

# The Impact of a Developmental Framework in Number on Primary Teachers' Classroom Practice

Janette Bobis

*University of Sydney*

<janette.bobis@sydney.edu.au>

This paper presents the findings of an investigation into the influence primary teachers' knowledge of a researched-based framework describing children's cognitive development in early number has on their teaching practices. Survey and interview data from twenty-eight teachers were collected to determine teachers' perceptions of their understanding of the framework, their ability to use the framework to assess students' mathematical development and to plan appropriate instruction. The findings raise further questions about the influence of affective factors, such as teachers' confidence in their own knowledge, on their instructional decision-making.

Teachers' knowledge of children's mathematical thinking strategies can be extremely influential in determining their instructional strategies (Swafford, Jones & Thornton, 2000). While distinct from knowledge (Thompson, 1992), teachers' *perceptions* of their knowledge seem to particularly impact on their classroom instruction (Cai, Perry & Wong, 2007). Without confidence in their knowledge to determine students' mathematical development, teachers may question their abilities to plan appropriate instruction.

'Confidence' is a dimension of attitude that has been studied quite extensively in relation to teachers' mathematical content knowledge, particularly in primary and middle school teachers (Beswick, Watson & Brown, 2005). Considered together with the work of researchers such as Deborah Ball (e.g., Hill, Sleep, Lewis & Ball, 2007) and those concerned with a program of research surrounding Cognitively Guided Instruction [CGI] (e.g., Fennema, Carpenter, Franke, Levi, Jacobs & Empson, 1996; Franke & Kazemi, 2001), we have gone some way in developing our understanding of teachers' abilities — and confidence in those abilities — to both assess students' mathematical development and to plan appropriate instruction as a consequence.

In a long-running series of studies, Carpenter, Fennema and a team of CGI researchers showed that primary teachers can identify the major strategies that children use to solve different kinds of problems, but their knowledge is generally not organised into a coherent network and possibly for this reason does not play a determining role in their instructional decision-making (Fennema et al., 1996). They proposed that research-based frameworks present that knowledge in a more organised manner and thus it would be easier to use to guide assessment and teaching practices. Fennema and colleagues used frameworks for addition/subtraction and then multiplication/division problem-types to study teachers' knowledge and beliefs about children's thinking in these areas, and explored the impact on instruction and children's learning of that knowledge. They found that knowledge of children's thinking made a difference in how teachers taught mathematics and what children learned (Franke et al., 2001). Exactly what these differences are and how teachers use this information to modify their instruction is the subject of on-going research of the CGI and other researchers concerned with the impact of teacher knowledge on instruction and student learning.

The explicit assessment of teachers' abilities to apply their knowledge of a research-based developmental framework in number was an important component of a larger study designed to explore the impact of a professional development program on teachers'



knowledge and classroom practices. Before presenting the specific research questions of the study relating to teacher knowledge, their perceptions of that knowledge and its impact on their teaching practices, background to the professional development program and the specific developmental framework in question is briefly presented to provide the context for the study.

### *Count Me In Too and the Learning Framework in Number*

The professional development program that formed the basis for this study was the Count Me In Too (CMIT) numeracy program. CMIT is a professional development initiative of the Department of Education and Training in New South Wales (NSWDET, 2007). Its main aims are to help teachers understand children's mathematical development and to improve children's achievement in mathematics. Key aspects of the program include the Learning Framework in Number (LFIN) and a diagnostic interview or Schedule in Early Number Assessment (SENA) (Wright, Martland & Stafford, 2006). The LFIN is a useful 'tool' used by teachers to not only identify the level of development each child has attained but to provide instructional guidance as to what each student needs to work towards. A stimulus for the current study was the need to know what teachers understand about the LFIN and how it impacts on their teaching and assessment practices.

