to children) were more strongly inter-related with correlations of about 0.5 or 0.6, indicating that the quality of staff–child interactions was more consistent than the other quality measures.

The full range of aspects of ECE quality that were covered in our ratings of the final ECE centre attended by participants in the original sample is given in the table below. The aspects associated with competency scores which remained statistically significant or indicative at age 16 (11 years later) after taking the equivalent age-5 competency, family income, and maternal qualifications into account are marked with an asterisk (*) in Table 4. They are much the same set as found previously, up to age 14.

Table 4 ***ECE process quality ratings used in the Competent Children, Competent Learners study***

Staff-child interaction	***Programme focus***	***Physical environment & resources***	***Self-esteem***
**Staff are responsive to children*	Children can select from a variety of activities	Children move freely between indoors and outdoors	Children can complete activities
**Staff guide children in centre activities*	Children engage in imaginative play	Enough age-appropriate resources	Children support one another
**Staff ask children open-ended questions*	**The centre is print-saturated*	Good safety practices	Non-sex-stereotyped play
**Staff join children in their play*	Stories are read	Equipment and activities encourage fine motor skills	Tikanga Mäori &/or te reo Mäori evident
Staff model & encourage children to use positive approaches to behaviour	Evidence of children's artwork & creativity	Equipment & activities encourage gross motor skills	Recognition of children's cultures
	Children work on maths/science problems themselves		

Only the aspects of quality shown in italics in Table 4 are reported in detail. One-way ANOVAs for the other aspects showed that there were no significant associations, and these results are not provided in this report.

Generally, the associations found applied to all income and maternal qualifications groups in the same way. Including family income or maternal qualifications in the ANOVA models did dilute some of the associations found, indicating some overlap between family resources and ECE quality. Parents with good incomes or with high qualification levels may be able to choose ECE centres which offer higher quality, or it is likely that there is greater consistency for children of these families in their centre and home experiences. For example, only 14 percent of the students whose mothers had no qualification had attended an ECE centre that scored above the top quartile for staff responsiveness, compared with 39 percent of those whose mothers had university qualifications. Forty-nine percent of those whose homes had low income when they were aged near-5 attended ECE centres that scored below the bottom quartile for staff asking open-ended questions (that could encourage thought and language use), compared with 13 percent of those from high-income families.

The strength of the associations between the quality aspects and family income and maternal qualifications was generally not strong ($\tau < 0.18$).[10] This suggests that any associations found between aspects of ECE quality and competency levels are not simply reflecting differences in home resources, and the kinds of experience associated with those differences (e.g. more exposure to literacy-related activities where mothers have high qualification levels).

The associations at age 16 are weaker, on the whole, than they were at age 14. This is likely to be a result of attrition over the two years. As described above, those who left the study are more likely to have mothers with fewer qualifications, and to have come from families with a lower income at age 5, and the associations are calculated on the same variables at age 14 and 16 (age-5 measures, not new measures). At age 16 there were weak associations between maternal qualifications and staff responsiveness ($\tau = 0.18$) and staff joining children in their play ($\tau = 0.13$). Associations with family income were with staff model and encourage children to use positive approaches to behaviour ($\tau = 0.12$) and print-saturated environment ($\tau = 0.16$).

Specific patterns for the quality items which showed positive associations with competency levels at age 16 are discussed in detail below. On the whole, the patterns are consistent with patterns found for earlier ages. The associations at age 16 were less likely to be statistically significant than at age 14.

In this analysis I have grouped the students into four quartile groups for each quality measure, and compared the quartile groups' average scores, to see if higher levels of ECE centre quality are associated with higher competency scores. The categorisation into quartile groups is the same as that used in previous rounds of analysis, so group membership has not changed over time, but the proportion in each quartile group is likely to change slightly with attrition.

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[10] I used Kendall's Tau-*b* to measure the strength of associations. Kendall's Tau-*b* is a measure of association often used with but not limited to 2-way tables. It is computed as the excess of concordant over discordant pairs (*C* - *D*), divided by a term representing the geometric mean between the number of pairs not tied on *X* (X_0) and the number not tied on *Y* (Y_0):

$$\tau_b = \frac{C - D}{\sqrt{(C + D + X_0)(C + D + Y_0)}}.$$

The value of τ_b can be interpreted much like a correlation coefficient.

ECE staff were responsive to children

A centre that received the highest possible rating for this aspect of quality would have staff who responded quickly and directly to children, adapting their responses to individual children. They provided support, focused attention, physical proximity, and verbal encouragement as appropriate, were alert to signs of stress in children's behaviour, and guided children in expressing their emotions. A centre that had the lowest possible rating would have staff who ignored children's requests, and were oblivious to their needs.

At age 12, we found that mathematics, PAT reading comprehension, and logical problem-solving scores increased in line with increases in ECE centre scores for responsiveness to children. At age 14, we found that students whose centre had scored above the median tended to have higher average scores for PAT reading comprehension, logical problem-solving, writing, curiosity, communication, and the *cognitive composite* competency. Mathematics no longer showed a statistically significant association, although the mean scores followed the same trend shown for the other competencies. At age 16, I found statistically significant differences for *literacy*, *cognitive composite*, and *social skills*, and indicative differences for *numeracy*, *logical problem-solving*, and *social difficulties*.

Table 5 ***ECE staff responsiveness to children and students' competencies at age 16***

ECE staff responsiveness → ***Age-16 competency ↓***	***1st quartile up to 3.5 (n = 58)****	***2nd quartile 3.5–3.9 (n = 84)***	***3rd quartile 4.0–4.32 (n = 45)***	***4th quartile 4.33+ (n = 59)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	5.72	*5.67*	6.08	***6.34***	0.031	3.6
Literacy	*6.44*	6.51	7.05	***7.37***	***0.002***	***6.0***
Logical problem-solving	5.18	*5.11*	5.67	***5.91***	0.026	3.7
Cognitive composite	5.78	*5.76*	6.27	***6.54***	***0.002***	***5.9***
Focused & responsible	6.73	*6.65*	7.06	***7.15***	0.230	1.9
Thinking & learning	6.30	*6.06*	***6.69***	6.44	0.137	2.4
Social skills	6.18	*5.90*	***6.74***	6.47	***0.009***	***5.0***
Social difficulties	*5.70*	5.84	6.64	***6.70***	0.028	4.0
Attitudinal composite	6.40	*6.20*	***6.83***	6.69	0.065	3.2

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 54, 76, 42, 56, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

\# Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

There were statistically significant differences in *literacy* and the *cognitive composite* at age 16 between those whose ECE centre was in the highest quartile group and those in the bottom two quartile groups, and in *social skills* between those whose ECE centre was in the second quartile group and those in the third quartile group.

