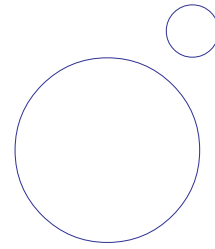


Count Me In Too

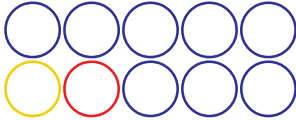
2000 REPORT



A Case Study of Implementation
A report prepared on behalf of
the NSW Department of Education & Training

by
Dr Janette Bobis
University of Sydney
December 2000

Count Me In Too

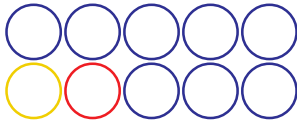


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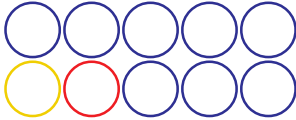
This report is the sixth in a series to be produced for the New South Wales Department of Education and Training as part of its ongoing monitoring and evaluation of the Count Me In Too Project. Other reports produced to date include:

1. Report of the evaluation of the Count Me In Project 1996. This report focused on the impact of Count Me In on the professional development of teachers.
2. Report of the Count Me In Too Project 1997. This report examined the degree of agreement between teachers when judging the arithmetical ability of young children on the Schedule for Early Number Assessment (SENA), a performance-based assessment instrument used in Count Me In Too to monitor students' arithmetical abilities.
3. The Mathematical Achievement and Self-concept of Kindergarten and Year 1 Children: Report of the Count Me In Too Project 1998. This report examined the impact of Count Me In Too (CMIT) on the mathematical achievement and self-concept development of Kindergarten and Year 1 children.
4. The Impact of Count Me In Too on the Professional Knowledge of Teachers: Report of the Count Me In Too Project 1999.
5. Count Me In Too: Guidelines for Successful Implementation. Report of the Count Me In Too Project 1999.

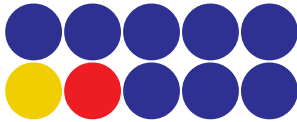


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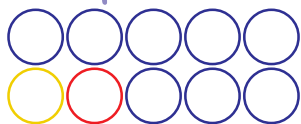
EXECUTIVE SUMMARY

This report presents the findings of an investigation into the Count Me In Too project operating in Department of Education and Training (DET) schools throughout New South Wales. The investigation was conducted in Terms 1 and 2 of the year 2000. Generally, its aim was to extend the findings of a previous study which had focused solely on the change in professional knowledge of teachers involved in CMIT (Bobis, 2000; Bobis & Gould, 2000). The present study not only sought to record the changes to teachers' knowledge, but to document the actual professional development process to enable a more in depth exploration of the *realities* of change experienced by teachers. In so doing, it was able to explore and identify some of the physical, emotional, academic and ideological obstacles that often accompany professional development programs exposing teachers to new knowledge and/or classroom practices. Concept mapping, classroom observations, formal interviews and regular informal discussions were used to develop case studies of 4 teachers as they were introduced to and began implementing CMIT in their classrooms.

SUMMARY OF CONCEPT MAPPING ANALYSIS AND TEACHER INTERVIEWS

Qualitative analysis of the concept maps and the accompanying interview data provided useful "snapshots" of each teachers' knowledge and espoused beliefs and practices at two points in time. It was found that the concept maps could distinguish fairly clearly between teachers with considerable variation in years of teaching experience and were useful for identifying the commonalities and subtle differences among the teachers. The maps were also useful in that they gave insight into how aspects of CMIT impacted on their knowledge, espoused beliefs and practices for the teaching of mathematics. To summarise, it was found that:

- There was general homogeneity of teachers' beliefs about how children learn mathematics and how it should be taught prior to CMIT (for example, through real-life applications and the use of concrete materials);
- CMIT had little impact on teachers' espoused beliefs and conceptions about the nature of mathematics and the way it should be taught (this is understandable given that the espoused beliefs were mostly in line with current curricula documents and those espoused by the CMIT program);
- The most notable change occurred in regard to teachers' knowledge of children's cognition, particularly their knowledge of children's strategy use and the associated stages of arithmetical development;
- There was an increase in knowledge of activities and a heightened awareness of the need for



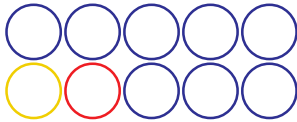
selecting appropriate activities for children at the different stages of development;

- There was generally a lack of knowledge integration evident in the first concept mapping exercise;
- An increase in knowledge integration was evident in the final concept mapping exercises but the level of integration varied from teacher to teacher; and
- The degree to which aspects of CMIT were integrated into existing knowledge and belief structures varied from teacher to teacher and did not seem to be related to years of experience.

SUMMARY OF FIELD NOTE DATA ANALYSIS

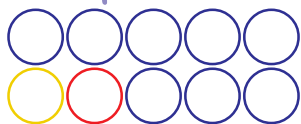
The realities of the change process in the 4 month period between concept mapping exercises is reported using themes that emerged from the initial interviews with teachers and subsequent field notes. This section draws upon information relating to teachers' espoused beliefs, knowledge and practices identified via the concept mapping exercise and initial interviews so as to compare and contrast them to those that were observed and corroborated by the consultant during her interview. In summary, the findings of data gathered during the period between concept mapping exercises indicated that:

- While changes to the mathematical content knowledge of teachers was difficult to detect through observations alone, new knowledge relating to the importance of bridging the decades, counting-back and counting-on from a range of numbers was evident;
- CMIT had varying degrees of impact on the different components of pedagogical knowledge for different teachers;
- Despite teachers' espoused familiarity and competence with the operation of group work in the classroom prior to CMIT commencing, the introduction of ability groups into mathematics lessons was a source of anxiety and stress for teachers;
- There was a significant positive impact on at least 2 teachers' use of group work for mathematics during the implementation of CMIT;
- There was an increase in use of concrete materials by the children in all classes;
- All teachers expanded their repertoire of activities and games, but more importantly, teachers were aware of the importance of assigning developmentally appropriate activities;
- The development of a large number of activities prior to children's needs being determined and by



people who were unaware of their intended uses, was detrimental to the implementation of CMIT;

- Less impact was noted in regard to teachers' use of the textbook—those who relied on the textbook prior to CMIT still relied on it afterwards and those who did not like it before seemed to like it even less;
- The two teachers who relied less on the textbook seemed to be more comfortable with the style of teaching espoused by CMIT and considered the textbook a constraint on their teaching;
- The textbook was perceived to be a constraint to CMIT as teachers sought to complete it to appease parents or school expectations;
- Teachers' knowledge and beliefs about how children learn mathematics underwent the most significant change, particularly in regard to children's use of strategies;
- Conceptions of the nature of mathematics were expanded for at least two teachers;
- Teachers considered that the amount of information available to them was inadequate and sought out-of-the-classroom training for a range of aspects;
- Considerable stress was caused to teachers by their own perceived lack of understanding about the Learning Framework in Number, the SENA, the process of allocating children to groups and by the preparation of resources;
- Not having to grapple with problems associated with the initial analysis of SENA results and the subsequent assignment of children into their groups contributed to teacher stress and confusion regarding these two aspects and had ramifications for the implementation of group work and a lack of confidence in the SENA ;
- Lack of time for reflection on the new knowledge, new practices, children's learning, to discuss issues with the consultant and the like, was a constraint that was frequently identified by teachers;
- The book, *Developing efficient numeracy strategies* (NSW DET, 1999) was considered by most teachers to be a useful source of information regarding ideas for activities and assessment;
- Changes to teaching practices were observed in all 4 teachers, but the degree varied from teacher to teacher. In particular, changes related to the use of open-ended questions, the asking of questions to elicit children's strategies, greater use of concrete materials and game-like activities, and the use of ability groupings to allow children access to developmentally appropriate activities;



- Variation in the degree of impact on teachers can be attributed in part to teachers' commitment to the program and was often evident by their attentiveness (or lack of it) during demonstration lessons conducted by the consultant; and
- Considerable improvements to the way the consultant implemented CMIT were made based on reflections of her experience.

CONCLUSIONS AND RECOMMENDATIONS

The present investigation sought to document the actual professional development process to enable a more in depth exploration of the *realities* of change experienced by teachers. In so doing, it was able to explore and identify some of the physical, emotional, academic and ideological obstacles that often accompany professional development programs exposing teachers to new knowledge and/or classroom practices.

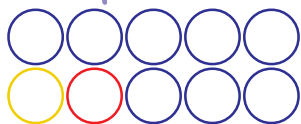
The crucial role of the consultant has been confirmed not only by this study, but by previous reports (Bobis, 1996; 2000). However, the present study highlighted how one or two 'problems' encountered early in the implementation of the program, such as with the making of the resources and the confusion surrounding the allocation of children to their ability groups, can have far reaching ramifications for the success of the rest of the program.

The extent to which the espoused beliefs and practices of teachers were enacted upon varied from teacher to teacher. While a particularly obvious nexus between the espoused and enacted practices of one teacher was the use of ability groups, other less obvious ones related to constraints brought about by the use of the textbook by teachers who preferred not to use one. Finally, a major obstacle to more far reaching changes occurring was perceived by the teachers to be the lack of access to relevant knowledge via sources outside the classroom or school.

A few recommendations are made throughout this report in response to specific aspects of the planning and implementation of CMIT. They, along with some additional suggestions, are summarised in the following points. It must be remembered that these recommendations are drawn from the experiences of just one school's implementation of CMIT and that many may not be appropriate in other contexts—indeed, some consultants may already be implementing them. Since, much of the way CMIT is introduced into schools is determined by individual consultants, it will be found that the majority of recommendations are pertinent to them.

RECOMMENDATIONS

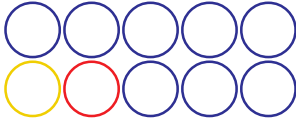
- I. Explicit structures that will provide opportunities for professional dialogue among teachers and



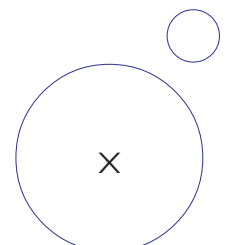
between teachers and their consultant outside of the classroom need to be built into the implementation stage of CMIT as early as possible. This may take the form of regular small group meetings during recess, after school or at network meetings.

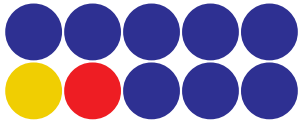
2. Teachers need to be given opportunities early in the implementation phase of the program to take responsibility for and develop independence in the assessment of their students and the subsequent allocation of students to their stages of development according to the LFIN.
3. Teachers should be encouraged to make decisions regarding the learning experiences their students need so as to determine what resources will be purchased and/or produced. While consultants will initially need to assist with this decision-making process they should *gradually* encourage teachers to take more responsibility for such decisions. Teachers are more likely to continue using the resources they are familiar with or have selected for specific purposes themselves.
4. The majority of teachers seem to need considerable support to establish the efficient operation of ability groups. This support may take the form of (a) demonstration lessons provided by the consultant or a teacher from the same school, and (b) opportunities for teachers to discuss their problems with either their colleagues or their consultant (see recommendation 1).
5. There is a need for consultants to make decisions about the appropriate conditions for different types of knowledge and to consider multiple learning contexts. Situating learning experiences for teachers outside of the classroom is important for reflection and the acquisition of some types of knowledge. However, classroom-based learning is also necessary to assist with the process of integrating the new ideas with practice.
6. Explicit structures in the form of an observation sheet or checklist help focus teachers' attention on specific aspects of CMIT being modelled by consultants during demonstration lessons. The observation sheets could be used as a catalyst for discussion after the lessons. A suggested observation sheet has been adapted from one already in use by another consultant and is included in Appendix C¹.
7. Variations in teachers' needs and capacities to understand more detailed accounts of the theoretical background to such aspects as the LFIN could be accommodated via the CMIT web-site and/or specially focused network meetings.

¹ The prototype from which this observational schedule was derived was provided by Kerry Robinson, the Mathematics Consultant for the Port Jackson District.



8. Consultants should actively seek ways to improve the way they implement CMIT. Reflection on each implementation experience can provide consultants and schools with valuable insights for improving the professional development process in the future. The reflection process could be more explicitly structured with the help of a teacher survey which is designed to provide individual consultants feedback on their introduction of the program.





A CASE STUDY OF IMPLEMENTATION

INTRODUCTION

This report presents the findings of an investigation into the Count Me In Too project operating in Department of Education and Training (DET) schools throughout New South Wales in 2000. It is the sixth in a series of reports to be produced for DET as part of its ongoing monitoring and evaluation of Count Me In Too (CMIT). Previous reports have focused on the impact of the project on the professional development of teachers (Bobis, 1996; 2000), the degree of agreement between teachers when judging the arithmetical ability of children on the performance-based assessment instrument used in CMIT (Bobis, 1997) and the mathematical achievement and self-concept development of children involved in the project (Bobis & Whitton, 1999).

The investigation reported here was conducted in Terms 1 and 2 of the year 2000. Its aim was to extend the findings of previous studies which had focused on the professional development of teachers involved in CMIT, but had failed to examine the actual process of change or document individual teacher 'journeys' (Bobis, 1996; Bobis, 2000). A closer monitoring of the actual professional development process was considered necessary to enable a more in depth exploration of the *realities* of change experienced by teachers. Such realities include the physical, emotional, academic and ideological obstacles that often accompany professional development programs exposing teachers to new knowledge and/or classroom practices.

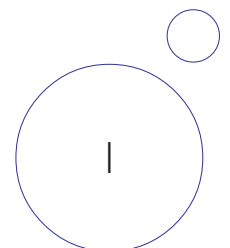
Case studies of 4 teachers working in the same school were developed from concept mapping exercises, classroom observations, formal interviews and regular informal discussions with the teachers, the principal and the mathematics consultant. Included in the documentation of each teacher's professional development journey, is specific information pertaining to their mathematical knowledge, beliefs, and instructional practices.

BACKGROUND TO THE STUDY

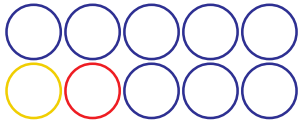
ORIGINS AND AIMS OF COUNT ME IN TOO

The Count Me In Too (CMIT) professional development program is an initiative of the New South Wales Department of Education and Training (DET). Its main aim is "for teachers to better understand children's mathematical strategies and their development from less sophisticated to more sophisticated strategies" (Stewart, Wright & Gould, 1998, p.557). Hence, there is a major focus on the development of children's mathematical thinking.

CMIT has its origins from the theory and methods of the Maths Recovery Program (Wright, Stanger, Cowper



Count Me In Too

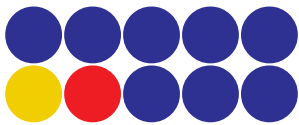


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A CASE STUDY OF
IMPLEMENTATION

& Dyson, 1996). The project, which commenced in 1996 and involved only a handful of schools, grew in 1999 to include over 360 primary or central schools throughout NSW. In 2000 a further 400 schools became involved in the CMIT. Key elements of the program include a research-based Learning Framework in Number and a Schedule for Early Number Assessment (SENA).

While the program operates differently from school to school it is essentially a classroom-based model of professional development that involves a close relationship between the district mathematics consultant and a group of teachers from each school. Consultants generally work in classrooms alongside teachers for a couple of hours each week, helping them assess the mathematical development of children according to the Learning Framework, and assisting with the planning and implementation of developmentally appropriate activities.



