

  


**MINISTRY OF EDUCATION**

*Te Tāhuhu o te Mātauranga*

New Zealand



**Contributions of early childhood education to  
age-14 performance**

**Evidence from the Competent Children,  
Competent Learners project**

**Cathy Wylie, Edith Hodgen, Hilary Ferral, and Jean Thompson**

**RESEARCH DIVISION**



**Wāhanga Mahi Rangahau**

**ISBN**                      **0-478-13408-8**

**Web Copy ISBN**        **0-478-13409-06**

© **Ministry of Education, New Zealand — 2006**

Research reports are also available on the Ministry's website: [www.minedu.govt.nz](http://www.minedu.govt.nz) under the Research heading.

Opinions expressed in this report are those of the authors and do not necessarily coincide with those of the Ministry of Education

*Contributions of early childhood education  
to age-14 performance*

**Evidence from the longitudinal Competent  
Children, Competent Learners study**

**Cathy Wylie, Edith Hodgen, Hilary Ferral, and Jean Thompson**



NEW ZEALAND COUNCIL FOR EDUCATIONAL RESEARCH  
TE RŪNANGA O AOTEAROA MŌ TE RANGAHAU I TE MĀTAURANGA  
WELLINGTON

2006

New Zealand Council for Educational Research  
P O Box 3237  
Wellington  
New Zealand

## **Acknowledgements**

We are very grateful for the continued involvement of the study's participants, their parents, and teachers. It has been an immense privilege to be able to follow this cohort as they grow through their experiences.

The value of longitudinal studies is becoming increasingly recognised, and we are grateful to the Ministry of Education for their continued funding and support, without which this project would have remained a wistful dream.

The fieldwork undertaken when the study participants were aged 14 took place from late 2002 to late 2003. What is a complex project all went smoothly thanks to Cathy Lythe and Tineke Fijn, who co-ordinated the fieldwork, and our very able fieldwork team: which consisted of Marion Bayne, Clare Falkner, Betty Irons, Joanne Leith, Patricia Meagher-Lundberg, Elizabeth Wagner, Marilyn Weir, Anna Wildey, Brigid Wikinson, and Kath Wood. The data entry and cleaning benefited from the keen eyes of Kim Lau, Denise Falloon and Melissa Anslow. We are also grateful to the high quality secretarial support of Christine Williams, and the copy editing of Shelley Carlyle.

The project advisory group has been very helpful in our instrument design, the issues we might encounter in fieldwork and analysis, and in their feedback on draft reports. We are grateful to Sharon Cox, Heleen Visser, and Lynne Whitney from the Research Division of the Ministry of Education, Sandie Aikin, Jude Allison, Dick Harker, Clive McGee, Anne Meade, and Robyn Baker. Our colleague Linda Mitchell also provided useful comment on our draft report.



# Contents

<b>ACKNOWLEDGEMENTS .....</b>	<b>i</b>
<b>EXECUTIVE SUMMARY .....</b>	<b>v</b>
<b>1. INTRODUCTION .....</b>	<b>1</b>
OVERVIEW OF RESEARCH.....	1
<i>Value of ECE in Relation to No ECE Experience.....</i>	<i>1</i>
<i>The Effects of Differences in ECE Experience.....</i>	<i>2</i>
THE COMPETENT CHILDREN, COMPETENT LEARNERS STUDY.....	4
<i>Previous Findings .....</i>	<i>6</i>
DOES AN ASSOCIATION WITH EARLY CHILDHOOD EDUCATION REMAIN VISIBLE AT AGE 14? .....	6
DESCRIPTION OF THE ANALYSIS AND RESULTS PRESENTED.....	7
<b>2. ECE EXPERIENCE AND COMPETENCIES AT AGE 14.....</b>	<b>9</b>
ECE FACTORS SHOWING NO ASSOCIATIONS.....	9
LENGTH OF ECE EXPERIENCE .....	10
<i>Starting Age .....</i>	<i>10</i>
<i>Length of ECE Experience.....</i>	<i>10</i>
EARLY CHILDHOOD EDUCATION CENTRE SOCIOECONOMIC MIX.....	12
EARLY CHILDHOOD EDUCATION QUALITY .....	13
<i>ECE Staff Were Responsive to Children.....</i>	<i>15</i>
<i>Staff Guide Children in Activities .....</i>	<i>16</i>
<i>ECE Staff Ask Children Open-Ended Questions.....</i>	<i>18</i>
<i>ECE Staff Joined Children in Their Play.....</i>	<i>19</i>
<i>Provision of a Print-Saturated Environment .....</i>	<i>20</i>
<i>Children Can Select Their Own Activities From a Variety of Learning Areas.....</i>	<i>21</i>
PROPORTION OF VARIANCE ACCOUNTED FOR IN AGE-14 SCORES.....	22
<b>3. DO ASPECTS OF ECE MAKE SEPARATE CONTRIBUTIONS TO COMPETENCIES AFTER AGE 5? .....</b>	<b>23</b>
<i>Mathematics.....</i>	<i>24</i>
<i>Reading Scores at 14 (PAT).....</i>	<i>27</i>
<i>Attitudinal Composite Competency at 14.....</i>	<i>30</i>
GENERAL PATTERNS .....	32
<b>4. DISCUSSION.....</b>	<b>35</b>
<b>REFERENCES .....</b>	<b>39</b>

**TABLES**

Table 1: Total Length of ECE and Students' Competencies at Age 14 .....	11
Table 2: ECE Socioeconomic Mix and Student Competencies at Age 14 .....	12
Table 3: ECE Process Quality Ratings Used in the Competent Children, Competent Learners Study.....	13
Table 4: ECE Staff Responsiveness to Children and Competency Scores at Age 14 .....	15
Table 5: ECE Staff Guide Children in Activities .....	16
Table 6: Mean Scores for the Mathematics Measures at Ages 5, 6, 8, 10, 12, and 14 by Quartile Groups of ECE Staff Guidance of Children .....	17
Table 7: ECE Staff Asked Children Open-Ended Questions and Age-14 Competencies .....	18
Table 8: ECE Staff Joined Children in Their Play and Age-14 Competencies .....	19
Table 9: Means for the Mathematics Measures at Ages 5, 6, 8, 10, 12, and 14 by Quartile Groups of ECE Staff Joined Children in Their Play.....	20
Table 10: Reading Comprehension Scores at Ages 5, 8, 10, 12, and 14 by Quartile Groups of ECE Was a Print-Saturated Environment.....	21
Table 11: Length of ECE Experience and Mathematics Scores.....	24
Table 12: Staff Guide Children in Activities and Mathematics Scores.....	25
Table 13: Staff Join Children in Their Play and Mathematics Scores.....	26
Table 14: ECE Centre Socioeconomic Mix and PAT Reading Scores .....	27
Table 15: ECE Staff Ask Open-Ended Questions and PAT Reading Scores.....	28
Table 16: ECE Staff Guide Children in Activities and PAT Reading Scores .....	29
Table 17: The Centre is a Print-Saturated Environment and PAT Reading Scores.....	29
Table 18: Length of ECE Experience and Attitudinal Composite Scores.....	30
Table 19: ECE Socioeconomic Mix and Attitudinal Composite Scores .....	31
Table 20: ECE Staff Guide Children in Their Activities and Attitudinal Composite Scores.....	31
Table 21: ECE Staff Ask Open-Ended Questions and Composite Attitudinal Scores .....	32



## Executive summary

This report adds to the research literature on the effects of early childhood education (ECE) by providing findings that show how differences in ECE experience are reflected in differences in performance at age 14, for the Competent Children, Competent Learners sample. In general, the difference between those who had the highest or most level of a particular aspect of ECE experience and others was around 9 percentage points (out of 100), which is a reasonable size difference.

Family resource factors (income and maternal qualification) make more of a difference, partially because they are continuing elements in a child's life as they move through school, but ECE experience continues to make a difference once these are taken into account. ECE experience appears to make most of its contribution by the time children start school, but a continuing contribution was still evident at age 14 after taking age-5 performance, family income, and maternal qualification into account.

The main findings:

- Children who started ECE between the ages of 1 and 2 had higher scores than those starting after age 3, and those who had less than 24 months' ECE experience had lower scores than others for attitudinal competencies (e.g. communication, perseverance, self-management).
- Five aspects of ECE quality had the most marked long-term effect. Children who had experienced high-quality in these aspects had higher scores for cognitive and attitudinal competencies than others. Most of these aspects were related to the interaction between ECE staff and children, which depends on staff knowledge as well as their approach.

These aspects of ECE quality were:

**Staff responsive to children**

higher scores for those whose final centre scored 4 or more on scale of 5

**Staff guide children in activities**

higher scores for those whose final centre scored 4.2 or more on scale of 5

**Staff ask children open-ended questions**

Increases with centre score

higher scores for those whose final centre scored 3.33 or more on scale of 5

**Staff join children in their play**

higher scores for those whose final centre scored 4 or more on scale of 5

**Children can select activities from a variety of learning areas**

higher scores for those whose final centre scored 5 out of 5 (attitudinal)

Children had lower scores if their final ECE service was lower in quality than others in terms of:

**Provision of “print-saturated” environment**

lower scores for those whose final centre scored less than 3 on scale of 5

- Children who attended an ECE service where most of the children were from middle-class families had higher mathematics and reading scores.
- There were no negative contributions to age-14 (or earlier) competency scores from attending two or more ECE services concurrently, or attending one that the parent thought had had some negative aspects for their child.

An overview of the current picture of research into the effects of early childhood education is given in the report to show how these findings are consistent with other studies. The consistency of findings points to the importance of providing high-quality staff:child interaction and a reasonable level of print-use in ECE services, in order to improve student performance and ensure that fewer children start school with low levels of performance. This is particularly important for services for children from low-income homes.



# 1. Introduction

The role of early childhood education (ECE) in children's lives, both at the time they participated in it, and later, has been a key focus for the Competent Children, Competent Learners study. At the time the study started in 1992 (with a pilot study), there were some overseas studies showing that ECE experience appeared to benefit children, with attention paid to structural aspects of quality provision such as adult:child ratios, group size, and staff qualifications, but no New Zealand study. Since this study began, more research into the contribution of ECE has also occurred, providing an increasingly robust understanding of the relationship between ECE experience and children's development, and the contextual and research aspects that can influence findings about that relationship. The Competent Children, Competent Learners study makes a useful contribution to this field of research because it is one of the few longitudinal studies to have followed its participants into adolescence.

## OVERVIEW OF RESEARCH

### Value of ECE in relation to no ECE experience

The long-term value of well-thought-out ECE intervention programmes has been shown into young adulthood for those from poor homes, with low parental education levels, in several US studies (Karoly & Bigelow, 2005; Ramey & Ramey, 2004), and for children from a range of income backgrounds (e.g. through the High/Scope programme emphasising "active learning", in the US (Schweinhart & Weikart, 1997), and Portugal (Nabuco, 1997, cited in Sylva, Sammons, Melhuish, Siraj-Blatchford, & Taggart, 1999). Other, more general, studies of "everyday" early childhood education show benefits for children's learning for those who attended ECE or particular ECE programmes in comparison to those who did not, over the years immediately following ECE. Recent studies include Bridges, Fuller, Rumberger, and Tran (2004), focusing on Californian early childhood education; Gormley, Gayer, Phillips, and Dawson (2005), focusing on Oklahoma school-provided early childhood education; Barnett, Lamy, and Jung (2005), for a sample of around 5000 from five US state-funded preschool programmes; Magnuson, Meyers, Ruhm, and Waldfogel (2004), analysing data from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999, following a nationally representative US sample; and the large and multifaceted English EPPE project (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004), with a sample of around 3000.

Generally, benefits for children from disadvantaged homes tend to be larger than for those from advantaged homes, and benefits found are more likely to be in cognitive than social or behavioural performance (though more studies have focused on cognitive performance than both aspects). Benefits tend to be larger if children have attended early childhood education regularly for more than a year. Boocock, Barnett, and Frede (2001) provide a succinct overview of international studies in both first and third world countries that compare the performance of children with and without ECE experience, and show benefits for those with early childhood education experience. Two studies looking at the longer-term contribution of ECE also show benefits for those whose (out of home) education began before compulsory schooling. Results for age-15 mathematics performance in the recent international PISA study showed that students who had attended ECE for at least a year scored 8 points higher on average than those who had not attended ECE, after taking socioeconomic background into account (OECD, 2004, p. 257). Goodman and Sianesi (2005), analysing data from the British National Child Development Survey (NCDS) that has followed all children born in a single week in March 1958, found higher average test scores at age 7, notably in mathematics, and, at a lower rate, ages 11 and 16. Teacher reports of attitudes and social skills were more favourable at age 7 for those who had had some pre-compulsory education, but parental reports of poor self-control were higher for this group; however, these patterns did not persist to ages 11 and 16.