Once age-5 early literacy scores, maternal qualifications, age-5 family income, gender, and ethnicity were added to the model for *literacy* and the *cognitive composite* score, staff responsiveness was no longer significant (*p* of 0.20 and 0.22, respectively, see Table 24 and Table 25 in the appendix). The differences for *social skills* remained statistically significant, as is shown in Table 6.

Table 6 ***ECE responsiveness to children, students' social skills at age 5 and 16, and social characteristics***

	Social skills	
Model fitted	***p-value****	***R^2 or η_p^2 #***
Staff responsiveness (SR) only	0.009	5.3
SR & age-5 social skills		6.6
SR	0.006	5.7
Age-5 social skills	0.004	3.8
SR & age-5 social skills & maternal quals		11.3
SR	0.009	5.5
Age-5 social skills	0.023	2.8
Maternal qualification	0.004	7.2
SR & age-5 social skills & maternal quals & age-5 family income		16.3
SR	0.010	5.5
Age-5 social skills	0.071	1.6
Gender	0.0002	6.9
Maternal qualifications	0.003	7.9
Age-5 family income	0.605	1.3

* Associated with the *F*-statistic for the variable as if fitted last to the model (type III sum of squares).

\# Adjusted R^2 value (adjusted for the number of parameters fitted) for full model; η_p^2 value for each variable in the model. Both expressed as a percentage.

At age 16 there were still indications of slight advantages to children attending an ECE centre with staff who were responsive to children, both in cognitive competencies (although this effect did not remain once the corresponding age-5 competency, maternal qualifications, and age-5 family income were taken into account) and *social skills*. How an individual interacts with other people has wide-ranging effects on what that person is able to achieve in life. Poor interpersonal skills can affect an individual's attitude and motivation, which in turn can affect their learning (cognitive skills) while in the education system, and eventually their path through life. The evidence from this study is that ECE where the educators are highly responsive to children can have an impact on the children's social skills that is still detectable 11 years later.

Staff guide children in activities

A centre that had a low score for this aspect of quality would have left children to choose all their own activities. Staff at top-scoring centres would have moved among the children to encourage involvement with materials and activities, and interacted with children by asking questions and offering suggestions. They would have offered active guidance and encouragement in activities that were appropriate for individual children.

This aspect of quality was also related to a wider range of the study participants' age-14 competency levels than their age-12 levels. At age 12, there was a significant association with mathematics, and indicative associations with the PAT reading comprehension test and perseverance. At age 14, there were significant associations with four of the attitudinal competencies and the writing score, and indicative associations with all the other competencies bar social skills with peers.

By age 16, this aspect of quality showed no significant associations with any of the competencies, but did show indicative associations with *numeracy*, *composite cognitive*, *focused & responsible*, and *social skills*.

Table 7 ***ECE staff guide children in activities and students' competencies at age 16***

ECE staff guide children → ***Age-16 competency ↓***	***1st quartile up to 3.4 (n = 68)****	***2nd quartile 3.4–3.66 (n = 57)***	***3rd quartile 3.67–4.2 (n = 67)***	***4th quartile 4.2+ (n = 54)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	5.70	*5.69*	5.87	***6.48***	0.014	4.3
Literacy	6.57	*6.47*	***7.10***	7.05	0.052	3.1
Logical problem-solving	*5.18*	5.40	5.29	***5.91***	0.118	2.4
Cognitive composite	*5.82*	5.85	6.09	***6.48***	0.036	3.5
Focused & responsible	*6.39*	6.92	***7.12***	7.09	0.036	3.7
Thinking & learning	*6.08*	6.29	***6.49***	6.47	0.404	1.3
Social skills	*5.83*	6.27	6.48	***6.49***	0.036	3.7
Social difficulties	*5.65*	6.02	6.41	***6.61***	0.098	2.8
Attitudinal composite	*6.10*	6.49	***6.69***	6.68	0.064	3.2

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 62, 51, 61, 54, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

\# Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

For *numeracy*, there was a significant contrast between the highest quartile group and the two lowest quartile groups, and an indicative contrast between the two highest groups; for the *cognitive composite* there was a significant difference between the lowest and highest quartile groups, and an indicative difference between the second-lowest and highest groups; for *focused & responsible* there was a significant contrast between the lowest

and second-highest quartile groups and an indicative contrast between the lowest and highest groups, and for *social skills* there was an indicative difference between the lowest quartile group and each of the two highest quartile groups.

At age 14 we reported on the consistency of results for mathematics between age 8 and age 14. Up to age 14, we reported results at earlier ages for all the students in the sample at each stage (so that the sample size for the age-8 results was greater than that for the age-14 results, and so on). This time I report the results *for the age-16 sample* only (so that the sample sizes for all results are approximately equal). We have established that those who withdrew from the study before age 12 were not markedly different to those who remained in the study (Wylie, Thompson, et al, 2004), but this was not necessarily true of those who withdrew later, particularly not those who withdrew between ages 14 and 16 (Hodgen, 2006). Those who withdrew between the ages of 12 and 16 tended to have mothers with lower levels of qualifications, to come from lower-income homes, and to have had lower cognitive and attitudinal scores from about age 10. Using the same sample at all ages allows more meaningful comparisons across ages.

At age 16, as in earlier rounds of data collection, the difference in achievement score for this ECE quality variable is most marked between those attending an ECE centre with a score above the third quartile, and those attending other centres. I therefore report the mean scores for those at centres rated above the third quartile and others[11], the results of the full ANOVA using all four quartile groups, and the difference between the highest and lowest means of the four quartile groups, and the difference between the two means tabulated (Table 8).

Table 8 ***Means for mathematics/numeracy measures at ages 5–16 by quartile groups of ECE staff guidance of children***

	ECE staff guided children in context of activities					
Mathematics/ numeracy	***Up to 4.2 (n = 192)***	***4.2+ (n = 54)***	***Prob. of F-value from ANOVA***	***Percent of variance acct. for***	***Difference between highest and lowest quartile groups***	***Difference between highest and other 3 quartile groups***
Age 5	5.07	5.33	0.65	0.7	0.45	0.26
Age 6	7.64	8.05	0.43	1.1	0.45	0.41
Age 8	6.29	6.97	0.17	2.1	0.78	0.69
Age 10	***6.10***	***7.25***	***0.003***	***5.7***	1.49	1.15
Age 12	4.99	6.04	0.02	4.0	1.20	1.05
Age 14	6.54	7.56	0.04	3.4	1.45	1.02
Age 16	5.76	6.48	0.014	4.3	0.79	0.72

Looked at in isolation (not including age-5 numeracy nor social characteristics), there is a similar effect at age 16 to that shown at ages 8–14.

