Developing Noticing of Reasoning through Demonstration Lessons

Leicha A. Bragg
Deakin University
<Leicha.Bragg@deakin.edu.au>

Colleen Vale
Deakin University
<Colleen.Vale@deakin.edu.au>

Observation of fellow educators conducting demonstration lessons is one avenue for teachers to develop sensitivity to noticing students' reasoning. We examined teachers' noticing of children's learning behaviours in one demonstration lesson of the *Mathematical Reasoning Professional Learning Research Program* (MRPLRP). The observations of teachers evident in the audio-taped post-lesson group interviews conducted at one school are reported in this paper. The teachers noticed that the children struggled to employ mathematical language to communicate their reasoning and expressed concern about gaps in children's understanding of key mathematical concepts. The teachers viewed limitations in language and mathematical conceptual understandings as a barrier to effective reasoning.

Observing, reflecting on and discussing lessons taught by experienced teachers or coaches are an effective strategy for teachers' professional learning (Casey, 2011; Clarke, et al., 2013; Lewis, Perry & Hurd, 2004). Collaborative observation of demonstrated or modelled lessons, as practiced in Japanese Lesson Study, also support and sustain communities of inquiry (Lewis, et al., 2004). Demonstration lessons are most effective when teachers' observation is purposeful and focussed on agreed learning objectives and students' thinking (Clarke et al., 2013; Lewis et al., 2004). In Lesson Study, the team prepares a detailed lesson plan which documents the learning objective, anticipated student thinking and teacher actions. The lesson plan, and/or pre-lesson briefings in demonstration or coaching contexts, provides the focus for teachers' observations who are typically provided seating plans or observation schedules on which to record their observations for collaborative post-lesson discussion (Lewis et al., 2004; Clarke et al., 2013).

The focus of teachers' attention and what they notice when observing lessons is critical for their pedagogical learning (Mason, 2010). "Learning to notice does not just involve noticing aspects of teaching that before went un-noticed but also includes the sensitivity and inclination to be aware" (Nicol, Bragg & Nejad, 2013, p. 370). Attending to students' thinking and responses enable teachers to identify the critical elements for students' learning. Clarke et al. (2013) reported that teachers typically focus on teacher actions and pedagogical approaches in demonstration lessons, whereas they are more likely to focus on students' thinking in Lesson Study.

Mathematical reasoning is the focus of the *Mathematical Reasoning Professional Learning Research Program* [MRPLRP] which used demonstration lessons to provide teachers with the opportunity to notice students' reasoning and develop their own understanding of mathematical reasoning and its teaching through collaborative discussion and reflection. The need for better understanding of mathematical reasoning (for example, Loong, Vale, Bragg, & Herbert, 2013) and for professional learning materials[1] to support enactment of reasoning in classrooms has been the driver for this project.

[1] See Top Drawer (http://topdrawer.aamt.edu.au/) professional learning materials designed by Judy Mousley using materials from "In Teachers' Hands," a Mathematical Association of Victoria project.

2014. In J. Anderson, M. Cavanagh & A. Prescott (Eds.). Curriculum in focus: Research guided practice *(Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia)* pp. 698–701. Sydney: MERGA.

Reasoning is an explicit mathematics learning requirement in Canadian mathematics curricula (Ministry of Education, 2007) and many other countries including Australia. It is regarded as central to students' mathematical learning as it supports students to think logically about mathematical concepts, the relations between them and make sense of mathematics (Kilpatrick, Swafford & Findell, 2001). Researchers and curricula identify many aspects or components of mathematical reasoning. The demonstration lesson that is the focus of this paper was designed to encourage, elicit and develop children's reasoning, especially their capacity to compare and contrast, generalise commonality across cases, and to justify their thinking and conjectures.

The Mathematical Reasoning Professional Learning Research Program

The MRPLRP was conducted in 2012 and 2013 with four primary schools in Victoria, Australia (17 teachers) and one elementary school in British Columbia, Canada (7 teachers) from low socio-economic metropolitan and rural school communities. The program involved an initial interview, observation of a demonstration lesson, audio-taped group post-lesson discussion and trial of the same lesson, or a modified version, in the teacher's classroom and individual interview. This sequence was repeated in the next school term. In this paper we analyse and report on the group interview data collected from teachers at the Canadian school who observed the first demonstration lesson taught in a Grade 3/4 class or a Grade 6 class. The lesson was taught twice at the school because the principal and all staff requested to be involved in the project. Hence teachers of all the grades from Kindergarten (5–6 year olds) to Grade 6/7 (12–13 year olds) at the school participated.

The 60 minute demonstration lesson was designed for a Grade 3/4 class (8-10 year olds) by the MRPLRP using an adaptation of the open-ended task "What else belongs?" (Small, 2011). Students initially worked in pairs to find a reason for grouping 30, 12 and 18, identify other numbers that belonged and to justify their reason. During the whole class discussion that followed, children were expected to justify their thinking and convince others that their conjecture was valid (see Bragg et al., 2013, for a detailed description of the lesson including the second task, whole class discussion and reflection).