## The effects of differences in ECE experience

Positive associations with length of ECE experience—generally, children who have attended ECE for longer than others show higher cognitive performance levels—have been reported from a number of longitudinal studies, including the Christchurch study (Fergusson, Horwood, and Lynskey, 1994), and in Swedish studies (Andersson, 1993; Broberg, Wessels, Lamb, & Hwang, 1997). The US research shows more mixed findings, as noted in the previous section, with some studies finding positive associations for length of ECE experience to be dependent on the quality of the ECE experience, or the school experience following it (Currie, 2000; Smith, A.B., Grima, G., Gaffney, M., Powell, K., Masse, L., & Barnett, S., 2000; pp. 30–37). Loeb, Bridges, Bassok, Fuller, & Rumberger (2005) in their analysis of ECE experience effects for 14,162 US children in their first year of school (called “kindergarten” in the US) found that those who had started ECE between the ages of 2 and 3 had higher pre-reading and mathematics scores; but that, on average, the earlier a child started ECE, the lower their social development scores (externalising behaviour, e.g. acting up, interpersonal skills, and self-control in the classroom). They also found higher cognitive scores for those whose ECE attendance in the year before they started school was more than 15 hours a week, but lower social scores, particularly for those attending for more than 30 hours a week. However, there were both cognitive and social skills benefits for children from lower-income homes from longer hours; it was the children from higher-income families whose scores were lower with longer hours in ECE.

Overseas studies have found that children attending higher-quality ECE services tend to have higher average cognitive skills than those attending services of lower quality. Quality has been measured by the observed quality of the programme, in terms of learning experiences and interactions between staff and children and between children (as in this report), and by structural, or “regulatable”, aspects such as adult:child ratios, group size, and teacher education. NICHD ECCRN and Duncan (2003) and Vandell (2004) provide succinct recent summaries. Much of the existing research is cross-sectional, looking at children’s performance while they are attending ECE, or follows children for a short time afterwards. The contribution of ECE to children’s performance has mostly been analysed in relation to social characteristics (e.g. family socioeconomic status, child gender, child ethnicity), rather than by comparison of current child performance with previous child performance, because until recently few studies have been longitudinal, and because of the relative lack of comparable assessments in early childhood, particularly before the age of 3.

Research findings relating to social or behavioural performance have been mixed (Love et al., 2003). Some small negative effects have been reported for children with extensive out of home care experience in terms of both length and long hours, usually more than 40. These findings are in Bridges et al. (2004), and in the large US NICHD Study of Early Child Care (SECC) (Vandell 2004). In terms of length of experience, Sylva et al. (2004) found in the EPPE study that at age 3 children who had attended nurseries (with an emphasis on care rather than education) before the age of 2 had slightly higher levels of antisocial behaviour, though they also found that if children with higher antisocial behaviour at age 3 attended a high-quality setting between ages 3 and 5, their antisocial behaviour decreased, and that generally, starting preschool between the age of 2 and 3 was beneficial for children’s social skills with peers.

It is useful to look at why these differences in findings exist. Love et al. (2003) provide findings from three settings with different mixes of quality (both structural—primarily staff:child ratio, group size, and staff qualifications, and process—related to staff-child and child-child interactions and kinds of learning experiences offered) and government regulations (e.g. maximums for group size or staff:child ratio). These settings, which were different from the NICHD-SECC study and from each other were Sydney in Australia, Haifa in Israel, and Headstart programmes in the USA).

In the Sydney study, social-emotional adjustment and teacher-child conflict were associated with stability of care: children who had experienced more changes in care arrangements (both formal and informal nonmaternal care) had lower teacher ratings for their social-emotional adjustment at age 6 than others. Formal care, in centres that had to meet regulations for employing qualified staff and for programmes, equipment, and space, was positively associated with higher ratings for competencies in learning (paying

attention and interest) in comparison with informal care in people's homes, where children who had longer hours of care had lower ratings for these competencies.

The Haifa study parallels the NICHD-SECC study, but does not have quite the same confounding of quality of care with socioeconomic status, because it includes public centres that include children from both middle- and low-income homes. These centres have very low caregiver:infant ratios of 1:8, and this ratio was found to be associated with a much higher proportion of insecure infants. The Head Start national evaluation also covers a different range of experience than the NICHD study, with children from low-income homes attending higher-quality programmes than their counterparts in the same community, or nationwide. This evaluation found positive associations with children's cognitive and social-emotional development and their Head Start experience, and no negative associations with large quantities of early childhood education (typically attending 30 hours a week or more, all year).

Love et al. (2003) suggest that the reason the associations found in these three studies between quality and children's social-emotional outcomes, in relation to length of care, were not apparent in the NICHD study was because of the smaller range of quality in the NICHD study centres.

Votruba-Drzal, Coley, and Chase-Lansdale's (2004) study of ECE experience for low-income children also found positive associations between early childhood education experience and children's behaviour, unless the care was of low quality. Interestingly and unlike other studies, this study did not find that high-quality ECE contributed to reading and mathematics skills in this sample, unless the home environment was also stimulating. Montes, Hightower, Brugger, and Moustafa (2005) found that increasing the quality of centres from good to excellent was associated with a decline in low-income children's socio-emotional risk factors.

### *Findings from the longitudinal EPPE project*

To provide additional context for our longitudinal analysis, we focus on the findings from the English EPPE project, which has followed its sample from age 3 to age 7. Positive associations between children's reading and mathematics scores on national tests, and the length of early childhood education experience and their preschool quality at age 3 were found at school entry, after controlling for the child, family, and home environment factors that had been found to have significant associations with their scores. High-quality ECE settings in this large study had staff with higher qualifications. "The quality of interactions between children and staff were particularly important: where staff showed warmth and were responsive to the individual needs of children, children made more progress" (Sylva et al., 2004, p. iv).

All children who attended centres with a higher proportion of mothers with tertiary or university degrees were also more likely to make more progress, which is consistent with our finding relating to the social mix of ECE centres. The EPPE study further found that disadvantaged children did better when their ECE centre served children from a range of socioeconomic backgrounds, rather than just children who were disadvantaged.<sup>1</sup>

Children who had attended some preschool had higher scores on average than those who had not attended, or those who had very little preschool attendance, on entry to school and at age 7 for reading and number skills. The effect size difference was around 0.25 for pre-reading and reading. For number skills, the difference decreased over time, from around 0.40 at age 4 to around 0.20 at age 7. Differences in behaviour were marked at entry to school, but no longer evident at age 7. The EPPE research team concluded that duration

---

<sup>1</sup> The project used an index based on 10 indicators of "multiple disadvantage": for the child, whether English was not their first language, they had three or more siblings, and they were premature at birth or below 2500 grams; for the parent, no qualifications, father's occupation was semi-skilled, unskilled, never worked, absent father, father not employed, age 13–17 at birth of the study child, single parent, not working/unemployed, and bottom quartile of the home environment scale. "All the variables were chosen because they related to low baseline attainment when looked at in isolation" (Sylva et al., 2004, p. 64).

was important, with “every month of pre-school experience after age 2 years linked to better intellectual development and improved independence, concentration and sociability” (Sylva et al., 2004, p. 56).

When the study used its measure of ECE centre effectiveness—the difference between the gains of children attending a particular centre compared to gains predicted on the basis of the children’s prior performance and intake characteristics (such as maternal qualification)—effect sizes of 0.15 were found at age 7 for mathematics and reading in relation to ECE centre effectiveness for early number scores, 0.05 in relation to ECE centre effectiveness for language, and in relation to ECE effectiveness for pre-reading, 0.09 for reading, and 0.04 for mathematics. These differences were stronger at age 6 than at age 7.

These particularly effective ECE centres showed more staff-child interactions that extended children’s thinking, including open-ended questions—though these were infrequent proportions of the questions asked even in these centres. Staff who had the highest qualifications (almost all trained teachers) provided children with more experience of language, mathematics, and cognitive challenge, and “less well qualified staff were significantly better pedagogues when they worked alongside qualified teachers” (Sylva et al., 2004, p. 37). These centres had long-serving staff, strong educational leadership, and ongoing professional development.

While there was some relationship between ECE quality and children’s social behaviour at school entry and in the first year of school, this was not so at age 7. However, children who had attended effective ECE centres in terms of children’s performance for independence and concentration and peer sociability had higher ratings at age 7 for self-regulation, and lower scores for anxious behaviour. There were some weak but statistically significant associations between ECE centre effectiveness for promoting early number knowledge and language in relation to self-regulation.

The study authors thought that the slightly weaker associations at age 7 compared to age 6 could be due to effects from the children’s primary school experience, meaning that ECE’s main contribution was to the knowledge and skills with which children started school, or from the study use of national assessments at age 7 (these vary from year to year), rather than the standardised tests they had used at age 6.

## **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 3 months of a child’s final ECE experience.<sup>2</sup> 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 3-hour period, on at least 3 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 2-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”.

Bearing in mind differences in the quality measures used, the overall quality of the 87 ECE services attended by the 307 study children in 1993–94 appeared to be somewhat higher than reported in studies in the USA at

---

<sup>2</sup> 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.

the time, and to show less variability. The median overall score on our rating scale was 71 percent, with a range from 38 to 89 percent. A 1995 report of quality in US ECE childcare centres found a median of 57 percent, using the ECERS<sup>3</sup> scale (Helburn, 1995). The average score for the centres in the EPPE study was just below the “good” range on the ECERS scale, somewhat higher than the US, but with limited mathematics and science learning opportunities. However, the average in the EPPE study covered a wide range, with centres from a “care” rather than “education” tradition offering lower quality, despite better staff:child ratios. “...care-oriented provision usually offers the lowest salaries to staff, employs workers with the lowest levels of qualifications, and has limited access to training, and higher staff turnover” (Sylva et al., 2004, p. 21). The higher the centre manager’s qualifications, the higher the overall quality of the centre as measured by ECERS.<sup>4</sup>

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). We also found that the level of staff-child interaction was related to the level of staff ECE qualifications for the ECE centre as a whole (with higher scores for those centres where all staff had ECE qualifications), to staff:child ratios (with decreased levels as the number of children per staff member increases), to group size (higher for those where it was less than 10), staff stability (with lower scores for those centres with a third or more staff turnover over the previous 12 months), and highest staff salary (with higher scores where the salary was more than \$9 hour (in 1993–1994). The frequency with which the study children explored, extended their language through discussion with adults increased as ECE centre scores increased for staff-child interaction; and aggressive behaviour was more likely with low ECE centre scores for staff-child interaction.

We found that the structural aspects of quality (staff:child ratio, group size, and staff qualification levels) did not all occur at the same level in individual ECE centres, with different patterns in different ECE types. For example, though kindergartens had all qualified staff, they also had larger group sizes and higher staff:child ratios. This suggested to us that the benefits from one aspect of quality could be undercut by lower levels of another: that in looking at the relation with quality, we would be seeing the effect of the mix of structural quality in each type. It also meant that it could be difficult to analyse separately the individual contributions of each of these aspects that other research had found to be linked to process quality of ECE—or the (direct) learning opportunities. Thus our analysis on the contribution of ECE experience after the children moved to school has mainly been focused on process quality, with attention also to their length of ECE experience, and their final ECE centre socioeconomic mix. Because the study started with children in their final year of ECE, we have only been able to include quality aspects related to their final ECE centre.

---

<sup>3</sup> Early Childhood Environment Rating Scale, developed by Harms and Clifford, and often used in US studies.

<sup>4</sup> This association between the qualifications of staff and the quality of the environment and teaching is also found in other studies. Whitebook (2003) provides an overview of relevant US research showing that centres with higher proportions of teachers with bachelor degrees with specialised training in early childhood development offered higher-quality. Vandell (2004) also notes two experimental studies that provide evidence of causal relationships between structural/caregiver characteristics and process quality. Gormley et al. (2005, p. 882) suggest that two factors which are relevant to their finding of benefits for children attending Oklahoma’s Pre-K programme are the high teacher education requirements, and pay levels which are the same as primary and secondary teachers’ in the state’s public schools. Barnett et al. (2005) also note that a common element in the state-funded programmes they studied that increased children’s early language, literacy, and mathematics development was that “all or nearly all teachers have a four-year college degree with an early childhood specialisation” (p. 2).

## Previous findings

The study participants' early childhood education experience was still contributing to their mathematics and reading comprehension scores 7 years later.<sup>5</sup> By age 12, more ECE aspects showed relationships with the children's mathematics scores than with their PAT Reading Comprehension scores. Perhaps this is because more reading activities occur in homes, so there was less variation in home reading experience than in home mathematics-related experiences. Another reason could be that the kinds of activities and interactions provided by ECE staff support mathematics performance through practice in patterns and puzzle-solving (though Young- Loveridge, Carr, and Peters (1995) found relatively few mathematics learning opportunities occurring in their study of four Waikato kindergartens).

Most of the associations with mathematics remained after taking the children's scores at age 5 and each of family income and maternal qualification into account. The proportion of variance in scores accounted for, and the size of the difference between the scores for children with different levels of early childhood education experience increased rather than decreased with time. Both these patterns suggest that early childhood education contributes to children's performance at age 12 through developing ways of working, thinking, and communicating, rather than the simple provision of knowledge at a certain level.

The particular early childhood education quality aspects that continued to show associations with the PAT Reading Comprehension scores focused on staff:child interaction, along with a "print-saturated" environment. The centrality of staff:child interaction found in this study for long-term outcomes is consistent with other large-scale research on concurrent and short-term relations between early childhood education quality and outcomes for children.