[11] The scores for ages 5 to 14 have been converted to a similar 0–10 scale to that used for age-16 scores.

When the relevant age-5 competency and the social characteristics were added to the models there was still an indicative effect for *mathematics/numeracy* (Table 9 below; Table 26 and Table 27 in the appendix for other results).

Table 9 ***ECE staff guide children, students' mathematics/numeracy at age 5 and 16, and social characteristics***

	Mathematics/Numeracy	
Model fitted	***p-value****	***R^2 or η_p^2 #***
Staff guidance only	0.014	4.5
Staff guidance & age-5 competency		31.8
Staff guidance	0.009	4.9
Age-5 competency	< 0.0001	42.7
Staff guidance & age-5 competency & maternal quals		36.7
Staff guidance	0.032	3.8
Age-5 competency	< 0.0001	34.4
Maternal qualifications	0.0002	9.7
Staff guidance & age-5 competency & maternal quals & age-5 family income		37.0
Staff guidance	0.035	3.8
Age-5 competency	< 0.0001	30.5
Maternal qualifications	0.014	5.6
Age-5 family income	0.283	2.2

* Associated with the *F*-statistic for the variable as if fitted last to the model (type III sum of squares).

Adjusted R^2 value (adjusted for the number of parameters fitted) for full model; η_p^2 value for each variable in the model. Both expressed as a percentage.

ECE staff ask open-ended questions

In a centre that had the highest possible score for this item, staff would often ask children open-ended questions, giving them opportunities to come up with a range of different answers, to encourage thinking and creativity. The lowest possible score was for centres where no open-ended questions were heard during the three periods of the study's observations.

At earlier ages, we found that children whose final ECE centre scored below the lowest quartile for staff asking open-ended questions had lower average scores for PAT reading comprehension than others, and that up to age 10, those whose final ECE centre scored below the median for this item had lower scores for mathematics than others.

The association with PAT reading comprehension remained significant at age 14. There was a significant association with writing, and some indicative associations with some of the attitudinal competencies. At age 16 the only significant association was with *social difficulties*.

Table 10 ***ECE staff ask children open-ended questions and students' competencies at age 16***

ECE staff ask open-ended questions → ***Age-16 competency ↓***	***1st quartile up to 3.0 (n = 83)****	***2nd quartile 3.01–3.33 (n = 45)***	***3rd quartile 3.34–4.0 (n = 94)***	***4th quartile 4.0+ (n = 24)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	5.77	*5.68*	***6.12***	6.06	0.288	1.5
Literacy	*6.53*	6.68	6.92	***7.47***	0.055	3.1
Logical problem-solving	*5.18*	5.36	5.53	***5.92***	0.260	1.6
Cognitive composite	*5.83*	5.91	6.19	***6.49***	0.11	2.5
Focused & responsible	*6.55*	6.84	***7.11***	7.06	0.137	2.4
Thinking & learning	*6.13*	6.21	6.43	***6.77***	0.257	1.8
Social skills	*5.98*	6.27	6.38	***6.70***	0.117	2.6
Social difficulties	*5.54*	5.97	***6.76***	6.29	***0.006***	***5.5***
Attitudinal composite	*6.22*	6.44	6.64	***6.84***	0.143	2.4

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 76, 41, 88, 23, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

The significant contrast in *social difficulties* was between the lowest and second-highest quartile group.

The association between *social difficulties* and ECE staff asking children open-ended questions remained statistically significant after age-5 attitudinal composite and social characteristics were added to the model (see Table 11 and Table 28 and Table 29 in the appendix for the other competencies).

Table 11 ***ECE staff asked children open-ended questions, students' social difficulties at age 5 and 16, and social characteristics***

	Social difficulties	
Model fitted	***p-value****	***R^2 or η_p^2 #***
ECE staff asked children open-ended questions only	0.006	5.5
ECE staff asked children open-ended questions & age-5 competency		6.9
ECE staff asked children open-ended questions	0.008	5.5
Age-5 competency	0.009	3.2
ECE staff asked children open-ended questions & age-5 competency & maternal quals		12.4
ECE staff asked children open-ended questions	0.006	5.8
Age-5 competency	0.029	2.2
Maternal qualifications	0.002	8.2
ECE staff asked children open-ended questions, age-5 competency, gender, maternal quals, & age-5 family income		18.3
ECE staff asked children open-ended questions	0.013	5.2
Age-5 competency	0.063	1.6
Gender	< 0.0001	9.0
Maternal qualifications	0.0006	9.7
Age-5 family income	0.802	0.8

* Associated with the *F*-statistic for the variable as if fitted last to the model (type III sum of squares).

Adjusted R^2 value (adjusted for the number of parameters fitted) for full model; η_p^2 value for each variable in the model. Both expressed as a percentage.

ECE staff joined children in their play

An ECE centre whose staff frequently joined in children's activities, offered materials or information or encouragement to facilitate play and learning around a particular theme would receive the highest rating possible for this quality item. A centre whose staff only monitored children's play but did not join in it at all would receive the lowest possible rating.

At ages 8, 10, and 12 we found associations with *mathematics*; and at age 10, with *reading comprehension*. Those whose final ECE centre scored above the top quartile for this aspect of quality had higher average scores than others.

At age 14, we found significant associations with *mathematics*, *writing*, *logical problem-solving*, and *self-management*, and indicative associations with *perseverance* and *PAT reading comprehension*. The same pattern was evident: those who had attended an ECE centre with a rating for staff joining children in their play that was above the top quartile (rating at least 4, on average) achieved higher average scores. Those whose ECE centre rated in the lowest quartile group for this quality aspect had somewhat higher scores for some competencies than those whose ECE centre rated in the second or third quartile groups, indicating that there were no real differences

between those rating about 3 on average (the bottom three quartile groups). The main differences were between students whose ECE centres rated above the highest quartile and those who scored below.

At age 16 there were statistically significant associations with *literacy*, *logical problem-solving*, *cognitive composite*, and indicative associations with *numeracy*.

Table 12 ***ECE staff joined children in their play and students' competencies at age 16***

ECE staff joined children in their play → ***Age-16 competency ↓***	***1st quartile up to 3.0 (n = 79)****	***2nd quartile 3.01–3.33 (n = 40)***	***3rd quartile 3.34–4.0 (n = 73)***	***4th quartile 4.0+ (n = 54)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	5.84	*5.72*	5.71	***6.45***	0.026	3.8
Literacy	6.81	*6.40*	6.57	***7.38***	***0.009***	***4.7***
Logical problem-solving	5.35	*5.00*	5.16	***6.19***	***0.002***	***5.9***
Cognitive composite	6.00	*5.71*	5.81	***6.67***	***0.001***	***6.5***
Focused & responsible	6.87	*6.53*	6.80	***7.19***	0.250	1.8
Thinking & learning	6.42	*6.07*	6.20	***6.53***	0.407	1.3
Social skills	6.19	*6.10*	6.30	***6.42***	0.717	0.06
Social difficulties	6.22	*5.49*	6.17	***6.55***	0.174	2.2
Attitudinal composite	6.49	*6.23*	6.43	***6.71***	0.429	1.2

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 71, 37, 67, 53, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

\# Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

For *literacy*, the contrasts that were significant were between the highest quartile group and each of the middle two groups, and for *logical problem-solving* and the *cognitive composite* the contrasts that were significant were between the highest quartile group and each of the other three groups.