Learning frameworks provide a description of skills, understandings and knowledge in a sequence in which they typically occur, giving a virtual picture of what it means to progress through an area of learning. Thus they provide a pathway or map for monitoring individual development over time. A student's location on a framework can be utilised as a guide to determining the types of learning experiences that will be most useful in meeting the student's individual needs at that particular stage in their learning. A number of professional development programs now exist that utilise such theoretical frameworks with the aim of increasing teachers' understanding of children's mathematical thinking (e.g., Bobis, Clarke, Clarke, Thomas, Wright, Young-Loveridge & Gould, 2005; Van den Heuvel-Panhuizen, 2001).

The CMIT Framework was initially developed by Wright (1994) and has since undergone further development through the impact of a wide range of research in early number (e.g., Gravemeijer, 1994; Mulligan & Mitchelmore, 1997). The LFIN characterises major stages of development in five key components of number, including: knowledge of forward and backward number word sequences, numeral identification, operation strategies using both counting by both ones and in groups, through to knowledge of fractions by sharing and partitioning. Teachers use these stage descriptions to profile their students' knowledge in each key component. Such information then provides instructional guidance as to what each student needs to progress. An important step in teachers' ability to utilise the framework in their instructional decision-making is their understanding of how all components are interrelated.

### *Aim of This Study*

The aim of this study was to explore teacher knowledge of the LFIN from the CMIT numeracy program, teachers' perceptions of that knowledge, and the impact this knowledge has on their teaching practices. In particular, the study addressed the following research questions:

1. What are teachers' perceptions of their knowledge about the Learning Framework In Number [LFIN]?

2. How confident do teachers feel about identifying children's levels of mathematical development on the LFIN?
3. Can teachers use their knowledge about children's mathematical development as indicated on the LFIN to plan appropriate instruction?

## Research Design

Three primary schools were purposively selected by NSW DET authorities and then invited to participate in the study. Criteria for selection were based on a school's action plan detailing 2008 outcomes and processes for the implementation of CMIT in their school and their willingness to participate in the study. A case study of each school was compiled that specifically focused on teacher knowledge of the LFIN and its impact on their teaching practices. While information for the larger study was gathered from three main sources — survey, interviews and teaching documents — given length restrictions, only data from certain sections and questions of the survey can be reported here.

### *Procedure and Instruments*

The survey consisted of three main sections. The first section sought biographical and contextual information about the school and the individual teacher completing the survey. Section 2 asked teachers to rate the level they perceive best described the implementation of CMIT at their school and in their own classroom. The third section of the survey required an open-ended response to a scenario involving a description of a student's reaction to a mathematical task. Teachers were asked to use the available evidence to approximate the child's performance as described by the LFIN and to make suggestions about the types of activities/learning experiences that would most suit the child's level of understanding. The survey was completed anonymously by teachers and then placed in individual, unmarked envelopes for collection by the researcher.

Responses to Questions 5-8 from Section 2 and the open-ended response to Section 3 of the survey will be reported in this paper. These questions related specifically to individual teachers' perceived understanding of the LFIN (Ques. 5), the extent to which they considered the LFIN had increased their understanding of children's number knowledge (Ques. 6), their confidence using it to assess students' development in number (Ques. 7) and the impact this knowledge has on their instructional decision-making (Ques. 8). Individual background data drawn from Section 1 of the survey will be drawn upon to help interpret some findings when appropriate.

## Results and Discussion

Twenty-eight surveys were returned from the three case study schools—10 from both School A and School C and 8 from School B. For Questions 5 to 8 of Section 2 on the survey, teachers were asked to use a rating scale from 0 (no understanding or confidence) to 4 (excellent /extensively). Hence, the higher ratings generally indicate more desirable and confident responses in terms of teachers' understanding of the LFIN and the perceived extent to which it impacted on their pedagogy. However, without an explanation or rationale for each rating, caution should be used interpreting the results. For instance, during site visits, interviewees were asked to rate themselves on similar items and to explain their rating. While some interviewees rated themselves only 1 or 2 for their understanding of the LFIN (e.g., Respondent 5 from School A), some explained the fairly low rating was because they now know that they "have a lot more to learn". This may also

be a reason why some teachers did not wish to indicate Excellent (Level 4) for any aspect of their understanding of the LFIN despite their familiarity working with the LFIN in the classroom for a number of years. Nonetheless, important trends in the data can still be identified, particularly when comparisons are made between schools.