## **DOES AN ASSOCIATION WITH EARLY CHILDHOOD EDUCATION REMAIN VISIBLE AT AGE 14?**

This report focuses on the research question:

*Does early childhood education continue to have an impact at age 14? If so, which aspects remain important?*

To answer the question we first fitted simple models, with only the early childhood education quality measure, and next, where this measure accounted for a significant proportion of the variability in the competency measure, we fitted larger models including the age-5 competency measure, and either maternal qualification or family income at age 5.

In the first phase, for each of the early childhood education quality measures, we fitted ANOVA models to each of the age-14 competency measures. We defined quartile groups for each of the quality measures, and tested whether the achievement levels of students in these four groups were the same or not. The tables presented show the mean competency scores of each of the quartile groups.

In the second phase, the model was extended in three ways. First the age-5 competency measure was added to see if the ECE quality measure was showing associations with the age-14 competency over and above that of the earlier competency. If this was the case, the second and third extensions were made. They involved adding maternal qualification and family income at age 5 (in two separate models) to see if the effect of the ECE quality measure still remained after accounting for differences in social characteristics.

We present the findings from these two analyses in turn, followed by a discussion of the patterns found in relation to other research.

---

<sup>5</sup> More detail is given in Wylie, Thompson, Hodgen, Ferral, Lythe, and Fijn (2004).



## DESCRIPTION OF THE ANALYSIS AND RESULTS PRESENTED

As described above, the analysis compared mean competency scores in the four quartile groups for each ECE quality measure. In the first section, the mean competency scores are presented, 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  $\eta^2$  were used to measure effect size.<sup>6</sup>

In the second section, where the age-5 competency and social characteristics were added to the models, we report on the contrasts that were still statistically significant, and report the adjusted  $R^2$  for the overall model, and the  $\eta_p^2$  values for each of the variables included in the model. Both  $R^2$  and  $\eta_p^2$  are reported as the *percentage* of variability accounted for.

The relative size of the effect sizes 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 71 percent, with a range from 38 to 89 percent. 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.

For most of this analysis, we used only the “original sample” for whom we have full material on early childhood education experience and quality. There were 240 in this group at age 14. We used the full sample when looking at starting age at ECE, combinations of different types of ECE services, and the type of ECE service last attended.

We 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  $p > 0.05$ .

---

<sup>6</sup> There are three commonly used measures of effect size used with ANOVA:  $\eta^2$  which is the proportion of the total variance that is attributed to an effect in the sample;  $\eta_p^2$  which is the proportion of the effect and residual variance that is attributable to the effect in the sample; and  $\omega^2$  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,  $\eta_p^2$  or  $\omega^2$  are more appropriate. Software such as SPSS produces  $\eta_p^2$  by default. In general the value of  $\eta_p^2$  is about twice that of  $\omega^2$  (the former is the estimate for the *sample*, the latter for the *population*). Where there is a single explanatory variable, unadjusted  $R^2$  and  $\eta^2$  are of the same order of size, as are adjusted  $R^2$  and  $\eta_p^2$ .



## 2. ECE experience and competencies at age 14

### ECE FACTORS SHOWING NO ASSOCIATIONS

Before we look in more detail at the ECE factors that did show an association with age-14 competency levels, we describe first the ECE factors that showed no associations in this study.

Though some ECE educators have been concerned about potential negative effects for children from **concurrent experience of different early childhood education**, we have found none. Just under half the sample had used more than one kind of early childhood education service at the same time. Twenty-one percent had combined home-based services (e.g. family day care) with sessional early childhood education, and 14 percent had combined two types of centre attendance. Most arrangements combined a high-cost and a low-cost option, and parents who used combinations were more likely to be in full-time paid work. Concurrent arrangements may not have been parents' preference (though some certainly saw home-based services as providing "warmth and care" while they expected sessional services to focus on "education" or "school readiness"), but different environments, with different adults and children, did not appear to affect the children's cognitive, social, or attitudinal competencies.

Different **types** of services had different combinations of some of the structural quality factors that have been found in previous research to have a bearing on children's performance, such as adult:child ratio, group size, and teacher qualification. However, these combinations usually had a higher level of one structural quality feature, and a lower level of another, so the net effect was a levelling out of quality, and of overall differences in structural quality between types.

There have been several consistent patterns of association between competency levels and early childhood education type over the years, but they appear to be due to other factors rather than ECE type itself. Mathematics and PAT reading comprehension test scores were much lower at age 14 for those who had attended aoga amata (around 23 percentage points on average), as they had been at ages 8–12. These patterns tended to become indicative ( $p$  between 0.01 and 0.05) once either family income or maternal qualification was included in the model. But there are three caveats around these associations. First, there were only nine students at age 14 who had attended aoga amata. Second, aoga amata had just begun when we collected our data. It is not clear that a similar study to this would find the same pattern now, some 11 years later. Third, we find a similar range of scores for Pacific students who did not attend aoga amata. An ANOVA model that first fitted student ethnicity, and then ECE type found no separate association between ECE type and student scores. Thus it is highly likely that the pattern found here is related to aspects other than aoga amata as an ECE type.

At some ages, we have found lower scores for mathematics for those who had attended kindergarten (at age 14, around 3–4 percentage points). As at earlier ages, this pattern does not remain once family income or maternal qualification is taken into account.

As in earlier phases, we found no associations with competency levels and **parental views**: their perception that the final ECE centre had some negative aspects for their child, and their satisfaction with ECE staff communication with them about their child's experience. The **level of parental involvement** in their child's final ECE centre also showed no associations, though our information about parental involvement was limited to voluntary help, ranging from work with children in the programme to fundraising, and did not include the kind of joint work related to learning and assessment so that centre and home activities and experiences can support one another (Mitchell & Cubey, 2003, pp. 74–79).

There are three aspects of ECE experience that do show associations with children's competency levels at age 14: length of the ECE experience, the socioeconomic mix of the families served by a young person's final ECE service, and final ECE quality.

## LENGTH OF ECE EXPERIENCE

We have two kinds of data on the length of time that the study participants spent in ECE: their starting age, and the total length of their experience.

### Starting age

We used data for all those in the study at age 14 to analyse the association between ECE starting age and competency levels at age 14. Twenty-nine percent of the participants in the study at age 14 had started ECE before they were a year old. Sixteen percent had started ECE in their second year, and 23 percent, in their third year. Thirty-two percent had started ECE after they were 3 years old.

We found significant ( $p \leq 0.01$ ) associations with mathematics and writing, and indicative associations with the PAT reading comprehension test and the cognitive composite competency. Those who had started early childhood education before they were 2 years old had higher scores than those who started after that age, with statistically significant contrasts in scores between those who started between the ages of 1 and 2, and those who started after the age of 3. Those who started ECE in their second year tended to have scores of around 5 percentage points higher than those who started after they were 2 years old. These differences generally remained after taking each of family income<sup>7</sup> and maternal qualification into account, with the strength of the difference sometimes reduced to an indicative level ( $p$  is between 0.01 and 0.05).

### Length of ECE experience

Length of experience is not synonymous with starting age, since some who started ECE experience had breaks in that experience. In the Competent Children, Competent Learners study, we have found associations between length of ECE experience and competency levels to be stronger at ages 6 and 8 than at ages 10 and 12, with some dilution after taking into account family income or maternal qualification. Children's length of ECE experience was related to their mother's qualification level, with children whose mothers had tertiary or university qualifications more likely to experience ECE for longer periods.

At age 12, those who had 48 months or more early childhood education experience had higher scores for mathematics. This was the only competency to show a statistically significant difference.

But at age 14, all competencies other than the PAT reading comprehension test showed statistically significant associations with length of ECE experience. Table 1 shows linear trends, but in general, the contrasts that remained significant once family income was taken into account were between those who attended early childhood education for 48 months or more, and those who had attended for less than 24 months. The differences tended to be reduced to the indicative level once maternal qualification was taken into account, but they remained significant for curiosity, perseverance, social skills with adults, logical problem-solving, and the composite competencies.

---

<sup>7</sup> For these analyses, we used family income levels at age 5, because these were a closer indicator of the resources available to the children when they were in early childhood education.

Table 1 Total length of ECE and students' competencies at age 14

Total length of ECE →	<24 months (n=34)	24–35 months (n=54)	36–47 months (n=67)	≥48 months (n=105)	Prob. of F-value from ANOVA	Percent variance acct. for ( $R^2$ ) <sup>#</sup>
Age-14 Competency ↓						
Curiosity	<i>48.4</i>	54.9	53.8	<b>60.3<sup>^</sup></b>	<b>0.003</b>	<b>5.2</b>
Perseverance	<i>59.1</i>	62.5	66.0	<b>70.7<sup>^</sup></b>	<b>0.010</b>	<b>4.4</b>
Self-management**	<i>69.2</i>	71.9	73.9	<b>78.5<sup>^</sup></b>	0.012	4.2
Self-efficacy**	<i>58.3</i>	63.2	62.9	<b>69.3<sup>^</sup></b>	<b>0.002</b>	<b>5.5</b>
Social Skills with Peers**	<i>68.9</i>	72.8	72.2	<b>76.0<sup>^</sup></b>	0.016	4.0
Social Skills with Adults**	<i>69.8</i>	73.7	75.6	<b>79.5<sup>^</sup></b>	<b>0.005</b>	<b>4.9</b>
Communication**	<i>58.1</i>	60.1	63.1	<b>68.2<sup>^</sup></b>	<b>0.002</b>	<b>5.6</b>
Mathematics	<i>57.5</i>	60.1	68.2	<b>73.3<sup>^</sup></b>	<b>0.0004</b>	<b>6.8</b>
PAT reading comprehension	50.8	<i>50.6</i>	51.6	<b>58.1</b>	0.10	2.4
Writing**	60.8 <sup>^</sup>	<i>59.0</i>	65.2	<b>64.9<sup>^</sup></b>	0.036	3.3
Logical Problem-solving**	<i>72.5</i>	75.1	77.6	<b>79.7<sup>^</sup></b>	<b>0.002</b>	<b>5.8</b>
Overall Composite*	<i>61.8<sup>^</sup></i>	64.0	66.4	<b>71.1<sup>^^</sup></b>	<b>0.0005</b>	<b>6.7</b>
Cognitive Composite	<i>60.6<sup>^</sup></i>	61.2	65.6	<b>69.0<sup>^</sup></b>	<b>0.003</b>	<b>5.3</b>
Attitudinal Composite*	<i>61.7</i>	65.6	66.8	<b>71.8<sup>^</sup></b>	<b>0.002</b>	<b>5.5</b>

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

<sup>^</sup> One fewer in this mean.

<sup>^^</sup> Two fewer in this mean.

The mean scores are percentages, not raw scores.

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.

<sup>#</sup> Unadjusted  $R^2$ .

## EARLY CHILDHOOD EDUCATION CENTRE SOCIOECONOMIC MIX

We have consistently found that children whose final ECE centre served mainly middle-class<sup>8</sup> families (as summarised by teachers) had higher average scores for the cognitive competencies (mathematics, PAT reading comprehension, writing, and logical problem-solving). We continued to find these associations at age 14, and, like the length of ECE experience, to find them for a wider range of competencies.

Table 2 ECE socioeconomic mix and student competencies at age 14

Socioeconomic mix of ECE →	Middle Class (n=107)	Low to middle income (n=50)	Wide range (n=75)	Low income (n=26)	Prob. of F-value from ANOVA	Percent variance acct. for ( $R^2$ ) <sup>#</sup>
Age 14 competency↓						
Curiosity	<b>61.1</b>	56.2 <sup>^</sup>	50.4	50.8	<b>0.0003</b>	<b>7.3</b>
Perseverance	<b>71.2</b>	64.3 <sup>^</sup>	62.6	60.8	<b>0.009</b>	<b>4.5</b>
Self-management**	<b>79.1</b>	72.4 <sup>^</sup>	72.1	69.1	<b>0.002</b>	<b>5.8</b>
Self-efficacy**	<b>69.0</b>	63.6 <sup>^</sup>	62.3	59.0	<b>0.005</b>	<b>4.9</b>
Social Skills with Peers**	<b>76.2</b>	73.1 <sup>^</sup>	71.6	68.0	<b>0.009</b>	<b>4.5</b>
Social Skills with Adults**	<b>80.2</b>	74.3 <sup>^</sup>	72.7	71.8	<b>0.0009</b>	<b>6.3</b>
Communication**	<b>68.6</b>	63.3 <sup>^</sup>	60.5	56.0	<b>0.0002</b>	<b>7.6</b>
Mathematics	<b>76.5</b>	61.9	62.2	53.2	<b>&lt; 0.0001</b>	<b>12.3</b>
PAT reading comprehension	<b>62.8</b>	53.9	45.1 <sup>^</sup>	42.0	<b>&lt; 0.0001</b>	<b>14.0</b>
Writing**	<b>67.9</b>	61.6	59.3	57.9	<b>&lt; 0.0001</b>	<b>8.1</b>
Logical Problem-solving**	<b>81.1</b>	75.3	75.5 <sup>^</sup>	71.3	<b>&lt; 0.0001</b>	<b>11.0</b>
Overall Composite*	<b>72.1</b>	65.6 <sup>^</sup>	63.7 <sup>^^</sup>	60.0	<b>&lt; 0.0001</b>	<b>11.4</b>
Cognitive Composite	<b>72.1</b>	63.2	60.6 <sup>^^</sup>	56.1	<b>&lt; 0.0001</b>	<b>15.4</b>
Attitudinal Composite*	<b>72.2</b>	66.7 <sup>^</sup>	64.6	62.2	<b>0.0004</b>	<b>7.0</b>

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

<sup>^</sup> One fewer in this mean.

