

Peer Observation as Professional Learning about Mathematical Reasoning

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Mathematical reasoning features in curriculum documents around the world, but is understood and enacted poorly by teachers in classrooms. We explore teachers' noticing of reasoning during observed lessons. Two teams of primary teachers in Canada and Australia worked to plan, deliver, and observe lessons intended to include reasoning. They observed each other teaching a lesson that was planned with the assistance of a researcher, and later, a researcher observed each post-lesson discussion. Given the reported benefits of teachers' noticing of reasoning during peer-observed lessons, targeted professional learning support is required to further enact teachers' peer discourse to facilitate mathematical reasoning.

Mathematical reasoning is at the forefront of efforts to reform mathematics teaching and features in the curriculum documents world-wide (e.g., Australian Curriculum Assessment and Reporting Authority [ACARA], 2017; Ministry of Education Province of British Columbia, 2007). “[Reasoning is the] capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising” (ACARA, 2017, p. 5).

Reasoning plays a critical role in learners' capacity to make sense of mathematics (Goos et al., 2017; Stiff & Curcio, 1999), but changing requirements of curriculum documents contribute to teachers' uncertainty. Clarke, Clarke, and Sullivan (2012) reported that “teachers incorporate some aspects of reasoning into their teaching, but not others” (p. 32) and further that “teachers need support in identifying tasks that prompt reasoning” (p. 32). Loong, Vale, Herbert, Bragg, and Widjaja (in press) found that most primary teachers in their study had limited understanding of the nature of mathematical reasoning before engagement in a professional learning program. Despite these difficulties, teacher enactment and student experiences of reasoning in Australian and Canadian classrooms remain relatively unexplored.

The focus of this paper is on what the teachers noticed about mathematical reasoning and its teaching during the enactment of the lesson they had prepared in their peer learning teams to embed reasoning purposefully, thus attending to the research question: What is the impact of professional learning through peer observation to foster a mathematical-reasoning-based pedagogy?

Further discussion of the literature informing this study can be found in the Background section, followed by details on the conduct of the study in the Methodology section. Thematic analysis of these data is presented and discussed in the Results and Discussion section. Finally, in the Conclusion, the results are summarised.

Background

This section commences with a discussion of the growing significance of mathematical reasoning in curriculum documents and teaching practices. Next, we explore the teachers' professional noticing, with a focus on the benefits and challenges of peer-observed lessons.

Reasoning

As a discipline, mathematics requires reasoning for deep understanding of mathematical content and for the validation of ideas (Bragg, Herbert, Loong, Vale, & Widjaja, 2016); with reasoning being “the glue that holds everything together, the lodestar that guides learning” (Kilpatrick, Swafford, & Findell, 2001, p. 129). Reasoning is a key component of mathematical proficiency. It is gaining prominence in mathematics curricula around the world, acknowledged as necessary in the learning of mathematics across all years of schooling (Kilpatrick et al., 2001; Vale, Widjaja, Herbert, Bragg, & Loong, in press). Reasoning is an explicit requirement of the Australian Curriculum, which emphasises that reasoning requires action from the learner. These actions are promoted through classroom practices as “students learn to give explanations and justifications when teachers provide tasks that require them to investigate mathematical relationships” (Goos et al., 2017, p. 37).

For teachers of mathematics to promote an increasingly sophisticated capacity for logical thought in their students, they must be able to notice and identify when reasoning is taking place, but noticing reasoning is not easy for teachers (Bragg et al., 2016). This current study provided opportunities for focussed peer observation of reasoning (along with team lesson planning and post-lesson discussion) as vehicles to enhance teachers’ noticing of reasoning in classrooms.

Developing Noticing of Reasoning through Observation

Professional learning requires developing sensitivity to notice and providing opportunities to learn from experience to inform future practice, since what teachers notice and focus their attention on when observing lessons is critical for 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). Hence, focussing the teachers’ awareness on key aspects of a lesson is essential to providing opportunities for professional learning.

