An Australian Project Which Links Mathematics Assessment and Teaching in Grades K-2

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Abstract
In this paper, I describe some of the early experiences of the Early Numeracy Research Project (ENRP), a professional development and research project in 35 schools in Victoria, Australia, in grades K-2. 230 teachers have been using information collected during a 40-minute interview with Kindergarten to Grade 2 students to inform planning and teaching for individuals, small groups and the whole class. The interview was based on a mathematics framework of "key growth points" in children's mathematics learning. The experience so far with ENRP indicates that the use of the one-to-one interview by classroom teachers with individual students provides powerful information on the mathematics children know and can do. The paper outlines the background of the project, some comments from teachers regarding highlights and surprises which emerged from the interview, and examples of classroom ideas and activities which teachers have developed using what they found.

Trends in Maths Assessment
In the 1980s in Australia, an increasing consensus emerged among classroom teachers that traditional forms of assessment were inadequate in meeting all the revised goals which teachers held for assessment. The argument was that if we value genuine understanding, problem solving and group skills, and the ability to use mathematics in "real" situations, then we needed to broaden the repertoire of assessment techniques from the classic pen and paper test, combining "informal" assessment with a greater range of formal methods of assessment.

Consequently, the late 1980s saw an increased emphasis on the use of anecdotal records, checklists, portfolios, student self-assessment and so on. These assessment alternatives continue today, with teachers refining them in light of experience.

In the 1990s, issues of accountability at classroom, school and system level brought a greater emphasis on nominating desired outcomes and ways of collecting, documenting and reporting student growth over time.

Irrespective of how these trends are viewed, much has been learned about assessment in the process. Unfortunately for the busy teacher, it remains true that the easier a given form of assessment is to use, the less useful the information it is likely to provide. The challenge remains therefore to make assessment meaningful but at the same time manageable. The experience of the ENRP is that the use of one-to-one interviews with children, if properly resourced, can be both meaningful and manageable.

A Brief Overview of The Early Numeracy Research Project
Teachers and children from 35 schools (28 Department of Education schools, 4 Catholic schools and 3 Independent schools) are part of the Early Numeracy Research Project for the next three years (1999-2001), in conjunction with Australian Catholic University and Monash University. This project follows the highly successful Early Literacy Research Project. The aims of the project include:

- to work with teachers to explore their beliefs and understandings about how students develop their understanding of numeracy, and how this can be supported through the teaching program; and
- to evaluate the effect of the professional development program on student numeracy outcomes.

[1] I acknowledge with thanks the ideas reflected in this paper from classroom teachers and fellow project staff in the Early Numeracy Research Project.

The Early Years Numeracy Coordinator and the teachers at Kindergarten to Grade 2 form the "professional learning team" at each school. Such teams meet weekly to share experiences and to plan programs together. Geographical clusters of learning teams from the 35 schools meet monthly, and all teachers in the project (around 230) meet as a large group several times a year. Each team and cluster is supported by one or more university staff and staff from the Early Years of Schooling Branch of the Department of Education (Victoria) who will have close and regular involvement in classrooms and cluster meetings.

The project team has used the research literature and the advice of recognised experts to create a "framework" for early years numeracy learning, with a particular emphasis on key "growth points" in children's understanding of mathematics. Growth points have been established in key areas of number and measurement, including Counting, Place Value, Time and so on.

Every child will be interviewed for approximately 30-40 minutes by their regular classroom teacher in March and November each year, in order to determine the level of growth in understanding across the year.

Over the course of the project, the research team will identify those teaching approaches and school and classroom structures which are most effective in supporting maths learning in the early years. These can then be shared with all the teachers and schools in the state. Cluster coordinators and teachers are also working with parents to discuss the kinds of everyday family activities which can support the work of the teacher and school in maths, and give children a positive and confident start in their maths learning.

The Power of the One-To-One Interview in Informing Planning and Teaching

Early in 1999, a task-based interview was developed by the research team, piloted and trialled for use in the ENRP. To this point, the mathematical focus of the interview has been on Number and Measurement, with Geometry/Space and Probability and Statistics tasks to be added in 2000. The interview takes the form of a "choose-your-own-adventure", in that depending upon children's responses to a particular task, the teacher may choose to skip some of the subsequent tasks, or take a small detour into other tasks which probe further conceptions or misconceptions revealed in the previous task.