RESEARCH PLAN

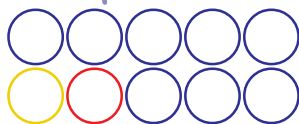
The present investigation extends the findings of two previous evaluations of the Count Me In Too program, namely, the 1996 investigation which reported in general terms on teachers' perceived impact of CMIT on their professional development (Bobis, 1996), and the 1999 investigation which reported in more explicit terms on the changes to teachers' knowledge of content, pedagogy and children's cognition (Bobis 2000). The aim of this study was to document the individual journeys of teachers to expose the realities of any such change processes. Of particular interest was the impact, if any, on each of the teacher's mathematical beliefs, knowledge and instructional practices. To do this, a case study methodology involving 4 teachers was adopted similar to the methodology described by Clarke (1999). In addition to the semi-structured interviews, informal discussions and classroom observations described by Clarke, concept mapping was utilised to access changes to teachers' beliefs and professional knowledge. Concept mapping has been used to examine how individuals change and organise their knowledge (Jones & Vesilind, 1996; Novak & Gowin, 1984) and has been shown to be a powerful and sound method for assessing conceptual change. Concept mapping proved useful in the 1999 Count Me In Too evaluation as it quite clearly showed how the knowledge of some teachers was completely restructured over time (Bobis, 2000).

A case study approach with the researcher acting as a participant observer was chosen because the aim of this study required an in-depth understanding of the change process. A similar approach is described by Hopkins (1994) when he talks about school improvement as a 'journey' in which he offered support and intervention, researching the journey as it occurred.

TEACHERS AND THE SETTING

Four teachers from the same primary school in the Sydney Metropolitan area were selected for case study. The selection of teachers was ultimately based on their willingness to participate, particularly since the study involved a participant observer in their classrooms on a regular basis. Another factor influencing their selection was the range of teaching experience of the 4 teachers—from Jane who was in her first year of teaching to Angela who had been teaching for more than 33 years. It was decided that case studies of 4 teachers from the same school would provide opportunities to document the ways in which individuals with varying amounts of experience and working in a similar context responded to similar professional development opportunities.

The school in which the 4 teachers worked had a student population of 350, with the majority coming from mid to low socio-economic backgrounds.



Approximately 36% of the students were from non-English speaking backgrounds.

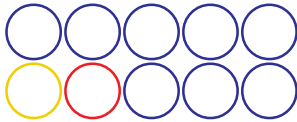
A decision had been made the previous year for all the Year 1 and 2 teachers to commence CMIT in Term 1 2000. Funding was provided by DET for 3 teachers and the school provided the funding for the fourth teacher.

THE CONSULTANT

Previous evaluations of Count Me In and CMIT have highlighted the significant role played by the district mathematics consultant (Bobis, 1996). Hence, it is essential that information about the consultant be included in a study of the program's impact on teachers. Information relating to the consultant was collected via numerous informal discussions, classroom observational visits, and one semi-structured interview held at the end of the study. Information pertaining to the consultant's general philosophy, intended aims and approaches to implementing CMIT are presented here as relevant background data but her responses to specific situations that arose during the implementation of CMIT are discussed under the relevant themes in the results section.

The consultant had a well defined philosophy on the aims and purposes of CMIT and on the manner in which it was to be implemented. This was partly due to the consultant having prepared her own 'package' for implementing CMIT. This package included all the information considered necessary by the consultant to inform teachers of the program and was compiled from information obtained from consultants' conferences and the CMIT professional development package (DET, 2000). For example, blackline masters and overhead projection sheets stating the program's aims, its history, the timeline for implementation, issues relating to the assessment of children, to classroom management strategies and the like were included. The consultant emphasised that the documentation mainly served to remind her of the topics to be discussed with teachers at each stage of the program and that generally the information was conveyed orally in informal discussions. While such material was pre-prepared, it was also easily adjusted if an aspect was revealed to be ineffective upon reflection of a particular implementation of the program. Adjustments made to the consultant's package as a result of the implementation reported in this study are discussed in the relevant part of the results section.

As detailed in the consultant's package, she considered the aims of CMIT to "increase teachers' understanding of how children learn mathematics" with a focus on their strategy use, and to improve the mathematics outcomes for all students. The consultant made it clear that she encourages all teachers to build on the good practices and ideas they already have "to make better use of them in the classroom".



Prior to the implementation of CMIT in the classrooms, the consultant had 2 meetings with the principal and 3 before-school meetings with the principal and the teachers participating in the program. It was at those meetings, that the consultant discussed the various aspects and issues relating to CMIT and tried to answer teachers' questions. During one of these meetings the consultant gave the teachers a folder of over 100 activities and proformas that she had gathered from other consultants and were considered applicable to CMIT. The consultant thought that the teachers would select the activities they liked and start using them in the classroom. It was also at one of these meetings that the consultant suggested the school borrow the resources from a neighbouring school previously involved in CMIT and duplicate aspects of it to provide them with a starter kit. Using the CMIT "kits" from another school as a guide, the school principal enlisted the assistance of parents to help prepare materials it was anticipated the teachers would need¹. The resultant boxes of resources were completed within the first few weeks of Term 1.

Before the consultant began classroom visits, she assisted teachers with the administration of the SENA. This was completed before the first half of Term 1. The consultant spent one day with each teacher demonstrating the administration of the SENA with children from their associated classes. According to the consultant, she kept demonstrating the SENA until the teacher in question felt comfortable to take-over the administering of the assessment. The consultant then gave the teachers the option of her helping them complete the SENA's or of them doing them by themselves. All 4 case study teachers elected to have the consultant help them complete the assessments. They were also assisted by the consultant with the allocation of students to groups according to the Learning Framework in Number on the same day. However, the consultant expected that the groupings would be "fine-tuned" by the classroom teachers based on their more in depth knowledge of individual children.

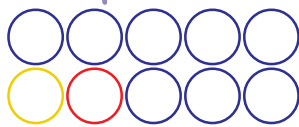
Classroom visits by the consultant began in the last 3 weeks of Term 1 and continued for several weeks into Term 2. The consultant made a total of 9 classroom visits to each of the 4 classrooms. However, 1 teacher was absent on one occasion and another teacher was absent for 2 visits.

DATA COLLECTION

Semi-structured interviews with each of the teachers were conducted on two occasions:

- at the beginning of the school year, prior to CMIT commencing; and

¹ In this particular case, the advanced preparation of such boxes of materials did not prove to be successful. The reasons for this are explained in the results section of this report.



- four months later, shortly after the classroom visits of the mathematics consultant ceased.

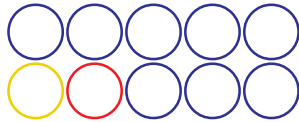
The initial interview established biographical details of each teacher and was used to conduct the first concept mapping task designed to elicit teachers' knowledge of teaching mathematics. During this interview, teachers received standardised instructions on how to draw concept maps and were given an opportunity to draw a practice map about a sample topic, such as sport. They were then asked to draw a concept map pertaining to their knowledge of teaching mathematics. After completing their concept maps, each teacher was interviewed. The purpose of this interview was threefold:

1. It provided an opportunity for teachers to explain their concept map to the interviewer;
2. It allowed the concept map to be used as a prompt to solicit teachers' knowledge and beliefs about teaching mathematics to young children; and
3. It was used to gather information relating to the experiences and factors teachers perceived as being responsible for their existing beliefs, knowledge of mathematics and the teaching of mathematics.

Four months after their initial interview and after approximately 10 weeks of involvement in the CMIT program, teachers were asked to draw a new map. During the final interview teachers were first asked to explain their new map. They were then shown their initial map and asked to compare the two. See Appendices A and B for a complete list of questions asked during the first and second interviews.

In addition to the informal discussions held with the consultant throughout the implementation phase of CMIT, a semi-structured interview was conducted at the end of the implementation phase. The purpose of this interview was to obtain the consultant's perspective on the relative 'success' of the implementation for each of the teachers and to elicit possible reasons for differential rates of success. While the degree to which each teacher was likely to 'take on board' and continue implementing the ideas and philosophy behind CMIT can be postulated from their own interview data and data derived from field notes, it was hoped that the consultant's perspective would further validate the researcher's analysis. The interview with the consultant also intended to elicit 'words of wisdom' in regard to what worked and what did not work in the implementation phase of CMIT. In addition, it was useful in obtaining the consultant's insights and suggestions for improving her own implementation strategies for the future.

Field notes were taken during classroom visits and during informal discussions out of the classrooms with both the teachers and the consultant. Observational visits occurred on a weekly basis in all 4 classrooms.



Five visits occurred prior to the consultant's involvement in the classrooms and continued for the duration of the professional development program. Six observational visits coincided with the consultant's visits in each of the rooms. In total, 44 classroom visits were made—11 in each room. As mentioned earlier, a participant observer role was adopted by the researcher, where support was mostly provided in the form of a teacher's aide—working with particular groups of children on tasks the teacher or consultant assigned. Occasionally, support extended to include advice on matters of concern to teachers when the consultant was not available or when they wished to have a second opinion.

DATA ANALYSIS

Analysis of concept maps can vary from a purely quantitative approach to a purely qualitative approach. Researchers using a quantitative approach usually adopt a scoring scheme to assign a numerical value to each map (e.g. Chinnappan, Lawson & Nason, 1999; Jones & Vesilind, 1996). Such scoring systems often rely on information being categorised as *examples*, *hierarchies*², *links*³, *crosslinks*⁴ and the like. For example, a concept map entry considered to fit into the *example* category would be awarded 1 point, but if a *hierarchy* was evident, 5 points would be awarded and if a *crosslink* occurred, 10 points would be awarded. The rationale for such a scoring system being that hierarchies and crosslinks indicate a greater “coherence and complexity” of knowledge than examples (Jones & Vesilind, 1996).

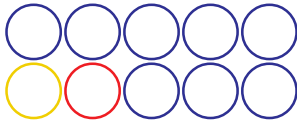
Because a case study methodology was selected for the current study and the purposes were to highlight the impact of CMIT on a small group of teachers, it was considered more appropriate to adopt a qualitative analysis strategy similar to that outlined by Williams (1998). Hence, each concept map was examined as an integrated whole and differences between teachers were sought. In addition, first and second round concept maps for each teacher were explored so that similarities and differences could be highlighted. Hence, comparisons among the teachers were made and of each teacher before and after their involvement in CMIT.

All field notes taken during informal discussions and classroom visits were rewritten weekly with additional reflective comments made by the researcher. Together with data from the initial interviews, the notes were analysed for emerging themes. With the assistance of NUD*IST (Qualitative Solutions & Research, 1997), these major themes were further divided to include a number of

² A hierarchy occurs when connections among concepts and examples are drawn, moving from the general to the specific.

³ Links are the connecting lines between nodes and indicate the existence of a relationship between the nodes.

⁴ A crosslink is a connection between a segment of one hierarchy and a segment of another hierarchy.



sub-themes (or nodes). Many units of data were coded as 3 or 4 different nodes, indicating how one aspect of data could relate to a number of themes or sub-themes. As field notes were included in the analysis new themes and sub-themes emerged and formed the basis of questions in subsequent discussions and the final interviews with teachers. While it is recognised that other commonalities existed in the data, the resultant list of 6 themes and their sub-themes were reflective of those aspects receiving most attention by all 4 teachers for the duration of this study. The final list of themes and sub-themes provided a concise framework by which the results of this study will be reported (see Table 1 for a list of themes and their definitions used to guide the coding of interviews and field notes).

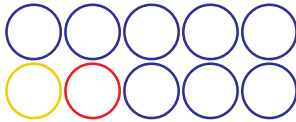
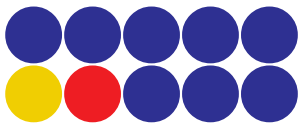


TABLE 1. Final list of emerging themes and sub-themes, and their descriptions

THEME	DESCRIPTION	SUB-THEMES
Content Knowledge	Knowledge of mathematical concepts, procedures and knowledge of content in curriculum documents.	(a) Personal (b) Curriculum documents
Pedagogical Knowledge	General knowledge of teaching and decision making. Includes knowledge and beliefs regarding strategies for classroom organisation and assessment.	(a) Group Work (b) Assessment (c) Activities & resources (d) Subject Integration (e) Textbooks (f) Real-Life & meaningful maths (g) Hands-on
How Children Learn	Knowledge and beliefs of how children acquire knowledge, the strategies they use and difficulties they may encounter.	(a) Children's cognition (b) Intuitive knowledge of how children learn mathematics.
Constituted Knowledge	General knowledge gained from experience and their beliefs and attitudes of what mathematics is and how it should be taught.	No sub-themes but may link with intuitive knowledge of how children learn mathematics.
Source of Knowledge/ Belief	Considered to be the source of the knowledge or belief by the teacher.	(a) Teaching Experience (i) Experience with children (ii) Other teachers (iii) Own reflection (b) Syllabus (c) Initial Teacher Education (d) Inservice (including CMIT) (e) Textbook (f) Other
Barriers & constraints	Barriers to a teacher teaching according to espoused beliefs or practice or to the implementation of CMIT (identified by teacher or researcher).	(a) Time (b) Own knowledge (c) Support (including the consultant) (d) Resources (e) Teacher reactions/ interest



RESULTS AND DISCUSSION

This section presents and discusses the findings of the 4 case studies. Biographical information of each teacher is provided first, accompanied by a qualitative analysis of their concept maps. Where appropriate, first and second concept maps for each teacher are presented in close proximity to assist with comparisons. This initial discussion establishes a “snapshot” of each teacher’s espoused beliefs and knowledge about what mathematics is, how it should be taught and how children learn it prior to their involvement in CMIT. Comparisons are made between the first and second concept map but are only accompanied by an initial analysis of the most striking characteristics.

The second segment discusses results of data collected from the interview with the consultant and field notes taken over the 4 month period in which the study was conducted. It mainly focuses on the realities of the change process and is reported using the framework of themes and sub-themes presented in Table 1. It includes information relating to teachers’ espoused beliefs, knowledge and practices as compared with those that were observed and provides a more significant analysis of data from the final interviews with teachers and their second concept mapping exercise.

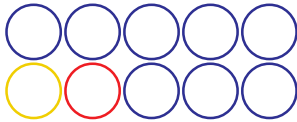
CONCEPT MAPPING ANALYSIS

CASE STUDY 1: JANE

Jane was a permanent full-time Year 1 teacher. At the time of the initial concept mapping session and interview, she had been teaching for less than one month. Jane was a targeted graduate having completed a Bachelor of Science with Honours in Psychology and a Diploma of Education from the University of Western Sydney. At the initial interview she reported that she liked Mathematics and considered herself “good at it” having studied 4 Units of Mathematics for the NSW Higher School Certificate and one year at university.

The decision to participate in CMIT had been made the previous year, so Jane played no part in discussions relating to the school’s involvement. Since aspects of CMIT had not been treated in her teacher education courses she was unfamiliar with the program, but had heard “that it was good”. She was looking forward to being “on the same par as the more experienced teachers” in regard to “learning new things about teaching”.

Figure 1 presents the concept map Jane constructed prior to her involvement in CMIT. The most striking observation of the map is the way the majority of the nodes are linked to the key node concerned with *how children learn*. When explaining her concept map and the emphasis



placed on this node, Jane commented that she had focused on this node because “that’s what I’ve learnt about how children learn mathematics”. This statement reflects her recent teacher education and early career stage. For example, the emphasis on social interaction, children’s own construction of meaning, the use of concrete materials and the gradual progression to the abstract, problem solving, and the like, are all typically presented as interdependent characteristics of mathematics teaching and learning in current mathematics curriculum documents and educational literature.