Over the years, the trend for *mathematics/numeracy* has been consistent, although the differences at age 16 were more of the same order of size that they were at age 6 than they were at ages 8–14 (Table 13).

Table 13 ***Means for mathematics/numeracy measures at ages 5–16 by quartile groups of ECE staff joined children in their play***

	ECE staff joined children in their play					
Mathematics/ numeracy	***Up to 4.0 (n = 192)***	***4.0+ (n = 54)***	***Prob. of F-value from ANOVA***	***Percent of variance acct. for***	***Difference between highest and lowest quartile groups***	***Difference between highest and other 3 quartile groups***
Age 5	4.99	5.61	0.163	2.1	0.87	0.62
Age 6	7.61	8.15	0.025	3.8	0.75	0.54
Age 8	6.25	7.08	0.039	3.4	1.10	0.83
Age 10	***6.11***	***7.23***	***0.006***	***5.0***	1.49	1.12
Age 12	***4.96***	***6.15***	***0.006***	***5.0***	1.51	1.19
Age 14	***6.55***	***7.55***	***0.002***	***6.2***	1.54	1.00
Age 16	5.77	6.45	0.026	3.8	0.73	0.68

For *logical problem-solving*, though, the trend has remained relatively consistent between ages 10 and 16 (Table 14).

Table 14 ***Means for logical problem-solving measures at ages 5–16 by quartile groups of ECE staff joined children in their play***

	ECE staff joined children in their play					
Logical problem-solving	***Up to 4.0 (n = 192)***	***4.0+ (n = 54)***	***Prob. of F-value from ANOVA***	***Percent of variance acct. for***	***Difference between highest and lowest quartile groups***	***Difference between highest and other 3 quartile groups***
Age 5	6.30	6.72	0.36	1.3	0.71	0.42
Age 6	5.35	5.94	0.039	3.4	0.88	0.59
Age 8	4.74	5.17	0.071	2.9	0.72	0.43
Age 10	6.08	6.57	0.045	3.3	0.64	0.49
Age 12	***6.92***	***7.59***	***< 0.0001***	***9.9***	1.08	0.67
Age 14	7.62	8.13	0.012	4.5	0.64	0.51
Age 16*	***7.93***	***8.45***	***0.002***	***5.9***	0.67	0.52

* Untransformed scores, for greater comparability. Those in Table 12 have been transformed to meet the normality assumption for model fitting.

Once the age-5 competency and social characteristics were added, there was still an indicative effect for *logical problem-solving* and the *composite cognitive* competency (Table 15; for full results see Table 30 and Table 31 in the appendix).

Table 15 ***ECE staff joined children in their play, students' competencies at age 5 and 16, and social characteristics***

	Logical problem-solving		***Cognitive composite***	
Model fitted	***p-value****	***R^2 or $\eta_p^{2\#}$***	***p-value****	***R^2 or η_p^2***
Staff joined only	0.002	6.3	0.001	6.9
Staff joined & age-5 competency		19.9		41.0
Staff joined	0.007	5.2	0.060	5.0
Age-5 competency	< 0.0001	20.0	< 0.0001	61.5
Staff joined & age-5 competency & maternal quals		30.0		48.3
Staff joined	0.047	3.4	0.058	3.3
Age-5 competency	< 0.0001	17.4	< 0.0001	52.0
Maternal qualifications	< 0.0001	16.1	< 0.0001	16.1
Staff joined & age-5 competency & maternal quals & age-5 family income		31.0		48.9
Staff joined	0.026	4.1	0.049	3.5
Age-5 competency	< 0.0001	16.3	< 0.0001	46.8
Maternal qualifications	0.0005	9.1	0.0001	10.5
Age-5 family income	0.096	3.5	0.168	2.9

* Associated with the *F*-statistic for the variable as if fitted last to the model (type III sum of squares).

Adjusted R^2 value (adjusted for the number of parameters fitted) for full model; η_p^2 value for each variable in the model. Both expressed as a percentage.

The staff–child interaction measures—providing guidance, joining children in their play, asking open-ended questions, and being responsive to children—had correlations with each other of around 0.5 or 0.6. This means that a centre that had a high score on providing guidance, for example, was also likely to have a high score on the other items.

Correlations between the staff–child interaction items and the next item, offering a print-saturated environment, were lower, in the 0.2 to 0.3 range.

Provision of a print-saturated environment

An ECE centre that achieved the highest possible rating for this aspect of quality would be very print focused. It would encourage print awareness in children's activities, have a lot of printed material visible around the centre, at children's eye-level or just above, and offer children a range of readily accessible books. A centre that scored the lowest possible rating would have no print evident at all: no books, posters, or other forms of writing.

At age 12, we found that children whose final ECE centre had been in the bottom quartile group had lower average scores for most of the cognitive competencies. At age 14, this pattern continued for the PAT reading comprehension scores, with differences of around 12–15 percentage points compared to the three other quartile groups. Including family income or maternal qualifications reduced the size of these differences by a third to a half.

The effect of attending an ECE centre that had low levels of print awareness and use has persisted over time up to, but not really beyond, age 14. At age 16 there were statistically significant associations for *logical problem-solving*, *cognitive composite*, and *social difficulties*, and indicative associations for *literacy*.

Table 16 ***ECE centre was a print-saturated environment and students' competencies at age 16***

ECE centre was a print-saturated environment → ***Age-16 competency ↓***	***1st quartile up to 3.0 (n = 65)****	***2nd quartile 3.01–3.66 (n = 64)***	***3rd quartile 3.67–4.0 (n = 85)***	***4th quartile 4.0+ (n = 32)***	***Prob. of F-value from ANOVA***	***Percent of variance accounted for (R^2)#***
Numeracy	*5.65*	***6.30***	5.80	6.00	0.075	2.8
Literacy	*6.36*	***7.25***	6.79	6.80	0.017	4.1
Logical problem-solving	*5.03*	***6.10***	5.22	5.36	***0.003***	***5.7***
Cognitive composite	*5.68*	***6.55***	5.94	6.05	***0.003***	***5.6***
Focused & responsible	*6.59*	***7.32***	6.72	6.92	0.053	3.4
Thinking & learning	*6.07*	***6.68***	6.20	6.46	0.109	2.7
Social skills	*6.09*	***6.60***	6.15	6.21	0.177	2.2
Social difficulties	*5.47*	***7.07***	6.08	6.00	***0.001***	***7.0***
Attitudinal composite	*6.25*	***6.87***	6.36	6.53	0.071	3.1

* The number of observations quoted at the top of the table applies for the cognitive competencies. The corresponding numbers for the attitudinal competencies are: 60, 59, 78, 31, respectively (the students still at school). Note that we do not have competency measures for all competencies, so the actual sample sizes when fitting the model were one or two fewer for some subgroups.