The results for Section 2 Questions 5 to 8 for all survey respondents are presented in Figure 1. Generally, respondents from School A (Respondents 1-10) rated their understanding of the LFIN as Adequate (Level 2) or higher with the majority considering their understanding as Good (Level 3). Respondent 6, who displayed the most positive responses overall, indicated on the survey that she is also the CMIT coordinator in her school so it is understandable that this respondent would be more experienced and confident in most aspects of the LFIN and its impact on instruction. Six respondents (Respondents 2, 3, 7, 8, 9, and 10) rated Question 7 (confidence identifying a student’s stage of development on the LFIN), as only Adequate. Given that four School A, respondents indicated that they had less than 12 months experience implementing CMIT in their classrooms (Respondents 2, 5, 9 and 10) it is highly likely that this lack of experience influenced their self-ratings on these items.

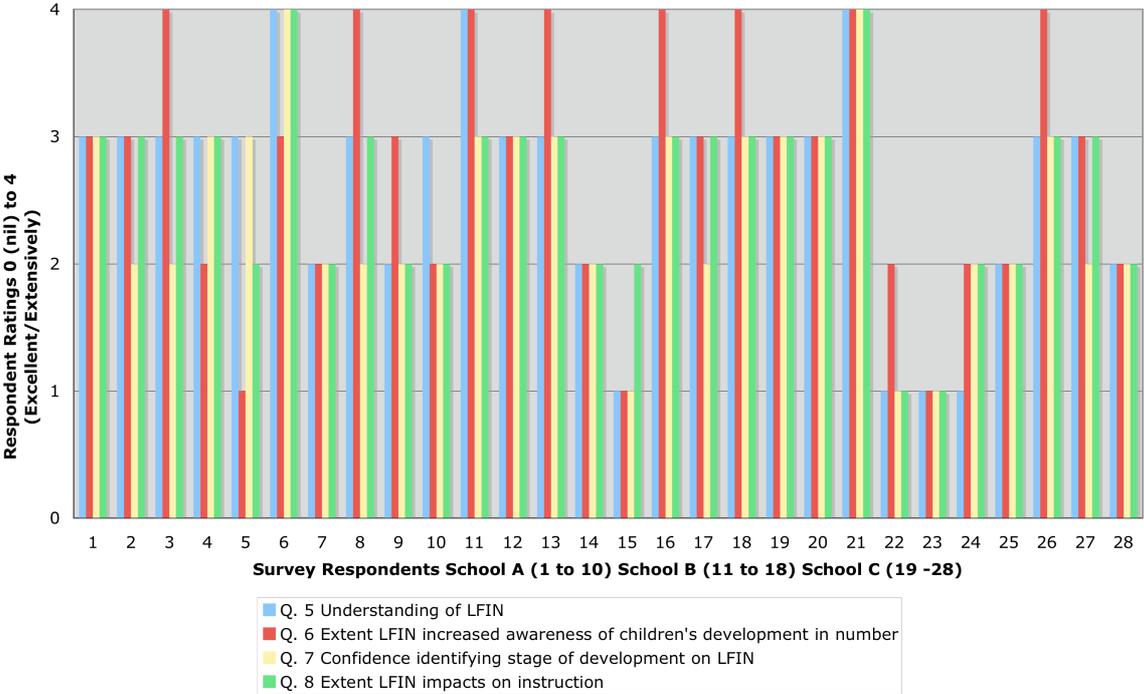


Figure 1: Responses to survey section 2 Questions 5 – 8.

Survey respondents from School B (Respondents 11 to 18) generally indicated more positive perceptions of their understanding and confidence using the LFIN. The majority provided a Good (Level 3) rating to each of the questions concerned with their understanding and implementation of the LFIN. From Section 1 biographical data provided by respondents, it was found that the average length of involvement in the program of all School B respondents was 5 years, making the staff of School B the most experienced CMIT users of all three case study schools. Half of the respondents considered that there had been Extensive (Level 4) increases in their awareness of children’s development in

number knowledge and strategies as a result of their introduction to the LFIN. Only one respondent (Respondent 15) selected ratings at Minimal (Level 1) for their understanding, increase in awareness and for their confidence identifying the stage of development using the LFIN. Understandably, and in accord with the findings of Frank et al. (2001), the same respondent considered that the LFIN had only a Level 2 impact on their instruction.

