Thoughtful Practice: Taking Professional Development a Step Further.

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ABSTRACT: This paper reports on a follow-up study of one teacher, two years after she participated in a numeracy staff development contract based on the Cognitively Guided Instruction (CGI) philosophy.

The discussion is based on classroom observations and a semi-structured interview focusing on Ms Smith's perspective on the experience. She explains how she uses the research-based knowledge about the development of children's mathematical thinking gained from professional development to inform the teaching and learning of mathematics in her classroom.

This single case study is used to give some insight into reflective practice, self-sustaining and generative change in the teaching of mathematics, and professional development.

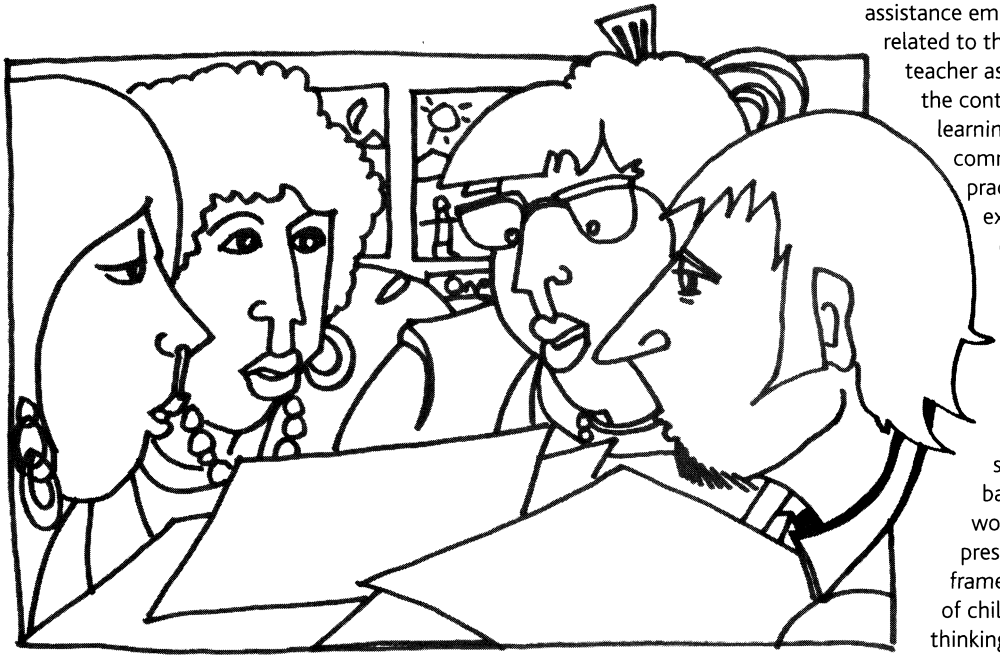
Introduction

There is an expectation by policy makers and professional developers that teachers' beliefs and knowledge, and ultimately practice, will change through professional development (Darling-Hammond & McLaughlin, 1995). A critical question is to ask how professional development can foster this learning process. The Cognitively Guided Instruction (CGI) professional development programme focuses on children's mathematical thinking and provides a basis for teachers to engage in ongoing practical inquiry (Franke, Carpenter, Fennema, Ansell, & Behrend, 1998). Initially teachers are provided with knowledge about the development of children's mathematical thinking. They are then expected to assess children's thinking in mathematics and use that knowledge in the context of their own classrooms (Carpenter, Levi, Franke, & Empsom, 1997). Teachers are encouraged to make sense of their student's mathematical thinking, to reflect on their teaching, to evaluate the student's thinking, and to use that to influence change in beliefs and practice. This model reflects the reformed view of professional development, diverging away from the conventional view that professional development is a transferable package of knowledge to be distributed in bite-sized pieces (Lieberman, 1995).