Tasks in the interview are tightly linked to the growth points mentioned earlier. Student responses therefore provide the opportunity for teachers to gain a sense of whether children have "reached" particular growth points.

An example is probably helpful in illustrating the "choose-your-own-adventure" nature of the interview, and its relation to the growth points. In one task, the child is asked to use a plastic cup to take a large scoop (approximately 20) of plastic teddy bears, the kind of teddies increasingly used for maths tasks in P-4 classrooms. The child is then asked to *estimate*, without counting, how many are in the scoop. They are then asked to *count* the teddies.

If the child can successfully count a collection of 20 or more objects, they can be considered "rational counters", and move into a range of tasks, involving counting forwards and backwards starting from varying points, and then into increasingly complicated skip counting. If they are unable to count the cup of teddies, they take a detour into a different set of tasks, which provide information on ordinal number, one-to-one correspondence, conservation of number, and patterning.

So, as a result of the interview, the teacher builds up a picture of the child's understanding of a range of key mathematical ideas, and is well placed to plan instruction for individuals, small groups and the whole class. Meetings of school professional learning teams, regional cluster

meetings, and statewide professional development programs enable these insights to be shared with colleagues, and for the "wisdom of practice" to be shared.

Highlights and Surprises From the Interviews as Identified by ENRP Teachers

Following the completion of the interviews in March, teachers were asked to write about highlights and surprises that had emerged from the interview process. Although many themes emerged, I will focus here on five of particular interest.

1. Surprise at What Many Children Were Able To Do.

Many of the surprises related to children's capacity to deal confidently with large numbers, and the wide variety of strategies used in solving the problems.

- Working with a gifted Kindergarten child who actually worked out the answers quicker than I did. Reading 24,746,154 on the calculator. Amazing!
- I have one grade 2 student in my P/1/2 class whom I know loves maths—number in particular. He worked out the answer for 134 and 689 in his head. This child was able to articulate all the strategies he used.
- My greatest surprise was that most children performed significantly better than I anticipated. Their thinking skills and strategies were more sophisticated than I expected.
- Some of the children who have a "lesser" understanding of numbers (and often literacy) were often more astute in the measurement activities.
- The fact that nearly all the Kindergarten children used a "counting-on" strategy; most said "because that's how the grade 1's do it!"

2. Surprise at The Difficulties Which Some Children Had With Certain Tasks.

Tasks involving multiplicative reasoning (e.g., putting two teddies in each car or sharing teddies between "teddy mats") surprised teachers with the difficulty children displayed, as did some of the tasks relating to concepts of time.

- A child of great potential, perhaps gifted, completed nearly the entire interview in all areas, but we found out he couldn't tell the time!
- Difficulty in counting backwards for some children was a surprise.
- I was amazed that many of my students had no logical system when naming the days of the week, or the months of the year. They just randomly stated days with no way of checking.
- One child in grade 2 who was mathematically skilled with numbers and very aware of them, was completely floored when he had to share the teddies evenly on the teddy mats. He tried every possible way and could not work it out.
- Some children tested could not explain their process of working "things" out and yet these children appeared to be very "able" in usual classroom activities.
- The greatest surprise from the assessment interview process was discovering that the children who you thought had specific concepts, in fact couldn't use these/didn't have them in a one-to-one situation—that they were good at "hiding" within the group.
- The other surprise was how few children had the ideas of early division.

3. The Emergence of The Quiet Achievers, Particularly Girls.

Several teachers commented that the interview with individual children "painted" a different picture from that which emerged during whole class and small group classroom activities.

- Finding out the ability of some of my quieter students amazed me. Being given a chance to answer a question they knew without another student interrupting them was very rewarding for them. But it was also exciting for me to see what ability they had.

- In every grade there is that quiet child you feel that you never really "know"—the one that some days you're never really sure that you have spoken to. To interact one-on-one and really "talk" to them showed great insight into what kind of child they are and how they think.

4. The Power of the Interview Data in Informing Teaching.

Many teachers indicated that the information provided by the interview suggested "starting points" for instruction.