Another interesting observation of Jane’s first map is the fact that nodes for the *Syllabus* and her conception of *what mathematics is* are not linked to any other node. As for the key node associated with how children learn, this feature can probably be attributed to her early career stage. For example, the fact that she was the only teacher who explicitly represented her personal conceptions about the nature of mathematics may be a result of her recent exposure to activities designed to encourage reflection on the nature of mathematics. The lack of links to other nodes representing more pedagogical concerns of teaching, such as grouping for instruction, or to nodes concerned with her beliefs and knowledge about how children learn mathematics, may be indicative of her limited classroom experience. For instance, Jane commented that:

Problem solving is on my map. I haven’t really had experience of this, but I’d love to do a lot of my mathematical teaching through having them solve problems...but I’m yet to see that work in practice.

Further to this, Jane remarked that while she considered the use of group work important to her belief of how children learn mathematics, she did not yet know how to organise it in her classroom. She expressed the desire to learn this during her involvement in CMIT.

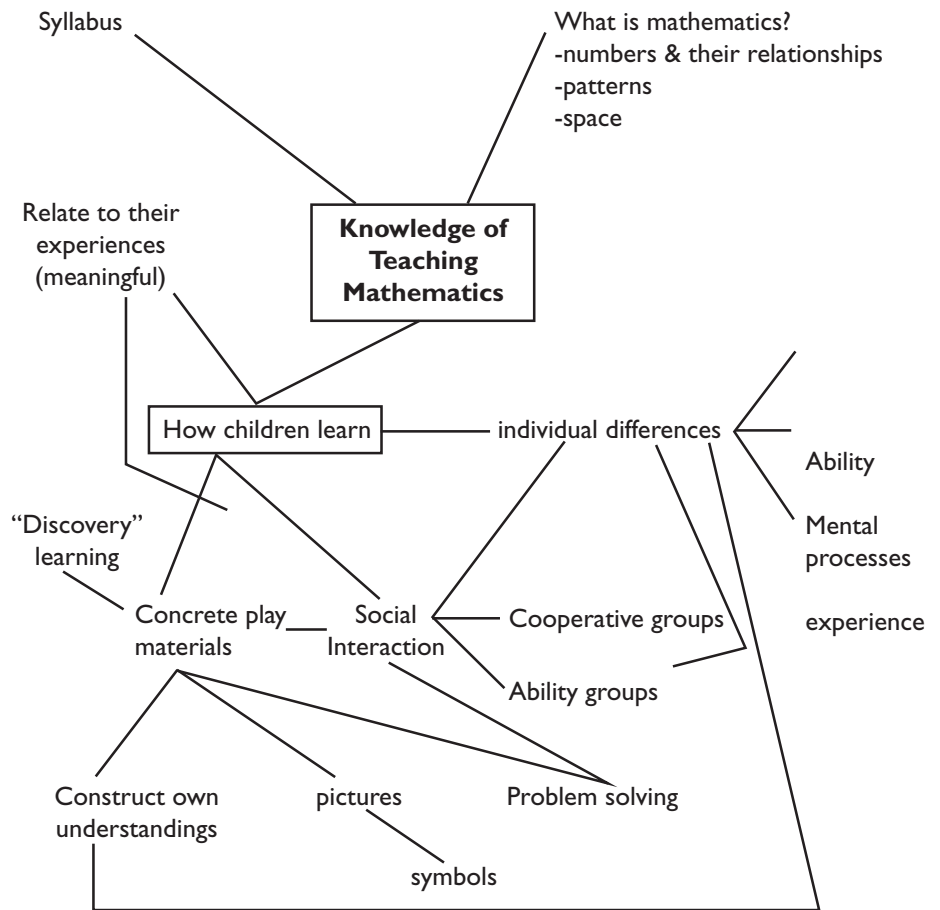
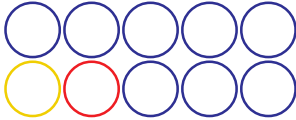


FIGURE 1. Concept map constructed by Jane prior to CMIT

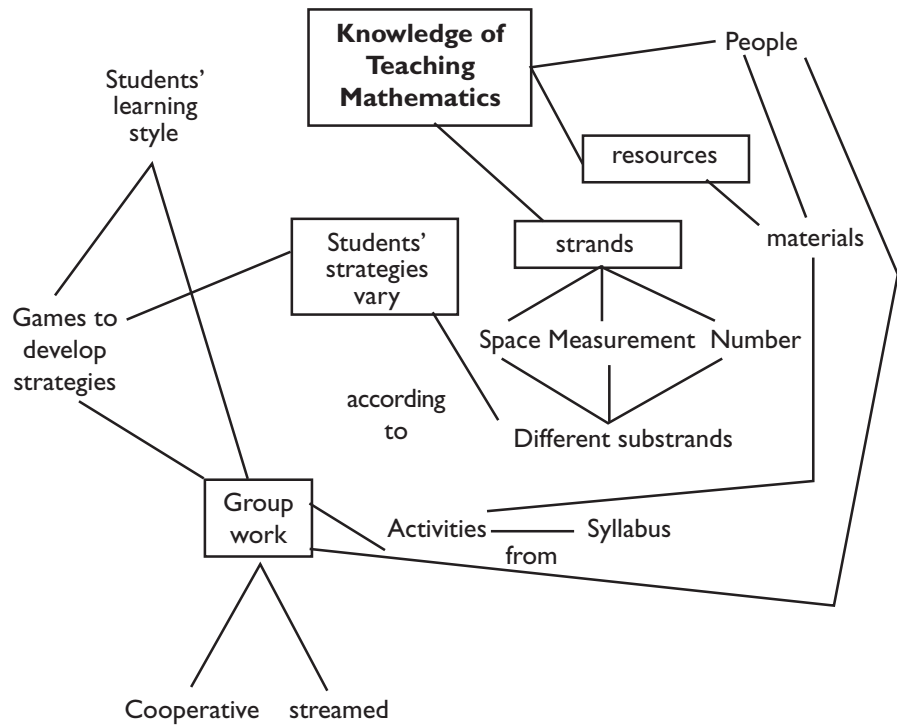
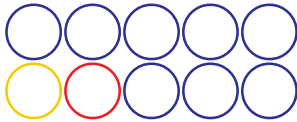


FIGURE 2. Concept map constructed by Jane during the final interview session



When elaborating upon her conceptions of mathematics in the initial interview, Jane added that mathematics is also “a way of thinking”. This comment implies that she was concerned with the processes and strategies children use when doing mathematics and not just with the children getting correct answers. While Jane did not make any explicit reference to the strategies that children might use, the focus on mathematical thinking is indicative of her recent exposure to issues currently receiving emphasis in the field of mathematics education.

The node titled *Syllabus* seemed to be included in a rather tokenistic fashion given that little comment was made in the interview other than Jane recognising that she “had to follow it”. At this point in her teaching career she was “undecided” how she was going to combine the use of the *Syllabus* with the textbook which may be another reason for the isolation of the *Syllabus* node on her first concept map. Part of this indecisiveness was probably a result of Jane’s growing dislike for a textbook:

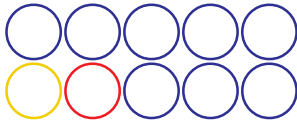
I only started using the textbook this week and I’m quickly discovering that that is not the best...it’s going all over the place and I don’t think that is the way I will do it...If it were my choice, then I probably wouldn’t want one...

The most notable difference between Jane’s first and second concept map is the degree of knowledge integration as evidenced by the crosslinks between the different hierarchies (compare Figure 1 with Figure 2). Links are drawn between aspects of her content knowledge, pedagogical knowledge and her knowledge of children’s cognition. For example, all references to the *Syllabus* and its contents are linked to children’s strategy use, which is linked to the activities used to develop different strategies which is in turn linked to her use of group work.

While there was still an emphasis on group work it was now considered as a method to cater for children’s strategy development. The concern for student’s individual differences is broken down to refer to students’ strategies and learning styles, but with the focus on providing appropriate activities for these differences. The inclusion of nodes referring to *people* and *resources* is indicative of Jane’s growing experience in the classroom and reflects how she learnt to manage group work in her room—with the help of support staff and by preparing resources appropriate to each group’s needs.

CASE STUDY 2: ANGELA

Angela’s initial teacher education was undertaken at Sydney Teacher’s College approximately 36 years ago where she obtained a 2 year Teaching Diploma. Since then she had completed a certificate course on children with learning difficulties and had considerable experience as a support teacher in the area. Angela was in her sixth



year of teaching at the school and had “mainly taught Kindergarten to Year 2”.

Angela considered herself to be “not good” at mathematics having done intermediate mathematics for her school leaving certificate. While she did not mind teaching mathematics to primary school children, she was hoping to learn from her involvement in CMIT how to group the children so as to “cater for their individual differences” and provide them with mathematics “at their own level”. Prior to CMIT commencing, Angela was concerned about the time required to conduct the initial assessment of the children and the time required to make the materials suggested by the consultant.

An initial inspection of Angela’s first concept map reveals two striking characteristics (see Figure 3). First, is the central role attributed to the key nodes *texts* and *syllabus*. The majority of all other nodes stem from one or other of these two. This implies that both these elements played a significant role in the way Angela taught mathematics.

A second striking feature is the absence of explicit links between the various aspects of the concept map, but with many elements being repeatedly represented albeit with slight variations of terminology. For example, the use of the terms ‘real-life’ and ‘everyday activities’, and the terms ‘talk’ and ‘language’ seemed to be used synonymously. Furthermore, while crosslinks were not drawn, it was apparent that Angela considered there to be a fairly strong connection between the use of the textbook and the syllabus. When referring to the nodes linked to the key node *texts* in the initial interview, she explained “the advantage of the text is there is a consistent delivery (across the two Year 2 classes) and you know that the syllabus is covered”.

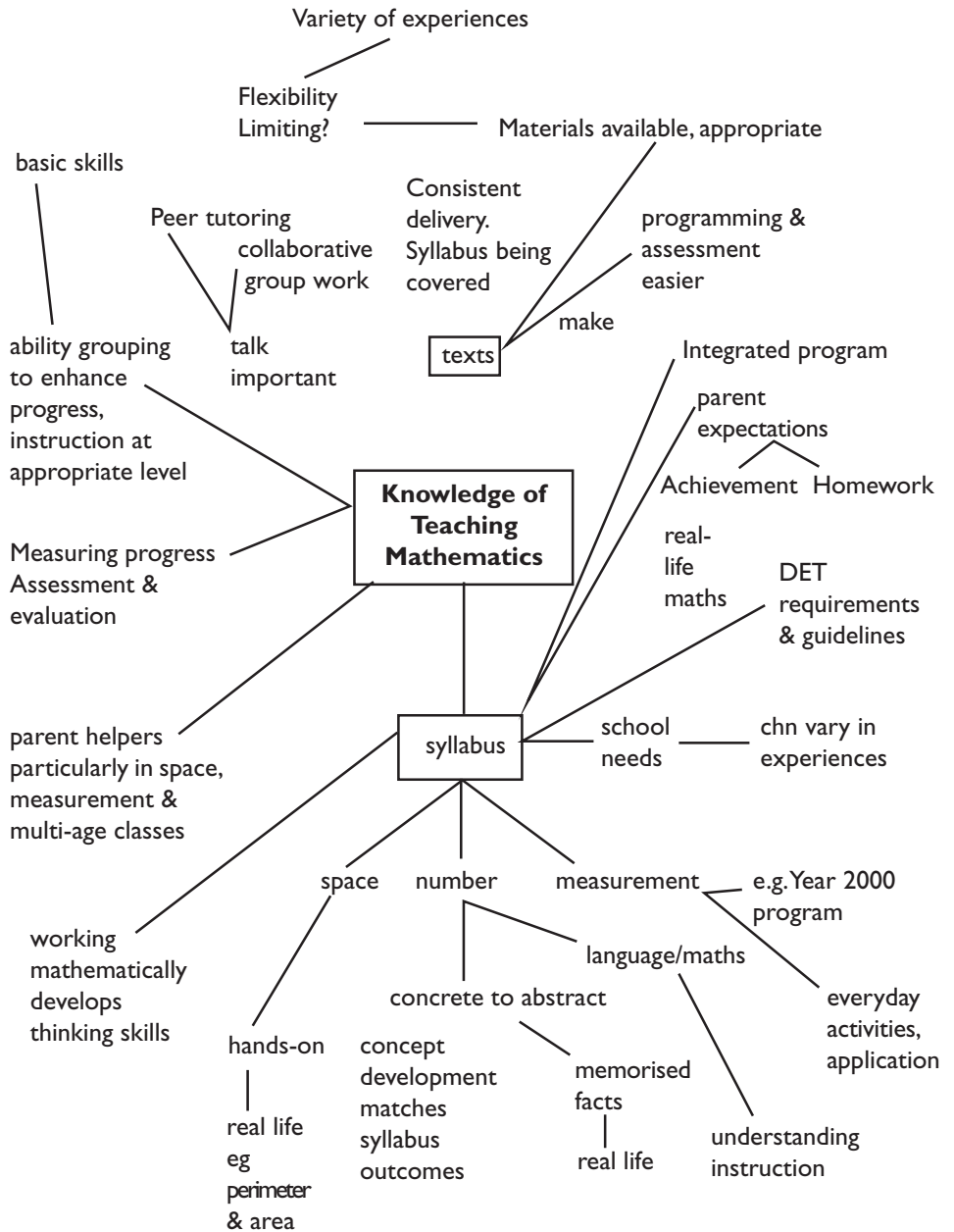
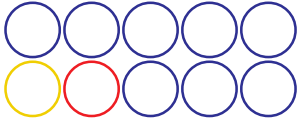
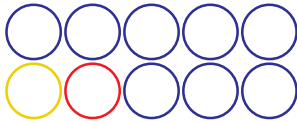


FIGURE 3. Concept map constructed by Angela prior to CMIT

While Angela indicated her reliance on the textbook to ensure she covered syllabus requirements, she also emphasised the importance of program integration and providing real-life mathematical experiences for the children. Both these elements are represented in her concept map on numerous occasions. Angela’s frequent reference to real-life applications of mathematics and the need for program integration, along with her concern for the use of concrete materials, moving from the concrete to the abstract, a focus on language and grouping were indicative of her espoused beliefs about how children learn mathematics. Most importantly, Angela emphasised her concern for children to be “thinking creatively and thinking critically all the time and questioning why this is”. She explained that she tried to achieve this by “questioning them”,



getting the children to “analyse what is going on”, “to work collaboratively in groups” and through what she referred to as her “flexible” teaching style. Angela described her flexible teaching style as “doing things in a different way” to what the children were accustomed. For example, if she knew the children were accustomed to “information being presented in a certain way”, such as the spelling lists for the week, she would present it “in a different format”.

Angela made the distinction on her map between collaborative group work and ability grouping. This distinction was reinforced during the initial interview, where she explained her use of the two grouping arrangements in her classroom:

Collaborative group work allows every child to achieve...because they are all talking about things together and learning from each other....Ability grouping is basic skills. You are just grouping them according to their basic ability to do something and then once they have got those basic skills then I will move them off onto something else.

Angela expressed her confidence in managing various grouping arrangements and from the initial interview it seemed that it, along with the use of concrete materials, was a dominant characteristic of her instructional practices.

The lack of links to the node referring to *measuring progress, assessment and evaluation* were perhaps explained by Angela’s belief that while “children...probably get more out of the integrated approach” she did not “know how to assess that”. Angela commented that she used a lot of observation for assessment purposes in her classroom, but was “hoping that CMIT will be helping me with this”.