\# Unadjusted R^2, expressed as a percentage.

The scores shown are means, where the scores are on 1–10 scales. The scores for *literacy*, *logical problem-solving,* and *social difficulties* have been transformed (Hodgen, 2006) to be more normally distributed.

The highest mean scores for each competency are in ***bold*** type, the lowest in *italics*.

The *p*-values and R^2 values of competencies where there were statistically significant differences are in ***bold*** type.

Once the corresponding age-5 competency and social characteristics had been added to the model, none of the effects attributed to the ECE being a print-saturated environment remained statistically significant (see Table 32 and Table 33 in the appendix). There was an indicative association for *social difficulties* (Table 17).

Table 17 ***ECE was a print-saturated environment, students' social difficulties at age 5 and 16, and social characteristics***

	Social difficulties	
Model fitted	***p-value****	***R^2 or η_p^2 #***
ECE print-saturated environment only	0.001	7.0
ECE print-saturated environment & age-5 competency		8.3
ECE print-saturated environment	0.002	7.1
Age-5 competency	0.008	3.2
ECE print-saturated environment & age-5 competency & maternal quals		11.4
ECE print-saturated environment	0.020	4.6
Age-5 competency	0.024	2.4
Maternal qualifications	0.021	5.4
ECE print-saturated environment, age-5 competency, gender, maternal quals, & age-5 family income		17.2
ECE print-saturated environment	0.044	3.9
Age-5 competency	0.063	1.6
Gender	< 0.0001	8.7
Maternal qualifications	0.007	6.9
Age-5 family income	0.744	0.9

* Associated with the *F*-statistic for the variable as if fitted last to the model (type III sum of squares).

\# Adjusted R^2 value (adjusted for the number of parameters fitted) for full model; η_p^2 value for each variable in the model. Both expressed as a percentage.

Other ECE quality measures

None of the other quality measures showed statistically significant associations with any of the competencies in a series of one-way ANOVA tests.

ECE measures and retention

Twenty-seven of the young people had left secondary education by the age of 16. Were there any associations between their early childhood education and leaving school early? I found a weak association between the socio-economic mix of the ECE centre and leaving school early. However, in a logistic regression model that included maternal qualifications, family income, and the young person's age-14 motivation cluster (their view of the value of education) as well as the centre socio-economic mix, the centre socio-economic mix was not quite significant at the 5 percent level.

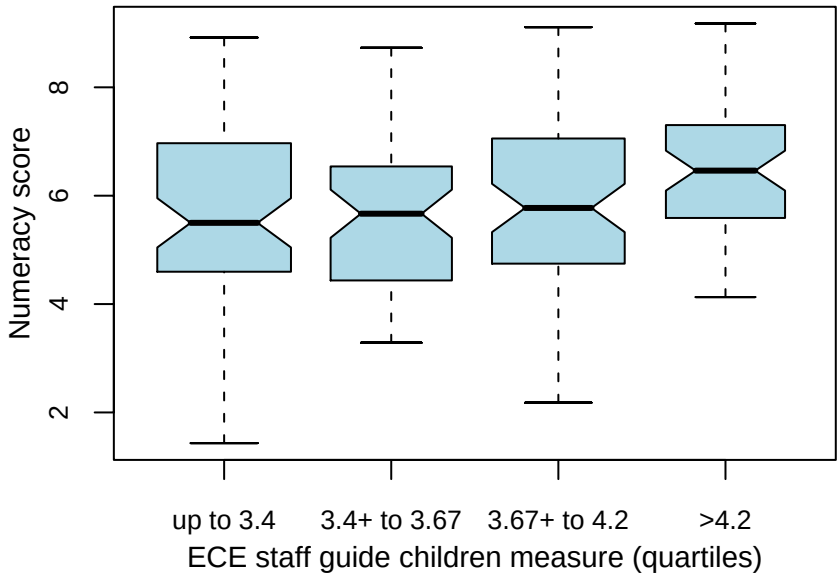
In other words, on our very small, and somewhat diverse sample of school-leavers, it was not possible to detect any ECE quality measures that were demonstrably protective, or promoted retention in secondary education. The decision to leave school appeared to be more influenced by the current situation: the young person's family and personal circumstances (family socio-economic status, and/or personal circumstances such as pregnancy) and views of and value placed on education.

5. Significance or importance?

I have demonstrated some statistically significant effects. Are they important? Or are they so slight as to be irrelevant? The size of the effects (where they are still significant) is similar across the competencies and ECE measures. The ECE measures accounted for between 3.5 and 5.5 percent of the variability in the competency measures, which can be regarded as medium or moderate effects. I look at a single example to answer this question of the importance of the effects, as the answer applies to all significant effects found.

ECE staff guiding children in their activities was shown to have an indicative effect on age-16 *numeracy* scores. This quality measure has shown an effect of the same order of size on mathematics scores between ages 10 and 16. Figure 1 shows a plot of the mean *numeracy* score for the four quartile groups, and it is clear from the graph that the largest difference is between the fourth (highest) quartile group and the other three (see also Table 7). It is also clear that while there are differences in the average scores across the groups, the highest and upper and lower quartile scores in each group do not differ by much.

Figure 1 ***Numeracy scores at age 16 for differing levels of ECE staff guidance of children in their activities***



Ignoring the age-5 competency and social characteristics, the difference in mean score between the lowest- and highest-scoring quartile group is 0.79, which is equivalent to 7.9 percent (Table 8). This sounds an impressive difference, but it needs to be interpreted in terms of the variability of the data. The standard deviation of the *numeracy* score for those in the original sample is 1.47 (on the 0–10 scale) so the difference is just over half a standard deviation (0.53 of a standard deviation). This difference is more or less equivalent to the Cohen's *d* effect

size[12], and a confidence interval for this effect size is between 0.35 and 0.72 (Cumming & Finch, 2001). Using Cohen's guidelines for effect sizes (Cohen, 1988) that an effect size of 0.2 is small, one of 0.5 is medium, and one of 0.8 is large, this would correspond to a moderate or medium effect.