<sup>^^</sup> Two fewer in this mean.

The mean scores are percentages, not raw scores. 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.

<sup>#</sup> Unadjusted  $R^2$ .

ECE socioeconomic mix<sup>9</sup> has overlaps with family income and maternal qualification. Thus it is not surprising that some of the significant contrasts seen in the table above became indicative or no longer notable after accounting for either of these. This occurred mainly with the attitudinal competencies.<sup>10</sup> The contrasts that remained statistically significant for the attitudinal competencies were usually between those who had attended a middle-class centre and those who had attended one serving a low-income community. With the cognitive competencies, the contrasts were reduced (by a third to a half), but contrasts between the average scores of those who had attended centres serving middle-class families, and those serving either low-income families, or a wide socioeconomic range remained significant after taking each of these two aspects

<sup>8</sup> 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.

<sup>9</sup> Also referred to in the research literature as "peer-mix" or "peer effects", or "compositional effects".

<sup>10</sup> In earlier reports, we have referred to these as "social and attitudinal". This possibly gave more emphasis than intended to "social" skills. The attitudinal competencies include curiosity, perseverance, communication, self-management, self-efficacy, and social skills.

of family resources into account. This would indicate that children from low-income families attending an ECE service serving mainly peers from middle-class families would score higher for mathematics at age 14 than those who attended an ECE service serving mostly those from low-income homes, and higher for reading than those who attended an ECE service serving mostly those from low-income homes, or from families with a wide range of incomes.

## EARLY CHILDHOOD EDUCATION QUALITY

Aspects of quality provision in the study participants' final ECE centre showed associations with the competency levels at ages 8, 10, and 12. 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, opportunities to practise skills and experience completion, and exposure to the written word. Teacher-child interaction has been noted as a key component of quality care, if not the pivot (e.g. Kontos & Wilcox Hertzog, A. 1997; Munton, Mooney, Moss, Petrie, Clark, & Woolner, 2002; Smith et al., 2000).

The full range of aspects of ECE quality that were covered in our ratings of the final ECE centre attended by the 307 children for whom we have full material about their ECE experience is given in the table below. We 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 aspects associated with competency scores which remained statistically significant at age 14 (9 years later) after taking family income or maternal qualification into account are shown in italics in the table. They are much the same set as we found when the study children were aged 10. One item showed associations at ages 8, 10, and 14, but not at age 12: *Children can select from a variety of activities*.

Three items showed associations for the first time at age 12: *Equipment and activities encourage fine motor skills*, *Evidence of children's artwork and creativity*, and *Equipment and activities encourage gross motor skills*. The last two also showed some associations at age 14. However, the associations were non-linear, and without any thresholds at either end of the spectrum, indicating that something other than the quality aspect itself was likely to be at work, or that the results were occurring by chance.

Table 3 **ECE process quality ratings used in the Competent Children, Competent Learners study**

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

Generally, the associations found applied to all income and maternal qualification groups in the same way. Including family income or maternal qualification 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 12 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 a tertiary or university qualification. Forty-two 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 24 percent of those from high-income families.

The strength of associations between the quality aspects and family income and maternal qualification were generally not strong ( $\tau < 0.20$ ).<sup>11</sup> 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).

Responsiveness of ECE staff to children shows a very modest association with maternal qualification ( $\tau = 0.17$ ) and having a print-saturated ECE environment a similar association with family income ( $\tau = 0.18$ ).

Other weaker (but not negligible) associations were between family income and

- Staff responsiveness ( $\tau = 0.12$ )
- Staff modelling and encouraging positive approaches to behaviour ( $\tau = 0.11$ )
- Staff guiding children in centre activities ( $\tau = 0.11$ )
- Good safety practices ( $\tau = 0.11$ )

Associations with maternal qualification were

- Staff modelling and encouraging positive approaches to behaviour ( $\tau = 0.12$ )
- Staff join children in their play ( $\tau = 0.12$ )

Specific patterns for the quality items which showed positive associations with competency levels at age 14 are discussed in detail below. On the whole, the patterns are consistent with patterns found for earlier ages. The associations at age 14 were more likely to be statistically significant than at age 12, which may be due to relatively small changes in the “original sample” numbers over the 2 years.

In this analysis, we 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.

---

<sup>11</sup> We 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  $\tau_b$  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, and 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.

Table 4 ECE staff responsiveness to children and competency scores at age 14

ECE staff were responsive to children→	1 <sup>st</sup> quartile up to 3.5 mean (n=62)	2 <sup>nd</sup> quartile 3.5+ to 4 mean (n=89)	3 <sup>rd</sup> quartile 4+ to 4.33 mean (n=47)	4 <sup>th</sup> quartile 4.33+ mean (n=62)	Prob. of F-value from ANOVA	Percent variance acct. for (R <sup>2</sup> ) <sup>#</sup>
Age-14 competency↓						
Curiosity	54.7	52.0 <sup>^</sup>	57.0	<b>61.9</b>	<b>0.008</b>	<b>4.6</b>
Perseverance	64.1	62.7 <sup>^</sup>	66.9	<b>73.0</b>	0.014	4.1
Self-management**	72.6	72.2 <sup>^</sup>	75.3	<b>80.0</b>	0.028	3.5
Communication**	61.2	61.0 <sup>^</sup>	65.1	<b>69.7</b>	<b>0.006</b>	<b>4.8</b>
Mathematics	65.6 <sup>^</sup>	63.2	68.4	<b>73.4</b>	0.066	2.8
PAT reading comprehension	48.4	50.5	58.2	<b>61.1</b>	<b>0.003</b>	<b>5.4</b>
Writing**	59.3 <sup>^</sup>	61.5 <sup>^</sup>	64.3	<b>68.6</b>	<b>0.002</b>	<b>5.6</b>
Logical Problem-solving**	75.6 <sup>^</sup>	75.4	79.1	<b>80.1</b>	<b>0.005</b>	<b>4.9</b>
Overall Composite*	65.2 <sup>^</sup>	64.7 <sup>^^</sup>	68.1	<b>71.9</b>	<b>0.008</b>	<b>4.5</b>
Cognitive Composite	62.3 <sup>^</sup>	62.7 <sup>^</sup>	67.5	<b>70.8</b>	<b>0.002</b>	<b>5.6</b>
Attitudinal Composite*	66.3	65.3 <sup>^</sup>	68.5	<b>72.6</b>	0.029	3.5

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

<sup>^</sup> One fewer in this mean.

<sup>^^</sup> Two fewer in this mean.

The mean scores are percentages, not raw scores. The highest mean scores for each competency are in **bold** type, the lowest in *italics*. The *p*-values and *R*<sup>2</sup> values of competencies where there were statistically significant differences are in **bold** type.

<sup>#</sup> Unadjusted *R*<sup>2</sup>.

The contrasts that remained significant after taking family income into account were mainly between quartile group 2, which had the majority of lowest mean scores, and the top quartile group. The associations became indicative when we took maternal qualification into account for the PAT reading comprehension test and writing. These changes in strength of association reflect to some degree different distributions of income and maternal qualification among the quartile groups. Overall, those whose final ECE centre had been in the top quartile for its level of responsiveness to children had higher scores than others, showing that there are advantages even at age 14 to having attended such an ECE centre.

## 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 ones with the PAT reading comprehension test and perseverance. At age 14, there are 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.

The general trend was for scores to increase in line with how well staff at the participants' final ECE centre had guided the children through their activities. Again, those whose final ECE centre had scored in the top quartile had higher average scores than others.

Table 5 ECE staff guide children in activities

ECE staff guided children in activities →	1 <sup>st</sup> quartile up to 3.4 mean (n=72)	2 <sup>nd</sup> quartile 3.4+ to 3.67 mean (n=61)	3 <sup>rd</sup> quartile 3.67+ to 4.2 mean (n=69)	4 <sup>th</sup> quartile 4.2+ mean (n=58)	Prob. of F-value from ANOVA	Percent variance acct. for (R <sup>2</sup> ) <sup>#</sup>
Age-14 competency↓						
Curiosity	52.8	52.3	57.8 <sup>^</sup>	<b>61.4</b>	<b>0.010</b>	<b>4.3</b>
Perseverance	<i>60.5</i>	64.0	68.3 <sup>^</sup>	<b>73.3</b>	<b>0.002</b>	<b>5.6</b>
Self-management**	69.7	73.4	76.5 <sup>^</sup>	<b>80.2</b>	<b>0.003</b>	<b>5.3</b>
Self-efficacy**	<i>61.2</i>	62.8	66.5 <sup>^</sup>	<b>69.8</b>	0.016	3.9
Social Skills with Peers**	71.3	72.4	74.3 <sup>^</sup>	<b>76.1</b>	0.17	1.9
Social Skills with Adults**	73.4	73.3	77.2 <sup>^</sup>	<b>80.8</b>	0.019	3.8
Communication**	59.3	61.5	64.5 <sup>^</sup>	<b>71.2</b>	<b>0.0002</b>	<b>7.2</b>
Mathematics	66.3 <sup>^</sup>	63.9	63.9	<b>75.5</b>	0.019	3.8
PAT reading comprehension	<i>48.4</i>	54.4	53.7	<b>60.5</b>	0.023	3.6
Writing**	59.1 <sup>^</sup>	61.1 <sup>^</sup>	66.4	<b>66.5</b>	<b>0.004</b>	<b>5.0</b>
Logical Problem-solving**	75.5 <sup>^</sup>	76.6	76.7	<b>80.8</b>	0.030	3.4
Overall Composite*	63.7 <sup>^</sup>	65.5 <sup>^</sup>	68.0 <sup>^</sup>	<b>72.4</b>	<b>0.003</b>	<b>5.4</b>
Cognitive Composite	62.4 <sup>^</sup>	64.2 <sup>^</sup>	65.2	<b>70.8</b>	0.012	4.2
Attitudinal Composite*	64.0	65.7	69.3 <sup>^</sup>	<b>73.2</b>	<b>0.003</b>	<b>5.4</b>

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

<sup>^</sup> One fewer in this mean.

<sup>^^</sup> Two fewer in this mean.

The mean scores are percentages, not raw scores. The highest mean scores for each competency are in **bold** type, the lowest in *italics*. The *p*-values and *R*<sup>2</sup> values of competencies where there were statistically significant differences are in **bold** type.

<sup>#</sup> Unadjusted *R*<sup>2</sup>.

The size of the differences between quartile group means reduced by 1 or 2 percentage points when either family income or maternal qualification were included in the ANOVA model. The significant contrasts were usually between the lowest and highest quartile groups for the level of quality of ECE staff guidance. These contrasts remained significant after taking either family income or maternal qualification into account for perseverance, self-management, communication, and the composite competency measures. These contrasts became indicative for PAT reading comprehension, writing, and logical problem-solving, and were no longer notable for mathematics.

There were some interactions, though these are at the indicative level, and sometimes involved small numbers of students in the subgroups. Those who had been in very low-income homes (\$20,000 or less) at the age of 5 appeared to benefit more than others in terms of their curiosity, communication, mathematics, logical problem-solving, and self-efficacy scores, if staff guidance at their final ECE centre had been of the highest quality. In relation to self-management scores, it was those with non-qualified or trades-qualified mothers who appeared to benefit most from having the highest quality of ECE staff guidance.

Since age 8 PAT reading comprehension test scores of those who had had the highest quality of ECE staff guidance (the top quartile) have been consistently around 9 percentage points higher than the scores of those who did not. For mathematics, the difference in scores increased up to age 10, and may now be closing a little.

Table 6 **Mean scores for the mathematics measures at ages 5, 6, 8, 10, 12, and 14 by quartile groups of ECE staff guidance of children**

ECE staff guided children in context of activities→ Mathematics↓	Up to .4 1 <sup>st</sup> quartile	3.4+ to 3.67 2 <sup>nd</sup> quartile	3.67+ to 4.2 3 <sup>rd</sup> quartile	4.2+ 4 <sup>th</sup> quartile	Prob. of F-value from ANOVA	Percent variance acct. for	Difference between highest & lowest Q	Average of the first three quartiles, highest quartile, & difference		
Age 5	48.5	<b>53.9</b>	48.8	51.8	0.36	1.1	3.3	50.2	51.8	1.6
Age 6	75.1	75.5	75.8	<b>78.5</b>	0.73	0.4	3.4	75.1	78.5	2.4
Age 8	60.7	60.1	63.2	<b>70.0</b>	0.043	2.9	9.3	61.4	70.0	8.6
Age 10	58.2	62.0	61.1	<b>71.6</b>	<b>0.005</b>	4.7	13.4	60.4	71.6	<b>11.2</b>
Age 12	47.7	47.9	49.5	<b>60.3</b>	<b>0.006</b>	4.6	12.5	48.4	60.3	<b>11.9</b>
Age 14	66.3	63.9	63.9	<b>75.5</b>	0.019	3.8	9.2	64.8	75.5	<b>10.7</b>

## ECE staff ask children 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. As with the first two ECE quality items, there was a wider range of associations at age 14 than at earlier ages. On the whole the 14-year-olds' scores increased as their final ECE centre's rating for staff asking children open-ended questions increased.