One effective strategy for teachers’ professional learning is observing, reflecting on and discussing lessons taught by experienced teachers or coaches (Casey, 2011; Clarke et al., 2013). Demonstration lessons provide teachers with opportunities to notice and are effective when teachers’ observation is purposeful and focussed on children’s thinking leading to learning objectives (Clarke et al., 2013). In an earlier study by the authors and colleagues (Bragg & Vale, 2013), demonstration lessons were employed to model the promotion and development of children’s mathematical reasoning and these lessons were successful in assisting teachers to identify aspects of reasoning (Herbert, Vale, Bragg, Loong, & Widjaja, 2015). However, logistically and financially, demonstration lessons are not always sustainable, as the employment of expert teachers to conduct the lessons and facilitate discussions is required, along with relief teachers to provide time out of class for teachers to undertake observations, reflection, and discussion. Also, Jaworski (1998) stressed the importance of a teacher experiencing and tackling a problem themselves thus “providing more power and control” (p. 19), and teachers who lack the authority to make pedagogical decisions become frustrated (Warfield, Wood, & Lehman, 2005). Therefore, we sought an alternative model for professional learning that was potentially more sustainable and would provide the teachers with autonomy.

The Department of Education and Early Childhood Development (DEECD, 2004) recommended peer collaboration for improved student and teacher learning, encouraging

peer observation to enhance improvements in student outcomes. “One of the most effective ways to learn is by observing others, or being observed and receiving specific feedback from that observation. Analysing and reflecting on this information can be a valuable means of professional growth ... [p]eer observation promotes an open environment where public discussion of teaching is encouraged and supported” (DEECD, 2004, p.11).

Dufour and Eaker (1998) found that peer observation was effective in improving student outcomes, while Johnston and Cornish (2016) suggested a number of advantages of peer observations, such as offering feedback for improved student learning, reducing isolation, promoting teachers’ self-reflection, encouraging teacher conversations, and providing exposure to a range of teaching approaches. Further, Wilson (2013) asserted that peer observation has potential to improve teaching by giving and receiving constructive feedback from colleagues, thus cultivating collegiality. Such discussion and reflection can facilitate a taken-as-shared understanding of the nature of good practice and hence moves towards improvements in teaching (Byrne et al., 2010).

A barrier to the success of peer observations can be a perceived imbalance of power (Gosling, 2002), especially where observation is utilised as a mechanism to evaluate teaching performance or under-performance or to appraise individuals (Byrne et al., 2010). Further, peer observations require colleagues to observe each other teaching and provide feedback on their observations for improvements to practice to occur, but this can be confronting for many teachers who are used to teaching in isolation, unobserved by peers. Therefore, successful peer learning communities must be comprised with non-judgemental, cooperative colleagues who share an equal status and seek to build an atmosphere of trust (Schuck, Aubusson, & Buchanan, 2008) and respect (Wilson, 2013).

Methodology

This paper reports on the second phase of a larger study that developed a professional learning program to foster greater understanding of mathematical reasoning and its facilitation in primary classrooms. This phase explored the use of peer observations following collaborative peer and researcher planning, with post-lesson discussions.

The two primary schools selected for this study—one regional Australian school and the other a suburban Canadian school—had been participants in the first phase of the study. The sample was convenience-based because the two teams of teachers agreed to continue into this stage of the research when approached by a researcher. This paper reports on two teams from the project, one Australian team of three Grade 5 teachers, and the other team comprised of a Grade 2/3 and a Grade 3 teacher from Canada.

Initially, the researchers conducted whole-school presentations to report findings from Phase 1 of the project and provide further resource materials generated by the larger project team. Each of us then participated in a meeting with a team of teachers to plan forthcoming mathematics lessons with a goal of ensuring aspects of mathematical reasoning were embedded into the lessons. Both teams planned one lesson to be taught in their own classrooms. The Australian team, who were experienced in planning lessons together, developed the same lesson to be taught across all three classrooms; while the Canadian team who were not used to planning together developed two different lessons to suit the needs of their classes. The researchers acted as participant-observers, contributing to the planning only when responding to teachers’ questions or requests for advice.

Each teacher in the relevant team then taught a lesson, with other members of the team observing. The observing teachers completed an observation schedule and reflective notes. After each teacher had taught a lesson, the team met with a researcher to reflect on

students' reasoning noticed in the lessons, actions to support reasoning, and the outcomes of the lesson. These post-lesson discussions were audio- and video-taped, and student work samples and notes from the observation were kept.

The recordings from these post-lesson discussions were transcribed and entered into *NVivo* (QSR International, 2017). Data analysis included an initial reading of the transcripts jointly by the researchers to establish themes and coding categories. The researchers independently coded the transcripts from one school with inter-judge reliability confirmed through verification of each other's coding. The transcripts were then scrutinised to refine themes into finer categories.

This paper reports on seemingly typical data from the two post-lesson discussions with the two teams.