The most obvious feature of Angela’s second concept map (see Figure 4) is the continuing emphasis on the Syllabus. While the textbook is still referred to on a number of occasions, it has assumed a less central role on the map. A second notable feature is the way the node *CMIT* acts as an origin for a range of aspects. These aspects mainly deal with pedagogical issues such as classroom management, resources and assessment, but there is also an explicit reference to children’s strategies. Interestingly, the node *testing* which referred to the CMIT assessment schedule, is linked to pedagogical aspects such as planning teaching/learning experiences and the management of group work. In the first concept map, nodes dealing with assessment issues were not linked to such instructional concerns, but were rather isolated.

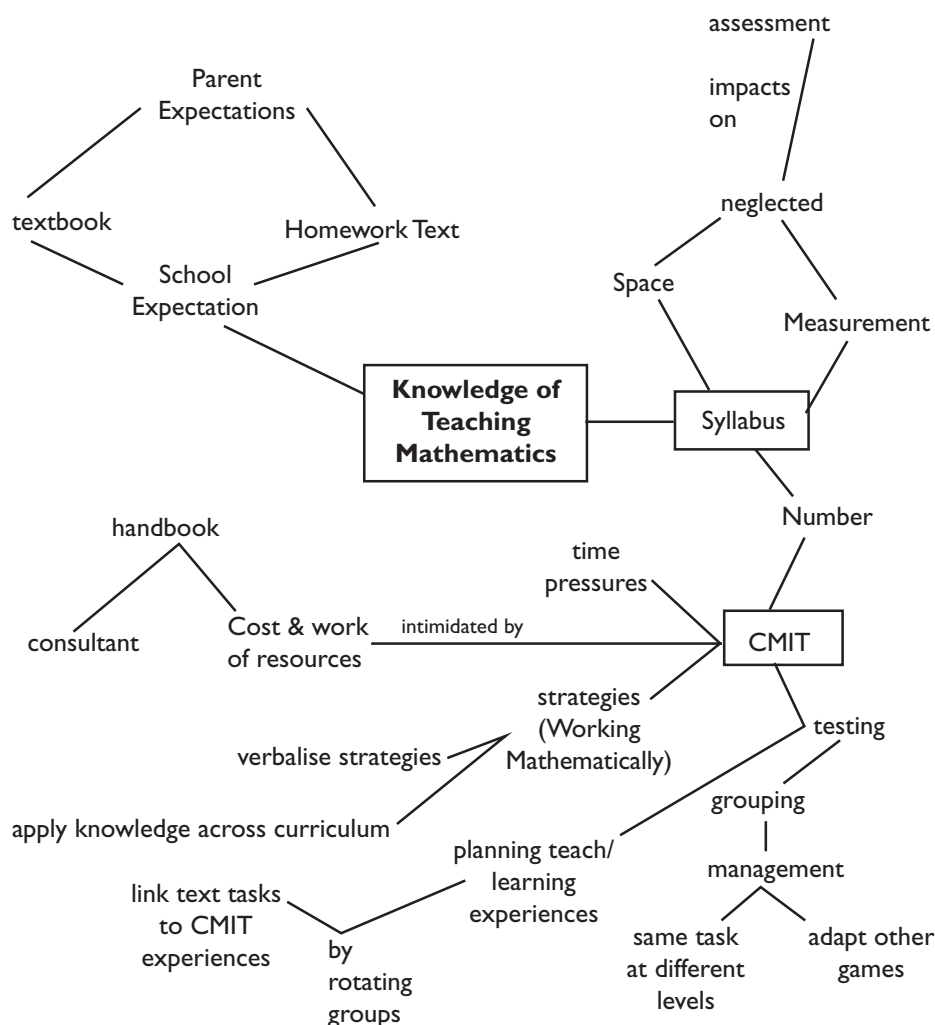
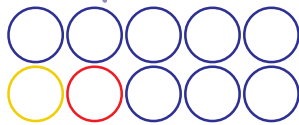
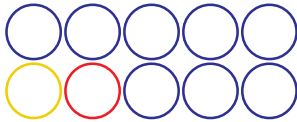


FIGURE 4. Concept map constructed by Angela during the final interview session

Finally, another obvious feature of Angela’s second concept map, is the continued lack of knowledge integration. This is evidenced by the absence of crosslinks between major hierarchies. In particular, the structure of the map indicates that Angela may consider all aspects of CMIT as unrelated to the rest of her beliefs and knowledge for teaching mathematics. This observation is supported by a number of Angela’s comments in the final interview. For example, when commenting on how she used the CMIT activities now that the consultant had stopped visiting her room, she indicated that they were additional to her normal classroom work since “the kids get them when they finish a task”. However, given the recency of the program’s introduction, it is understandable that many aspects of CMIT would not yet be fully integrated into her established beliefs and knowledge structures.



CASE STUDY 3: REBECCA

Rebecca had been teaching full-time for 2½ years. While she had been teaching Year 1 at the current school for 18 months, she had taught all grades on a casual basis for approximately 2 years prior to her full-time appointment. Rebecca completed a Bachelor of Teaching at the University of Technology, Sydney and had also completed TAFE courses in human resources and computers. While she undertook 2 units of mathematics for the HSC, she claimed not to have liked it. Rebecca indicated that she enjoyed teaching mathematics particularly when it was integrated with other subject areas. She did not like to use textbooks because she found them limiting.

Like Angela, Rebecca was concerned by the time required to make resources for CMIT as indicated by the consultant, and while she considered the initial assessment “good” it too was criticised for the time it required. Rebecca hoped that CMIT would assist her students to progress in mathematics more quickly, but was concerned by what she perceived to be an emphasis on mental strategies and the lack of “concrete materials”.

Figure 5 presents Rebecca’s first concept map. A notable feature is the use of only two major hierarchies. Similar to the first concept map constructed by Angela, one of the major hierarchies deals almost solely with the syllabus (compare Figure 5 with Figure 3). However, unlike Angela’s first map the textbook has been linked to the syllabus and given much less emphasis. This is probably due to Rebecca’s dislike for “teaching from maths textbooks”.

Another striking feature of Rebecca’s map is the isolation of the node *real world experiences*. The absence of any links to this node is interesting given the pedagogical aspects emphasised in the second major hierarchy. Namely, the belief that by integrating mathematics with other subject areas, she was making it more meaningful for the children. However, the realisation of a link between any mathematics inherent in science, art or music and *real world experiences* was not explicitly represented in this map or apparent from her explanation of the map.

It was while explaining this second major hierarchy that Rebecca’s beliefs about how children learn best and how she teaches as a result of this set of beliefs became most evident. Besides her belief that “children learn everything best if it is meaningful to them”, Rebecca explained the emphasis she placed on the use of games for rote learning, concrete materials, play and hands-on learning:

There are definitely steps. They go from concrete hands-on...free play of new equipment so they are getting to feel it and experiment with it. Then you move onto structured and hands-on activities. I think that they are the steps of how I teach.

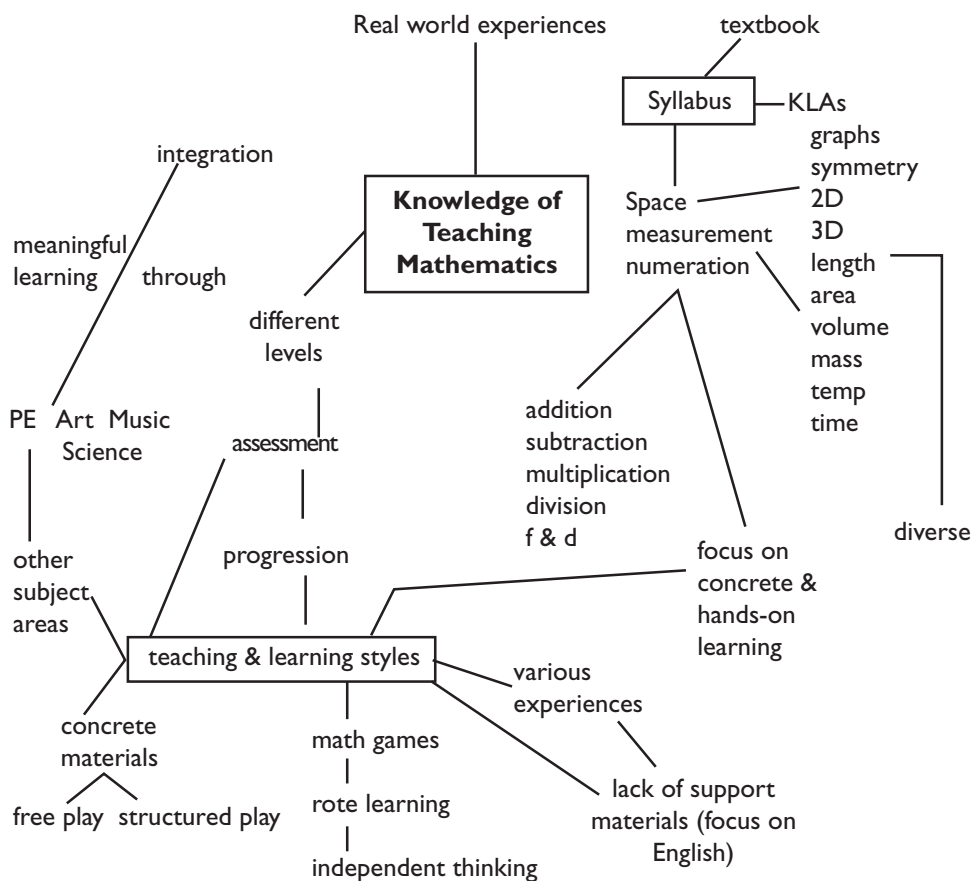
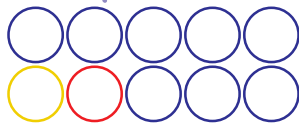


FIGURE 5. Concept map constructed by Rebecca prior to CMIT

Many features of Rebecca's first concept map are still present in her second map (see Figure 6). For example, the emphases on the syllabus and subject integration are retained. A notable feature of Rebecca's second concept map that is reminiscent of Angela's second map is the way in which aspects of CMIT are separated from all other aspects. This may be indicative of the degree to which aspects of CMIT had been accommodated into Rebecca's established beliefs and knowledge structures concerning the teaching of mathematics. However, as explained earlier, it is understandable that many aspects would not yet be fully integrated given the recency of the program's introduction.

Another similarity with Angela's map is the absence of crosslinks between hierarchies. Again, this is indicative of a lack of integration between the different types of knowledge required for teaching mathematics. However, the absence of explicit links does not mean that such links do not exist—at least at a subconscious level. For example, in her second map Rebecca referred to children's progression through stages at three separate points. When discussing each occasion in which it occurred on her map, Rebecca referred to assessment and group work but seemed to be unaware of the associations she repeatedly made. Hence, no links were drawn between the hierarchies containing each of these aspects.

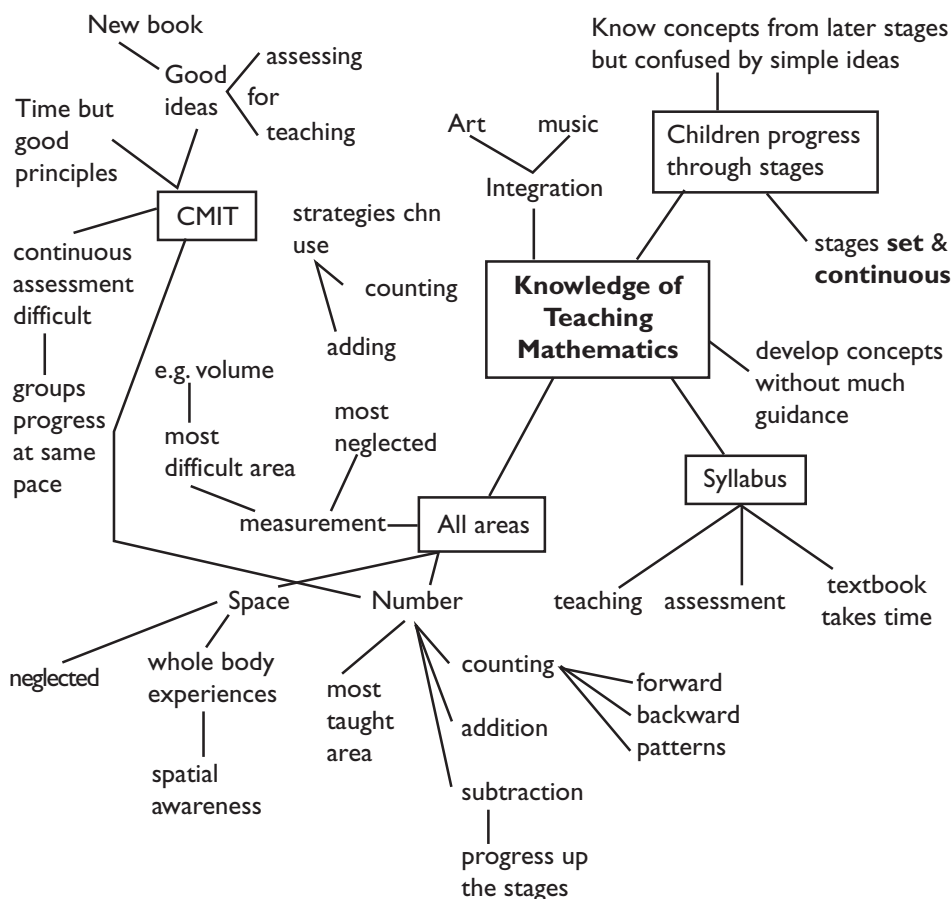
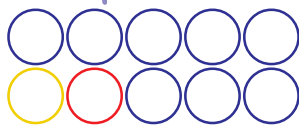


Figure 6. Concept map constructed by Rebecca during the final interview session

CASE STUDY 4: SARAH

Sarah was an executive teacher with more than 20 years teaching experience, including 6 years at the current school. While this was her third year of teaching Year 2, she had generally taught Years 3 to 6. Sarah undertook her initial teacher education at Bathurst where she completed a Teaching Diploma. In 1993 she completed a Bachelor of Education part-time. Sarah indicated that she had always liked mathematics and considered herself to be reasonably good at it. She not only “loved teaching maths” at school, but enjoyed tutoring older primary-aged students in mathematics after school.

Figure 7 presents the concept map Sarah constructed prior to her involvement in CMIT. The most obvious feature of Sarah’s first map compared to the maps of her colleagues, is the frequency of crosslinks between hierarchies. Importantly, the crosslinks occur between the nodes Sarah used to represent her knowledge of how children *learn* mathematics and the strategies she employed to *teach* mathematics. For example, there is a crosslink between children not understanding mathematics and her belief that mathematics should relate to real-life situations such as when they deal with money.