Table 7 **ECE staff asked children open-ended questions and age-14 competencies**

ECE staff asked open-ended questions →	1 <sup>st</sup> quartile up to 3 mean (n=94)	2 <sup>nd</sup> quartile 3+ to 3.33 mean (n=50)	3 <sup>rd</sup> quartile 3.33+ to 4 mean (n=99)	4 <sup>th</sup> quartile <sup>12</sup> 4+ mean (n=25)	Prob. of F-value from ANOVA	Percent variance acct. for (R <sup>2</sup> ) <sup>#</sup>
Age-14 Competency↓						
Curiosity	52.9	53.5	58.2	<b>62.5</b>	0.035	3.3
Perseverance	62.2	65.2	68.8	<b>73.0</b>	0.041	3.2
Self-management**	71.2	74.5	76.6	<b>80.5</b>	0.059	2.9
Self-efficacy**	61.5	63.3	66.7	<b>73.2</b>	<b>0.009</b>	<b>4.4</b>
Social Skills with Peers**	71.5	71.4	74.8	<b>79.0</b>	0.028	3.5
Social Skills with Adults**	73.9	73.9	77.2	<b>83.4</b>	0.017	3.9
Communication**	60.9	61.9	65.7	<b>71.2</b>	0.022	3.7
Mathematics	65.2	64.9	69.4	<b>69.9</b>	0.52	0.9
PAT reading comprehension	47.4	54.6	<b>58.5</b>	58.1	<b>0.005</b>	<b>4.9</b>
Writing**	59.1	63.1	65.7	<b>68.4</b>	<b>0.004</b>	<b>5.0</b>
Logical Problem-solving**	75.8	76.8	78.2	<b>79.9</b>	0.28	1.5
Overall Composite*	64.3	65.7	69.2	<b>72.6</b>	0.016	4.0
Cognitive Composite	62.0	64.8	67.9	<b>69.1</b>	0.031	3.4
Attitudinal Composite*	64.9	66.2	69.7	<b>74.7</b>	0.015	4.0

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

The mean scores are percentages, not raw scores. The highest mean scores for each competency are in **bold** type, the lowest in *italics*. The *p*-values and *R*<sup>2</sup> values of competencies where there were statistically significant differences are in **bold** type.

<sup>#</sup> Unadjusted *R*<sup>2</sup>.

In one-factor ANOVA models (where we are looking at each ECE factor on its own), the quality of "staff asking open-ended questions" has over the years consistently accounted for between 7 and 11 percent of the variance in competency scores, with gradual increases in the difference between those whose final ECE centre had scores above the median for this item, and those below; from 5.6 percentage points at age 5, to 8.5

<sup>12</sup> The unbalanced split into quartile groups is because there were 54 scores of 4.

percentage points at age 14. This would suggest that this aspect of ECE quality not only has some ongoing contribution, but a contribution that grows stronger.

At age 14 the significant or indicative contrasts were generally between the lowest and highest quartile groups. Allowing for either family income or maternal qualification generally kept these contrasts at their statistically significant or indicative level, but reduced differences by around 2 percentage points.

### 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: higher average scores for those who had attended an ECE centre rated above the top quartile for staff joining children in their play. 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. The main differences were between students whose ECE centres rated above the highest quartile and those who scored below.

Table 8 ECE staff joined children in their play and age-14 competencies

ECE staff joined children in their play→	1 <sup>st</sup> quartile up to 3 mean (n=86)	2 <sup>nd</sup> quartile 3+ to 3.33 mean (n=42)	3 <sup>rd</sup> quartile 3.33+ to 4 mean (n=78)	4 <sup>th</sup> quartile 4+ mean (n=54)	Prob. of F-value from ANOVA	Percent variance acct. for (R <sup>2</sup> ) <sup>#</sup>
Curiosity	54.1	57.6	54.9 <sup>^</sup>	<b>59.0</b>	0.35	1.3
Perseverance	64.9	64.0	63.9 <sup>^</sup>	<b>73.3</b>	0.033	3.4
Self-management**	72.6	72.5	73.2 <sup>^</sup>	<b>81.9</b>	<b>0.007</b>	<b>4.7</b>
Self-efficacy**	63.4	64.5	64.5 <sup>^</sup>	<b>68.3</b>	0.44	1.1
Social Skills with Peers**	73.0	72.3	72.6 <sup>^</sup>	<b>76.2</b>	0.48	1.0
Social Skills with Adults**	74.3	75.4	76.0 <sup>^</sup>	<b>79.4</b>	0.29	1.4
Communication**	62.1	62.5	63.0 <sup>^</sup>	<b>68.9</b>	0.090	2.5
Mathematics	70.1 <sup>^</sup>	60.2	61.9	<b>75.5</b>	<b>0.001</b>	<b>6.1</b>
PAT reading comprehension	55.2	48.6	51.1	<b>59.9</b>	0.049	3.0
Writing**	62.7 <sup>^</sup>	60.1 <sup>^</sup>	61.3	<b>69.0</b>	<b>0.007</b>	<b>4.7</b>
Logical Problem-solving**	76.7 <sup>^</sup>	74.9	76.4	<b>81.3</b>	<b>0.009</b>	<b>4.4</b>
Overall Composite*	66.6 <sup>^</sup>	65.4 <sup>^</sup>	65.5 <sup>^</sup>	<b>72.1</b>	0.029	3.5
Cognitive Composite	66.2 <sup>^</sup>	61.1 <sup>^</sup>	62.7	<b>71.4</b>	<b>0.002</b>	<b>5.8</b>
Attitudinal Composite*	66.3	67.0	66.9 <sup>^</sup>	<b>72.4</b>	0.11	2.3

\* In these cases the squared model was a better fit than raw data.

\*\* In these cases the Cox-Box transformation gave a better fit than raw data.

<sup>^</sup> One fewer in this mean.

<sup>^^</sup> Two fewer in this mean.

The mean scores are percentages, not raw scores. The highest mean scores for each competency are in **bold** type, the lowest in *italics*. The *p*-values and *R*<sup>2</sup> values of competencies where there were statistically significant differences are in **bold** type.

<sup>#</sup> Unadjusted *R*<sup>2</sup>.

Including family income in the model generally diluted the contrasts between the top quartile group and the other three quartile groups by 1–2 percentage points. Including maternal qualification had a somewhat bigger impact on the size of the contrasts, reducing them by as much as a third to a half, depending on the competency.

Mathematics scores have been consistently associated with this aspect of ECE centre quality, with the proportion of variance in scores accounted for showing a slight increase as the study sample grows older.

Table 9 Means for the mathematics measures at ages 5, 6, 8, 10, 12, and 14 by quartile groups of ECE staff joined children in their play

ECE staff joined children in their play→	1 <sup>st</sup> quartile up to 3	2 <sup>nd</sup> quartile 3+ to 3.33	3 <sup>rd</sup> quartile 3.33+ to 4	4 <sup>th</sup> quartile 4+	Prob. of F-value from ANOVA	% var. acct. for	Highest minus lowest	Difference between the average of the first three quartiles & the highest quartile		
Mathematics↓	mean (n=86)	mean (n=42)	mean (n=78)	mean (n=54)						
Age 5	51.7	48.0	47.8	54.7				49.5	54.7	5.2
Age 6	78.5	74.0	73.6	<b>80.3</b>	0.019	3.3	6.7	75.7	80.3	4.6
Age 8	64.1	61.1	58.7	<b>70.5</b>	0.016	3.7	9.5	61.4	70.5	9.1
Age 10	62.9	57.1	60.4	<b>71.0</b>	<b>0.010</b>	4.1	13.9	60.8	71.0	10.2
Age 12	51.0	45.4	45.5	<b>61.5</b>	<b>0.001</b>	5.9	15.0	48.3	61.5	13.2
Age 14	70.1	60.2	61.9	<b>75.5</b>	<b>0.001</b>	6.1	15.3	65.0	75.5	10.5

The staff-child interaction items—providing guidance, joining children in their play, asking open-ended questions, and being responsive to children—had correlations with each other of around  $r = 0.5$ – $0.6$ , indicating that they are reasonably likely to be found together at a similar level. Correlations between the staff-child interaction items and the next item, offering a print-saturated environment were lower, between  $r = 0.18$  and  $0.29$ .

## 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 qualification 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.

Table 10 Reading Comprehension scores at ages 5, 8, 10, 12, and 14 by quartile groups of ECE was a print-saturated environment

The ECE centre was a print-saturated environment →	1 <sup>st</sup> quartile up to 3	2 <sup>nd</sup> quartile 3+ to 3.67	3 <sup>rd</sup> quartile 3.67+ to 4	4 <sup>th</sup> quartile >4	Prob. of F-value from ANOVA	% var. acct. for ( $R^2$ ) #	Diff. between the lowest quartile & the average of the last three quartiles		
Competency↓	mean	mean	mean						
Age 5 Early Literacy	64.9	<b>73.3</b>	67.8	68.3	0.017	3.4	64.9	69.9	5.0
Age 8 PAT Reading test <sup>13</sup>	31.1	43.7	41.4	<b>48.3</b>	<b>0.0002</b>	<b>7.0</b>	31.1	43.5	<b>12.4</b>
Age 10 PAT Reading test	39.1	52.3	51.1	<b>55.7</b>	<b>&lt; 0.0001</b>	<b>7.9</b>	39.1	52.6	<b>13.5</b>
Age 12 PAT Reading test	43.9	<b>59.0</b>	57.0 <sup>^^</sup>	<b>59.0</b>	<b>&lt; 0.0001</b>	<b>9.2</b>	42.9	58.0	<b>14.1</b>
Age 14 PAT reading test	44.2	58.4	56.2	<b>59.2</b>	<b>0.0002</b>	<b>7.3</b>	44.2	57.5	<b>13.3</b>

The mean scores are percentages, not raw scores. 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.

At age 14 we also saw significant associations between this aspect and writing and communication, and indicative associations with mathematics, logical problem-solving, curiosity, and self-efficacy. However, these showed no linear trends (with average scores increasing as the level of a centre being print-saturated increased). This suggests that, unlike some of the other quality aspects, where “more” is better, there is a certain minimal level of using print every day in ECE centres that matters. This would indicate that where resources are scarce and ECE staff want to improve quality, providing print-based resources and displays should not occur at the expense of staff working together on the quality of their interaction and language use with children.

### Children can select their own activities from a variety of learning areas

A centre that achieved the highest possible rating for this aspect of quality would allow children to self-select activities supporting learning from a wide range, with some new or different activities over time. A centre that achieved the lowest possible rating would provide a very limited range of activities for children to choose from at any one time (less than three at most times).

At age 8, we found that high scores for this aspect of process quality were related to higher scores for communication, perseverance, and social skills with peers. At age 10, we found that the highest average scores for self-management and social skills were achieved by children whose final ECE centre had scored above the median for this aspect of quality, but there were no statistically significant associations at age 12. At age 14 we see indicative associations with perseverance, communication, and the attitudinal composite. Those whose final ECE centre had scored above the top quartile had higher average scores than others; by around 7–8 percentage points for perseverance, 6 percentage points for communication, and 4–6 percentage points for the attitudinal composite. The size of these differences was reduced by 1–2 percentage points when taking either family income or maternal qualification into account.

<sup>13</sup> At age 6, the measures we used for reading were the Burt word recognition test, and Tunmer’s invented spelling test. We have not included them in this table because neither focuses on comprehension. The age-5 early literacy score also does not focus on reading comprehension, but on early reading and writing behaviours, but it is included to provide some indication of children’s current performance at the time they attended their final ECE centre.

## **PROPORTION OF VARIANCE ACCOUNTED FOR IN AGE-14 SCORES**

Apart from the socioeconomic mix of the final ECE service, the proportion of variance in age-14 competency scores accounted for by the aspects of ECE discussed above ranged from 2–7 percent, with most associations accounting for 3–5 percent of the variance. This was often reduced somewhat by including family resources in the model.

We next examine the effect of adding the age-5 competency measure to the models. This allows us to see whether ECE continues to make a traceable contribution after children leave ECE. We know the age-5 measure is correlated with the age-14 competency measure. By including a variable that accounts for some of the variability between children in the model, we can see how much of the variability that has *not* been accounted for can be attributed to the ECE quality measure, and whether any associations we find persist after adding either family income or maternal qualification to the model.



### 3. Do aspects of ECE make separate contributions to competencies after age 5?

To see if aspects of ECE make separate contributions to competencies after age 5, we focused on mathematics, PAT reading comprehension, and the attitudinal composite. We modelled each ECE factor that accounted for a statistically significant amount of the variance in competency scores at age 14<sup>14</sup>, then added the age-5 scores, to see if the factor continued to make a contribution over and above the age-5 score. If it did, we added family income and maternal qualification in separate models to see if the ECE factor continued to make a contribution over and above the two social characteristic factors that are strongly related to competency scores.