Results and Discussion

The purpose of the current study was to better understand the impact of peer observation to foster mathematical reasoning-based pedagogy. The themes arising from the teachers' post-demonstration discussion, are summarised as: *Reasoning, Opportunities, Observations, Language, Content, Challenges, and Connections*. The 27 comments coded under the theme of *Observations* are the focus of this paper, as these data offered the best insights into the teachers' impressions of the peer observation process. Under *Observation*, three categories were established: Advantages, Disadvantages, and Noticing reasoning.

Advantages

As expressed by the teachers, advantages of peer observation included constructive feedback from peers to suggest reasoning opportunities, an exposure to varied teaching practices, cultivating collegiality and a respectful environment, a "stronger connection to the process" over alternative professional learning experiences, and opportunities to become aware of previously unnoticed student interactions. Teachers felt that peer observation assisted them to develop strategies for orchestrating class discussions eliciting reasoning. The following quote demonstrates the observing teacher's noticing and sharing possible improvements for her peer to promote reasoning in the future.

Kate: ... I was interested because you picked the kids that showed their answer and I was like, "Okay." But I was thinking, "What if you would have—before you did that—say, 'Who would like to show me why it's why or why not?'"

Conversely, some teachers took up the opportunity peer observation offered to learn from their colleagues through focussing on teacher actions (as suggested by Clarke et al., 2013).

Sue: I did a lot of work with Dan a couple of years ago with this style of maths and I deliberately went last. It was great to be able to watch Cath and Dan. Probably I didn't think my language, I wasn't prompting as well as Dan and Cath were, because I wasn't tuned into maths.

Johnston and Cornish's (2016) suggestion that peer observation offers exposure to diverse teaching approaches was evident when the observing teachers actively engaged in noticing good pedagogical practice, although had been unrecognised by those teaching at times.

Amy: The neat thing that Kate did as they were doing that ... [she] kept identifying the strategy they were using. So, she named the strategy.

Kate: I don't even know I do that.

Amy: It's like "Did you realise you're using multiplication?" "Oh, all right you're using ..." so it was good just to identify what it was.

Consistent with Wilson's (2013) claim that peer observation develops collegiality, we also found evidence of this in the comments from the teachers in this study. The following quotes indicate enjoyment and effectiveness in working together.

Researcher: It's nice to see you two both excited about it.

Amy: It was, it was fun.

Kate: We enjoyed it.

Cath: It's much easier to work with other people ... We expressed how valuable we thought it was and so there has been talk about us doing that—I'm not sure—once a month, or ... increasing emphasis on peer observations.

The views expressed here are also reflected in Wilson's (2013) comment that peer observation "can foster an environment in which reflecting on our own practice is valued" (p. 46). Schuck et al. (2008) stressed the importance of peer-learning teams made up of supportive, cooperative colleagues sharing equal status working towards a common goal. Participants articulated the value they perceived in working in this way with peers for a clearly defined purpose.

Dan: [Observing] was good, too, in a non-threatening environment because we had a purpose.

Sue: But I think that's probably easier for us because we all know each other really well ... Imagine if you did that weekly or fortnightly ... for coaching.

Cath: It definitely made you stay focussed and on task with the reasoning whereas I think if, for instance, if you had just come and asked me to do that lesson it

Some participants commented that peer observation was better for developing their understanding of mathematical reasoning than demonstration lessons with a pre-prepared lesson plan. As noted by Warfield et al. (2005), the teachers had the authority to make decisions, developing and adapting their own lesson for their own purposes, with a researcher's assistance, in embedding reasoning opportunities that they had agreed on.

Cath: Planning with each other and observing each other was much better than just watching and trialling the demonstration lesson.

Amy: And I just thought the value, I'm—yeah, I see it, I see it, I see it.

Sue: I think it's great—I like it.

Peer observation gave participants the opportunity to listen to students' conversations that they might normally miss in teaching a lesson and managing a class.

Kate: You know what was interesting—you didn't hear it—was one of the conversations the kids were having when they were partnering together...so I listened to each of their reasons.

This point does not appear to have been raised in previous research.

Disadvantages

Despite the number of advantages noted by the participants during the post-lesson discussions, two disadvantages were raised: personal discomfort and financial cost. Two participants commented about being nervous when being observed.

Amy: I was nervous having Kate come into my room and watch me teach.

Sue: We were still a little bit anxious about it but it had a much more natural feel to it [than demonstration lessons].

