



Numeracy in the early years

Project Good Start

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A project funded by the Australian Government through the Department of Education, Science and Training, and conducted by the Australian Council for Educational Research (ACER).

A major policy objective of the Australian Government is to provide all young people in Australia with strong foundational skills in literacy and numeracy. To this end, Project Good Start was funded under the Australian Government's Numeracy Research and Development Initiative to investigate the practices and learning experiences that support the early numeracy development of a sample of children in the year before school and the first year of schooling. The key questions under investigation were:

- How can effective numeracy programs be identified at both the year before school and in the first year of school, and
- What constitutes evidence of effectiveness?

In order to address these questions, the approach taken by Project Good Start was to profile children's numeracy development at the beginning and the end of their pre-school year and at the beginning and end of their first year of school. By doing this, we were able to gauge children's numeracy development due to the pre-school's program, and due to the school's early years' program.

Further information about the project can be found in the Final Report for the project which can be accessed through the Department of Education Science and Training website at:

www.dest.gov.au/sectors/school_education/publications_resources/default.htm#Publications

from the ACER website at:

www.acer.edu.au/research/projects/goodstart

or by contacting the project manager:

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What did Project Good Start do?

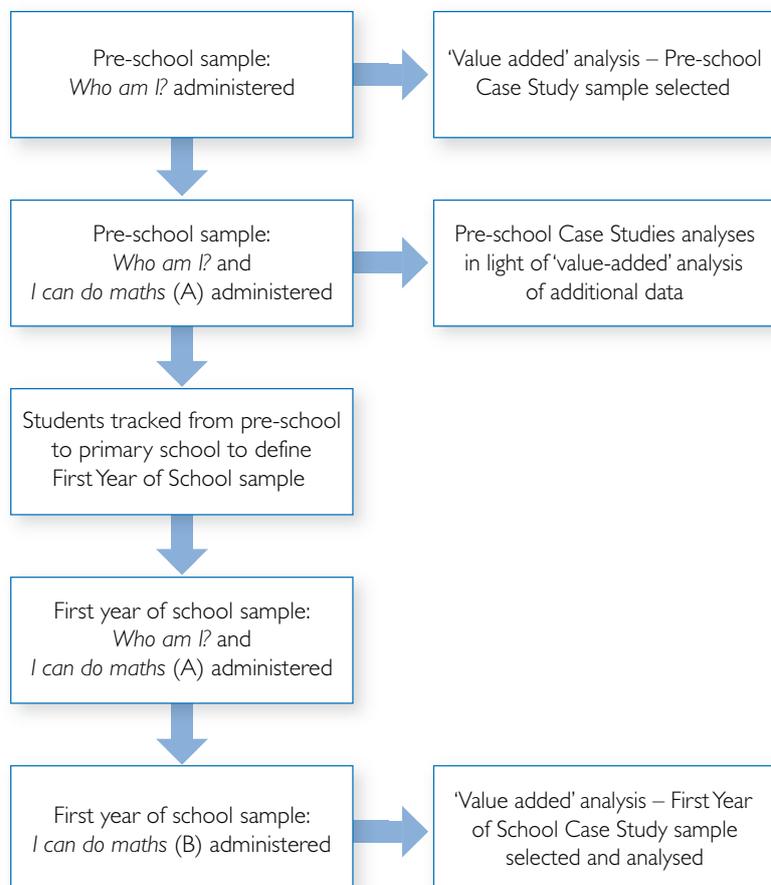
The aim of *Project Good Start* was to collect information from pre-schools, early childhood centres and day care centres and primary schools, and to visit a number of pre-school and first year of school sites to examine evidence about current practices in early years numeracy programs and compare this information with that obtained from the assessment data collected.

Project Good Start collected data in a range of ways. Children's numeracy skills were assessed, surveys were provided to teachers, pre-schools, schools and parents and observational data was also collected. These data combine to capture a rich picture of numeracy in the year before school and in the first year of school.

Two instruments were used to profile children's numeracy skills: *Who am I?* which is a developmental instrument requiring children to copy geometric shapes, write some numbers, letters of the alphabet, words, a simple sentence and draw a picture of themselves, and *I can do maths*, which requires children to

write, draw, count and measure, typically in the areas of number, measurement and space. Both instruments were initially developed for other projects to assess different aspects of learning in the early years of schooling, but through this project have been found to be age appropriate for examining aspects of learning in the year before school. Some examples of items used on each of these instruments can be seen in Figure 1 and Figure 2.