Professional development programmes such as CGI promote 'reform' classrooms "requiring wholesale changes in deeply held beliefs, knowledge and habits of practice" (Stein, Smith, & Silver, 1999, p. 238). However, while initial teacher change may appear transformative, it should also be sustainable. Franke, Carpenter, Levi, and Fennema's (2001) research on long-term teacher change following CGI professional development provides a useful framework for analysing ongoing teacher learning. Based on the presupposition that professional development focuses on what teachers learn, and more specifically on what they learn about student thinking, the framework identifies three features of teacher learning: (a) generativity - teachers' ability to continue to add to their understanding, (b) creating knowledge that is rich in structure and connections, and (c) viewing knowledge about teaching and learning as constructed, self-created, and continually changing. Using the framework, we report on changes in Ms Smith's teaching, two years after she had participated in the professional development programme. Initial outcomes of the professional development programme are reported in an earlier paper (Anthony, Bicknell, & Savell, 2001).

Background: Cognitively Guided Instruction

The teacher in this case study, Ms Smith, participated in a numeracy professional development programme with colleagues from the junior syndicate of her own school and two neighbouring schools. The professional development model, based on CGI, embraced the new paradigm for professional development: "Teacher assistance embedded in or directly related to the work of teaching; teacher assistance grounded in the content of teaching and learning; development of teacher communities of professional practice; and collaboration with experts outside the teaching community" (Stein, Smith, & Silver, 1999, p. 239).



The professional development programme involved teachers participating in a series of workshops with follow-up support from the university-based educators. During the workshops teachers were presented with a structured framework of the development of children's mathematical thinking in specific content

strands. A textbook and video material from the Cognitively Guided Instruction Professional Development Program developed at the University of Wisconsin, Madison, were used to support teachers in reflecting on their current practices and classroom norms in relation to children's mathematical thinking. Discussion in the workshops focussed on teachers' appraisal of the validity of the framework and its value as a structure upon which to assess their teaching of numeracy. Children's communication of their solution methods and the provision of appropriate equipment to facilitate their problem solving were recurring themes throughout the workshops. Ms Smith, along with some of the other teachers, studied a special topic university education paper 'Numeracy in the Early Years' that was offered in conjunction with the programme.

Reflecting on Teaching

Ms Smith realised that the CGI approach to teaching presented her with a structured way of using children's thinking about numbers to influence her practice. What it didn't provide was a step-by-step set of instructions, prescribed material and activities. It was not a recipe approach of the type that she had previously met in professional development contracts. Ms Smith felt it gave her license to focus on children's thinking, to spend more time on a few selected problems and to make more explicit links among concepts.

> Whereas before I would teach fractions, multiplications, division, now I teach fractions, multiplication and division in the context of a problem; together they become part of one. It makes my teaching easier because I can make links with where they are and what they are doing.

Ms Smith continues to explain how she sees the emphasis placed more on process; she thinks more about the children's thinking, analyses their responses and often changes the direction of her teaching. Her planning is linked to children's stages of thinking; she chooses problems to develop mathematical concepts and considers the interrelationships among concepts.

> When I saw what the teachers [CGI teachers in the video] were doing and how they were doing things, I thought this is me. I can see myself doing things this way. I could make links to my own teaching. I could see that what I was doing wasn't really working but I didn't have an alternative. CGI offered me that alternative.

A classroom episode

The following teaching sequence was observed with the teacher initially working with the whole year two class. The students were presented with the problem: "Harry had 6 buckets. He put 2 dinosaurs in each bucket. How many dinosaurs did he have altogether?" The teacher reported (in a post-lesson interview) that the series of problems for the lesson had been carefully chosen so that students were not simply practising procedural knowledge. Rather, the problems were chosen to provide a context for practice of multiplication, and the development of the concept of division.

The students had a range of equipment to choose from to model the problems including counters, rods, blocks and buttons. They readily tackled the problems and selected a range of material to support their thinking. The students were then encouraged to record and share their solution strategies with the class. The teacher then posed a similar but more challenging problem: *Harry had 5 buckets. He put 4 dinosaurs in each bucket. How many dinosaurs did Harry have altogether?*

In response to the different solutions, the teacher posed various questions to the children to encourage them to evaluate their solution strategies:

> How many did you get?
>
> We have different answers here so let's have a look at how you solved the problem.
>
> Where are your buckets?
>
> How many buckets have you got?
>
> How many buckets do you need?
>
> How many dinosaurs are there in each bucket?
>
> Show me how you counted them.