School C survey results are represented by Respondents 19 to 28 in Figure 1. Taken as a whole, the range in responses is more varied than for Schools A and B with a greater number of respondents selecting lower (Level 1 or 2) ratings to describe their understanding and confidence working with the LFIN. Importantly, respondents who rated any aspect relating to their knowledge and implementation of the LFIN as a Level 3 or 4 were either Kindergarten teachers (Respondents 20, 21 and 27), the CMIT Facilitator (Respondent 26) or executive staff (Respondent 19 Year 5 teacher) with at least 4 to 5 years experience working with CMIT in their classrooms. The remaining respondents (Respondents 22, 23, 24, 25 and 28) each had less than 2 years experience implementing the program with Respondent 28 indicating less than a few months experience. Respondent 21, who indicated the highest level of confidence about their understanding of the LFIN and their ability to use it to identify children's developmental stages and plan for instruction also had the greatest number of years experience working with CMIT in the classroom (nearly 6 years). While reasons for individual ratings still need to be clarified via interview data, there is a clear trend at School B and C indicating that the more exposure teachers had to CMIT, the more confident they felt about their understanding of the LFIN and their ability to use it to guide their assessment and instructional decision-making. Understandably, the more time spent familiarising oneself with new knowledge and practices, the more comfortable a teacher would feel incorporating them into their teaching. However, as argued later, this was not the case for all teachers, and it became apparent that while 'length of time' may be necessary for a more robust implementation of CMIT, it is certainly not a sufficient factor.

Section 3 of the survey presented an excerpt from a 'hypothetical' interview in which a child's early arithmetical strategies were being assessed. Respondents were required to respond with advice for the teacher of this child regarding (a) the child's numerical development, and (b) what to teach the child. Due to the enormous variation in responses to this item, a rubric was established to assist with analysis of respondents' comments. The rubric, along with the number of respondents from each school falling into each level and sample responses, is presented in Table 1. Importantly, an allocation to a particular level on the rubric does not indicate that one teacher is considered a better teacher than any other — it simply means that they are considered to have a different level of understanding of the LFIN.

Three survey respondents (1 from School A and 2 from School C) did not respond to this section on the survey so were given an automatic Level 0 rating according to the rubric. Only two other respondents received this level rating due to the fact that their answers did not explicitly address the question. Seventy-eight percent of respondents (23 out of 28) provided responses that were rated at Level 1 or above with 50% receiving ratings in the top two levels.

Table 1

*Rubric for Analysing Teachers' Responses to the Assessment Scenario of the Survey.*

Level	No. of teachers responding at each level per school & total (%) for all schools <sup>1</sup>	Description of response level	Sample responses and list of respondents in each category
0	School A = 2 School B = 0 School C = 3 Total = 5 (17.8%)	No response, unreasonable or inappropriate response indicating little/no understanding of task or unable to make sense of response.	No response (Respondents 10, 20 & 25). Depends on how old the child is (Respondent 23). Respondents 4, 10, 20, 23, 25
1	School A = 3 School B = 2 School C = 3 Total = 8 (28.5%)	Strategy development described or LFIN referred to but inappropriate stage selected. No follow-up suggested or some understanding evident of follow-up activities but may not be the most appropriate given stage selected.	Child is counting from 1 for addition (Respondent 7) Child is emergent and needs the more efficient method of counting-on from larger number (Respondent 14) Respondents 6, 7, 9, 14, 15, 19, 21, 22
2	School A = 3 School B = 1 School C = 3 Total = 7 (25%)	Appropriate strategy described or LFIN referred to. Follow-up learning experiences mostly appropriate.	Perceptual level. Teach child to count on from the larger number (Respondent 17) Respondents 1, 2, 5, 17, 24, 27, 28
3	School A = 2 School B = 4 School C = 1 Total = 7 (25%)	Comprehensive understanding of strategy development or LFIN and/or uses LFIN to justify choice of appropriate follow-up learning experiences.	Level 1 Perceptual. Still needs concrete materials and counts from 1. Reinforce counting forwards and backwards to increase confidence, working towards counting on from numbers other than 1. Activities such as 'Rabbit ears' will help reduce reliance on concrete materials (Respondent 16) Respondents 3, 8, 11, 12, 16, 18, 26

