Researchers Noticing Young Children's Mathematics

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Noticing young children's mathematics can involve talking to them and watching as they undertake mathematical tasks or answer questions. Interviews are a key methodology for researchers who focus on young children's mathematical learning, providing opportunities to notice what children are doing and gain insights into their thinking. This paper focuses on one-to-one task based interviews as a tool for noticing young children's mathematics and particularly the use of flexible, semi-structured interviews with children with Down syndrome. Such flexible approaches maximised the chances of children with Down syndrome showing what they knew and could do mathematically.

Task-based, One-to-One Interviews With Young Children

The power of a one-to-one task-based interview as a tool for both teachers and researchers to notice young children's mathematics has been well documented (Bobis, et al., 2005; Clarke, Clarke, & Roche, 2011). They can show what children can do through well designed tasks and questions. Of course, researching and understanding young children's mathematical thinking is challenging, as much of what we want to know is cognitive processes or strategies, and young children may have difficulty articulating these processes and strategies.

Following the work of Piaget, clinical interviews have been used for many years in mathematics education research (Ginsburg, 2009). Typically, such research had been conducted with relatively small numbers of children. However, the late 1990s, in Australia and New Zealand, saw the development and use of research-based one-to-one, task-based interviews with large numbers of children (Bobis et al., 2005).

The interview that was developed as part of the Early Numeracy Research Project (ENRP) (Clarke et al., 2002) is typical of the type used in these kinds of projects. While it is structured with specific instructions for administration and recording, it allows for more conversation and recording of varied strategies than many more formal psychological assessment protocols. Such strict protocols are arguably more reliable for comparison but do not provide the same richness of data for both the researcher and the teacher.

Of course a structured interview can provide surprising insights. A favourite anecdote from the interviews for the ENRP came from a teacher and related to the "draw a clock" task that was used to initiate a discussion of their understanding of time and clocks.

> 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?" (ENRP teacher)

Of particular interest when considering young children and the transition to school is the First Year of School Mathematics Interview (FYSMI), a component of the larger ENRP interview. Details of the FYSMI including data from a large sample of children were reported in Clarke, Clarke, and Cheeseman (2006). The teachers in a special school within the ENRP found it to be a very valuable tool that was easily used and interpreted in their context (see Clarke & Faraghar, 2004).

A further feature of a carefully-designed one-to-one task-based interview is that the children in the early years have the opportunity to go beyond the mathematics dictated by

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the curriculum, with little likelihood of a ceiling effect. The ENRP interview provided both teachers and researchers with unexpected insights as illustrated by the following quote:

> I have to admit I was really surprised when I did the testing on them, at how much two or three of them knew, they knew far more than I realised. A couple of them are being held back because they still can't do the counting, one, two, three, they go wrong. But when we go beyond that, it's just amazing how much understanding they've got. I was just blown away by a couple of the results, I really was. (Special school teacher interview as reported in Clarke & Faragher, 2004)

While instruments such as the ENRP interview, provide opportunities for individual children's thinking and strategies to be evidenced, they generally assume a traditional trajectory of mathematics learning and may limit options. They evidence a "moment in time" rather than a definitive assessment of an individual child's mathematical understanding. This is particularly relevant and possibly limiting when interviewing children with specific learning difficulties. In a recent project that attempted to map the mathematical development of children with Down syndrome (Faragher, Brady, Clarke, Clarke, & Gervasoni, 2008), the interview was adapted and a slightly different approach taken to its application. This work is discussed in the following section.

Interviewing Young Children with Down Syndrome

We were aware of literature that indicated that children with Down syndrome interviewed in unfamiliar contexts by people they did not know tended to demonstrate reduced performance on literacy tasks (Brown & Semple, 1970). We therefore interviewed participants in their home or school, in the presence of their parents (or teacher) who watched from behind the child. The adults were invited to comment on the performance of the child, either by taking notes during the interview, or in a discussion following the interview. The interviews were videotaped.

With a limited research base, methods to chart the mathematical learning of children with Down syndrome are yet to be developed. The choice of task-based, one-to-one interviews was appropriate, being a well-established methodology. The ENRP interview (Clarke et al., 2002) and EMU interview (Gervasoni, 2004) were used as the basis of an interview for use in this study. While these instruments were already demonstrably effective, modification, trial and development was undertaken for this special context.