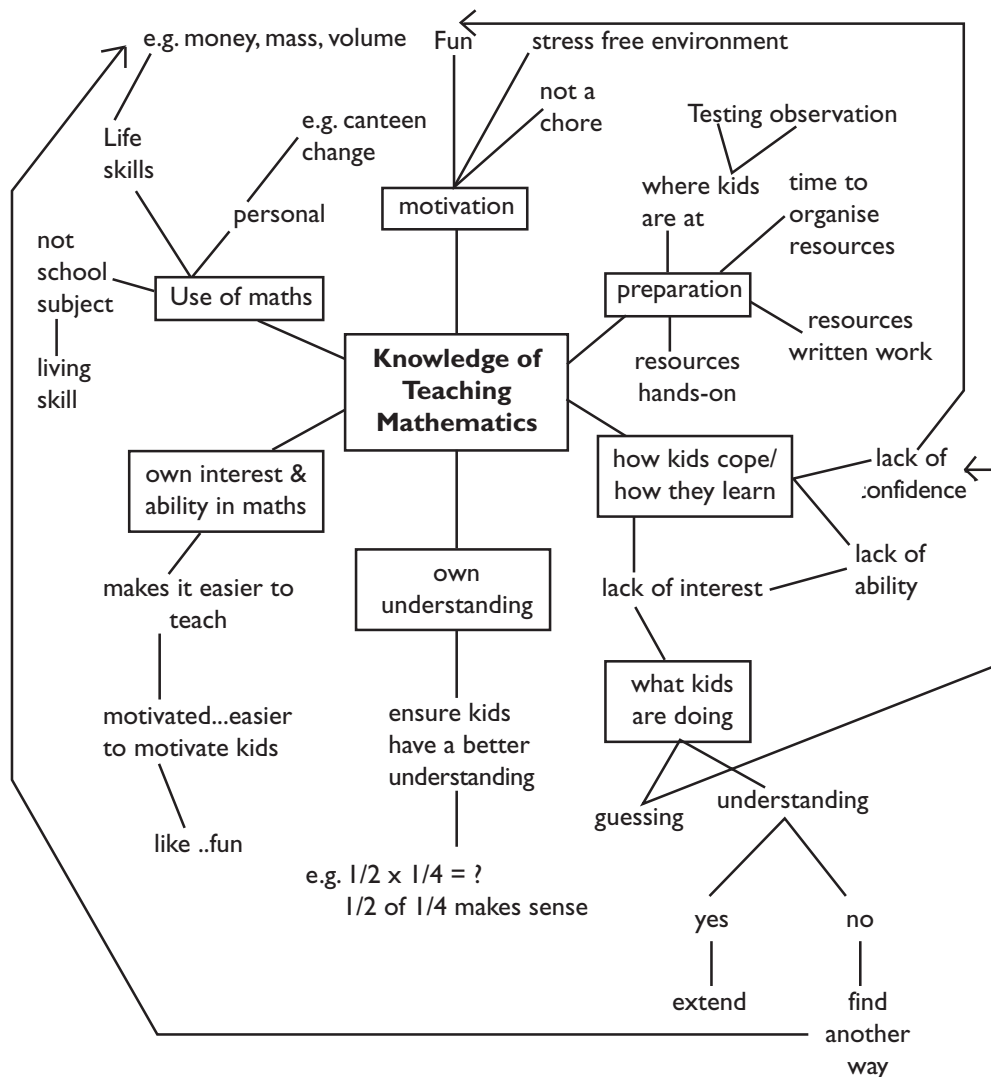
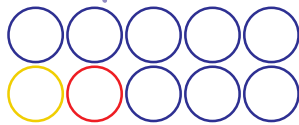
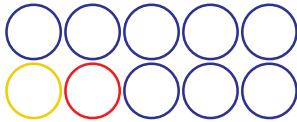


FIGURE 7. Concept map constructed by Sarah prior to CMIT

Another notable characteristic of Sarah’s first concept map is the focus on her own love and interest for mathematics. A firm belief that her own personal interest, ability and understanding of mathematics had a positive impact on the children’s attitudes and achievements in mathematics is evident from her map. Such a view was supported by comments that her “own interest and ability in maths makes it easier for me to teach. Because I am motivated it makes it easy to motivate the kids”.

Sarah’s conceptions of what mathematics is and how it should be taught can also be deduced from her map. For instance, there is an emphasis on understanding, making mathematics meaningful, relating it to real-life and teaching it in a stress free environment. Many of these aspects also characterised the initial maps of Jane, Angela and Rebecca. However, unlike the first maps of her colleagues, Sarah’s map did not contain any reference to the syllabus. While explaining her map, it was found that Sarah considered she got most of her “knowledge about teaching from teaching. Not from the syllabus and none at all from my initial training”. While the textbook was not represented in her map, she commented that she



used it often “because I want to cover what they need to cover in Year 2. That is my basic tool rather than the syllabus...it keeps me on track, where they should be at for their level”. A similar reliance on the textbook was also noted in the initial interview with Angela.

Once again, the most striking feature of Sarah’s second concept map is the high level of knowledge integration as evidenced by the increased use of crosslinks (see Figure 8). Every hierarchy is linked to at least one other. The ability to construct a more integrated map could be a factor of repeating the concept mapping exercise. However, an interesting point is the way in which the majority of the crosslinks culminate at her belief in the importance of instilling a love and interest of mathematics in the children. While this belief has not changed since the first mapping session she has been able to represent this overarching concern in a more concise and organised way.

It is also interesting to note how two new key nodes—children’s stages of development and basic concepts—are not only linked to each other, but appear to be integrated into pre-existing knowledge and beliefs about teaching mathematics. This is in contrast to the maps drawn by Angela and Rebecca (see Figures 4 and 6 respectively) where new knowledge gained from the CMIT program was represented as a separate and rather isolated hierarchy.

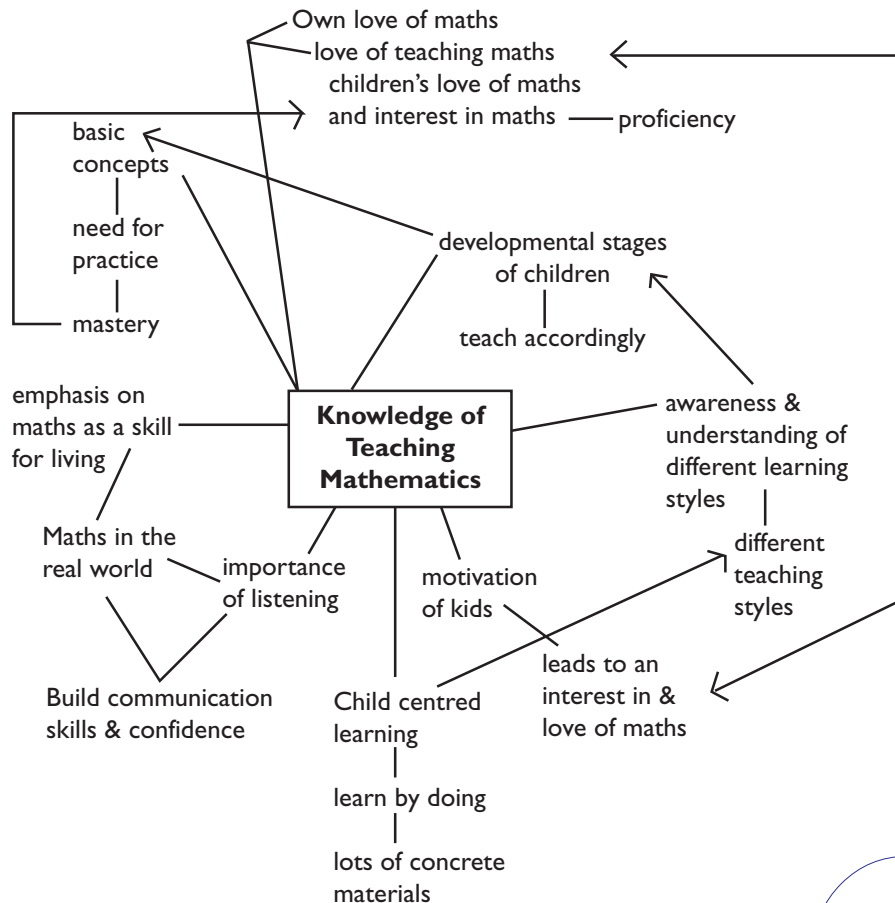
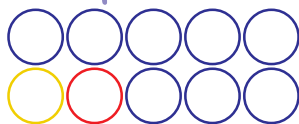


FIGURE 8. Concept map constructed by Sarah during the final interview session.



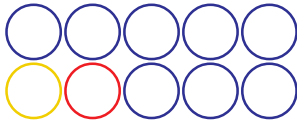
SUMMARY OF CONCEPT MAPPING ANALYSIS

Qualitative analysis of the concept maps and the accompanying interview data provided useful “snapshots” of each teachers’ knowledge and espoused beliefs and practices at two points in time. It was found that the concept maps could distinguish fairly clearly between teachers with considerable variation in years of teaching experience and were useful for identifying the commonalities and subtle differences among the teachers. The maps were also useful in that they gave insight into how aspects of CMIT impacted on their knowledge, espoused beliefs and practices for the teaching of mathematics. To summarise, it was found that:

- There was general homogeneity of teachers’ beliefs about how children learn mathematics and how it should be taught prior to CMIT (for example, through real-life applications and the use of concrete materials);
- CMIT had little impact on teachers’ espoused beliefs and conceptions about the nature of mathematics and the way it should be taught (this is understandable given that the espoused beliefs were mostly in line with current curricula documents and those espoused by the CMIT program);
- The most notable change occurred in regard to teachers’ knowledge of children’s cognition, particularly their knowledge of children’s strategy use and the associated stages of arithmetical development;
- There was an increase in knowledge of activities and a heightened awareness of the need for selecting appropriate activities for children at the different stages of development;
- There was generally a lack of knowledge integration evident in the first concept mapping exercise;
- An increase in knowledge integration was evident in the final concept mapping exercises but the level of integration varied from teacher to teacher; and
- The degree to which aspects of CMIT were integrated into existing knowledge and belief structures varied from teacher to teacher and did not seem to be related to years of experience.

TEACHERS’ JOURNEYS: THE REALITIES OF CHANGE

As indicated in the previous section the concept maps and accompanying interviews not only provided insight into each of the teachers’ mathematical knowledge and espoused beliefs and practices, they highlighted the commonalities and differences between them. These commonalities and differences emerged as identifiable themes and sub-themes and formed a framework by which data from subsequent field notes could be interpreted. The final list of themes



and sub-themes were presented in Table 1. Hence, this section will focus on the realities of the change process in the 4 month period between concept mapping exercises. It draws upon information relating to teachers' espoused beliefs, knowledge and practices identified in the previous section so as to compare and contrast them to those that were observed. It also draws upon information obtained from the consultant via informal discussions and the interview conducted at the end of the study. This information was used to help corroborate the researcher's interpretations of the data. During the discussion, it will be evident that there is considerable overlap in the themes in some instances.

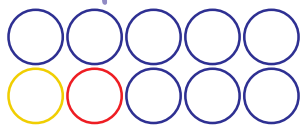
CONTENT KNOWLEDGE OF MATHEMATICS

Both Sarah and Jane indicated in their initial interviews that they had experienced a great deal of personal success as learners of mathematics and were confident in their content knowledge of mathematics. However, during an observational visit to Sarah's classroom it was noted that she gave an incorrect explanation of the relationship between rectangles and squares and made several misleading statements to the children to distinguish between the two terms. While such misconceptions are recognised as common among primary school teachers, it was surprising that a teacher with Sarah's degree of expertise and interest in mathematics should still hold such misconceptions.

On the other hand, Rebecca and Angela acknowledged that they had experienced less success with mathematics as learners, but both were confident that their knowledge of mathematical concepts was more than sufficient for the level at which they had to teach it. For example, Rebecca noted that "for Year 1 I can understand the concepts I am teaching...I might not check the syllabus every time I teach something."

It was evident from the start of the study that all 4 teachers seemed to possess a comprehensive knowledge of the syllabus content by the references they made to the space, number and measurement strands. However, Angela was the only teacher who explicitly mentioned content from the new strand, working mathematically. Classroom observations confirmed Jane's and Rebecca's familiarity with syllabus content with several activities observed that were derived from the number or measurement strands. During a follow-up discussion after one of the lessons, Jane commented that she planned "the term based on the syllabus units and I choose relevant activities from the syllabus". Alternatively, as already mentioned in the previous section, Sarah and Angela relied on the textbook to cover the syllabus content. Sarah explained that she found it easier to use the textbook "rather than wading through the syllabus".

Changes to the mathematical content knowledge of each teacher were difficult to detect just through



lesson observations, particularly since it could not be determined if the knowledge was new unless a teacher was explicitly asked to comment on it. For example, after witnessing activities designed to enhance children's bridging of the decades, counting-back and counting-on from a range of numbers, Angela commented that she "did not know about these things before" CMIT.

PEDAGOGICAL KNOWLEDGE AND BELIEFS FOR THE TEACHING AND LEARNING OF MATHEMATICS.

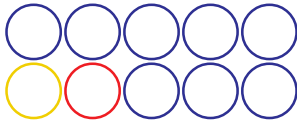
1. Group Work.

During the informal discussions with the consultant she indicated that she had suggested to each teacher during the initial meetings that they teach each group of children 2 or 3 activities appropriate to their level. The consultant also made suggestions as to how they might slowly introduce group work if it was not already functioning in their rooms. Such suggestions included the establishment of a whole class lesson requiring little direction from the teacher and the withdrawal of one group at a time to instruct them in a new activity. In this way, it was anticipated by the consultant that by the time she was to commence the classroom visit phase, that CMIT groups would be operating in each classroom and that each group of children would be familiar with a couple of activities appropriate to their abilities. However, due to various circumstances which will be elaborated upon in the following discussion, the establishment of group work was fraught with difficulties and, as a result, was met with considerable resistance from at least 2 teachers.

Prior to CMIT Angela appeared confident and knowledgeable about the various grouping arrangements apparently operating in her classroom. However, field notes taken very early in the study reveal that there were many aspects of her *espoused* teaching practices that were not consistent with the ones observed. One of these aspects related to her extensive use of group work. For instance, field notes taken during the third visit to her classroom revealed:

The 'picture' Angela described to me of how she taught mathematics was very different to what I observed. Every lesson so far has been conducted as a whole class with a great deal of teacher-directed instruction...It is obvious that the children are not familiar with group work as there are lots of arguments amongst the children, many are unable to work independently of an adult even on game-like activities that are familiar to them.

Towards the end of the study, Angela explained her method of coping with ability grouping in her classroom. She hoped that in the future she could "group the children according to ability and then groups would rotate to the same activity as the next group but at a different level". This reaffirmed a field note entry made during the 8th observational visit that "she only seemed comfortable when all the children were doing the same task".



With only a few weeks teaching experience, Jane indicated during her initial interview that she had already used paired work and social groups in her classroom for subjects other than mathematics and was prepared to use ability groups “just to target and extend and remediate where it is necessary”. She also indicated that as yet, she was unsure how the ability groups might operate. Observational notes taken during the visits prior to CMIT confirmed that Jane mainly used whole class instruction but that she also used paired work for space and measurement tasks.

From the start of CMIT, Jane quickly began to effectively manage ability groups during her mathematics lessons. During the eighth observational visit it was noted that:

Jane was her usual calm and relaxed self. She had already started one group on an activity and was setting the others to work when the consultant and I arrived...The children seem to be very accustomed to group work - the noise level is very low and children seem to be able to cooperate with one another even if a teacher is not present. This indicates that they do group work often and feel comfortable and secure in the work they are doing.

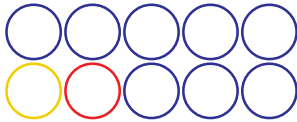
Despite the obvious comfort with which group work eventually operated in her room, Jane commented in the final interview that she was “still working at getting the children to work in groups better and improving” her organisation of the groups.

Sarah and Rebecca indicated at the start of the study that they did not use group work in mathematics. However, Rebecca explained that her children were grouped for reading. Observation notes taken during the first visit documented the gradual introduction of ability groups into Rebecca’s mathematics lessons. In the first few attempts to utilise group work she arranged the children “into their CMIT groups but the activity was exactly the same for each group”. Interestingly, she had put the names of the children according to their stage of arithmetical development onto a chart and laminated it. The chart was then placed high on a wall for her reference. It was commented upon in the field notes because it

was indicative of her desire for high levels of organisation...it also indicates that she does not understand the mobility intended to occur between the groups as individual children start to develop more sophisticated strategies. It will be interesting to see when she comes to that realisation and how she copes with it...