Controlling for the age-5 competency and social characteristics, the effect size is slightly reduced. The greatest difference is 0.64, which corresponds to an approximate Cohen's *d* of 0.43, a small to moderate effect.

Looked at slightly differently, from Table 9, using the η_p^2 measures, early number knowledge accounts for most of the variability in *numeracy* scores (30.5 percent), followed by maternal qualifications (5.6 percent), staff guiding children in their activities (3.8 percent), and age-5 family income (2.2 percent). Or, the age-5 score accounts for about eight times as much as staff guidance, and maternal qualifications for about 1.5 times as much.

It would seem that, while smaller than the effect of maternal qualifications, there is still a residual effect of some aspects of ECE experience that have a non-negligible effect on achievement at age 16.

[12] Cohen's *d* is more correctly applied to a 2-group situation, with typically one of the groups being a "control". Here there is a 4-group situation in which the most extreme groups are compared. Our effect size may be an overestimate.

6. Summary

At age 16 there are indications that some of the aspects of ECE centre quality (but not quantity—age of starting ECE and length of ECE experience—nor, with the exception of *social difficulties*, socioeconomic mix of the centre) are having an impact over and above that of the equivalent age-5 competency, gender, maternal qualifications, and age-5 family income.

For *numeracy*, just under 30 percent of the variation in the age-16 score was accounted for by the age-5 early numeracy score[13], a further 10 percent was accounted for by maternal qualifications (ignoring family income, which did not add significantly to the model). In addition, ECE staff guiding the children accounted for just under 4 percent of the variability in the score. Other aspects of ECE experience that had an apparent effect in the one-way ANOVAS but were no longer significant once the age-5 score and social characteristics were added to the model were: length of ECE experience; ECE centre socioeconomic mix; ECE staff responsiveness to children; and joining children in their play.

For *literacy*, about 9 percent of the variation in the age-16 score was accounted for by the age-5 early literacy score, a further 10 percent by maternal qualifications (ignoring family income, which did not add significantly to the model), and about 5 percent by the young person's gender. In analysis at earlier ages, we found associations between literacy (PAT reading comprehension) and ECE centre socioeconomic mix, ECE staff asking open-ended questions, ECE staff guide children in activities (indicative, not significant), and ECE centre was print-saturated (indicative) in models that included early literacy and one of the social characteristics. By age 16 there were no statistically significant associations between ECE measures and *literacy*, once the age-5 score and social characteristics had been included in the model. The ECE measures that were statistically significant in the one-way ANOVA models were: starting age; ECE centre socioeconomic mix; staff being responsive to children; staff joining children in their play; and the ECE centre being a print-saturated environment.

For *logical problem-solving*, about 16 percent of the variability in the score was accounted for by the age-5 logical reasoning score, about 9 percent by maternal qualifications, and 3 percent by age-5 family income. The only association with an ECE measure that remained indicative was that for ECE staff joining children in their play (accounting for 4 percent of the variability in the score).

For *cognitive composite*, about 50 percent of the variability in the age-16 score was accounted for by the age-5 score, and a further 16 percent by maternal qualifications (ignoring family income, which did not add significantly to the model). When ECE staff joined children in their play was added to the model, there was an indicative effect (accounting for just under 4 percent of the variability in the score). The other associations that were significant or indicative in the one-way ANOVAS (starting age, length of ECE experience, ECE centre socioeconomic mix,

[13] These percentages are the effect sizes, which approximate the percentage of variation accounted for.

ECE staff responsiveness to children, ECE staff guide children, ECE centre was a print-saturated environment) were not significant in the model including the age-5 score and social characteristics.

The variability in *social skills* was accounted for by maternal qualifications (accounting for 7 percent of the variability in the score), gender (about 6 percent), and age-5 attitudinal composite (2 percent). ECE staff responsiveness to children had a significant effect (5 percent) in a model including maternal qualification and age-5 score.

For *social difficulties*, 8 or 9 percent of the variability was accounted for by the young person's gender, about 7 percent of the variability was accounted for by maternal qualifications, and about 3 percent by age-5 attitudinal composite. ECE staff ask open-ended questions remained statistically significant when fitted after the age-5 competency and social characteristics, and accounted for about 5 percent of the variability in the score. However, the highest group score was for the third quartile group, not the fourth (both had quality scores of at least 4 on average). The socioeconomic mix of the ECE centre also remained statistically significant when the age-5 competency and social characteristics were added to the model, and accounted for about 7 percent of the variability in the score. The ECE centre being a print-saturated environment remained indicative once the age-5 score and social characteristics were added to the model, accounting for 4 percent of the variability in the score.

Focused & responsible and *thinking & learning* did not show any marked relationships with any of the ECE measures, once the age-5 competency and social characteristics were included in the model.

Overall, high quality ECE can have a positive, long-lasting effect on a range of both cognitive (mainly *numeracy* and *logical problem-solving*) and attitudinal (mainly their social abilities, both positive and negative) competencies, traces of which are still discernible at age 16. High-quality ECE can both boost achievement, long term, and can afford a measure of protection for at-risk children, indicated by the reduction in *social difficulties* for children attending ECE centres with children from mainly middle-class families, centres that were print-saturated, and/or where the staff asked open-ended questions. This protection may come from the peer group that the young people became part of, and may be from a boost to their self-confidence/self-belief and self-image provided by the staff at the centres as they were encouraged to use more varied language, think laterally, and explore ideas.

References

Bowles, S. & Gintis, H. (1976). *Schooling in Capitalist America*. New York: Basic.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cumming, G., & Finch, S. (2001). A primer on the understanding, use, and calculation of confidence intervals that are based on central and noncentral distributions. *Educational and Psychological Measurement, 61*(4), 532–574.

Cunha, F., Heckman, J. J., Lochner, L., & Masterov, D. (2005). Interpreting the evidence on life cycle skill formation. *British Educational Research Journal, 30*(5), 713–730.

Heckman, J.J., Stixrud, J., & Urzua, S. (2004). Noncognitive skills, Working paper, University of Chicago.

Hodgen, E. (2006). *Competent Learners @ 16: Competency levels and development over time— Technical report*. Wellington: New Zealand Council for Educational Research.

NICHD ECCRN (Early Child Care Research Network), & Duncan, G. (2003). Modeling the impacts of child care quality on children's preschool cognitive development. *Child Development, 74*(5), 1454–1475.

R Development Core Team. (2006). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. Available at http://www.R-project.org

Thompson, B. (2002). What future quantitative social science research could look like: confidence intervals for effect sizes. *Educational Researcher, 31*, 25–32.

Wylie, C., Hodgen, E., Ferral, H., & Thompson, J. (2006). *Contributions of early childhood to age-14 performance*. Wellington: New Zealand Council for Educational Research.