We are mindful of Schuck et al.'s (2008) advice about creating an atmosphere of trust to overcome the teachers' personal discomfort, so it is interesting that these teachers were initially nervous being observed by supportive colleagues. "Mutual respect and responsibility are, therefore, important foundations for long-term improvements to practice" (Byrne et al., 2010, p. 216).

Another disadvantage related to the difficulties of funding time release.

Cath: It was really powerful those couple of years ago when Dan and Bonnie did have release to help with planning but it meant that they could also release someone to go and watch someone else teach. If there is a budget for it.

Noticing Reasoning

Peer collaboration in the planning, observation, and debriefing of the lesson offered opportunities for the teachers to notice and discern students' reasoning. Byrne et al. (2010) also noted the importance of conversations to facilitate learning by fostering reflection.

Amy: It's very, very valuable, but you need to be very, very calculated in the wording that you choose. Whether it is 'Show me' or 'Convince me' or 'Show me another way', 'What's another strategy?' and realising that they might have not had a strategy. This was something that I picked up from Kate's lesson because one of her students said, "Is it like when we did this?" Then Kate said, "Oh you made a connection to ..." and built on that strategy. Now I have strategies to build on that we've actually discussed as a class. So, the reasoning is really, really important, and taking the time to find out why you think that.

The shared language drawn from the peer observation lesson reinforced the employment of reasoning prompts. Further advice for improving pedagogical practices and language to cultivate reasoning were noted by peers, who indicated missed opportunities to promote reasoning.

Kate: Yeah that's the one thing I was going to say—because you kept saying "Tell me". And I thought that's where you would have said, "Show me."

Teacher's learning to notice is more than observing previous un-noticed behaviours, but becoming more aware and sensitive of classroom interactions (Nicol, Bragg, & Nejad, 2013). During peer observation, participants noticed changed behaviour when reasoning was embedded in the observed lesson, such as the expectation that students would have the freedom and obligation to explain their thinking.

Amy: They had the freedom to borrow from one another.

Kate: They had the freedom they could borrow from somebody else.

Additional positive behaviours noticed by the teachers as a result of injecting reasoning into the lesson can be seen in the following quotes: respect for each other; and, higher levels of engagement and reasoning.

Amy: What was really amazing, I was blown away by how they listened to each other. They can be very disrespectful to one another and they really did listen and nobody said, "No, you're wrong"

Amy: I just couldn't get over how they were focussed the whole time.

Kate: Yeah, they were focussed the whole time.

Amy: I wouldn't have got that from him otherwise. I would have just thought he couldn't tell me why it was right or wrong. I thought, "That was some pretty good reasoning."

Some observers expressed surprise at what they heard the children expressing.

Amy: Because you were allowed to have a completely different opinion; there was no one thing I was looking for. I forget that and I just saw the power of it today, of giving them that freedom. I just

thought to myself, “I just saw four or five kids contribute to something that I would never have thought they would have.”

Kate: Aiden just shook his head after he listened to Lucy. He goes “Boy was I wrong!” So, I said, “Oh so Lucy convinced you?” He goes, “Yep!”. So, I thought that was really interesting.

The results of this study confirm the benefits of peer observation identified in the literature as a means of professional learning, such as awareness of diverse teaching approaches, fruitful discussion, supported reflection, autonomy, and collegiality. In addition, we have recognised in the data the importance of teachers tuning into children’s conversations about their mathematical reasoning as something that had previously gone un-noticed and may not have been noticed without the support of peer observation.

Conclusion

Whilst mathematical reasoning is emphasised in curriculum documents around the world, little is known about teacher professional learning in implementing this new focus in the curricula. This focus is important because the ability to reason is fundamental in connecting mathematical ideas (Goos et al., 2017). Both in the larger and current study, we have responded to the call to provide teachers with more support in embedding a range of reasoning actions in their mathematics lessons (Clarke et al., 2012).

In this study, peer observation of lessons was trialled as a means of professional learning to build teachers’ understanding of reasoning. Two groups of teachers met together to plan a lesson based on an expected content area but with a particular focus on ensuring reasoning was also fore-fronted. They observed each other teaching the lesson, then met to consider the lesson and its outcomes.

Participants discussed the value of this form of professional learning, commenting on peer observation raising opportunities to listen to students’ conversations and observe pedagogical strategies for eliciting reasoning. They noticed changes in student behaviour when reasoning was encouraged and valued. Peer observations also served to cultivate collegiality, with autonomy and ownership over lessons they prepared. These advantages indicate that this form of professional learning for building teachers’ capacity to embed reasoning in their mathematics lessons warrants further research.

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