This point of interest was answered by Rebecca herself in the final interview. She described her observation “that they all master an activity about the same time... so they all go onto the next level of the game” at the same time.

As Rebecca made a few resources from the book, *Developing Efficient Strategies for Numeracy Strategies* (DET, 1999), she started to provide different activities for children at the emergent stage and allowed children

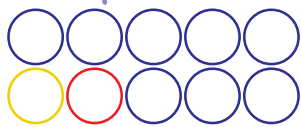


in the perceptual and figurative groups to either have free-play with pattern blocks or play a maths game she found in the mathematics resource room. By the fourth observational visit, Rebecca had enough activities so that each group could work on tasks that were appropriate for their stage of development. Field notes taken during the second visit referred to how she seemed “to be very much in control of the group work and management of it”. Surprisingly, once the consultant started to visit Rebecca’s room it was noted that “she was not as organised as in previous weeks and appeared stressed and tense...she seemed to want to communicate all her frustrations to the consultant”. Obviously upset at the extra work she was required to do to make the groups operate effectively, she spoke abruptly and raised her voice to the consultant. Similar behaviour was noted in the consultant’s subsequent visit, but was not observed for the final 4 weeks of the program. Despite this outburst, Rebecca commented in the final interview that “the group work is a good idea because they can work at their own pace”.

Results of the 1999 CMIT evaluation indicated that group work was one of the aspects teachers found most difficult to manage in the program (Bobis, 2000). It also showed that while many teachers considered they were using group work prior to CMIT they in fact were really just arranging the children’s desks in groups. The children usually worked individually on the same tasks. Teachers in the current study also identified group work as an aspect that caused them concern and stress. However, there were a number of extra ‘problems’ which contributed to the difficulties these teachers faced.

First, the allocation of children to ability groups according to their results on the SENA were inconsistent with what the teachers perceived to be the children’s true abilities. While the consultant had advised teachers to “fine-tune” the groups according to their own knowledge of the children, their limited knowledge of the Learning Framework in Number—the basis for allocating students to groups—left them confused as to where to reallocate the students in question. Therefore there was a resistance to group the children this way, particularly by Sarah and Angela. This point will be discussed further shortly as it had ramifications for a range of other aspects of the program.

Secondly, while thought to be a benefit to the teachers, the principal borrowed resources from a school who had been involved in CMIT the previous year and organised parents to replicate all the resources. This was an expensive exercise but one that the teachers initially viewed positively because they considered it would save them time. Unfortunately, this proved to be the source of much frustration as it was revealed that many activities contained either no instructions or the incorrect instructions and were often missing vital components such as numeral cards, dice or counters.



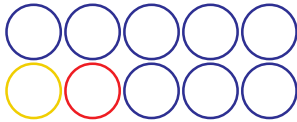
Field notes taken during the fourth observational visit recorded Sarah's reaction the first time she tried group work using the prepared resources: "Sarah was panic-stricken. She had arranged for a mother to attend and help with group activities but had then discovered she did not understand any of the games in the kits". Hence, with the expected activities virtually useless, the teachers were left floundering at the last minute to provide appropriate activities for each of the groups. The consultant was unaware of this problem until she came to conduct the first classroom visit some weeks later and while she has since introduced a mechanism to avoid the problem occurring elsewhere, the episode had already dampened a few teachers' enthusiasm for the program.

By the eighth observational visit, Sarah seemed more relaxed with group work and appeared "more prepared than usual...She had arranged for a parent to attend and had organised the various activities she wanted for each group...The lesson went quite smoothly as the children seemed to be more accustomed to working in groups".

To summarise the status of group work, Jane had firmly established group work in her classroom well before the observation period of this study concluded. She was confident about her management of the groups and was pleased by the children's positive reactions toward it. Rebecca and Sarah were using group work competently but neither were comfortable with its operation. While Rebecca considered that she would continue using group work because she now had the materials to help make it work, the frustration Sarah experienced in regard to her grouping the children combined with the inability to use the prepared resources had left a permanent negative impression on such an organisational strategy. Of the 4 teachers, Angela was considered the least likely to continue using ability groupings for mathematics. This was despite the initial competence she espoused with group work as a teaching strategy.

2. Assessment.

The schedule in early number assessment (SENA) has always received mixed evaluations from teachers (Bobis, 1996; 2000). Usually teachers consider the SENA to be too time consuming and difficult to administer to a whole class, but also consider it a vital component due to the information that it provides them about their children. In this instance, nearly all the initial interviews were conducted by the consultant with the teachers present. The consultant's intention was to demonstrate as many assessments as each teacher needed to feel comfortable conducting one alone. However, Rebecca commented that she "made the consultant do them all. I just kept pretending I didn't feel confident. She can do them faster than me and I just don't have the time". The consultant then took the major responsibility for allocating children to their appropriate stages of development based on the SENA results. This proved to



be a significant stumbling block for the implementation of the program particularly for the credibility of the consultant and the SENA from the teachers' perspectives. All of the teachers were confused by the groupings and concerned that their children were grouped too low. For example, four children whom Sarah considered to be "quite capable, were assessed as being less than emergent". Sarah commented in the final interview that "had we had training I could have grouped them myself and known what I was looking for".

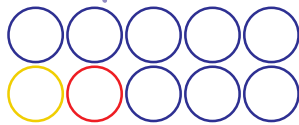
Rebecca indicated that CMIT had "a lot of good ideas for assessing children. The one page assessment ideas in the *Developing efficient numeracy* book are fabulous". In particular, Rebecca and Sarah found it difficult to continually reassess the children's strategy-use to determine if they needed to move to a different group. For example, Rebecca considered "the continuous assessment required in CMIT is quite difficult. The idea of continually assessing and moving children around the groups is impractical".

In short, not having conducted any (or many) initial SENAs or having to grapple with the initial arrangements of groups, the teachers did not fully understand the bases for allocating children to particular developmental stages. Therefore, they found it difficult to know when a child was ready to move to a more advanced group for instruction and were uncertain of their ability to conduct the final assessment and analysis of their children's results.

3. Activities and resources.

Previous evaluations of the CMIT program have indicated that teachers considered the variety of activities to be one of its most positive features (Bobis, 1996; 2000). However, as already outlined in the section on group work, the pre-preparation of a huge number of resources without an understanding of the purposes or how they were to be implemented resulted in most of the activities left idle in their boxes for the duration of the program. An inspection of the kits indicated that many of the activities were still very useful, but would require a lot more time to get them to a point where they could be used. Understandably, given the time and money already allocated to the making of the resources, the staff were reluctant to spend more time on the boxes. The impact of this problem with the resources was quite detrimental to the successful implementation of the whole program. The lack of confidence in the consultant escalated and resulted in extra stress for the teachers as they had to hunt for extra resources at the last minute. For example, field notes taken during the third observational visit recorded that "Sarah seemed daunted by the number of resources and how she would learn how to use them all". An entry made during the ninth observational visit recorded:

Sarah was initially tidying a few things in her room while the consultant introduced a new activity. As



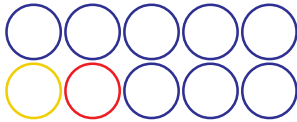
seems quite common, she was a little flustered and panicky about not having all the equipment ready for the various groups...When we broke into groups, she allocated me to a group playing a trading game, but there were no dice and I had to borrow some from the consultant.

While the teachers seemed to be extremely impressed by the activities introduced by the consultant each week, they all expressed annoyance that they were “new” activities not in the boxes already produced by the school.

As already mentioned in the discussion on group work, the consultant was unaware of the difficulties surrounding the making of resources until she came for her first classroom visit. As a result of the experience, the consultant developed a “starter kit” comprising 25 activities—5 for each stage of the CMIT learning framework. The kit consists of blackline masters from which teachers can make the number of resources they need, instructions containing suggested stage, group size, materials required, and variations of each activity. This mechanism overcomes the problem associated with schools replicating unnecessary or unusable resources from other sources.

Despite this setback in the program, the teachers *did* recognise the value and significance of the activities they began accumulating. Frustrated with the materials prepared by the parents, Jane and Rebecca (to a lesser extent Sarah, and even lesser extent still, Angela) made their own activities derived from the book, *Developing efficient numeracy strategies* (NSW DET, 1999) and from what the consultant demonstrated each week. This proved to be more successful than producing a huge number of activities at the start, as Jane commented in the final interview: “I’ll definitely continue with the games I have made because I have chosen the ones I think are good”. However, she also recognised that “it is not just having the resources that is important. CMIT has helped me know how to use them...”. Hence the classroom demonstrations by the consultant were identified as a major benefit. Similarly, Angela commented that “the tasks that were introduced by the consultant when she came to visit were far easier to use”. In the final interview Sarah commented that the activities seemed to benefit “the weakest group and the best group” more, but she had “noticed that everyone’s interest in maths and their motivation has increased tenfold. The bulk of the class are more interested in maths”.

In short, all 4 teachers increased their repertoire of activities, but more importantly, they were all aware of the importance of assigning appropriate activities to children of different abilities. Angela was more comfortable using the same activity with the whole class and varying its level of difficulty to suit the different abilities. This strategy probably helped her cope better with ability grouping in her classroom.

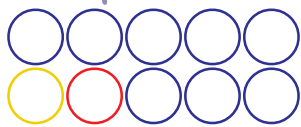


4. Integration of subjects and of CMIT aspects into their mathematics lessons.

It was evident from the first concept mapping and interview session that Angela and Rebecca considered the integration of mathematics with other subjects an important aspect of their teaching. This was particularly evident in Angela's classroom where she was conducting an integrated program on the Year 2000.

Of more interest to the current study was the degree to which aspects of mathematics teaching espoused by the CMIT program were integrated into their existing knowledge, beliefs and practices for teaching mathematics. A new aspect of CMIT or a specific teaching strategy was introduced to the teachers by the consultant each week. For example, during the second classroom visit the consultant spoke to each teacher about lesson closure and suggested they try some of the strategies she had modelled in a subsequent lesson. This suggestion was followed-up with a written component handed to each teacher at the end of the lesson. Other teaching strategies the consultant was noted to have introduced to teachers during the classroom visit phase of the program included the use of discussion in mathematics, using open-ended questions, paying attention to children's strategy use during group work and encouraging children to explain their strategies. The consultant highlighted in her interview at the end of the study, that she did not like to "force" teachers to try a strategy, but would only suggest trialing a strategy or recommend reading further about a strategy. The consultant considered that introducing new aspects of CMIT in "bite-size chunks" would alleviate the problem of over-burdening the teachers with too much information all at once. Since the consultant was largely responsible for conducting the lessons during the remainder of the observational visits, it was difficult to gauge how much each of the teachers actually incorporated these strategies into their teaching. However, it was noted during an observational visit to Rebecca's classroom in the final weeks of the program, how she utilised open-ended questions and engaged the children in discussion about their thinking strategies while waiting for the consultant to arrive.

Analysis of the concept maps already alluded to the fact that Sarah seemed comfortable accommodating the notion of children's stages of development and providing them with activities that explicitly focused on the development of a range of strategies and knowledge. Rebecca's and Angela's maps and follow-up interviews indicated that most aspects of CMIT were viewed separately from the rest of their practices, knowledge and beliefs about mathematics. The greatest degree of integration between the aspects of CMIT and a teacher's existing structures for teaching mathematics were evident in Jane's second map. This was not only verified by observations recorded as field notes, but in the final interview when she commented that she "would incorporate (aspects of CMIT) into the whole program not just have CMIT mornings".



5. Textbooks.

As stated in the previous sections, Sarah and Angela were very reliant on the textbook prior to CMIT. Both considered that the textbook ensured that they covered the content in the syllabus that was appropriate to Year 2 and would keep them “on track” with each other. This reliance on the textbook was evident from the initial observational visits in both their classrooms. In Angela’s case, the textbook remained the focus around which the applicability of CMIT was measured. For example, when asked in the final interview if she would continue with the activities she had been introduced to she replied: “I would have to see if I could marry the tasks in the textbook with what is going on in these games so I can get through the textbook”. The focus on the textbook was not as evident in Sarah lessons, but the concern for completing it was still strong.

Alternatively, Rebecca and Jane had indicated from the outset that they did not like textbooks and found them limiting. While there was no evidence that the textbook had a focus in their teaching of mathematics, Rebecca and Jane both admitted their concerns in the final interview that the parents had purchased the book and were expecting it to be completed.

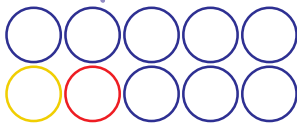
6. Real-life and meaningful maths.

From the initial interview it was obvious that all of the teachers strongly believed in the importance of making mathematics meaningful to the children and linking it to real-life experiences. The strong convictions inherent in their beliefs on this topic did not seem to change throughout the study. It was noted in field notes taken during the first and second visits that all teachers used examples from real-life to help build an understanding of the mathematics involved. This was particularly evident in Angela’s lessons, when she would often side-track to provide yet another example from everyday life.

7. The use of concrete materials.

Prior to CMIT all 4 teachers professed their use of concrete materials and to the use of games “to make maths fun” (Sarah, initial interview). However, Angela commented that she probably did not use the games as much as she used to. Sarah and Angela had also indicated a reliance on the textbook. Of the lessons observed prior to CMIT, both Sarah and Angela’s mathematics lessons were characterised by a high proportion of teacher talk. For example, on one occasion Angela

spoke to her children for about 20 minutes about their theme, 2000. There was not much input from the children during this time unless answering direct questions. The children were then asked to sit in a large circle while she sat in the middle and demonstrated making 2000



using base 10 material. At least ten children could not see the materials. (Field notes, Visit 1)

The lessons observed in Sarah's classroom prior to CMIT were also characterised by long periods (up to 30 minutes) of the children sitting at the front of the room engaged in whole class counting in multiples and discussions that was mainly initiated and maintained by her questions. Geoboards were used in the second lesson observed, but mainly because the textbook exercise made them essential.

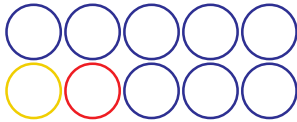
Alternatively, both Jane and Rebecca were observed from the start of the study to use a variety of concrete materials and to have the children much more actively involved. For example Jane, encouraged her children to use cuisenaire rods to find things in the room that were longer or shorter.

Changes to the practices of Rebecca were noted as early as the second observational visit as she started to use some of the games she had made from the book *Efficient numeracy strategies* (NSW DET, 1999). Similarly, once Jane started using the activities from CMIT, all her lessons were characterised by an abundance of dot cards, dice, counters and game boards. However, the most dramatic changes occurred in Sarah's room. Despite the frustration and stress associated with the materials prepared by the parents being incomplete, her efforts to incorporate concrete materials recommended by the consultant were obvious. Ten frames were evident in her room from the third observational visit and later playing cards, dominoes, counters and dice were all easily accessible. Angela was also observed using more of these materials, but it was obvious from their lack of accessibility and the children's reactions to them that they were not as commonly used as in the other rooms.

HOW CHILDREN LEARN MATHEMATICS

It was evident from an analysis of the concept maps that each teacher espoused a well-defined set of beliefs about how children learn mathematics. These beliefs were a result of knowledge gained from their own personal experiences as learners of mathematics and from their experiences as teachers. All the teachers made reference to children being at different levels or stages of development prior to CMIT, but as expressed by Jane, this mostly referred to "things in terms of the stages of concrete and symbolic rather than children's strategy use".