- The greatest highlight of all is to be able to clearly see where the child is at and what maths work needs to be worked on to further enhance his skills.
- I was very surprised with how much many of the children knew and how many different, complex strategies were being utilised in order to work at the answers to the many open ended problems. It has been an eye-opener and I have since based a lot of my own teaching on the results gained.
- My greatest surprise(s) was the wealth of information gained from the assessment interview—how confident the children were in responding to a neverending supply of questions … and how I've been about to "use"(adapt) some of the ideas into my classroom practice.

5. The Level of Enjoyment and Confidence Displayed By the Children During The Interview.

We can sometimes be preoccupied with children's cognitive growth, with insufficient attention paid to affective aspects. The enjoyment showed by almost all children during the interview, whether their mathematical understanding was high or not so high was important. It emphasises that children appreciate the opportunity to show their understanding, particularly when they have the teacher all to themselves.

- How enjoyable for both teacher and child. It gave the children the opportunity to spend individual time with the teacher and the children responded positively. Many couldn't wait for their turn and chatted away during the interview.
- How adaptable/patient and flexible young children can be when working under difficult conditions, and how resilient teachers are after sitting on a small chair for 2 days!
- I have a child with cerebral palsy who is in a wheelchair and has limited motor skills. He was determined to do all the tasks without help from his aide and he did. The look on his face when he completed each task was amazing.
- My highlight was when the children tried to explain how they worked out their answer. Several said "my brain told me". The best one was "my mum told me the answer would be that".
- The greatest highlight was that no matter at what level the children were operating mathematically, <u>all</u> children displayed a huge amount of confidence in what they were doing. They absolutely <u>relished</u> the individual time they had with you; the personal feel, and the chance to have you to themselves. They loved to show what they can do.

On a humorous note, a favourite anecdote from the interviews was the following comment from a Kindergarten teacher: Children had been asked to "draw a clock", for use as a basis of discussion of their understanding of how time and clocks work. The teacher takes up the story: "I asked the child 'What are the numbers on the clock doing?' The child looked strangely at me and said 'the numbers are doing nothing, they are waiting for the arrows to come around. Don't you know that? Are you stupid or something?'"

Linking Assessment and Teaching

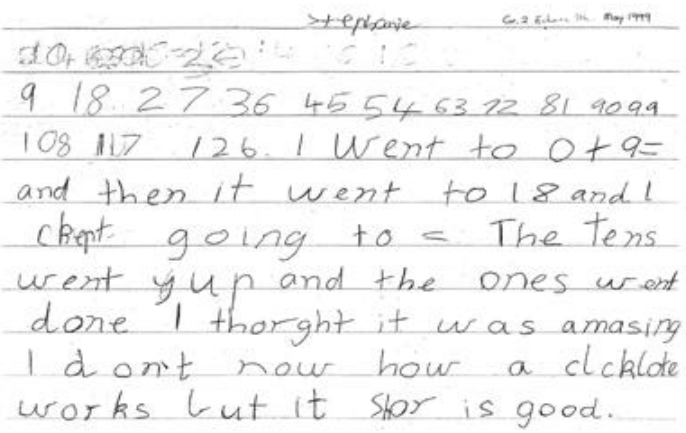
Since the interview period in March, ENRP teachers have been using what they found to plan classroom activities which help children move towards the growth points. Some examples from

teachers at Anglesea, Echuca South, Mandama and Ocean Grove Primary Schools illustrate the purposeful choice of activities, with clear links to important maths ideas.

Ordering Numbers. One teacher noticed from the interviews that many of her Grade 1 children could read, write and interpret two and three digit numbers, but they had considerable difficulty when it came to ordering them. She asked children to cut out numbers from a variety of catalogues, and to order them, thus focusing on this important idea.