The statistical techniques used to analyse the data allowed the researchers to calculate the value-added component of the pre-school or school setting. This analysis plots student achievement after the influences of the students' home background and prior achievement have been accounted for. The standardised residuals calculated indicate how much better, or worse, the group of students has performed than what would be expected given their family backgrounds and prior achievement. Most pre-school centres and schools performed as would be expected, however.



g p 10

A sample of pre-school centres and first year of school classes were visited to provide further observational data and documentation. These samples were selected so as to represent schools which

had done better than expected, not as well as expected, and a few that had done as we would have expected, so that a range of strategies for teaching numeracy could be examined.

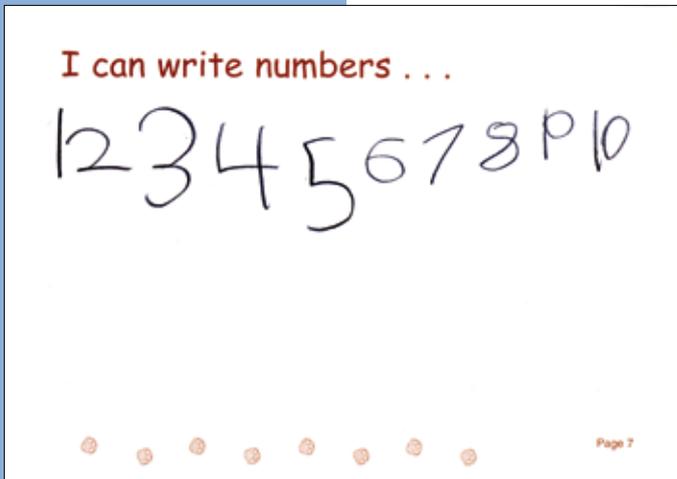


Figure 1: Example of item from *Who am I?*

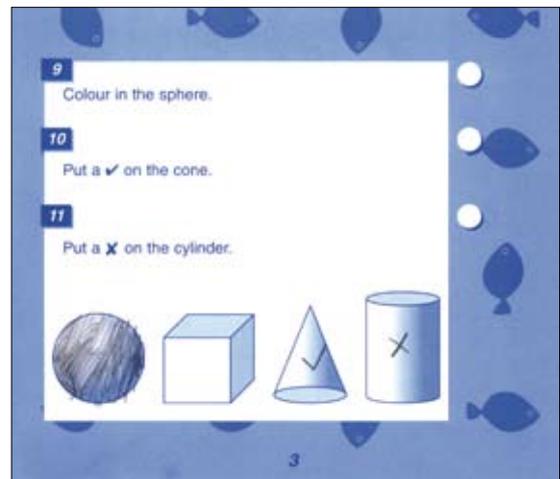


Figure 2: Example of item from *I can do maths*

55 pre-school centres and 26 Child care Centres, and 1615 children, participated in the first phase of the project.

1620 children from 44 schools, including 231 from the year before school sample, participated in the second phase of the project.

All States and Territories participated in the study.

Numeracy was a term not clearly defined for the preschool teachers in this study. Mathematics was a more familiar term but considered by some to be inappropriate at the pre-school level.

Despite State curriculum frameworks, these often lacked sufficient detail, guidelines or activities for teachers who lacked experience or confidence with numeracy.

Who participated in Project Good Start?

Eighty-one pre-school and early childhood Centres (55 pre-schools/kindergartens and 26 Child Care Centres) participated in the first round of data collection for the project. These Centres provided background information on the children sampled (about 25 in each Centre), information on the numeracy practices of the Centre, and collected information from *Who am I?* and *I can do Maths*. Data were collected for 1615 children in their year before school, representing all states and territories of Australia.

As many children as possible from the year before school sample were tracked into their primary schools. To obtain a context for the classes these children were working in, their whole class was then taken as the sample for the first year of school. Altogether, 1620 children from 44 schools participated in the study in the first year of school, including 231 children from the year-before-school sample. Children once again completed *Who am I?* and *I can do Maths* at the beginning of this year, and then *I can do Maths* at the end of the first year of school.

Numeracy in the year before school

The pre-school centres involved in the case study site visits tended to fall into two categories in terms of the emphasis they placed on numeracy development within their centre's overall philosophy. The importance of play was a main focus in the philosophy of many centres. These centres tended to introduce numeracy concepts in a subtle form, through play activities in which the children were not aware they were learning concrete numeracy skills and concepts. While this can be achieved, if the teacher is good enough, it is also true that for a number of centres this resulted in children not achieving at particularly

high levels on *I can do Maths*. It may be that learning numeracy in this manner needs very careful scaffolding, as the higher achieving centres had a focus on more structured play and activities involving numeracy games and concepts.

In some other centres, numeracy was integrated into the daily programme in a more formal manner in preparation for school, including through the examination of numeracy in the every day world. This does not necessarily mean that children were taught numeracy in a regimented manner, but more that the philosophy of

Pre-schools with well-developed and structured numeracy programmes achieved better numeracy outcomes.