There seem to be particular “thresholds” for some aspects that can make a difference. This is a somewhat different finding from other studies, though it may reflect our use of ANOVAs, which do not assume that the relationships between the ECE quality measures and the competencies are linear.<sup>15</sup> Langlois and Liben (2003, p. 973) note that because “most research in developmental psychology” uses linear models, it may “miss important U-shaped patterns in development”. Our findings relating to patterns of associations between some competency levels and family income and maternal qualification levels also find thresholds rather than linear, or steadily increasing, relationships.

We look first at the results of this modelling for mathematics, then for the PAT reading comprehension, and finally for the attitudinal composite.

Because of the relatively strong correlation between the age-5 score and the age-14 score, the percentage of the variability in the age-14 score that is accounted for by the models that include the age-5 score is markedly larger than the proportion accounted for by the models that include only an ECE factor. We therefore quote the *adjusted R*<sup>2</sup> for both models and an estimate of the effect size (ES) of the ECE factor ( $\eta_p^2$ ). The adjusted *R*<sup>2</sup> for the initial model looking only at the proportion of variance accounted for by an ECE factor is in each case approximately equal to the ES as measured by  $\eta_p^2$ , so only the former is quoted.

The adjusted *R*<sup>2</sup> is the percentage of the variability in the competency of interest that is accounted for by the model. The effect size ( $\eta_p^2$ ) for one of the variables in the model is the percentage of the variability in the competency of interest that is accounted for by that ECE factor.

---

<sup>14</sup> We used the R software package for this modelling, which allowed us to calculate an adjusted *R*<sup>2</sup> which accounts for the number of parameters fitted and tends to be lower than the unadjusted *R*<sup>2</sup>, particularly in models with many parameters.

<sup>15</sup> We have not tested this out by analysing the data using models based on linear assumptions, since we do not have the resources to do both. However, in this next section, we do use models based on linear assumptions.

## Mathematics

The early numeracy scores at age 5 accounted for 32 percent of the variability in mathematics scores at age 14. Maternal qualification level accounted for a further 16 percent of the variability in mathematics scores at age 14, and mathematics scores on average increased with higher levels of maternal qualification. Family income at age 5 accounted for a further 14 percent of the variability in mathematics scores at age 14 when added to early numeracy scores at age 5, and mathematics scores on average increased with higher family income.

### *Length of ECE experience*

Length of ECE experience alone accounts for 6 percent of the variance in mathematics scores at 14. When we allowed for the effect of early number knowledge in the model we still found an indicative overall effect for length of ECE experience; that is, length of ECE experience was making a contribution to age-14 scores on top of the age-5 scores. Both groups with 37–48 months' ECE experience ( $p = 0.04$ ) and those with 48 months or more ( $p = 0.006$ ) attained, on average, significantly higher mathematics scores than those with less than 24 months' ECE experience. The proportion of variance accounted for by the whole model was 33.5 percent, and the ES of the length of ECE experience was 3.8 percent.<sup>16</sup>

After allowing for maternal qualification in the model, the length of ECE experience ceased to have a statistically significant effect on mathematics scores at 14. Allowing for family income, an indicative effect remained between the longest and second-longest ECE experience groups ( $p = 0.03$ ), and a significant effect between the longest and shortest ECE experience groups ( $p = 0.01$ ). However the overall effect (from the ANOVA) is reduced to non-significant.

What this means is that the 6 percent of variation in mathematics score at age 14 that is accounted for by length of ECE experience in the simple model, reduces to around half that amount once the mix of home experiences represented by maternal qualification and family income is included. This may indicate differences in the quality of ECEs chosen or affordable over the preschool period, as well as home experiences.

Table 11 **Length of ECE experience and mathematics scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	39.6	37.9
ES for age-5 score (%)	37.0	35.6
ES for social characteristic (%)	13.7	7.4
ES for ECE variable (%)	2.4	2.9

<sup>16</sup> We chose to use  $\eta_p^2$  to measure the ES, as this is the effect size measure that SPSS users would be most familiar with. Had we used  $\omega^2$ , we would have quoted an ES of 0.012 (for the *population*).

### *ECE socioeconomic mix*

By itself, the ECE socioeconomic mix accounted for over 11 percent of the variance in mathematics scores at age 14. When allowing for early number knowledge, a significant effect is still observed ( $p = 0.003$ ). Children who attended ECE centres serving mainly middle-class families on average scored significantly higher marks in mathematics at age 14 than children who attended ECE services categorised as “wide range”, “low-income”, or “low-middle income” ( $p = 0.01, 0.003, 0.01$  respectively). The proportion of variance accounted for by the model was 34.7 percent, with an effect size for ECE socioeconomic mix of 5.7 percent. ECE socioeconomic mix differences stem from both the children present (the peers), and some differences in the levels of process quality.

When either maternal qualification or family income is allowed for in the model, ECE socioeconomic mix offered no statistically significant further explanation of the variance in mathematics scores at 14 (the ES is reduced to 1.6 percent for maternal qualification, and 2.5 percent for family income at age 5). However, although not statistically significant, the difference in mathematics score due to ECE socioeconomic mix does still have a slight persistent effect over and above home experiences on mathematics scores at age 14. This would indicate that these home experiences are more important than the ECE centre social-mix or that the social-mix differences between centres are not so large in the New Zealand context as they were in the EPPE study, though that study’s findings are limited to the first few years out from ECE experience.

### *Staff guide children in activities*

On its own, this aspect of quality accounted for 2.6 percent of the variance in age-14 mathematics scores. It remains as a significant effect in the model ( $p = 0.007$ ) after allowing for the early number skills score. There are no statistically significant interactions in this model meaning that there are no differences between the quartile groups in the way that early number skills scores relate to mathematics scores at 14. The significant contrasts in this model are between the group of children whose ECE service scored highest on the guidance in context quality measure and each of the other quality groups. The proportion of variance accounted for by the model including the age-5 early number skills score was 34.2 percent, and the ES of staff guiding the children was 4.9 percent.

Including maternal qualification in the model dampened the effect of this quality measure on mathematics scores at 14. The effect continues to show non-linearity, i.e. we cannot say that as the quality measure increases, so does the mathematics score at 14. Again those whose final ECE centre was in the top quartile for staff guiding children in activities showed significantly higher scores in mathematics at 14, after allowing for early number skills and maternal qualification. There were no interactions.

Staff guidance also persisted in the model at an indicative level after allowing for family income. The significant contrasts were between the highest quartile group and the middle two quartile groups.

**Table 12 Staff guide children in activities and mathematics scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	40.5	38.9
ES for age-5 score (%)	41.2	40.9
ES for social characteristic (%)	13.8	7.9
ES for ECE quality variable (%)	4.0	4.7

At age 14 whether the student attended an ECE centre where the staff guide children in activities still has a slight but statistically significant effect on their mathematics score. Those from ECE centres with the highest scores for this quality measure achieved higher mathematics scores than the other students, even after taking age-5 number knowledge, maternal qualifications, and family income into account. Thus, having a high level of ECE staff guidance and interaction with children has long-term benefits.

### **Staff join children in their play**

This aspect of quality accounted for 2.6 percent of the variance in age-14 mathematics scores on its own. The association with age-14 mathematics scores remained (at an indicative level,  $p = 0.026$ ) when accounting for early number knowledge. The significant contrasts, however, were now restricted to the contrasts between the second quartile group and the top quartile group ( $p = 0.01$ ), i.e. there was no linear pattern. The model accounted for 33.5 percent of the variance in age-14 mathematics scores, and the ES of the ECE quality variable was 3.7 percent.

When we added maternal qualification to the model, this quality measure sustained its indicative effect ( $p = 0.033$ ). After accounting for family income in the model, the quality measure also sustained an overall indicative effect ( $p = 0.017$ ). Those whose final ECE centre rated in the top quartile for the degree to which staff joined children in their play averaged 2.04 (NS), 10.61 ( $p = 0.01$ ), and 7.14 ( $p = 0.03$ ), percentage points above the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> quartile groups, respectively.

Attending an ECE centre where the staff are more likely to join children in their play (one scoring above the median on this quality measure) had a small but persistent effect on mathematics scores at age 14 after accounting for early number knowledge, maternal qualifications, and family income. Thus this aspect of quality also has the potential to have a long-term benefit for mathematics learning.

Table 13 **Staff join children in their play and mathematics scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	40.3	38.6
ES for age-5 score (%)	37.7	35.3
ES for social characteristic (%)	14.9	9.5
ES for ECE quality variable (%)	3.6	4.2

## Reading scores at 14 (PAT)

Early literacy scores at age near-5 accounted for 16 percent of the variability in PAT reading scores at 14 (much lower than the 27 percent of mathematics scores at age 14 that were accounted for by early numeracy scores at age near-5). Maternal qualification levels accounted for 17 percent of the variability in reading scores, with reading scores on average increasing with increasing levels of qualification. Family income accounted for 15 percent of the variability in reading scores, with reading scores on average increasing with increasing income.

### *ECE centre socioeconomic mix*

The socioeconomic mix of the last ECE service attended accounted for 13.1 percent of the variance in reading scores at 14 ( $p < 0.0001$ ).

When age-5 early literacy scores were accounted for, the ECE socioeconomic mix was still a highly significant main effect in the model, with children who attended centres rated as middle-class or serving low-middle-income communities scoring significantly higher, on average, in their reading scores at 14 than those who had attended ECE centres categorised as serving mainly low-income or wide income range groups. The proportion of variance accounted for by the model was 21.9 percent, with ES for ECE socioeconomic mix of 9.2 percent.

Accounting for maternal qualification and family income separately in the models reduced the effect to an indicative level.

This means that there was still a small residual effect of ECE socioeconomic mix on the age-14 reading scores, after accounting for early literacy, maternal qualification, and family income, of around 4–5 percent.

Table 14 **ECE centre socioeconomic mix and PAT reading scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	28.3	26.4
ES for age-5 score (%)	10.2	9.6
ES for social characteristic (%)	11.9	7.1
ES for ECE variable (%)	3.7	4.7

### *ECE staff ask open-ended questions*

This ECE quality measure accounted for 4 percent of the variance in reading scores at 14. When fitted after early literacy scores at age 5, the effect remained significant ( $p = 0.004$ ). The proportion of variance accounted for by the whole model was 19.1 percent, with ES for ECE staff asking open-ended questions of 5.6 percent. There were no statistically significant interactions. Significant contrasts were between the lowest and second quartile groups ( $p = 0.03$ ), and the lowest and third quartile groups ( $p = 0.0004$ ), with lower reading scores at 14 for the lowest quartile group.

When allowing for maternal qualification, ECE staff asking open-ended questions of children remained significant in the model indicating different reading outcomes for children whose ECE services offered different opportunities for open-ended questions. The significant contrasts were as before. When family income was fitted before the quality measure, this aspect of ECE quality remained as an indicative effect only ( $p = 0.013$ ).

For this quality measure, it is the absence of being asked open-ended questions that appears to have a long-term (negative) effect on reading comprehension. Students attending ECE centres where such questions were rare were still achieving lower reading comprehension scores at age 14 than were students who had been asked open-ended questions in their final ECE centre, even after taking early literacy scores, maternal qualifications, and family income into account.

Table 15 **ECE staff ask open-ended questions and PAT reading scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	29.2	26.2
ES for age-5 score (%)	14.6	13.1
ES for social characteristic (%)	15.1	10.7
ES for ECE quality variable (%)	5.3	4.5

### *Staff are responsive to children*

This quality measure accounted for 4.2 percent of the variance in age-14 reading scores on its own ( $p = 0.003$ ). However, after including the age-5 early literacy scores, the association was reduced to an indicative level ( $p = 0.05$ ), with 17.3 percent of the variance in age-14 scores accounted for by the model and an ES of 3.2 percent for ECE staff being responsive to children.

When maternal qualification or family income were included in the model, there was no longer an association with this aspect of ECE centre quality (effect sizes of 1.8 percent and 2.3 percent for the ECE quality measure fitted after maternal qualification and family income at age 5, respectively).

### *Staff guide children in activities*

This quality measure accounted for 2.5 percent of the variance in reading scores at 14 ( $p = 0.02$ ). After accounting for the early literacy score the effect of this quality measure was no longer significant. However, looking at the contrasts between the separate groups across the quality measure, we observed that those who had attended ECE services that scored in the top group on this quality measure attained significantly higher reading scores at age 14 on average than those who attended ECE services rated in the bottom quality measure group. Moreover, there was a linear effect across the quality groups; i.e. as the quality rating increased, so did the reading scores at 14. The proportion of variance accounted for by the model taking into account the age-5 competency score was 17.1 percent, with ES of 3.0 percent for the ECE quality factor.

An indicative effect remained between the highest and the lowest rating groups when maternal qualification was allowed for ( $p = 0.03$ ), and similarly, when family income was allowed for ( $p = 0.03$ ).

Table 16 **ECE staff guide children in activities and PAT reading scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	27.1	24.5
ES for age-5 score (%)	13.3	12.6
ES for social characteristic (%)	16.0	10.8
ES for ECE quality variable (%)	2.3	2.1

### *The centre is a print-saturated environment*

This quality attribute accounted for 6.7 percent of the variance in reading scores at 14 ( $p = 0.0001$ ).