The concept mapping exercise clearly showed that teacher's knowledge of children's cognition, particularly in regard to their strategy use, increased quite significantly. However, what was not evident from the concept mapping exercise was the difficulty encountered by the teachers while trying to make sense of the arithmetical stages of development,



particularly as it related to the grouping of their children for instruction. For example, Angela's confusion over grouping the children according to their arithmetical strategies was evident soon after the initial testing was complete. During the third classroom observational visit, she commented that "the kids got different results in different tasks so how do you group them? I could not work that out." Field notes taken during the ninth observational visit recorded that when it was time to move to groups, "she selected children whom she 'thought' had similar abilities to work together. These groups of children did not correspond to the levels or stages indicated by the SENA results".

Confusion over the allocation of children to the various stages of development was observed in all 4 teachers and was the origin of a great deal of concern and stress particularly for Sarah. She commented on the difficulty she had understanding the process of selection in her final interview:

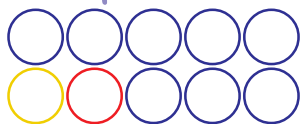
That is the most difficult thing I have found with CMIT. The initial grouping I didn't really understand how it was done and I didn't agree with how they were grouped. I'm still finding it difficult to see where each group is according to CMIT. Now I find it difficult to know when to move the kids on according to the CMIT stages.

Teachers' initial confusion and a lack of an in-depth understanding of the Learning Framework in Number, combined with a number of children being assessed by the consultant at levels lower than what the teachers felt reflected their true abilities turned quickly to a mistrust of the consultant's judgements and to the appropriateness of the SENA. Field notes taken during the consultant's first classroom visit demonstrate the growing lack of confidence in the consultant's knowledge and judgement:

Angela has looked at the grouping arrangement of the children and has questioned (like Sarah) the consultant's grouping of the children. She asked me to 'check' the groupings. Angela's first comments to the consultant were in regard to the children she felt were not placed in their appropriate level of development on the learning framework in number. This shows a growing lack of confidence in her expertise.

Most of the difficulties associated with the allocation of children to their stages of development seemed to stem from the fact that the teachers' did not conduct their initial SENAs and were not responsible for allocating the children to their groups accordingly. A desire for more background information on a range of aspects was communicated by all 4 teachers and is supported by Sarah's comment in the final interview:

The training that the consultant gave to teach us how to test the kids I found inadequate. We need training out of school on what the program is, what the stages are, how you work kids through the stages, show examples of the



games and talk about pre and post testing. The consultant had two of my capable students in the emergent group and I said I would not put them there as that would be demeaning. Had we had training I could have grouped them myself and known what I was looking for.

Similarly, Jane thought that the children were “under assessed quite dramatically”, but that if she had “read the *Developing efficient numeracy strategies* book at the start...I could have done the assessments more effectively”. She also expressed the desire on a number of occasions for more information on the theoretical background of the Learning Framework so that she “could understand it better”.

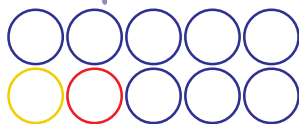
Towards the end of the study, it was clear that Jane and Rebecca had begun to make sense of the stages of development and were able to apply that knowledge quite comfortably in their classroom instruction. For example, Jane commented in the final interview that she felt she had gained “explicit knowledge of the strategies that students use, where students are at and the strategies you should move them on to”. Similarly, Rebecca considered that CMIT:

helped me learn the strategies they use. I can watch them now and recognise that they are counting-on in their head or that they are using their fingers. I didn't know all that before...I can recognise the significance of those strategies now...

Sarah and Angela had obviously increased their knowledge in regard to the strategies children use. This was evident by the way children in their classes referred to their own strategies using the terminology from the Learning Framework. For example, one child from Sarah's class was observed instructing another child how to “count-on from the larger number instead of counting from one”. However, the initial confusion surrounding the allocation of children to groups had still not been completely resolved and they did not seem as convinced of its usefulness as Rebecca and Jane. CMIT's usefulness for Sarah seemed to be more in terms of the “insight into providing activities for the different levels” it provided.

CONSTITUTED KNOWLEDGE

Teachers' initial conceptions of the nature of mathematics and how it should be taught were presented when the results of the concept maps were discussed in an earlier section of this report. Basically this set of beliefs and knowledge was gained from experience as learners and teachers of mathematics and on reflection of those experiences. While it is understandable that a 4 month period of professional development is unlikely to drastically alter conceptions that have taken years to form, it was noted on a number of occasions that teachers recognised elements in CMIT that reinforced their



established personal convictions. For example, Angela commented in the final interview that CMIT had made her more aware of the strategies that children use and that “that easily helps me to achieve one of the strategies in my first concept map...to develop their thinking skills”. Rebecca’s conception of mathematics was definitely extended as she herself noted towards the end of the study:

I’ve come to realise that the patterns in number are really important, because if they can see the patterns and understand the patterns then they have more of an idea of how to work things out. That’s something that I’ve come to realise recently, not just because of CMIT. It’s like they’re teaching me that they can see the patterns. I guess I’m asking them different questions.

An important extension to Jane’s understanding of mathematics and how children learn it was derived from her own reflections on the program and its impact on the children. Namely, “how children learn is quite different from the strategies they use. Learning style is probably more constant whereas strategies change”.

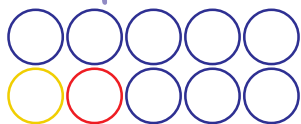
SOURCES OF KNOWLEDGE AND BELIEFS FOR THE TEACHING OF MATHEMATICS

The sources from which teachers identified they gained their knowledge included their own teaching experience, the syllabus, initial teacher education, the consultant, other teachers, textbooks and more recently the book, *Developing efficient numeracy strategies* (NSW DET, 1999). Prior to CMIT, Sarah stated that she got:

most of my knowledge about teaching from teaching. Not from the syllabus and none at all from my initial training. I found that most of the knowledge I have got was from private tutoring one-on-one....I have learnt a lot by having children with problems rather than a whole class that is reasonably capable.

Jane, as a recent graduate, said in the initial interview that most of her knowledge and beliefs about how children learn mathematics came from her initial teacher education or the syllabus, but that she was quickly learning things “just from teaching”. Angela and Rebecca considered that their knowledge had not only come from their teaching experience, but from the syllabus. In addition, Rebecca was adamant that she “didn’t learn a thing about teaching maths from uni, teaching maths is something I definitely learnt in the classroom. I didn’t enjoy the way they taught it when I was at uni”. It was also made clear in the initial interview and classroom observations that a lot of Angela’s and Sarah’s knowledge was derived from the textbook.

Of more concern to the present study were the sources of knowledge teachers identified helpful for the CMIT program. The text, *Developing efficient numeracy strategies* (NSW DET, 1999) was recognised as a major



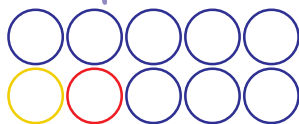
source of information and ideas for activities and assessment by Jane and Rebecca. For instance, Jane commented in the final interview that she “got the ideas to make materials from the *Efficient numeracy* book and some of the consultants’ ideas which I have reworked. I’d recommend people read the book first. It has given me direction”. However, Angela stated that she did “not have time to read the *Efficient numeracy* book” and that she “found it difficult to use”. Angela’s problem with the text related to when she “tried to marry the groups to tasks I could find in the book for which equipment had been made. I could not do it. It was just too hard”.

All teachers considered a significant source of knowledge was the consultant’s classroom visits. During the visits activities were demonstrated and briefly discussed by the consultant. While the visits were the primary source of teaching ideas for Angela and Sarah, observation records indicate that Rebecca and Jane used a variety of sources, including the syllabus and ideas from other teachers. For instance, field notes taken during the eighth visit refer to an “activity called memory which Rebecca had got from Angela”.

As a beginning teacher, Jane commented in the final interview that she had also “learnt a lot from the other teachers”. It was also obvious from comments made by Sarah, Rebecca and Jane that they had gained a great deal of knowledge from reflection on the program and their own teaching. For example, Rebecca commented in the final interview that she now considered the identification of patterns in mathematics to be important. She also considered that she had learnt to ask different types of questions. This was confirmed in field notes taken during the ninth visit: “Rebecca used open ended questions today. For example, ‘What numbers add together to make 10?’” It was also noted in field note entries from the sixth, seventh and eighth visit that she was asking more questions to elicit children’s thinking strategies. While Rebecca felt that she had learnt these things “not just because of CMIT” it was obvious that the emphasis on identification of children’s thinking strategies was impacting on the type of learning she was starting to value.

BARRIERS AND CONSTRAINTS

For the purposes of this study, barriers were defined as those events, people or items that were perceived either by the teachers, the consultant or the researcher to inhibit the implementation of CMIT or to prevent teachers teaching mathematics in accordance with their espoused beliefs and practices. While most of the barriers have been alluded to in earlier sections, this section will serve to summarise those already discussed and present those not already directly linked to being a negative influence.



1. TIME.

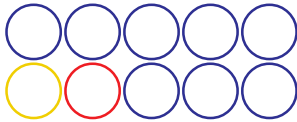
The most frequently quoted barrier to the introduction of CMIT and to their normal classroom teaching was lack of time. Field notes and interview transcripts referred to time constraints on over 20 separate occasions. For example, Angela lamented that she did not have time to read the book, *Developing Efficient Numeracy Strategies* (NSW DET, 1999), all teachers commented on the “intimidating level of cost and time” involved in making the resources, and then not having the time to “look through the resource kits the parents made” to decide what activities could be used. As an executive teacher, Sarah found it difficult to find time to assemble all the necessary equipment on a day-to-day basis. While Rebecca complained that the textbook took time away from her doing the type of activities she preferred, Angela and Sarah complained that there was not enough time to do CMIT and the textbook work which they considered important to complete. It was noted by Jane that no time had been allocated to deepen her understanding of the “theory behind the framework” or to discuss issues with teachers from other schools or even teachers in her own school. This comment was confirmed by a field note entry during the ninth observational visit that commented on the “hectic pace required of the consultant” each time she conducted classroom visits. This meant that there was insufficient time for the consultant to address the specific problems or questions teachers had about a range of issues—from the assessment and subsequent grouping of students to how particular activities in their kits were supposed to operate. Further supporting this analysis, was a comment made by Sarah during the last interview regarding the “need for time outside of school”, particularly to allow her to reflect on what was happening.

2. OWN KNOWLEDGE.

As was commented upon earlier, some misconceptions in a teacher’s mathematical content knowledge was evident on at least one occasion. However, of more interest to the current study, is the lack of knowledge teachers had which they thought would impede their implementation of CMIT. For example, Sarah considered that “the training...to test the kids...was inadequate”. She was concerned that she still did not understand the basis for the various stages of development and did not know “what to look for” to move the children to the next stage of development. Similarly, Jane expressed the desire to know more about the theoretical framework in number as she believed it would help her assess the children better.

3. SUPPORT.

The teachers were satisfied with the support they got from the principal, each other, parents and support teachers. However, they expressed discontent with the



consultant's support outside the classroom. While they valued the activities she introduced each week and thought the actual "classroom support was good", they were dissatisfied with the support for understanding the assessment and allocation of children to groups.

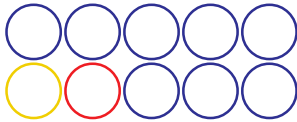
4. RESOURCES.

As already reported in previous sections, the preparation of a large number of resources prior to CMIT starting proved to be detrimental to the implementation of the program. The main reasons for this include: the inappropriateness of many resources for the grades involved; the absence of instructions or the wrong instructions for using many of the games and activities; incomplete activities (extra equipment was needed and not available); a lack of opportunity to see the games being demonstrated; and the inability of teachers to see the rationale behind many activities. The negative impact created by this problem with the resources had far reaching ramifications. For example, teachers immediately 'blamed' the consultant, because "it was her suggestion that we look at the resources from another school" (field note entry, visit 4). Hence, the confidence in the consultant's expertise and ability to efficiently inservice the teachers was questioned from the start. This had implications for teachers' initial attitudes towards the consultant and the CMIT program. In addition, the cost to the school unnecessarily escalated since teachers began to make their own resources independently rather than try and make sense of the activities prepared by the parents. This meant that quite a few activities were duplicated as teachers preferred to have activities in their own rooms to allow quick and easy access. Despite this problem with the initial acquisition of resources, the variety and quality of the activities that the consultant demonstrated during her classroom visits was still rated by all 4 teachers as one of the best aspects of the program. For instance, Rebecca commented in her final interview that "the making of all those resources at the beginning was ridiculous. The activities that were introduced by the consultant in the classroom were so much better...we don't need all that other stuff."

5. TEACHERS' ATTITUDES AND COMMITMENT.

Field note entries made during the fourth, sixth and ninth observational visits refer to Rebecca's negative attitude to "the making of the resources" and "the continual assessment of the children". Rebecca was the only teacher whose negative attitude toward particular aspects of CMIT was intentionally communicated to the consultant and it was perceived at the time that she was particularly stressed about the extra work load.

Angela's behaviour on a number of occasions gave others in the room the impression that the activities the consultant was demonstrating were less than

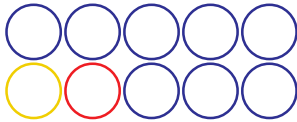


important. For example, field notes taken during the ninth visit revealed that “when the consultant started demonstrating a whole class activity, the teacher left the room to convey a message to another teacher giving the impression that she had little interest and regard for learning new activities or teaching strategies from the consultant..”. Similarly, it was noted on at least two occasions, that Sarah left the room briefly to attend to another matter or busied herself arranging resources on desks and was not able to fully attend to what or how the consultant was teaching. As discussed in an earlier section that dealt with the integration of aspects characteristic of CMIT, the consultant introduced a new teaching strategy each week. For example, one week she would briefly talk to teachers during the class about the importance of lesson closure or the use of open-ended questions and then demonstrate to teachers some strategies they might like to try in a subsequent lesson. Hence, on occasions when teachers left the room or were not fully attentive, the modelling of any new strategy was not perceived by the teachers and is probably why changes to instructional practices were noted to have occurred for some teachers more than others. It is possible that if a more explicit structure were imposed on teachers in the form of an observation sheet or checklist during their observation of demonstration lessons then this may help focus their attention on specific aspects of teaching and could be used as a catalyst for discussion after the lessons.

Understandably, the problem with the resources early in the program had a lasting negative impact on teachers’ attitudes towards CMIT. Coupled with the confusion and lack of understanding surrounding the allocation of children to their groups for instruction, the teachers remained sceptic of the program’s worth for its duration. While, this scepticism does not imply that the teachers did not gain anything from their involvement, it seriously hampered the degree to which the program could be implemented successfully.