The children in this study continually surprised teachers and researchers by the numeracy they knew and could do. This was often due to the incidental learning that had occurred at home but also due to a lack of specific numeracy assessment data and low teacher expectation.

In higher-achieving Centres there were frequent and high-level verbal interactions between staff and children.

In those cases when school teachers and principals were asked about the 'value' of pre-school assessment information, the responses were disappointing. Typical of responses was: 'We prefer to begin at the beginning, rather than make assumptions about children's prior achievement progress and development'.

the centre included embedding numeracy explicitly into the daily programme.

Generally the Centres that performed well had well-developed and structured numeracy programmes that were purposeful and outlined the educational content as it related to numeracy acquisition, such as the key principles of the goals, and statements of intention and intended achievements. Documentation also covered the key areas of numeracy that the children would be exposed to in preparation for school readiness, such as: counting, shapes, size, length, weight, sorting, and sequencing.

Staff in higher performing Centres believed that numeracy skills need to be developed extensively and systematically, and worked towards this goal by careful planning and with a structured programme. These Centres had well defined plans, goals and structures in place that clearly defined what type of numeracy learning experiences the children would be exposed to. At the same time well-developed programmes allowed flexibility to cater for the needs of each child and different interests.

Many of the teachers at the higher-achieving Centres spoke of the high expectations of their children's achievement. This was frequently in association with high expectations of the parents of the children.

Most Centres visited were well resourced, although there was a wide range in both quantity and quality of resources, particularly between Centres with a large quantity of commercial resources and those with a large quantity of 'home-made' resources.

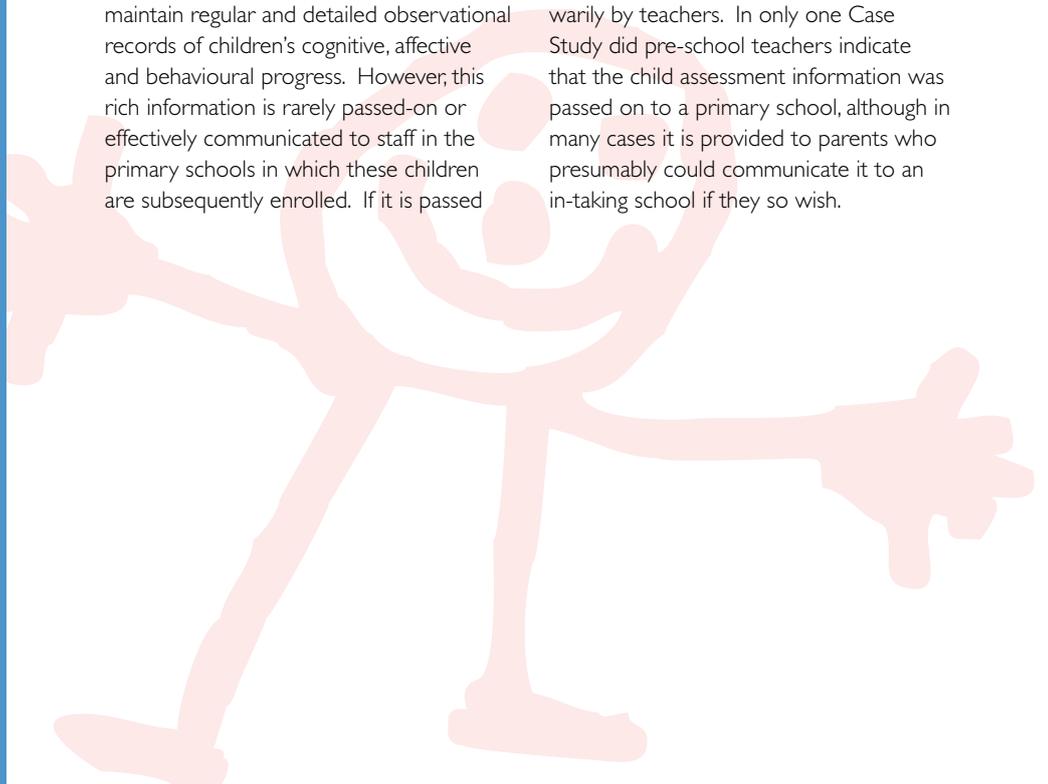
At most Centres, but more so in the higher achieving Centres, there was a great deal of verbal interaction between the staff and children. In the higher achieving Centres there was a higher level of interaction with regards to numeracy, in that teachers used the language of mathematics frequently and in a natural way. The quality of the interactions between teachers and children in numeracy was quite evident at these Centres, as was the confidence with which the teacher approached the teaching of numeracy.