Wylie, C., Thompson, J., Hodgen, E., Ferral, H., Lythe, C., & Fijn, T. (2004). *Competent children at 12*. Wellington: New Zealand Council for Educational Research.

Wylie, C., Thompson, J., & Kerslake Hendricks, A. (1996). *Competent children at 5—families and early education*. Wellington: New Zealand Council for Educational Research.

Appendix 1: Table of modelling results with age-5 scores and social characteristics

Table 18 ***Starting age at ECE, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Starting age	0.267	1.7	0.176	2.2	0.323	1.5	0.242	1.9
Age-5 competency	< 0.0001	29.0	< 0.0001	7.9	< 0.0001	15.9	< 0.0001	49.1
Ethnicity	0.807	0.2	0.540	0.6	–	–	0.882	0.1
Gender	–[#]	–	0.001	5.0	–	–	0.250	0.6
Maternal qualifications	0.030	4.8	0.003	7.5	0.0006	8.8	0.0002	10.4
Age-5 family income	0.48	1.5	0.399	1.8	0.208	2.6	0.333	2.1
Adjusted R^2		35.4		24.2		29.3		47.8

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 19 ***Starting age at ECE, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Starting age	0.591	0.9	0.357	1.5	0.441	1.3	0.936	0.2	0.365	1.5
Age-5 competency	0.203	0.8	0.025	2.4	0.103	1.3	0.073	1.5	0.073	1.5
Ethnicity	0.051	2.9	0.165	1.7	–[#]	–	–	–	0.123	2.0
Gender	< 0.0001	8.5	0.003	4.3	0.0003	6.3	< 0.0001	9.1	< 0.0001	7.5
Maternal qualifications	0.0003	10.7	0.013	6.2	0.001	8.8	0.0009	9.2	0.0007	9.5
Age-5 family income	0.313	2.3	0.130	3.4	0.399	1.9	0.697	1.0	0.257	2.5
Adjusted R^2		18.6		14.3		12.8		14.2		17.3

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 20 ***Total length of ECE, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Length of ECE	0.580	0.9	0.936	0.2	0.122	2.5	0.67	0.7
Age-5 competency	< 0.0001	27.3	< 0.0001	7.3	< 0.0001	15.4	< 0.0001	46.9
Ethnicity	0.732	0.3	0.607	0.4	–	–	0.862	0.1
Gender	–[#]	–	0.0009	5.0	–	–	0.223	0.7
Maternal qualifications	0.015	5.5	0.002	8.0	0.0004	9.2	< 0.0001	11.2
Age-5 family income	0.457	1.6	0.371	1.9	0.244	2.4	0.308	2.2
Adjusted R^2		34.8		22.6		30.0		47.2

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 21 ***Total length of ECE, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Length of ECE	0.942	0.2	0.636	0.8	0.882	0.3	0.641	0.8	0.811	0.5
Age-5 competency	0.211	0.7	0.024	2.4	0.112	1.2	0.089	1.4	0.076	1.5
Ethnicity	0.060	2.7	0.185	1.6	–[#]	–	–	–	0.140	1.9
Gender	< 0.0001	8.4	0.003	4.2	0.0004	6.2	< 0.0001	9.3	0.0001	7.4
Maternal qualifications	0.0006	9.7	0.027	5.3	0.002	8.0	0.0007	9.4	0.002	8.5
Age-5 family income	0.332	2.2	0.170	3.1	0.458	1.7	0.637	1.2	0.312	2.3
Adjusted R^2		18.0		13.6		11.9		14.7		16.4

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 22 ***ECE socioeconomic mix, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
ECE socioec. mix	0.235	1.9	0.231	2.0	0.109	2.7	0.346	1.5
Age-5 competency	< 0.0001	28.9	0.0005	5.7	< 0.0001	15.1	< 0.0001	43.6
Ethnicity	0.846	0.1	0.439	0.7	–	–	0.796	0.2
Gender	–[#]	–	0.0009	5.1	–	–	0.189	0.8
Maternal qualifications	0.029	4.8	0.005	6.9	0.0009	8.5	0.0003	10.1
Age-5 family income	0.702	1.0	0.651	1.1	0.550	1.3	0.605	1.2
Adjusted R^2		35.9		24.5		30.0		47.7

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 23 ***ECE socioeconomic mix, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
ECE socioec. mix	0.166	2.5	0.101	3.0	0.201	2.2	0.004	6.6	0.123	2.8
Age-5 competency	0.108	1.3	0.015	2.9	0.084	1.4	0.015	2.8	0.042	2.0
Ethnicity	0.052	2.9	0.198	1.6	–[#]	–	–	–	0.156	1.8
Gender	< 0.0001	8.3	0.005	3.9	0.0004	6.1	< 0.0001	8.9	0.0002	7.1
Maternal qualifications	0.003	7.9	0.062	4.4	0.005	7.3	0.002	8.1	0.006	7.1
Age-5 family income	0.481	1.7	0.328	2.2	0.650	1.2	0.772	0.9	0.525	1.5
Adjusted R^2		20.0		15.8		13.5		19.5		18.5

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 24 ***ECE staff responsiveness to children, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Staff responsive	0.359	1.4	0.180	2.2	0.300	1.6	0.219	2.0
Age-5 competency	< 0.0001	28.3	0.0004	5.8	< 0.0001	16.8	< 0.0001	46.7
Ethnicity	0.641	0.4	0.568	0.5	–	–	0.817	0.2
Gender	–[#]	–	0.0008	5.2	–	–	0.215	0.7
Maternal qualifications	0.018	5.3	0.003	7.4	0.0004	9.4	0.0002	10.6
Age-5 family income	0.372	1.9	0.374	1.9	0.185	2.7	0.277	2.3
Adjusted R^2		35.2		24.1		29.3		47.8

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 25 ***ECE staff responsiveness to children, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Staff responsive	0.536	1.0	0.073	3.4	0.010	5.5	0.103	2.9	0.074	3.4
Age-5 competency	0.190	0.8	0.020	2.6	0.071	1.6	0.038	2.1	0.057	1.7
Ethnicity	0.069	2.6	0.187	1.6	–[#]	–	–	–	0.165	1.7
Gender	< 0.0001	8.6	0.002	4.7	0.0002	6.9	< 0.0001	8.9	< 0.0001	7.9
Maternal qualifications	0.0008	9.4	0.021	5.6	0.003	7.9	0.002	8.3	0.002	8.4
Age-5 family income	0.364	2.1	0.199	2.9	0.605	1.3	0.745	0.9	0.384	2.0
Adjusted R^2		18.7		15.8		16.3		16.5		18.7