The children explained, self corrected and used their recordings (mostly drawings although a few used symbols) to support the communication of their reasonings.

Following this episode, a further problem was presented with a choice of numerals. There was an established expectation that the children individually select which numbers to work with. The more challenging problem was: "I have 16 dinosaurs. I put them in 5 buckets. How many dinosaurs will go in each bucket?" After children modelled answers to this problem and shared counting strategies the teacher asked the children what could they do with the one that was left over. Interestingly, the children were not concerned with the context and happily 'cut up' a model of the leftover dinosaur. Those working on this problem modelled the fraction using paper strips. Their previous experience with fractions had involved halves and quarters, so the challenge was to extend their fraction understanding. Folding the strip into fifths also provided a modelling challenge.

In all cases these tasks provided 'problematic' situations for the students (Heibert et al., 1997). The teacher had carefully chosen problems that would challenge all students and allow them to make connections with previous mathematical understandings. The problems were within reach of the students, yet were genuine problems. Some of the problems dealt with leftovers of one to be shared between two people, others dealt with quarters and fifths. In discussions with the students, the teacher made links between modelling regions and modelling sets as leftovers from the division problems.

The teacher took responsibility for selecting appropriately challenging tasks when choosing her problems for the day. Ms Smith reported a preference for students to work as a class on problems that have a similar structure and context but differ mathematically in their complexity - varied by careful selection of numbers. An interesting feature of the multi-problem format was that children were often provided with the opportunity to self-select the level of difficulty of their problems. Ms Smith noted that most students do not choose a problem that is too simple, although on occasions will choose one that is too challenging. These young children understand what it means to 'work on a problem'. The expectation to generate their own solution methods and to informally record their solution strategies was well established.

Ms Smith encouraged multiple solution methods for the one problem, asking the children: "Who did it another way?" The children were encouraged to listen to

others, and to use models or drawings to support their answers. It was evident that the 'wait time' necessary for these young children as they modelled and explained was an accepted norm. Occasionally the teacher's questioning provided hints and support to promote clarity so that classmates would make sense of the explanation. Those who had provided an incorrect answer usually discovered the mistake as they elaborated on the solution method. The discovery was one of excitement in finding out "Oh no, it's not that, it's ...". The teacher conveyed a keen interest and provided positive feedback to the child for the solution strategy that had been used and the thinking that had been displayed.

A notable feature of the classroom norms was the shared responsibility for establishing correct solutions. Students certainly did not look to the teacher to provide the right answer, to correct their solutions or method. By careful focus on the students' strategies Ms Smith was observed to facilitate the correct solution development using the logic of the mathematics rather than the authority of the teacher. "Listening carefully to descriptions of methods sends a powerful signal to students that methods are to be respected" (Hiebert et al, 1997, p.165).

It is evident that the culture of this classroom is one in which reflection and communication are valued. The students seemed confident in choosing an appropriate problem, sharing their solutions and in having their solution challenged by their peers. The teacher encouraged, through questioning, the modification of solutions as students modelled and explained their strategies. Ms Smith explains: "They are encouraged to discuss and offer their ideas; their ideas are valued. I think it is all about reflection and self-evaluating of their work. That is the whole culture of the classroom."

In organising the classroom discussion Ms Smith was quite conscious of the need to establish norms of student participation. While most students readily volunteered to give their solution strategy, Ms Smith deliberately selected different students to share their strategies with the rest of the class. Ms Smith reports that her motives for choosing children vary:

> I try and pick out different children, children whose thinking I want to know more about, others that I feel need reaffirming that they are doing really well and others who I believe have the concept underway. During the week I try and get every child to have a say.

