Visual Stimuli That Prompt Young Children to Notice Their Mathematical Thinking: Two Researchers' Experiences

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As described in the symposium overview, this paper is built on two researchers' interests and research concerning mathematics learning and teaching at the time of children's transition to primary school, including prior-to-school and the first years of school. Our previous research has shown that young children are aware of their own mathematical thinking and the experiences during which mathematics learning has occurred; however, for young children it is often easier to talk about something tangible rather than something abstract. In our attempts to elicit the mathematical thinking of four to seven year-olds we have found that the use of visual stimuli prompts children to not only notice their own learning, but also share this learning with others. In this paper we describe two forms of visual prompting we have found to be very useful as research methodologies for assisting children to notice their mathematical thinking: children's drawings and video-stimulus recall.

Children's Drawings

One element of Amy's earlier research was the use of children's drawings as part of a representations methodology, which explored the ways in which children represent their mathematical experiences and understandings through drawings, photographs, and narratives. The study focused on children's experiences with, and understandings about, measurement as they commenced primary school. This paper focuses on the use of children's drawings as a means of prompting children to notice, recall and represent their thinking about measurement; details about the larger study and children's other forms of representations are reported elsewhere (for example, MacDonald, 2012).

Six open-ended drawing tasks were carried out with 97 children aged four to six years who were in their first year of primary school. Guided by the work of Sullivan and Lilburn (1997), open-ended tasks were used so that: the children were encouraged to do more than recall known facts or reproduce a skill; the children were able to learn from the process of doing the task; and the researcher, along with the children's teachers, were able to be informed as to the children's capabilities. The tasks were inspired by the work of Pengelly (1985, cited in Clarke, 1998a) with her "Draw a clock" task, where children aged 3 to 7 years were asked to create a clock face using a variety of resources. The six tasks were negotiated with the classroom teachers to reflect the content they were planning to cover in class. The tasks were designed to progress from an open-ended exploration of what children considered to be measurement, through to investigations of specific content areas and concepts. The task details were deliberately vague, allowing children to apply their own meaningful and personalised contexts. The tasks were:

1. Draw yourself measuring;
2. Draw something tall and something short;
3. Draw something heavy and something light;
4. Draw something hot and something cold;
5. Draw a ruler; and
6. Draw a clock.

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These drawing tasks were undertaken with the children twice over the period of a year; the tasks were initially completed during the first few weeks of school, and were then repeated at the end of the year, as the children neared the end of their first year of primary school. Hence, the drawing tasks were not only used as a means for children to visually represent their measurement knowledge, understandings, and experiences; they were also used to determine how the children's measurement knowledge and understanding was developing over the first year of primary school. While completing their drawings, the children were encouraged to talk to the researcher about their drawings (if they wished), and the children's comments were annotated on the drawings. During the second implementation of the activities, many of the children also took it upon themselves to write their own narratives and explanatory notes on their drawings. Asking the children to talk and/or write about their drawings provided an additional opportunity for the children to reveal their understandings in different but complementary ways. The information revealed during this drawing/narrating process proved to be far more informative than the drawing was on its own.

Detailed findings from the drawings activity are found in MacDonald and Lowrie, (2011), and include examples of the representations themselves and detailed analysis of the measurement content knowledge they elicit. In summary, the children in this study demonstrated that they had sophisticated understandings of measurement at the start of school. These understandings both aligned with, and challenged, extant frameworks for the development of measurement knowledge. Within an emergent measurement context, the children showed understandings about the measureable attributes of objects, comparisons of attributes, and the application of units. In particular, the children showed a remarkable awareness of a range of formal units, including some which they would not normally be expected to have an awareness of, for example, megalitres. The children also demonstrated individualised, idiosyncratic ways of understanding measurement concepts, such as using one attribute to understand another, for example, comparing heights in order to compare volumes. Of crucial significance is that these were the understandings the children had developed *for themselves* in out-of-school contexts.

Video-Stimulus Recall

One element of Jill's earlier research (Cheeseman, 2010) was the use of videotape to record entire lessons and specifically, one-to-one interactions between a child and the teacher. The perspectives of the teacher, the child and the researcher in relation to these events were gathered and analysed. Fifty-three five to seven year-old children were selected for interview. An excerpt of video which directly involved the teacher's interaction with each child was used as a stimulus to recall a specific part of the lesson. The interview was conversational in style. While there was an interview script, it was adapted in order to elicit responses from each child. The scripted questions were:

1. I am interested in the times when teachers talk to kids in maths lessons—you know when they are really just talking to one child. I noticed that your teacher had a talk with you / stopped to work with you / asked you about your work in that maths lesson. Can you remember that? Can you tell me what happened?
2. I think that we got that on video. Would you like to see it?
3. What were you thinking about? (Maybe just watch it at first.)
4. Can you say what was happening?
5. What did you learn in maths today? Was there anything else? (Cheeseman, 2010)

Previous to this research it was not known whether children as young as five years old could give an account of classroom events where they were challenged to think mathematically. Hence the research question: to what extent can young children give a subsequent account of a classroom mathematical event from their perspective?