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 26 ***ECE staff guide children in activities, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Staff guide children	0.032	3.8	0.142	2.5	0.468	1.1	0.252	1.8
Age-5 competency	< 0.0001	29.8	< 0.0001	7.5	< 0.0001	16.4	< 0.0001	48.2
Ethnicity	0.669	0.4	0.588	0.5	–	–	0.800	0.2
Gender	–[#]	–	0.004	3.8	–	–	0.322	0.4
Maternal qualifications	0.025	5.0	0.003	7.5	0.0001	10.5	0.0002	10.4
Age-5 family income	0.384	1.8	0.276	2.3	0.230	2.5	0.238	2.5
Adjusted R^2		36.7		24.3		29.0		47.8

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 27 ***ECE staff guide children in activities, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Staff guide children	0.081	3.2	0.779	0.5	0.176	2.4	0.292	1.8	0.201	2.2
Age-5 competency	0.149	1.0	0.026	2.4	0.073	1.5	0.040	2.0	0.056	1.8
Ethnicity	0.026	3.5	0.187	1.6	–[#]	–	–	–	0.099	2.2
Gender	0.0003	6.5	0.008	3.4	0.002	4.5	< 0.0001	8.0	0.0007	5.7
Maternal qualifications	0.0004	10.2	0.033	5.1	0.004	7.6	0.0009	9.2	0.002	8.3
Age-5 family income	0.307	2.3	0.163	3.1	0.474	1.7	0.768	0.9	0.299	2.3
Adjusted R^2		20.4		13.4		13.7		15.5		17.8

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 28 ***ECE staff ask open-ended questions, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Open-ended questions	0.252	1.8	0.613	0.8	0.710	0.6	0.662	0.7
Age-5 competency	< 0.0001	29.7	< 0.0001	7.1	< 0.0001	17.0	< 0.0001	48.2
Ethnicity	0.551	0.5	0.664	0.4	–	–	0.817	0.2
Gender	–[#]	–	0.001	4.7	–	–	0.247	0.6
Maternal qualifications	0.015	5.5	0.001	8.2	0.0001	10.6	< 0.0001	11.5
Age-5 family income	0.330	2.0	0.437	1.7	0.214	2.5	0.309	2.2
Adjusted R^2		35.4		23.1		28.6		47.2

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 29 ***ECE staff ask open-ended questions, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Open-ended questions	0.358	1.5	0.937	0.2	0.411	1.4	0.013	5.2	0.616	0.9
Age-5 competency	0.212	0.7	0.038	2.1	0.153	1.0	0.063	1.6	0.097	1.3
Ethnicity	0.071	2.6	0.236	1.4	–[#]	–	–	–	0.181	1.6
Gender	< 0.0001	8.0	0.005	3.9	0.0009	5.4	< 0.0001	9.0	0.0002	6.7
Maternal qualifications	0.0005	10.0	0.033	5.1	0.002	8.1	0.0006	9.7	0.002	8.4
Age-5 family income	0.353	2.1	0.171	3.1	0.500	1.6	0.802	0.8	0.332	2.2
Adjusted R^2		19.1		13.1		12.8		18.3		16.7

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 30 ***ECE staff join children in their play, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Join in play	0.487	1.1	0.071	3.2	0.026	4.1	0.047	3.6
Age-5 competency	< 0.0001	27.2	0.0002	6.5	< 0.0001	16.3	< 0.0001	45.9
Ethnicity	0.633	0.4	0.576	0.5	–	–	0.774	0.2
Gender	–	–	0.0004	5.8	–	–	0.206	0.7
Maternal qualifications	0.029	4.8	0.003	7.3	0.0005	9.1	0.0002	10.1
Age-5 family income	0.360	1.9	0.376	1.9	0.096	3.5	0.247	2.4
Adjusted R^2		35.0		24.9		31.0		48.7

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 31 ***ECE staff join children in their play, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Join in play	0.201	2.2	0.241	2.0	0.755	0.6	0.093	3.1	0.314	1.7
Age-5 competency	0.237	0.7	0.043	2.0	0.126	1.1	0.070	1.6	0.098	1.3
Ethnicity	0.065	2.6	0.235	1.4	–[#]	–	–	–	0.170	1.7
Gender	< 0.0001	9.0	0.002	4.8	0.0003	6.3	< 0.0001	10.3	< 0.0001	7.9
Maternal qualifications	0.0008	9.3	0.032	5.1	0.004	7.5	0.0009	9.2	0.003	8.0
Age-5 family income	0.248	2.6	0.093	3.8	0.382	2.0	0.685	1.1	0.204	2.9
Adjusted R^2		19.6		14.6		12.1		16.6		17.4

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).

[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 32 ***ECE was a print-saturated environment, students' cognitive competencies at age 5 and 16, and social characteristics***

	Numeracy		***Literacy***		***Logical problem-solving***		***Cognitive composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Print-saturated environment	0.601	0.8	0.561	0.9	0.089	2.9	0.521	1.0
Age-5 competency	< 0.0001	27.8	0.0002	6.4	< 0.0001	15.7	< 0.0001	45.0
Ethnicity	0.693	0.3	0.550	0.5	–	–	0.808	0.2
Gender	–	–	0.001	4.9	–	–	0.279	0.5
Maternal qualifications	0.018	5.3	0.004	7.0	0.0005	9.1	0.0003	10.0
Age-5 family income	0.304	2.1	0.450	1.7	0.146	3.0	0.259	2.4
Adjusted R^2		34.8		23.2		30.2		47.3

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).
[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).

Table 33 ***ECE was a print-saturated environment, students' attitudinal competencies at age 5 and 16, and social characteristics***

	Focused & responsible		***Thinking & learning***		***Social skills***		***Social difficulties***		***Attitudinal composite***	
Variables	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2	***p-value****	η_p^2
Print-saturated environment	0.523	1.1	0.519	1.1	0.523	1.1	0.044	3.9	0.523	1.1
Age-5 competency	0.202	0.8	0.026	2.4	0.078	1.5	0.063	1.6	0.078	1.5
Ethnicity	0.088	2.3	0.241	1.4	–[#]	–	–	–	0.207	1.5
Gender	< 0.0001	8.0	0.004	3.9	0.0002	7.0	< 0.0001	8.7	0.0002	7.0
Maternal qualifications	0.002	8.6	0.049	4.6	0.004	7.4	0.007	6.9	0.004	7.4
Age-5 family income	0.381	2.0	0.215	2.8	0.362	2.1	0.744	0.9	0.362	2.1
Adjusted R^2		18.7		13.9		16.9		17.2		16.9

* Associated with the *F*-statistic for the variable as if fitted last to the model (Type III sum of squares).
[#] Not included in the model, as known to have no significant effect (Hodgen, 2006).