Generative Change

Central to the paper however is the issue of whether the professional development provided Ms Smith with opportunities to add to her understanding through ongoing learning. Observations of Ms Smith's classroom practice, discussions and communications lead us to believe that changes in Ms Smith's teaching and associated knowledge are generative. This kind of change "does not involve gaining a set of procedures to implement with fidelity; rather it frequently entails teachers making changes in their basic epistemological perspectives, their knowledge of what it means to learn, as well as their conceptions of classroom practice" (Franke at al.,1998, p. 67). Teachers change in a way that provides a basis for continued growth. Two years on Ms Smith comments:

> All the way through I am seeing how things fit and I am learning. I needed the framework to build from. From the framework you keep building layers and layers. Unless you have something to build from, you can't build these layers.

The discussions with students and the analysis of their thinking provide the basis for Ms Smith to continue to learn with understanding. She readily shares exciting moments that continue to contribute to her understandings about how children learn. The change is not only sustained but also generative as she continually evaluates and adapts her classroom practice.

Additionally, Ms Smith reports that she has transferred her knowledge of what it means to learn mathematics and her conception of classroom practice to the other learning domains within her classroom:

> The spin-off has gone further into my other classroom activities. I always did some reflective work but I do more of it now. I encourage more verbalisation. I do more because of what has happened, my understanding. I use those [CGI] philosophies all the way through the curriculum. When something new comes along I think about it, analyse it and focus on the process. What does this mean for the children, what do I know about what they know and how will I use their knowledge to build on?

Using a Framework of Teacher Change

Most studies focus on the impact of professional development soon after the conclusion of a programme. Only a few studies have followed teachers more than a year after the professional development (see for example Clarke, 1999). A CGI longitudinal study (Franke, Carpenter, Levi, & Fennema, 2001) documents changes in beliefs and practices from a sample of 22 teachers who participated in the CGI development programme in 1993, and in 1997 were involved in a follow-up study. From data analyses a classification scheme used in the initial study was adapted to characterize levels of teacher development (for more detail see Fennema et al., 1996; Franke et al., 1998). The framework provides a series of benchmarks that indicate skills and understandings teachers have acquired and conceptions of how teachers think about the teaching and learning of mathematics. These levels of development criteria can be helpful when examining the quality of teacher change. A summary is provided in the table below.

Table 2

Levels of Engagement with Children's Mathematical Thinking

Level 1: The teacher does not believe that the students in his or her classroom can solve problems unless they have been taught how.

Does not provide opportunities for solving problems.

Does not ask the children how they solved problems.

Does not use children's mathematical thinking in making instructional decisions.

Level 2: A shift occurs as the teachers begin to view children as bringing mathematical knowledge to learning situations.

Believes that children can solve problems without being explicitly taught a strategy. Talks about the value of a variety of solutions and expands the types of problems they use.

Is inconsistent in beliefs and practices related to showing children how to solve problems.

Issues other than children's thinking drive the selection of problems and

activities.

Level 3: The teacher believes it is beneficial for children to solve problems in their own ways because their own ways make more sense to them and the teachers want the children to understand what they are doing.

Provides a variety of different problems for children to solve.

Provides an opportunity for the children to discuss their solutions.

Listens to the children talk about their thinking.

Level 4A: The teacher believes that children's mathematical thinking should determine the evolution of the curriculum and the ways in which the teachers individually interact with the students.

Provides opportunities for children to solve problems and elicits their thinking.

Describes in detail individual children's mathematical thinking.

Uses knowledge of thinking of children as a group to make instructional decisions.

Level 4B: The teacher knows how what an individual child knows fits in with how children's mathematical understanding develops.

Creates opportunities to build on children's mathematical thinking.

Describes in detail individual children's mathematical thinking.

Uses what he or she learns about individual students' mathematical thinking to drive instruction.

(Franke et al., 2001, p.662)

It is not presumed that all teachers move through the levels in a linear way or in a similar time frame but the levels indicate teacher skills, understandings and beliefs that link to the teacher's focus on students' mathematical understanding and sense-making.

This framework can be used to analyse Ms Smith's teaching practice. Ms Smith views children's thinking as driving all aspects of her classroom practice, not just in the context of number but in other content strands such as geometry and measurement. Her conversations focused on specific children – what they had been able to do and how they solved the problem. She became excited when talking about Steven who was reticent in other curriculum areas but was developing confidence in mathematics.