After accounting for the age-5 early literacy score in the model, the effect was reduced but still significant ( $p = 0.001$ ). The proportion of variance accounted for by the model was 20 percent, with effect size for the ECE quality factor of 6.8 percent. Children who attended ECE centres with the lowest level of provision of a print-saturated environment appeared to be doing significantly less well on average in their reading scores at 14 than those who attended ECE services with higher ratings on this aspect of quality. We observed a linear trend here: the higher the ECE rating on this quality measure, the higher were age-14 average reading scores.

Accounting for maternal qualification and family income separately in the models reduced the effect to an indicative level.

Table 17 **The centre is a print-saturated environment and PAT reading scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	28.4	25.7
ES for age-5 score (%)	13.1	12.2
ES for social characteristic (%)	13.8	8.8
ES for ECE quality variable (%)	4.1	3.7

## Attitudinal composite competency at 14

The attitudinal composite at age 5 accounted for nearly 7 percent of the variance in the attitudinal composite scores at age 14. Maternal qualification accounted for 5.9 percent of the variance in the attitudinal composite at 14, and attitudinal composite scores increased with higher maternal qualification levels. Family income accounted for 6.5 percent of the variance in the attitudinal composite at 14, and attitudinal composite scores generally increased with increasing family income levels.

### *Length of ECE experience*

The time spent in early childhood education accounted for 4.7 percent of the variance in age-14 scores for the attitudinal composite ( $p = 0.002$ ).

With the attitudinal composite at age 5 included in the model, the association with age-14 scores remained significant ( $p = 0.001$ ) with those who spent over 4 years altogether in ECE scoring significantly higher on average than those who spent less than 4 years in ECE. The proportion of variance accounted for by the model was 11.4 percent, with ES for length of ECE experience of 6.8 percent.

When maternal qualification was incorporated into the model, the length of ECE experience remained significant ( $p = 0.006$ ), with those who were in ECE the longest (over 48 months) scoring more highly on the attitudinal composite at 14 than others. The same pattern was observed when adding family income to the model ( $p = 0.003$ ). The significant contrast was between the group that spent over 4 years in ECE and the group that spent less than 2 years. As length of ECE experience increases, so do the attitudinal composite scores at 14.

Length of ECE experience still has a small effect on attitudinal scores at age 14. This effect is over and above that of a similar measure at age 5, maternal qualifications, and family income (in spite of the association between length of ECE experience and the child's mother returning to work, which in turn has associations with maternal qualification and family income).

Table 18 **Length of ECE experience and attitudinal composite scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	12.7	14.4
ES for age-5 score (%)	5.1	5.8
ES for social characteristic (%)	3.6	5.1
ES for ECE variable (%)	5.1	5.6

### *ECE socioeconomic mix*

The socioeconomic mix of the last ECE centre attended accounts for 5.5 percent of the variance in attitudinal composite scores at 14 ( $p = 0.0005$ ).

This association remains significant when fitted after the age-5 attitudinal composite score ( $p = 0.004$ ). Those who attended middle-class ECE centres had better average scores on the attitudinal composite score at age 14 than others. The proportion of variance accounted for by the model was 11.9 percent, with ES for ECE socioeconomic mix of 7.5 percent.

When allowing for maternal qualification, the effect of differences in ECE socioeconomic mix became indicative ( $p = 0.041$ ), as it did when allowing for family income ( $p = 0.025$ ).

Socioeconomic characteristics of a child's world at age 5 still have an impact on their attitudinal scores at age 14. A small amount of this impact can be attributed to the ECE socioeconomic mix, and the rest to the socioeconomic characteristics of the home (maternal qualification and family income).



Table 19 **ECE socioeconomic mix and attitudinal composite scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	11.1	12.6
ES for age-5 score (%)	5.0	5.9
ES for social characteristic (%)	2.4	2.6
ES for ECE variable (%)	3.4	3.9

**Staff guide children in activities**

This aspect of ECE quality accounted for 4.5 percent of the variance in attitudinal composite scores at 14 ( $p = 0.002$ ).

Allowing for attitudinal composite scores at age 5, this association remained significant ( $p = 0.0004$ ). There were no interactions. The proportion of variance accounted by the model was 12.1 percent with ES for staff guidance of children in activities of 7.5 percent.

Allowing for maternal qualification, the quality measure remained as a significant main effect ( $p = 0.006$ ). There were no interactions. Those who had attended ECE centres with the highest ratings for staff guidance of children in centre activities scored higher than the lowest and next-to-lowest-rated quartile groups ( $p = 0.001$  and  $p = 0.006$  respectively). The pattern is linear in that higher ratings in this quality measure appear to result in higher scores in the attitudinal composite at 14. Allowing for family income, this aspect of quality also remained as a main effect ( $p = 0.004$ ). Significant contrasts were again between the group who attended top-rated ECE services and the two groups with ratings below the median.

Table 20 **ECE staff guide children in their activities and attitudinal composite scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	12.8	14.2
ES for age-5 score (%)	5.5	6.3
ES for social characteristic (%)	4.1	4.5
ES for ECE quality variable (%)	5.2	5.5

**Staff are responsive to children**

The responsive quality measure accounts for 2.7 percent ( $p = 0.020$ ) of the variance in the attitudinal composite scores at 14—an indicative effect only.

Adding the attitudinal composite score at age 5 did not alter the overall effect of the quality measure on attitudinal composite scores at 14 ( $p = 0.015$ ). Those who had attended ECE centres that scored more highly for the degree of staff responsiveness to children appear to be scoring higher, on average, than others. The proportion of variance accounted for by the model was 9.2 percent, with ES for this ECE quality factor of 4.2 percent.

However, when either maternal qualification or family income were added, the effect of the quality measure was no longer statistically significant (effect sizes for the ECE quality variable of 2.6 percent and 2.9 percent in the models including maternal qualification and family income at age 5, respectively).

### Staff ask open-ended questions

This aspect of ECE quality accounted for 3.2 percent of the variance in the attitudinal composite scores at 14 ( $p = 0.010$ ).

Adding the attitudinal composite score at age 5 reduced the effect of the quality variable to an indicative level ( $p = 0.046$ ), with the significant contrasts being between the top and bottom quartile groups ( $p = 0.014$ ), and the bottom and third quartile groups ( $p = 0.042$ ). The proportion of variance accounted for by the model was 8.4 percent, with ES for this ECE quality factor of 3.2 percent.

When maternal qualification was added to the model, this quality aspect was no longer statistically significant. Adding family income also reduced this association below the indicative level overall, although those in the top-rated ECE services were still scoring more on the attitudinal composite at 14 than those who had attended centres with the lowest quality ratings ( $p = 0.036$ ).

Table 21 **ECE staff ask open-ended questions and composite attitudinal scores**

Variable	Social characteristics	
	Maternal qualification	Family income at age 5
$R^2$ for whole model (%)	9.9	11.5
ES for age-5 score (%)	3.5	4.2
ES for social characteristic (%)	4.6	5.4
ES for ECE quality variable (%)	1.8	2.3

## GENERAL PATTERNS

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 qualification. The size of the difference between those with 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 by 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 when 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 patterns found suggest some thresholds to aim for in order to use early childhood education to improve overall performance levels. Ensuring that ECE services that serve children from low-income homes could meet these thresholds would also help close the gaps between average scores for children from these homes and others, giving a more solid early foundation, and thus reducing the "long tail" of underachievement over time.

Key aspects of quality that could improve performance

*Staff responsive to children*

Threshold—higher scores for those whose final centre scored 4 or more on scale of 5

*Staff guide children in activities*

Threshold—higher scores for those whose final centre scored 4.2 or more on scale of 5

*Staff ask children open-ended questions*

Increases with centre score

Threshold: higher scores for those whose final centre scored 3.33 or more on scale of 5

*Staff join children in their play*

Threshold—higher scores for those whose final centre scored 4 or more on scale of 5

*Children can select activities from a variety of learning areas*

Threshold—higher scores for those whose final centre scored 5 out of 5 (attitudinal)

*Provision of print-saturated environment*

Threshold—lower scores for those whose final centre scored less than 3 on scale of 5

The overall length of early childhood education experience does not make a marked independent contribution after age-5 scores and family resources to the cognitive competencies. However, overall ECE length of experience appears to do so for the attitudinal competencies. There is a benefit to those who had 48 months or more, compared with those who had less than 24 months, and a benefit to those who started ECE between the ages of 1 and 2, and those who started after age 3. This would seem to support the desirability of the availability in all locations of accessible good quality ECE for at least 24 months, with children able to start before/around age 3 (c.f. in some areas, starting after age 4).



## 4. Discussion

The Competent Children, Competent Learners project offers the opportunity to see whether everyday early childhood education (other than the intervention programmes mentioned at the start of this report) can make a longer-term contribution. What we have found is that there are aspects of the interaction between staff and children that are associated with their competency levels at age 14, and which appear to be making a contribution to those levels over and above the contribution made at the time the participants were attending early childhood education. Length of ECE experience and the ECE socioeconomic mix appear to have both concurrent and additional contributions to children's attitudinal, rather than cognitive, competency levels.

Analysing the ECE factors by themselves accounts for around 3–7 percent of the variance in individual scores at age 14. Sundell (2000, p. 109) reported a similar range in an analysis of the relation between early childhood education quality variables and Swedish children's social and cognitive performance. Herrera, Mathiesen, Merino, and Recart (2005) found that the quality of Chilean children's early childhood education settings (using the ECERS scale) when they were aged 4 or 5 years accounted for 6.7 percent of the variance in their reading scores when they were age 8, in a model that accounted for 47 percent of the variance in reading scores. The model also included children's characteristics, family resources, and interaction with child (accounting for 20.4 percent of the variance), school, and social context variables.

NICHD ECCRN and Duncan (2003) in their summary of studies showing a relationship between observed child care quality and language and cognitive development when children were still in early childhood education, or shortly after, note that the relationship is modest, usually accounting for 5 percent or less of the variance in children's scores after taking into account family selection factors (usually socioeconomic).

Their own modelling from the NICHD\_SECC study, with a sample of 1364, established effect sizes of .04 to .08, and a linear relationship between ECE quality and children's cognitive outcomes, with higher effect sizes for ECE centre-based experience in children's third and fourth years. They note that the effect sizes for the NICHD study are lower than several other US studies of variation in child care quality, and lower than experimental studies of programmes for at-risk children. They suggest that this may be related to the narrower range of quality for the settings included in their study, or to their measure of child care quality, which focused on:

*...the sensitivity or responsiveness and affective quality of caregiver-child dyadic interactions. As such, it may be missing dimensions of quality more directly related to the educational content of the child care setting and to cognitive achievement outcomes for children, such as specific learning-focused exchanges, the curriculum, or available learning materials (NICHD ECCRN & Duncan, 2003, p. 1472).*

The effect sizes found for ECE factors were around half the size found for the prime factors of parenting and poverty. Vandell (2004, p. 396), concludes that "Against these benchmarks, one can conclude that effects associated with child care quality are meaningful."

In the Competent Children, Competent Learners study, we found that when family income or maternal qualification were taken into account, there was a reduction in the proportion of variance accounted for by some measures of ECE quality, length of ECE experience, and particularly the ECE socioeconomic mix. NICHD ECCRN and Duncan (2003) report a reduction by almost half after taking into account maternal qualification and the child's gender and ethnicity. Vandell (2004, p. 390) notes that while the use of multiple covariates "reduces the likelihood that obtained relations can be explained by omitted variables ...the strategy yields a conservative estimate of effects. Thus, investigators may be controlling for and thereby removing the very effects of interest." Our other analytical strategy to isolate the ongoing contribution of ECE after its

conclusion was to include children's performance at age 5. Vandell (2004) notes that this kind of analysis has less statistical power than controlling for demographic factors.

Bearing these caveats in mind, it is not surprising that the contributions we find from early childhood education to age-14 scores are in the modest range. Early number knowledge was found to account for about 40 percent of the variance in the age-14 mathematics score; the children's social characteristics each accounted for a fifth to a third as much (8–15 percent); and the ECE quality variables and length of ECE experience for a fifth to a third as much again (2.5–5 percent). The ECE factors were relatively less important than the other factors. Nonetheless, they are making a separate contribution, 9 years after the study participants moved on to school.

Early literacy scores accounted for 10–15 percent of the variance in the age-14 PAT Reading Comprehension score; the children's social characteristics accounted for a roughly equal proportion; and the ECE quality variables and length of ECE experience for a quarter to a half as much (2–5 percent).

The ECE quality variables made a more equal contribution to the age-14 attitudinal scores: the effect sizes for all three variables are all in the 2.5–6 percent range.