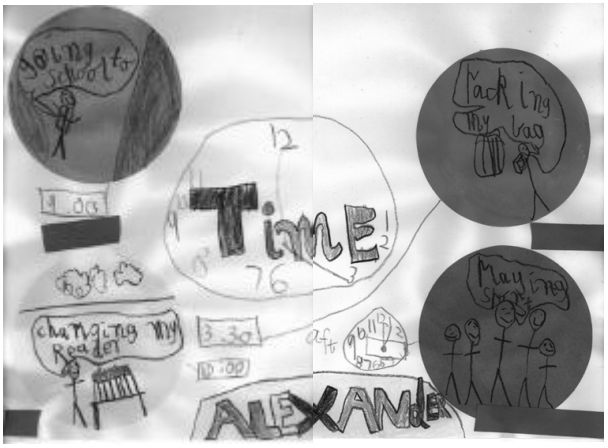
Another teacher used a simple card game to provide practice in recognising the smaller and larger of two one-digit numbers. Having removed the picture cards, and shared the pack between the two players, the students take it in turns to place a card down. The student whose card is larger takes both cards. The game continues until all cards are with one player. (This can take a long time!)

Using the Constant Function on the Calculator to Explore Number Patterns. Many teachers have found that the constant function enables children to explore and understand important patterns (such as adding 10, subtracting ten, adding 9, and so on). Stephanie wrote about patterns that she found as she used the calculator to add 9:



Stephanie

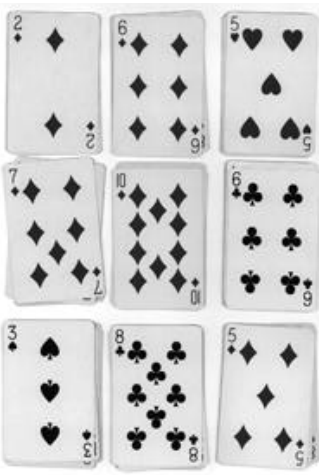
9 18 27 36 45 54 63 72 81 9099
108 117 126. I went to 0+9=
and then it went to 18 and I
chept going to = The tens
went yup and the ones went
done I thorght it was amasing
I dont now how a clcklate
works but it stor is good.



Relating Times of the Day to Key Events. Some Kindergarten teachers noticed that children needed more practice with linking times of the day to regular events. Children were asked to think of things that they did at different times of the day, and to draw pictures, illustrating these. The teacher then encouraged them to link length measurement with time, by placing a strip of paper beside each drawing, with its length chosen to reflect the relative time needed for each activity.

Adding to Ten. In developing strategies for solving addition and subtraction problems, one key growth point includes a confident understanding of combinations which add to 10. Many ENRP teachers are using "tens frames" to help children develop this understanding.

One teacher used a card game to help children to recognise combinations of cards which add to ten. All non-picture cards are spread out in an array, face up, and children in turns take a selection of cards (two or more) which add to ten, where possible. The game continues until no such combinations remain.



On the same mathematical point, another teacher posed the following problem: "The principal has told me that ten new Kindergarten children are coming soon, but he forgot to ask how many girls and how many boys. How many of each could there be?" The children took this question, and developed a range of different strategies for determining and representing the possibilities. It was a nice example of a task which links different content areas—in this case, Number and Chance and Data.

Given the wide range of understanding revealed in the interviews, many teachers have used open questions to enable children to respond at their own level of understanding. The card task above is just one example of this.

All of the examples discussed exemplify focused teaching, where teachers have identified areas for attention, and planned activities which pinpoint these areas.

Conclusion

I have often used two related quotes to illustrate that assessment divorced from subsequent action is unlikely to lead to improved learning:

"Nobody ever got taller by being measured" (Professor Wilfred Cockroft, UK)

"You don't fatten a pig by weighing it" (American equivalent)

While my views haven't changed greatly on this point, it could be argued that the children involved in these interviews "grew" in the process. They grew in their own confidence in themselves as learners of mathematics, and in their understanding of some mathematics concepts which they were meeting for the first time, in a supportive and enjoyable environment.

I have also claimed for a long time that teachers build up a very clear and accurate picture of children's understanding of mathematics through watching and listening to them, as they engage in

everyday classroom activity. The experience of ENRP teachers seems to indicate that this picture can be greatly "sharpened" through focused time with individuals.

Although the Early Numeracy Research Project is still in its early stages, we can confidently claim that the time and cost involved in giving teachers one-to-one time with children around a range of rich mathematical tasks provides a powerful opportunity for children to show what they know and can do, and creates a great starting point for teachers in providing meaningful and challenging experiences for all their students.