> He could verbalise this morning what he was doing and could tell, very simply explain what he was doing; it was just amazing. I noticed Ben this morning who has taken on board the idea of equal sharing, how many pieces they could cut into. The growth, the understanding was there and I now know where he is at.

She affirms that it is the children's thinking that drives her practice. There wasn't a sense of panic about how much there was to cover but an air of excitement about how the links could be made between content areas.

Ms Smith talked more about the philosophy advocated by CGI rather than the framework itself, although it was clear in her planning and in classroom observations that her practice was modelled on the CGI framework of problem types. The solution strategies helped her to know about problem difficulties and influenced instructional decisions about what problems to pose.

Ms Smith provided details about the thinking displayed by some children with little or no prompting in the interview. She explained how a child had solved a problem, their choice of equipment and the significance of a child realizing that the equipment was not appropriate. "He was trying to use the hundreds board, he found out that it wasn't working and couldn't do it so went back to something he understood, used it and did it himself without me telling him. I was thrilled". In relation to the framework, previously outlined, the teacher at Level 4 is not only able to detail the children's thinking but would help students extend their explanations and have a clear idea of how to help students progress in their understanding. Ms Smith's purposeful introduction of problems that linked multiplication and division and involved remainders, revealed a deliberate focus on mathematical development. Ms Smith uses her knowledge of what she learns about individual student thinking to make instructional decisions and so creates opportunities to extend their mathematical thinking.

Ms Smith sees herself as a learner, one who has to make changes and evaluate what's going on for the children. "All the time I am thinking where have the children been, where are they now, how do they feel about maths. I make changes, catering for groups and individuals so that they are making progress". She explains that she has made shifts in thinking about what children could do and what they can do now. She believes that she has made significant changes and that there has been a spin-off into other classroom activities. The characteristics displayed by Ms Smith in her classroom practice and her articulated beliefs also support the notion of a teacher operating at Level 4 on the Framework. Rather than merely sustaining change she displays evidence of generative change. She listens carefully to details of her student's mathematical thinking and uses these to make instructional decisions. The children's thinking is viewed as their own; as their teacher she was privy to this thinking and uses it to help students advance their mathematical thinking.

Implications

Rather than viewing the professional development as separate from her classroom practice Ms Smith viewed her classroom as a "learning laboratory" (Cobb, Wood, & Yackel, 1990, cited in Mewborn, 2003). By focusing the teachers' thinking and reflection on her students' mathematical thinking the teacher was actively involved in, and aware of, the change process. The professional development experience has given Ms Smith, the teacher in this case study, both the licence and confidence to pursue continual change in her practice.

Continuing contact with Ms Smith has provided a first-hand opportunity to learn about sustaining and generating change in beliefs and practice. For Ms Smith a significant difficulty associated with sustaining practice relates to school environment. She teaches in a school where there have been significant staff changes and collegial levels of interest and commitment vary considerably. While the professional development programme began as a junior school project, Ms Smith feels that two years on it is for her a lone teacher's effort. She shares her philosophy and teaching practices with other staff members but comments: "I keep feeding them bits of information; change isn't going to happen overnight. It's starting to happen but it's going to be slow". Teacher collaboration can support teacher learning; ideally engaging in

generative growth should not be a solitary endeavour (Franke et al., 2001). The levels of teachers' involvement and extenuating circumstances have meant that there has not been a critical mass to sustain school wide development.

This case study of one enthusiastic teacher highlights aspects of Ms Smith's practice and experiences that have contributed to on-going personal professional growth and illustrates how teacher change can be mapped to levels of engagement with children's mathematical thinking. However, the study reports one teacher's view of the changes she experienced in her beliefs about how students learn mathematics and the impact this has had on how she teaches mathematics in the classroom. A more balanced view would be gained by revisiting others who participated in the project. Too often the evaluation of a professional development programme ends with the completion of the project. In light of the current large-scale professional development programmes associated with numeracy, it is critical that we identify exemplary practice and measure change in teacher beliefs and practice over sustained periods of time. Ideally, teacher change in knowledge, beliefs, and practice should be self-sustaining and generative.

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