I can do maths was first given to children to complete at the end of the year before school. This instrument showed that far from having low levels of numeracy at this stage of their schooling, some students were really quite adept. For instance, most students understood concepts of 'smaller', 'more', 'longest', and 'shortest', but substantial proportions (more than one-third of children) could also answer far more complex items such as 'put a ✓ on the shape that makes the side of the cube'. It was a surprise to many of the pre-school teachers that students generally did well on this task.

Transition from pre-school to school

In most cases examined, pre-school staff maintain regular and detailed observational records of children's cognitive, affective and behavioural progress. However, this rich information is rarely passed-on or effectively communicated to staff in the primary schools in which these children are subsequently enrolled. If it is passed

on, it is often underestimated or treated warily by teachers. In only one Case Study did pre-school teachers indicate that the child assessment information was passed on to a primary school, although in many cases it is provided to parents who presumably could communicate it to an in-taking school if they so wish.



Numeracy in the first year of school

Teachers at both year levels need extensive professional development aimed at both numeracy and the Early Years; they were implementing their school's high priority numeracy plan in practical ways. Many first year of school teachers reported not having the opportunity to participate in high quality professional development within the last two years.

High-achieving schools conducted detailed and regular planning in teams linked clearly to learning outcomes in Curriculum documents, which was not at the expense of creativity.

A variety of both formative and summative assessment techniques should be used to measure students' progress, and information collected used to report to parents and inform teaching practice.

Parents of students in high achieving schools were likely to have high to very high expectations, and were more likely to be willing and able to participate actively in the school's numeracy programmes.

Schools appear to have identified and made Early Years literacy and in many cases numeracy a priority. Literacy, however, appears to be given particular priority. It is apparent, however, that the high achieving schools were more able to clearly articulate their numeracy goals and could point to specific numeracy programmes such as 'daily, focussed one-hour numeracy sessions' or extra events such as the Maths Olympiad and Maths Competitions. These schools appeared to have been giving numeracy, or rather Mathematics, more of a focus and a higher priority.

High achieving schools were more often able to describe how detailed and regular planning was undertaken. Often this planning was undertaken in Early Years teams. Teachers in the higher achieving schools related lesson planning well to State Curriculum documents, and it was also common for these teachers to emphasise that they also look for ways to integrate numeracy into themes or other aspects of the curriculum. They did not let their planning stifle creativity. Perhaps their detailed planning meant that they were well-prepared or 'sensitised' to take advantage of interesting, numeracy 'rich' opportunities as they arose naturally. In contrast, teachers at the lower achieving schools tended to work more in isolation and were more inclined to plan 'in their head' or in minimal detail.

Teachers in high achieving schools were able to describe in detail not just how they assessed their students' progress but also why they did and how they made use of the information collected. It was clear that they used a variety of techniques covering both formative and summative assessment. They also used regular and formal assessment tasks related to Learning Outcomes described in State Curriculum documents in order to report progress to parents. School Entry Assessment

and Early Years Interviews were valued by teachers in higher-achieving schools because of their structure, the information they provided and the way they clearly pointed to the follow up teaching needed. In contrast, teachers in lower achieving schools were less likely to be able to describe a range of assessment strategies, were more likely to rely on observations and memory and appeared to give assessment a lower priority in their daily practice. School Entry Assessment information was often completed but filed away rather than used to inform practice.

The parents of children in high achieving schools were likely to have high to very high expectations, were more likely to be willing and able to participate actively in the school's numeracy programmes and more likely to be encouraged and given training in how to effectively assist in the classroom.

Achievement in numeracy in the early years of school is not apparently related to the child's gender: Males and females achieved equally well on *I can do maths*, and growth was similar for both. However there were significant differences in achievement by socioeconomic level, with those from a high socioeconomic level outscoring those from a low socioeconomic level, although entry to school appears to have begun to close that gap, emphasising the value of pre-school education for *all* children.

The most disappointing finding was the wide gap between the numeracy achievements of those children from Indigenous Australian backgrounds and those from non-Indigenous backgrounds (given the caveat that numbers of Indigenous children were very low in this study). Unfortunately, according to numeracy data from later in primary school and secondary school provided by national surveys such as PISA and TIMSS, this gap continues to widen.

Earlier reference publications

Two publications have preceded the final report. The first, 'A good start to numeracy' presents a review of the international and Australian research literature on numeracy in early childhood. This review was designed to provide early childhood professionals and parents with a basis for identifying effective numeracy strategies. The second, 'Current strategies in numeracy' documents current strategies in the Government and Catholic sectors in each of the eight Australian states and territories. Both are available from the ACER Project Good Start web site (www.acer.edu.au/goodstart).