The detailed lesson plan was distributed to the teachers several days ahead of the lesson for review. Both demonstration lessons were taught by Bragg with 3 to 4 participant teachers observing each lesson. The teachers were provided with an observation schedule and requested to silently observe the students, taking anecdotal notes during whole class discussion periods. During independent pair-work periods the teachers could observe, note take and talk with the students. They were requested to refrain from "teaching" the students but rather were encouraged to ask probing questions to explore the students' reasoning. Both lessons were video-taped and student work samples were collected.

At the conclusion of the demonstration lesson, the participating teachers gathered for an audio-recorded, group interview of 30-40 minutes in duration. They were invited to share their observations of students' reasoning, achievement of the lesson objectives and the teacher's actions to elicit reasoning. The discussion centred on the following questions: "*What examples of children's reasoning did you observe? When and how were the children reasoning?*" The results are based on the analysis of data from the two post-lesson group interviews conducted with these Canadian elementary teachers after the first demonstration lesson. The data were transcribed and analysed using NVivo (a qualitative data analysis tool) to identify and categorise teachers' noticing of children's reasoning.

Results, Discussion and Concluding Remarks

The following two quotes illustrate the few examples of teachers noticing reasoning:

> [Reasoning occurred] mostly when they were talking to one another. I thought they were trying things out and then getting confirmation or not from the other person...

> … the boy in the corner built on from L's work. So he has got the 6s … so sort of that's deducted, if it's divisible by 6 it has to be divisible by 3.

The main focus of their noticing was on the students' limitations in expressing their reasoning. All the teachers identified that most students were restricted in their ability to reason due to perceived limitations in their mathematical understandings. For Mallory[2], an early-years teacher, these limitations required action before reasoning could take place:

> I was watching, when you were talking to them and it just came to me that we all have to make sure that these children have been exposed to a variety of concepts before we can even get to this place, this lesson. They have to understand what the digit is, they have to understand what the rounding is, they have to be able to be immersed in what is a set, and before we could get to this conversation open, they needed to have things, of prior knowledge and experience, and as an early primary teacher, that's my job is to create that. As we were saying that foundation for them to be able to have these ideas to draw upon, to be able to provide reasons, because without that they wouldn't even be able to do that. … What do we need to do for them to get to this place?

Mallory was hesitant to incorporate reasoning into her lessons until she had established the foundation knowledge of mathematical concepts required for the task. However, it is worth considering how the children might consolidate foundation knowledge without experiencing opportunities to reason. In a similar vein, Nick, an upper grade level teacher, was concerned about undertaking the lesson until he had recapped particular concepts with his class. He felt the children possessed the knowledge but needed a reminder.

> Nick: Not that I am going to teach to the lessons but like do a concept … of prime and composite numbers in review. Do a quick lesson on … a concept … to double check their understanding of multiples and factors before the lesson so whether you're using the vocab in this lesson.

> Heather: See then you're prepping them – I would almost do that [review] after.

> Nick: But it wouldn't be connected to this – it would be – last year we did prime and composite numbers – a quick concept review.

Even though Nick was keen to review concepts prior to the lesson to avoid negatively impacting the reasoning process, his colleagues felt not recapping was an opportunity to evaluate and assess the current understandings of their students and identify areas that may require further attention.

> Heather: Because then you're also seeing what they remember from last year. Some of them might come up with the primary composite.

> Keira: Because you're going to have to teach something after this for sure. Like Heather has got a big list now.

Heather's "big list" of areas to address included the issue of language deficiency in the children. Language deficiency was discussed in both groups and was viewed as a serious problem, especially by the upper grade level teachers.

> Heather: I had big surprises. It became very clear to me that they didn't fully comprehend the vocab divisibility, multiples, factors and so forth. Okay is that something they'd heard in the past? Have I

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[2] Pseudonyms used throughout

> not used it enough? The connection wasn't being made there. It was just so stark for me and I went okay, and I wrote notes down for connection, vocab – "Heather use vocab consistently" – but not just this year [Grade 6] but it's something that we need to do from the beginning.

Similar to Mallory above, Heather was concerned about her role in facilitating the students' deficiencies. Through noticing the mathematical language concerns the teachers were devising approaches to assist the students to develop their mathematical reasoning. It was unclear whether limitations in language noticed by the teachers was a barrier in providing meaningful justifications or resided in the students' reasoning capabilities. Examination of the children's interactions may offer greater insights and ways forward.

Concluding remarks

In conclusion, this paper provides a snapshot of teachers' concerns, namely mathematical language and conceptual understandings arising from their observation of students' reasoning. The demonstration lessons and post-lesson group discussion were illuminating as a vehicle for noticing perceived gaps arising within the teachers' classroom and the school community more broadly. In turn considerations for change to pedagogical approaches in the future were signposted as the MRPLRP offered food for thought for the participating teachers. The findings suggest that these teachers perceived reasoning to involve communication of thinking with an emphasis on oral and written communication rather than diagrams or symbolic representations as justification. They were sensitive to the role that prior learning plays in reasoning and aware of open-ended tasks for assessment, but they were less sensitive to the way in which justifying enabled the students to make sense of their prior knowledge. Deeper analysis of data collected and on-going research will support our goal of facilitating opportunities for professional learning and classroom enactment of mathematical reasoning.

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