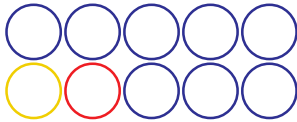
SUMMARY OF FIELD NOTE DATA ANALYSIS

The previous discussion focused on the realities of the change process in the 4 month period between concept mapping exercises. The commonalities and differences that emerged among the teachers formed a useful framework by which data was reported. It draws upon information relating to teachers’ espoused beliefs, knowledge and practices identified in the previous section so as to compare and contrast them to those that were observed. It will be noted that there was considerable overlap in the themes in some instances indicating how the impact of one experience or a piece of knowledge—good or bad—can have ramifications for a number of other interrelated aspects of teaching and teacher professional development. In addition, it was noted how the

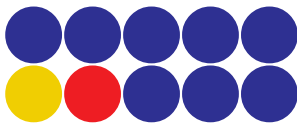


ramifications of the same experience could be different for each teacher. In summary, the findings of data gathered during the period between concept mapping exercises indicated that:

- While changes to the mathematical content knowledge of teachers was difficult to detect through observations alone, new knowledge relating to the importance of bridging the decades, counting-back and counting-on from a range of numbers was evident;
- CMIT had varying degrees of impact on the different components of pedagogical knowledge for different teachers;
- Despite teachers' espoused familiarity and competence with the operation of group work in the classroom prior to CMIT commencing, the introduction of ability groups into mathematics lessons was a source of anxiety and stress for teachers;
- There was a significant positive impact on at least 2 teachers' use of group work for mathematics during the implementation of CMIT;
- There was an increase in use of concrete materials by the children in all classes;
- All teachers expanded their repertoire of activities and games, but more importantly, teachers were aware of the importance of assigning developmentally appropriate activities;
- The development of a large number of activities prior to children's needs being determined and by people who were unaware of their intended uses, was detrimental to the implementation of CMIT;
- Less impact was noted in regard to teachers' use of the textbook—those who relied on the textbook prior to CMIT still relied on it afterwards and those who did not like it before seemed to like it even less;
- The two teachers who relied less on the textbook seemed to be more comfortable with the style of teaching espoused by CMIT and considered the textbook a constraint on their teaching;
- The textbook was perceived to be a constraint to CMIT as teachers sought to complete it to appease parents or school expectations;
- Teachers' knowledge and beliefs about how children learn mathematics underwent the most significant change, particularly in regard to children's use of strategies;
- Conceptions of the nature of mathematics were expanded for at least two teachers;
- Teachers considered that the amount of information available to them was inadequate and



- sought out-of-the-classroom training for a range of aspects;
- Considerable stress was caused to teachers by their own perceived lack of understanding about the Learning Framework in Number, the SENA, the process of allocating children to groups and by the preparation of resources;
- Not having to grapple with problems associated with the initial analysis of SENA results and the subsequent assignment of children into their groups contributed to teacher stress and confusion regarding these two aspects and had ramifications for the implementation of group work and a lack of confidence in the SENA ;
- Lack of time for reflection on the new knowledge, new practices, children's learning, to discuss issues with the consultant and the like, was a constraint that was frequently identified by teachers;
- The book, *Developing efficient numeracy strategies* (NSW DET, 1999) was considered by most teachers to be a useful source of information regarding ideas for activities and assessment;
- Changes to teaching practices were observed in all 4 teachers, but the degree varied from teacher to teacher. In particular, changes related to the use of open-ended questions, the asking of questions to elicit children's strategies, greater use of concrete materials and game-like activities, and the use of ability groupings to allow children access to developmentally appropriate activities;
- Variation in the degree of impact on teachers can be attributed in part to teachers' commitment to the program and was often evident by their attentiveness (or lack of it) during demonstration lessons conducted by the consultant; and
- Considerable improvements to the way the consultant implemented CMIT were made based on reflections of her experience.



CONCLUSIONS AND RECOMMENDATIONS

More than anything else, the combined analyses of the concept mapping exercises and field notes confirm findings by Hollingsworth (1996) and Clarke (1999), that teachers who encounter virtually the same professional development experiences “can respond in quite different ways” (Clarke, 1999, p. 21). The present investigation sought to document the actual professional development process to enable a more in depth exploration of the *realities* of change experienced by teachers. In so doing, it was able to explore and identify some of the physical, emotional, academic and ideological obstacles that often accompany professional development programs exposing teachers to new knowledge and/or classroom practices.

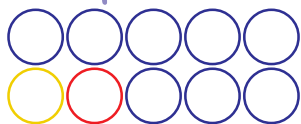
While the available evidence indicates that Jane made the most significant changes to almost every aspect of her knowledge and teaching practices, she is also the teacher that had the most to gain and was the easiest to ‘mould’ given her early career status and the lack of any firmly established teaching practices. Observations of her classroom practices towards the end of the study suggested that CMIT had probably influenced the way she will teach mathematics for a long time. Whether the same would be true for all beginning teachers is impossible to confirm with out further studies designed to compare teachers at similar stages in their careers. However, it is conceivable that there are many more factors likely to impinge on the outcome other than just years of experience.

As to the experiences and factors that influenced the changes that were evident, the role of the consultant has been confirmed not only by this study, but by previous reports (Bobis, 1996; 2000). However, the present study highlighted how one or two ‘problems’ encountered early in the implementation of the program, such as with the making of the resources and the confusion surrounding the allocation of children to their ability groups, can have far reaching ramifications for the implementation of the rest of the program.

The extent to which the espoused beliefs and practices of teachers were enacted upon again varied from teacher to teacher. While a particularly obvious nexus between the espoused and enacted practices of one teacher was the use of ability groups, other less obvious ones related to constraints brought about by the use of the textbook by teachers who preferred not to use one.

Finally, a major obstacle to more far reaching changes occurring was perceived by the teachers to be the lack of access to relevant knowledge via sources outside the classroom or school.

Criticisms by teachers that professional development conducted outside the classroom is too far removed from the realities of teaching has seen the growth of

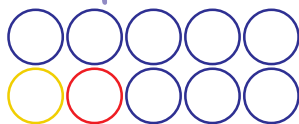


classroom-based professional development programs such as CMIT. While one can easily make sense of this position, it is also important to take heed of the obvious—when in the classroom, teachers are usually very busy *teaching* and do not always have time to reflect on their own teaching and learning or on what their children are learning. As highlighted by Sarah in her final interview, some aspects of the program were better suited to be learnt outside of the classroom. While the strength of CMIT still lies in its classroom-based model, consultants may also need to consider that different kinds of knowledge may need different settings. Such a proposal is in line with a situated perspective of knowledge which proposes that “for some purposes, in fact, situating learning experiences for teachers outside of the classroom may be important—indeed essential—for powerful learning” (Putnam & Borko, 2000). However, while learning situated away from the classroom can result in opportunities for reflection and the acquisition of different types of knowledge, classroom-based learning is also necessary to assist with the process of integrating the new ideas with practice. Hence, there is a need to make decisions about the appropriate conditions for different types of knowledge and to perhaps consider multiple contexts for teacher professional development.

A few recommendations have been made throughout this report in response to specific aspects of the planning and implementation of CMIT. They, along with some additional suggestions, are summarised in the following points. It must be remembered that these recommendations are drawn from the experiences of just one school’s implementation of CMIT and that many may not be appropriate in other contexts—indeed, some consultants may already be implementing them. Since, much of the way CMIT is introduced into schools is determined by individual consultants, it will be found that the majority of recommendations are pertinent to them.

RECOMMENDATIONS

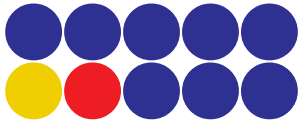
1. Explicit structures that will provide opportunities for professional dialogue among teachers and between teachers and their consultant outside of the classroom need to be built into the implementation stage of CMIT as early as possible. This may take the form of regular small group meetings during recess, after school or at network meetings.
2. Teachers need to be given opportunities early in the implementation phase of the program to take responsibility for and develop independence in the assessment of their students and the subsequent allocation of students to their stages of development according to the LFIN.
3. Teachers should be encouraged to make decisions regarding the learning experiences their students



need so as to determine what resources will be purchased and/or produced. While consultants will initially need to assist with this decision making process they should *gradually* encourage teachers to take more responsibility for such decisions. Teachers are more likely to continue using the resources they are familiar with or have selected for specific purposes themselves.

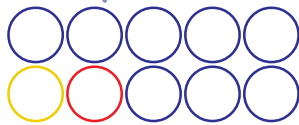
4. The majority of teachers seem to need considerable support to establish the efficient operation of ability groups. This support may take the form of (a) demonstration lessons provided by the consultant or a teacher from the same school, and (b) opportunities for teachers to discuss their problems with either their colleagues or their consultant (see recommendation 1).
5. There is a need for consultants to make decisions about the appropriate conditions for different types of knowledge and to consider multiple contexts. Situating learning experiences for teachers outside of the classroom is important for reflection and the acquisition of some types of knowledge. However, classroom-based learning is also necessary to assist with the process of integrating the new ideas with practice.
6. Explicit structures in the form of an observation sheet or checklist help focus teachers' attention on specific aspects of CMIT being modelled by consultants during demonstration lessons. The observation sheets could be used as a catalyst for discussion after the lessons. A suggested observation sheet has been adapted from one already in use by another consultant and is included in Appendix C⁵.
7. Variations in teachers' needs and capacities to understand more detailed accounts of the theoretical background to such aspects as the LFIN could be accommodated via the CMIT web-site and/or specially focused network meetings.
8. Consultants should actively seek ways to improve the way they implement CMIT. Reflection on each implementation experience can provide consultants and schools with valuable insights for improving the professional development process in the future. The reflection process could be more explicitly structured with the help of a teacher survey which is designed to provide individual consultants feedback on their introduction of the program.

⁵ The prototype from which this observational schedule was derived was provided by Kerry Robinson, the Mathematics Consultant for the Port Jackson District.



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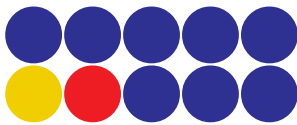
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APPENDIX A

INITIAL INTERVIEW SCHEDULE FOR TEACHERS

Equipment: Tape Recorder and blank audio-tape, samples of concept maps, blank paper for teacher constructed concept maps, blue, black and red fine-tipped pens.

Confirm that the teacher:

- has signed consent form,
- understands the purpose of the study and their role as a participant (see below),
- understands that information they provide will be kept confidential,
- understands that the interview will be audio-taped but that they can stop the tape any time they wish,
- understands that they can withdraw from the study any time they wish with out penalty.

Purpose: The purpose of this interview is to gather information relating to the experiences and factors you perceive as being responsible for your current mathematical beliefs, knowledge of mathematics, and the teaching of mathematics to young children.

CONCEPT MAPPING TASK:

Explain to teacher that he/she is going to 'map' his/her knowledge of mathematics. Provide teacher with concept map sample 1, 'Sport'. Explain the purpose of concept maps and how they are created. For example, draw attention to the way **links** are made between concepts and the way **hierarchies** are structured. Note links between hierarchies etc.

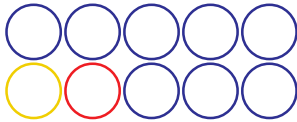
Repeat explanation for concept map sample 2 if necessary. Allow teacher to draw a practice concept map on topic of choice e.g. sport, Science & Technology etc. Answer any questions teacher may have in regard to concept maps.

Ask teacher to complete concept map.

FOLLOW-UP QUESTIONS

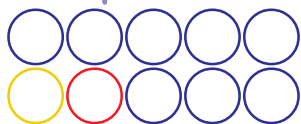
N.B. These questions are a guide only. They may be used as prompts to help focus the discussion around the 'professional knowledge' of individual teachers involved in CMIT. Questions may deviate. Teachers may modify their map (using a different colour pen) if they desire throughout the interview.

9. Tell me everything you can about your concept map?



If more (specific) prompting required:

10. What aspects of your map are a record of your mathematical content knowledge?
11. Where do you think you gained this content knowledge?
12. What aspects of your map are a record of your knowledge of teaching strategies or activities and resources for teaching mathematics?
13. Where do you think you gained this knowledge?
14. What aspects of your map are a record of your knowledge of how children learn mathematics?
15. Where do you think you gained this knowledge?
16. Were there concepts you weren't sure where to put?
17. Which aspect(s) of your map are you the most certain of?
18. How do you think your beliefs of what mathematics is and how it should be taught have influenced the way you have drawn your map?
19. Do you think that these beliefs and knowledge (outlined in map) have an impact on the way you teach mathematics? If so, how? If not, why not?



APPENDIX B

INTERVIEW SCHEDULE FOR TEACHERS ROUND 2

Equipment: Tape Recorder and blank audio-tape, concept maps from first interview, blank A3 paper for new teacher-constructed concept maps, blue, black and red fine-tipped pens.

I. Confirm that the teacher:

- understands the purpose of the follow-up interview (see below),
- understands that information they provide will be kept confidential,
- understands that the interview will be audio-taped but that they can stop the tape any time they wish,
- understands that they can withdraw from the study any time they wish with out penalty.

Purpose: The purpose of this second/third interview, is to consider the impact CMIT has had on your mathematical beliefs, knowledge, and classroom practices, and to discuss the factors you perceive have contributed to changes in your knowledge since the first interview.

CONCEPT MAP TASK

Teachers construct new concept map.

Ask follow-up questions.

FOLLOW-UP QUESTIONS

N.B. These questions are a guide only. They may be used as prompts to help focus the discussion around the 'professional knowledge' of individual teachers involved in CMIT. Questions may deviate

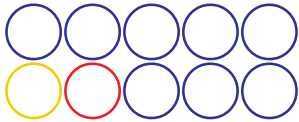
I. Explain your concept map to me.

Ask teachers to look at their concept map drawn during their first interview.

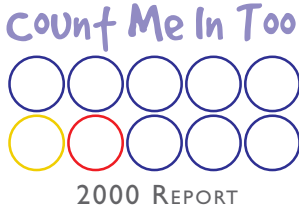
I. Did you change your map from the one you drew last time?

If changes were made:

2. Were any changes a result of new mathematical content or strategy knowledge?
3. Were any changes a result of new teaching strategies or knowledge of new activities and resources for teaching mathematics?
4. Were any changes a result of new knowledge of how children learn mathematics?



5. Can you identify where this (these) changes to your knowledge came from? For example, was there anything that you read, heard, saw, or did that influenced the changes?
6. Were any changes a result of changes to your beliefs about mathematics, how it is learnt and how it should be taught?
7. What made you want to change your map?
8. Which aspect(s) of your map do you think has changed most?
9. Which aspect(s) of your map do you think has changed least?
10. Do you think that any changes in your knowledge that you have just mapped have had an impact on the way you teach mathematics to children? Can you give some examples?



APPENDIX C

LESSON OBSERVATION SHEET

(with example focus questions for subsequent discussion)

Class: _____ Lesson: _____ Week: _____ Date: _____

ACTIVITY	TEACHING STRATEGIES	STUDENT ENGAGEMENT	MATHEMATICAL STRATEGIES
Introduction	How is class structured? Why? What type of questions are asked? Are they 'good' questions? Why? How are chn encouraged to participate? How is student attention maintained?	Are students engaged in the lesson from the start? How? Why? What are children doing? Are chn contributing to the lesson? How?	Are there opportunities for chn to discuss or consider strategies? Do children volunteer their strategies for solving problems?
Main Body of Lesson	How are chn arranged? Why? How are chn instructed to move to new activities? How is equipment distributed to chn? How are chn encouraged to commence work quickly and independently?	Are all chn on task? Why? Why not? Are tasks appropriate? What are chn discussing? With whom are they discussing?	Focus on one or two chn. Observe & note the strategies they use. If strategy is not obvious question them to elicit their strategies. Do they report just one strategy? Are/Is the strategy appropriate for their ability?
Lesson Closure	How is the class structured? Why? What opportunities are provided for students to discuss/share new knowledge or strategies? Is reflection on learning encouraged? How?	Are students actively engaged physically and /or mentally in this component of the lesson? How? Are students able to reflect on their learning? If so, why? How do they reflect? If not, why?	Do chn get opportunities to report strategies? How are strategies reported? Is there evidence of growth in chn's use of strategies? How do you know?
<p>Language: What language was the teacher using? What language were children using? Evidence of new language or lack of language.</p> <p style="text-align: center;">Evaluation/Future Planning</p>			