<sup>1</sup> School A (n = 10), School B (n = 8), School C (n = 10), Total (n = 28)

Respondents from Schools A and C dominated Level 1 and 2 ratings indicating that respondents from these two schools were clearly able to use the available information to either identify the type of strategy used by the child in the scenario or suggest appropriate follow-up instruction. However, Level 1 type responses usually did not refer to a specific stage from the LFIN or, if they did, they selected the wrong strategy 'label'. For instance, Respondent 14 suggested the child was demonstrating 'Emergent' characteristics when a

‘Perceptual’ strategy assessment is more appropriate. Respondents providing Level 2 type responses usually provided an appropriate description of the strategy being used by the child or used the correct terminology from the LFIN. However, they normally suggested follow-up instruction indicating the child now needed to “count-on from the larger number” (e.g., Respondent 17). While this is certainly a necessary strategy development for the future of this child, there are a few more urgent skills the child needs prior to being able to develop the more sophisticated strategy of counting-on. Such appropriate strategy development was more typically suggested by responses rated as Level 3.

Level 3 type responses provided evidence of a comprehensive understanding of strategy development via their ability to analyse the information provided in the scenario. They were also able to use their knowledge of the LFIN and strategy development to justify their choice of appropriate follow-up learning experiences (see, Respondent 16’s justification in Table 1). Over half of the responses demonstrating Level 3 characteristics were from School B respondents. Consistent with results from Sections 1 and 2 on the survey, respondents from this school not only possess the most experience with CMIT in terms of the number of years they have implemented it in their classrooms, but they also generally rated themselves more highly in terms of their confidence in understanding and using the LFIN to guide their instruction. Importantly, the trend across all three case study schools linking length of time in which respondents have implemented CMIT with their self-identified levels of understanding, and confidence using the LFIN is further supported by the results of Section 3 on the survey. However, it should not be assumed that ‘time’ by itself is the definitive factor for improving teachers’ abilities to understand and integrate the LFIN into their pedagogy. The interview data will be critical in identifying what these schools are doing with their ‘time’ that seems to be having such a positive impact on teachers’ abilities to implement CMIT.

## Conclusion

The aim of this study was to explore teachers’ perceptions about their knowledge of the Learning Framework In Number, their confidence in identifying children’s stages of development according to the LFIN and the extent to which they could use this knowledge to plan appropriate instruction for students. While the larger study drew upon more varied and richer data sources (e.g., interviews and teacher programs), the closed and open-ended survey items reviewed for this paper indicate trends (such as the link between the duration a school was involved in CMIT and the degree to which teachers felt it was being implemented) and further questions that were explored in more detail during the follow-up interviews. In particular; (a) What is the link between the duration of a teachers’ exposure to the program, their perceived confidence using the LFIN and the extent to which they could successfully assess and plan appropriate instruction for individual students? (b) Why is it that the majority of teachers rated their understanding of the LFIN as Level 3 and their confidence using the LFIN as Level 3 or lower; yet a quarter of all respondents achieved the highest possible rating when given a realistic case scenario to assess and plan instruction?

As shown by Ball and her colleagues (e.g., Hill et al., 2007), and findings by the CGI team (e.g., Frank et al., 2001), knowledge of children’s mathematical thinking can be influential in changing teachers’ instructional strategies and can potentially increase their abilities to cater for various levels of children’s mathematical understanding when it is presented to teachers in a coherent network of knowledge. The LFIN is a tool that is intended to provide such a network of knowledge. It is therefore imperative that the impact

of this tool be evaluated so that we better understand how to help our teachers understand and use it more effectively.

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