At the time of the research there appeared to be scant literature describing the use of stimulated recall using video with young children in mathematics. There were studies using video-stimulus methodologies; for example, Williams (2003) asked Year 8 students to reconstruct the learner's perspective using video-stimulated interviews and Ainley and Luntley (2005) studied teachers' views of the events in their classrooms using video-stimulated recall. Theobald (2008) studied four to six year old children's interactions in a playground and concluded that video-stimulated interview was a useful method when used alongside fine grained analytic approaches. Various techniques have been adopted to select the video to be used as an interview stimulus. Pirie (1996) described how videos of the classroom were watched by the children, and stopped at critical points (selected by the researcher) to ask the participants what they were thinking at that moment. In Clarke's (2003) study, the students were asked to stop the video where they wished to comment on events of personal importance.

The protocols for the research discussed here were defined through piloting. Young children responded to their video excerpt in a very different way from that of their teachers. When teachers were shown whole excerpts of the lesson they were able to talk about what was going on and even reconstruct their thinking at the time. Young children though, would watch the video as a passive observer and if asked at the end of the excerpt to talk about what was happening, they would give a look as if to say "What do you mean? You just watched what was happening!" They seemed to feel that the video required no explanation or interpretation. It became clear that the best way to prompt recall was to play a little of the beginning of an incident of interest to set the scene for the child then to pause the video and to ask, "Do you remember that bit, what was happening there?" If a child had no recollection of the event, the entire video episode involving them in conversation with the teacher was played and used as a stimulus to help them describe their thinking or reflect on their learning. In general, the video was used as a starting point and it was paused as soon as the child had remembered the event.

Findings show that stimulated by video excerpts, children could: recount their actions, tell narratives of the interaction with the teacher from their perspective, and describe and justify their reasoning at the time. It was impressive to find that such a substantial proportion of five- to seven-year-old children (42%) could reconstruct their thinking and justify it. It is assumed that the experiences offered to children in mathematics classrooms contribute to their learning. These data indicate that 59% of children could talk about their learning as a result of the lesson; some at a factual level, some at a procedural level, and some at a conceptual level (Cheeseman, 2010).

Implications

It is important to be able to elicit children's ideas in order to build on children's mathematical thinking so as to make school mathematics learning relevant and meaningful. Amy's study demonstrates that drawing activities can be used to access the thinking of four to six years-old children, and have the potential to be used with younger or older age groups. Such activities could also serve as effective assessment tools for teachers wanting to implement open-ended tasks such as these in their own classroom. However, teachers wishing to initiate similar assessment activities need to consider repeating these tasks. As

Clarke (1998b) cautions, a single completion of the task may not be an accurate representation of a child's understanding of the concept; rather, it may represent a "snapshot" that shows which aspects of the concept the child was attending to at a given point in time, or their greater interest in aesthetic appeal rather than the mathematical ideas in which the teacher is interested. By using the task throughout the year, teachers are provided with information about the contexts and experiences that influence children's understandings, and are offered insight into the personalised ways in which children think about mathematics.

Jill's study shows both researchers and educators that video-stimulus recall can be successfully used with five- to seven-year-old children to understand interactions that challenge children to think mathematically. In part, video-stimulus prompted young children to give their account of mathematical events from their perspective when the video was paused early in the excerpt. Children could recall their conversations with the teacher during the day's mathematics lesson. These recollections gave insights into interactions that appear to have some lasting effects.

We argue that visual stimuli are valuable tools for mathematics education researchers to use to elicit young children's thinking. They can enable us to share in the ways children construct mathematical understandings and gain insights into the "legacy" of a mathematics lesson. Finally, they can prompt children to notice, explain and justify their mathematical reasoning in a way which is accessible to researchers and educators.

References

Ainley, J., & Luntley, M. (2005). The role of attention in classroom practice: Developing a methodology. In P. Clarkson, A. Downton, D. Gronn, M. Horne A. McDonough, R. Pierce & A. Roche (Eds.) Building connections: Research, theory and practice (pp. 73-80). Melbourne: Mathematics Education Research Group of Australasia.

Cheeseman, J. (2010). *Challenging children to think: An investigation of the behaviours of highly effective teachers that stimulate children to probe their mathematical understandings*. Unpublished PhD thesis, Monash University, Melbourne.

Clarke, D. (1998a). Children's understanding of the clock in the digital age. *Primary Educator, 4*(3), 9-12.

Clarke, D. (1998b). Making a difference: Challenging and enthusing children for mathematics in the early years. *Keys to life. Early years of schooling conference. Sharing the journey. Conference proceedings* (pp. 1-5). Melbourne: Department of Education.

Clarke, D. J. (2003). *The learner's perspective study*. http://extranet.edfac.unimelb.edu.au/DSME/lps/assets/lps.pdf

MacDonald, A. (2012). Young children's photographs of measurement in the home. *Early Years, 32*(1), 71-85.

MacDonald, A., & Lowrie, T. (2011). Developing measurement concepts within context: Children's representations of length. *Mathematics Education Research Journal, 23*(1), 27-42.

Pirie, S. (1996). *Classroom video-recording: When, why and how does it offer a valuable data source for qualitative research?* Paper presented at the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Panama City, FL.

Sullivan, P., & Lilburn, P. (1997). *Open-ended maths activities: Using "good" questions to enhance learning*. Melbourne: Oxford University Press.

Theobald, M. (2008, November). *Methodological issues arising from video-stimulated recall with young children*. Paper presented at the AARE annual conference, Brisbane.

Williams, G. (2003). *Social and affective factors that promoted and inhibited insightful and creative mathematical thinking.* Paper presented at the Conference of the Learner's Perspective Study international research team, University of Melbourne, December 1-3, 2003.