However, as Brooks-Gunn (2000) notes in relation to US research, this is notable in that it has persisted over time, and the level of contribution compares well with effects related to other aspects of education occurring later in children's lives. The NICHD ECCRN team noted that:

*Evaluations of the practical importance of research findings that are modest in magnitude are not straightforward, because effect size estimates are affected by measurement, design, and method (McCartney & Rosenthal, 2000). In the health domain, small effects are taken seriously. Consider the fact that the effect of aspirin on reducing heart attack is statistically very small ( $r^2 = 0.001$ , with corresponding  $r = 0.034$ ; Rosenthal, 1994), yet the findings have influenced medical practice (NICHD ECCRN, 2003, p. 1001).*

They concluded that:

*Even small effects, when experienced by many children, may have broad-scale implications for larger policy discussions (Fabes, Martin, Hanish, & Updergraff, 2000; Jeffrey, 1989). Indeed, the detected effects may have no implications for how any individual child should be cared for or how any individual family functions, but could have implications at broader levels concerning how classrooms, communities, and even societies operate (NICHD ECCRN, 2003, p. 1002).*

The aspects of ECE centre quality that we have found in this study to have long-lasting associations with literacy and mathematics are consistent with the key emphases of other research related to child development:

*Drawing from the literatures on both home and child care environments, the proximal processes that influence cognitive outcomes involve interactions with adults characterised by ample talking, turn taking during play, contingent and focused attention on the child, and rich opportunities for exploration (NICHD ECCRN & Duncan, 2003, p. 1455).*

Our findings are also consistent with research focusing on the concurrent or short-term contributions of early education. Pianta (2003)<sup>17</sup> refers to a range of US studies that:

---

<sup>17</sup> In this paper, Pianta outlines the background to a current US study developing tools for assessing classroom quality for the Pre-K–grade 3, making the case that assessment of the experiences of children is needed because “the technical adequacy (reliability, validity) of direct assessments for young children is widely recognised as lower than for older children, in large part because children's competencies are somewhat unstable and situationally dependent” (p. 3). Carr and Wylie (2004) also see value in assessing the “opportunity to learn” in relation to assessment of the new key competencies, partly for pragmatic reasons (the time it could take to appropriately assess children in a formative way), and partly to provide a tool for ongoing professional learning that can feed back into changes in teaching, but which could also be used to get national pictures of classroom experiences.

---

*...establish that the kind of instruction and interactions with adults that occur in pre-kindergarten and early elementary settings have reliable and detectable effects on children's achievement and social competence... Although much of this work has focused on pre-k, kindergarten, and first grade settings, recent studies clearly demonstrate that characteristics of child-teacher interactions, such as feedback and warmth, produce gains in children's performance in third grade classrooms as well... These findings strongly support the view that for young children, experiences in classrooms matter and that interactions between children and teachers are a primary mechanism through which classroom experiences have effects on development (Pianta, 2003, pp. 3–4).*

The Competent Children, Competent Learners study has found some continuing contribution at age 14 from children's ECE experience, which finished 9 years earlier. The aspects that appear to make this contribution are consistent with other research, in different contexts, and using different samples and methods of analysis. Thus we are confident that they are real, rather than an artefact of sample or analysis. They help deepen our understanding of what it is important to focus on in early childhood education practice, policy, and review.

Raising the quality of ECE staff guidance to the children they work with, their participation in the children's play, and the use of language (including the kinds of questions children are asked and therefore the kinds of thinking that they are called upon to practise and develop) all look like fruitful avenues to pursue in initial teacher education and professional development so that children are given the most opportunity to develop deep understandings and habits that will endure. This dimension is easily included with most professional development, for example, as it is with the current opportunities for ECE staff to work with the ECE exemplars for formatively assessing children's performance in relation to *Te Whāriki*. It should be a focus in external and self-reviews. (Some ECE centres have used the NZCER rating scale originally used in the Competent Children, Competent Learners study and further developed since to gauge their strengths and areas for further development, which helps set priorities rather than trying to do everything.)

Government policy that supports the ability of ECE staff to interact well with children, and supply sufficient experiences with print, should improve student performance overall. In terms of tackling gaps in performance between different social groups, and tackling the "long tail" of low levels of performance in New Zealand that somewhat shadows our relatively high average performance and proportion of high performers on international comparisons, it will be particularly useful to ensure that ECE services attended by children from low-income homes can offer high levels of staff-child interaction, and that policies to encourage and enable increased participation for these children ensure that they are attending services offering high quality.

---





## References

- Andersson, Bengt-Erik. (1993). *Long-term effects of early day care in relation to family type and children's gender*. Department of Child and Youth Studies, Stockholm Institute of Education.
- Barnett, W.S. (2002). Early Childhood Education. In Molnar, A. (Ed.), *School reform proposals: The research evidence*. Greenwich, Conn.: Information Age Publishing. Available at <http://www.asu.edu/educ/eps/EPRU/documents/EPRU%202002-101/Chapter%2001-Barnett-Final.pdf>. Downloaded 6 May 2005.
- Barnett, W.S., Lamy, C., & Jung, K. (2005). The effects of state prekindergarten programs on young children's school readiness in five states. National Institute for Early Education Research, Rutgers University, December 2005. Available at <http://nieer.org/resources/research/multistate/fullreport.pdf>. Downloaded 19 January 2006.
- Boocock, S.S., Barnett, W.S., & Frede, E. (2001). Long-term outcomes of early childhood programs in other nations: Lessons for Americans. *Young Children*, September, 43–50.
- Bridges, M., Fuller, B., Rumberger, R., & Tran, L. (2004). Preschool for California's children: Promising benefits, unequal access. PACE Policy Brief 04-3. Available at [http://pace.berkeley.edu/packard\\_foundation\\_study.html](http://pace.berkeley.edu/packard_foundation_study.html). Downloaded 6 May 2005.
- Broberg, A.G., Wessels, H., Lamb, M.E., & Hwang, C.P. (1997). Effects of day care on the development of cognitive abilities in 8-year-olds: A longitudinal study. *Developmental Psychology*, 33 (1), 62–69.
- Brooks-Gunn, J. (2000). 'Do you believe in magic?' What we can expect from early childhood intervention programs. Draft paper presented at Congressional research briefing, *Early childhood intervention programs: are the costs justified?* 10 May, Washington DC. Available at <http://www.tc.columbia.edu/academic/cyef>. Downloaded 2001 (specific date not recorded).
- Carr, M., & Wylie, C. (2004). Assessment of key competencies in school entry assessment. Position paper for the Ministry of Education. (Unpublished)
- Currie, J. (2000). *Early childhood intervention programs: what do we know?* Joint Center for Poverty Research paper. Available at <http://www.jcpr.org>
- Fergusson, D.M., Horwood, L.J., & Lynskey, M.T. (1994). A longitudinal study of early childhood education and subsequent academic achievement. *Australian Psychologist*, 29 (2), 110–115.
- Goodman, A., & Sianesi, B. (2005). Early education and children's outcomes: How long do the impacts last? Institute for Fiscal Studies, July 2005. Available at [http://www.ifs.org.uk/docs/ee\\_impact.pdf](http://www.ifs.org.uk/docs/ee_impact.pdf). Downloaded 19 January 2006.
- Gormley, W.T. Jr, Gayer, T., Phillips, D., & Dawson, B. (2005). The effects of universal Pre-K on Cognitive Development. *Developmental Psychology*, 41 (6), 872–884. Available at <http://www.apa.org/journals/releases/dev416872.pdf>. Downloaded 19 January 2006.
- Helburn, S. (Ed.). (1995). *Cost, quality, and child outcomes in child care centers: Technical report*. Denver: University of Colorado at Denver, Department of Economics: Center for Research in Economic and Social Policy.
- Herrera, M.O., Mathiesen, M.E., Merino, J.M., & Recart, I. (2005). Learning contexts for young children in Chile: Process quality assessment in preschool centres. *International Journal of Early Years Education*, 13 (1), 13–27.
- Karoly, L.A., & Bigelow, J.H. (2005). *The economics of investing in universal preschool education in California*. Santa Monica, CA: Rand Corporation. Downloaded 20 April 2005 from [www.rand.org](http://www.rand.org)

- Kontas, S., & Wilcox Herzog, A. (1997). Teachers' interactions with children: why are they so important: Research in review *Young Children*, 52 (2), 4–12.
- Langlois, J.H., & Liben, L.S. (2003). Child care research: An editorial perspective. *Child Development*, 74 (4), 969–975.
- Loeb, S., Bridges, M., Bassok, D., Fuller, B., & Rumberger, R. (2005). How much is too much? The influence of preschool centres on children's development nationwide. Paper presented at the Association for Policy Analysis and Management, Washington, D.C., 4 November, 2005; to be published in *Economics of Education Review*. Available at [http://gse.berkeley.edu/research/PACE/Stanford\\_Berkeley\\_pr23DA13.doc](http://gse.berkeley.edu/research/PACE/Stanford_Berkeley_pr23DA13.doc). Downloaded November 2005.
- Love, J.M., Harrison, L., Sagi-Schartz, A., van Ijzendoorn, M.H., Ross, C., Ungerer, J.A., Raikes, H., Brady-Smith, C., Boller, K., Brooks-Gunn, J., Constantine, J., Kisker, E.E., Paulsell, D., & Chazan-Cohen, R. (2003). Child care quality matters: How conclusions may vary with context. *Child Development*, 74 (4), 1021–1033.
- Magnuson, K.A., Meyers, M.K., Ruhm, C.J., & Waldfogel, J. (2004). Inequality in preschool education and school readiness. *American Educational Research Journal*, 41 (1), 115–157.
- Mitchell, L., & Cubey, P. (2003). *Characteristics of professional development linked to enhanced pedagogy and children's learning in early childhood settings: Best evidence synthesis*. Wellington: Ministry of Education. Available at [www.minedu.govt.nz](http://www.minedu.govt.nz)
- Montes, G., Hightower, A.D., Brugger, L., & Moustafa, E. (2005). Quality child care and socio-emotional risk factors: No evidence of diminishing returns for urban children. *Early Childhood Research Quarterly*, 20, 361–372.
- Munton, T., Mooney, A., Moss, P., Petrie, P., Clark, A., & Woolner, J. (2002). *Research on ratios, group size and staff qualifications and training in early years and childcare settings*. London: Department for Education and Skills, Research report RR320.
- Nabuco, M.E.M. (1997). *The effects of three early childhood curricula in Portugal on children's progress in the first year of primary school*. PhD, Institute of Education, University of London.
- NICHD ECCRN (Early Child Care Research Network). (2003). Does the amount of time spent in child care predict socioemotional adjustment during the transition to kindergarten? *Child Development*, 74 (4), 976–1005.
- 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.
- OECD. (2004). *Learning for tomorrow's world—first results from PISA 2003*. Paris: Author.
- Pianta, R.C. (2003). Standardised classroom observations from Pre-K to Third Grade: A mechanism for improving quality classroom experiences during the P-3 years. Downloaded 5 May 2005, from <http://www.ffcd.org/uploadDocs/Standardizedclrmobsfrompre-kto3rdFINAL.doc>
- Ramey, C.T., & Ramey, S.L. (2004). Early learning and school readiness: Can early intervention make a difference? *Merrill-Palmer Quarterly*, 50 (4), 471–491.
- Sammons, P., Sylva, K., Melhuish, E., Siraj-Blatchford, I., Taggart, B., Elliot, K., & Marsh, A. (2004). *The continuing effects of pre-school education at age 7 years*. Institute of Education, London University, EPPE Project, Technical paper 11.
- Schweinhart, L.J., & Weikart, D.P. (1997). *Lasting differences, the High/Scope preschool curriculum comparison through age 23*. Ypsilanti, Michigan: High/Scope Press.
- Smith, A.B., Grima, G., Gaffney, M., Powell, K., Masse, L., & Barnett, S. (2000). *Early childhood Education—literature review for the Ministry of Education*. Dunedin: Children's Issues Centre, University of Otago.

- Sundell, K. (2000). Examining Swedish profit and non-profit child care: The relationships between adult-to-child ratio, age composition in child care classes, teaching, and children's social and cognitive achievements. *Early Childhood Research Quarterly*, 15 (1), 91–114.
- Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2004). *Effective pre-school education*. Institute of Education, London University, EPPE Project.
- Sylva, K., Sammons, P., Melhuish, E., Siraj-Blatchford, I., & Taggart, B. (1999). *An introduction to the EPPE project technical paper 1*. London: Institute of Education, University of London.
- Vandell, D.L. (2004). Early child care: The known and the unknown. *Merrill-Palmer Quarterly*, 50 (3), 387–414.
- Votruba-Drzal, E., Coley, R.L., & Chase-Lansdale, P.L. (2004). Child care and low-income children's development: Direct and moderated effects. *Child Development*, 75 (1), 296–312.
- Whitebook, M. (2003). Bachelor's Degrees are best: Higher qualifications for pre-kindergarten teachers lead to better learning environments for children. Research review for the Trust for Early Education. Accessed on 6 May 2005 from [www.trustforearlyed.org](http://www.trustforearlyed.org)
- Wylie, C. (2003a). Longitudinal research: The Competent Children project. In C. Davidson & M. Tolich (Eds.), *Social science research in New Zealand*, 2<sup>nd</sup> edition, (pp. 217–228). Auckland: Pearson Education New Zealand Ltd.
- Wylie, C., Thompson, J., & Kerslake Hendricks, A. (1996). *Competent children at 5—families and early education*. 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.
- Young-Loveridge, J., Carr, M., & Peters, S. (1995). Enhancing the mathematics of four-year-olds. The EMI-45 study. Hamilton: University of Waikato.