Rather than using the interview as a protocol driven instrument, it was implemented in this project in a more flexible form than the original projects to ensure maximum opportunities for individual children to show what they knew. Tasks were first asked in the same form of wording as the original instrument but follow-up questioning, instructions or guidance were provided at the discretion of the interviewer. This allowed the interviewer to follow up on responses from the child, to double back to earlier tasks, to ask a similar task in a different way and to add tasks. In order to do this, the interviewer needed to know the purpose behind the interview questions as well as be able to make preliminary judgements about what was being observed in the interview while it was in progress.

Sometimes, children with Down syndrome exhibit behaviours that hinder the assessment of their mathematical understanding. In the case of one child, Gina, giving the answer "one" repeatedly seemed to be "avoidance" behaviour, a well-established aspect of behaviour in children with Down syndrome (Wishart, 1996). This is a learned behaviour, and not in any sense misbehaviour. There were seven occasions during the interview when Gina gave an answer "one". On only one occasion was this an appropriate response. It appeared from the analysis of the video that it was her "default" response. It would seem to be an attempt to disengage with the question, perhaps to effectively avoid thinking about

the question, or maybe to provide a response when knowing what to do was unclear. A particular example is quite enlightening:

> Gina was presented with some dot cards and numeral cards and asked to find the number to match the dots. She did not show evidence of matching but pointed to the numeral 3 and said "three". The interviewer used this as a cue to ask if she knew any other numbers. During this sequence, the interviewer picked up the numeral 4 and asked Gina what number it was. Gina responded quickly by saying "one" and then said "four" quietly. It was as if "one" was her standard answer and then she realised that she actually could read the numeral.

Gina was an engaging child but struggled with much of the interview. She was one of the youngest of the children interviewed. However, the flexible approach gave greater insights into her thinking. A more traditional protocol-driven assessment where the first answer is taken as final or where restatement or adaption by the interviewer is not permitted would have limited what was found. Of course, differences in methodology are generally due to different purposes, but for this project we wanted to expand the opportunities for the children to show what they knew.

A further example involved one of the questions from the FYSMI that focused on location language. The original task asked children to place a small plastic teddy in a specified position relative to another teddy. Maggie was asked to place a green teddy behind a blue teddy that was in front of her on the table. She did not do this so the interviewer got out of her seat, moved over to the clear space with Maggie and asked her to stand behind her. Maggie did this successfully, showing some understanding of the concept "behind" in this more physical context. This additional task became a feature of future interviews providing additional information on the mathematical understanding of the children.

A major reason for the use of the semi-structured approach to the task-based interview was in response to the behaviour of the children. As previously mentioned, avoidant behaviour has been extensively documented even in very young children with Down syndrome. Therefore, we were not surprised (though we were certainly entertained!) by the many instances where children were using strategies to avoid attempting the tasks, e.g., changing the tasks, playing with the equipment, using behaviours to distract the interviewer (burping, being 'cute', changing the subject) and refusing to participate. It is important to note that children used avoidant strategies even when they were able to do the tasks. Our interview protocol and flexible technique allowed us to work around these actions to gather data we could trust. Some studies on mathematics performance by children with Down syndrome give a more pessimistic view than the experiences of parents and teachers would suggest (Abdelhameed & Porter, 2006). The discrepancy may be due to research methods that are unable to take account of the avoidant behaviours and therefore limit opportunities.

Concluding Comments

Structured, task-based one-to-one interviews are an important methodology for researchers to notice the mathematics of young children. Highly structured protocols provide reliable comparisons but limit the opportunities for some children to evidence the richness of their mathematical understanding. Structured interview protocols that are designed to elicit different strategies, encourage conversations and highlight children's thinking (such as the ENRP interview) provide greater insights for individual children. A more flexible approach in the form of semi-structured interviews has provided richer and more valid data for children with Down syndrome and has much potential for researching

the mathematics of young children in general. A knowledgeable interviewer is required for this method to be effective. It requires sophisticated knowledge of the mathematical development of young children as well as the skills to engage the children, to intervene or stay silent, to persist, and to know when to move on.

Children are rich mathematical thinkers. They are entitled to experience methodologies that provide opportunities to show what they know to researchers. In advocating a place for more flexible approaches to interviewing we would argue that it provides greater richness and validity in terms of results for individual children.

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