Chapter 6 Conclusions

The review of literature and the evaluative research gave me a good understanding of the nature of deep subject knowledge and also provided evidence of the impact of the MaST Programme on the participants' subject knowledge. However, it was the development of an analytical framework for the observations and interviews that proved to be a key part of this study. The process of selecting the criteria for the interview analysis and observation records guided me towards an effective structure for organising and analysing the evidence, and highlighted possible lines of enquiry.

The research questions had two focus areas, firstly, the nature of deep subject knowledge and secondly, the impact of the MaST Programme. These conclusions are organised into those two focus areas.

How does deep subject knowledge differ from the basic mathematical knowledge that teachers bring to the classroom? How does deep subject knowledge impact on pedagogy?

This study began with the intention of evaluating the impact of the MaST Programme on the participants' deep subject knowledge. Through the literature review it became apparent that clarifying what was meant by deep subject knowledge for primary teachers was essential to be able to analyse the impact of the MaST Programme.

The *Deep Subject Knowledge* model (Figure 2.3) evolved from the findings of a number of research papers and developed into a very useful model for identifying and analysing the subject knowledge of teachers while observing them teach or interviewing them. I was able to identify strengths and weaknesses in their subject knowledge and determine whether they excelled in enough of the elements to show deep subject knowledge.

During the lesson observations it was evident that two of the elements of the model, *progression* and *concepts,* were not distinct enough, making the evidence difficult to record. I focussed on the teachers' curriculum knowledge for the *progression* element and how they dealt with small steps in learning and misconceptions for the *concepts* element. This is now a revised model (Figure 5.1), which I will use when supporting mathematics subject leaders in developing the subject knowledge of their staff.

A possible area of further study would be the use of the model to identify the deep subject knowledge of KS3 and KS4 mathematics teachers, and also for other areas of the curriculum. At a recent Primary Education Conference I gave a poster presentation of this study to the delegates. I discussed subject knowledge with a geography university lecturer and he showed an interest in the model for identifying aspects of subject knowledge in geography. I will consider using the model for observations of subjects other than mathematics to determine the possible generalised elements of subject knowledge.

The following conclusions and generalisations can tentatively be drawn from this study concerning deep subject knowledge:

Conclusions	Evidence
Prior academic attainment alone has limited impact on the depth of subject knowledge, but may have an impact on attitudes, belief and confidence.	Analysis pages 31-33 Discussion page 50
Initial Teacher training did not guarantee that primary teachers would have deep subject knowledge, but it can be developed through teaching experience, self-research and CPD.	Analysis pages 31-33 Discussion page 51
The most effective teachers may adopt a connectionist approach, but perhaps support is needed for teachers on how to manage this in the classroom.	Analysis pages 37-43 Discussion page 52-53
To develop knowledge about mathematics and ways of teaching, teachers need to value research, draw upon relevant research and, perhaps, need to develop research skills to use the research effectively.	Analysis pages 32, 36 Discussion pages 51, 54
Teachers in this study showed more evidence of a knowledge of children *learning* mathematics than they had of *teaching* mathematics.	Analysis pages 37-46 Discussion page 49-50

How does the Maths Specialist Teachers (MaST) Programme develop deep subject knowledge in the participants?

There was evidence that the MaST Programme has increased the subject knowledge of the three teachers in this study. The five 'big ideas' and the eight key pedagogies introduced on the programme were well received, extended their knowledge and articulated the beliefs and attitudes of the teachers towards their teaching of mathematics. However, some of the content that was beyond primary expectation was seen as irrelevant to them in their own setting. They valued ideas and activities that they could use immediately in the classroom and then share with other staff in the school. The research element of the programme was recognised as important for gaining subject knowledge, but was not seen as particularly effective for the teachers in this study.

The following conclusions and generalisations can tentatively be drawn from this study concerning the impact of the MaST Programme:

Conclusions	Evidence
The content, delivery and structure of the MaST Programme has had an overall positive impact on the subject knowledge of the participants.	Analysis pages 34-40, 44-46 Discussion page 53-54
The five 'big ideas' and the eight key pedagogies provide an effective framework to base the programme around, developing knowledge and a connectionist approach.	Analysis pages 35-36, 43-45 Discussion page 53
The relevance of content that is beyond the primary phase needs to be made more explicit to the participants.	Analysis pages 34, 36 Discussion page 54
Conducting research helps participants gain subject knowledge, providing it is relevant and manageable.	Analysis pages 34-36 Discussion pages 54
The mentoring and coaching aspects of the programme support participants in implementing change in school.	Analysis pages 35, 45-46 Discussion page 53

Recommendations

These are recommendations from the study for any future delivery of the MaST Programme:

1. Highlight the progression and connections to the primary curriculum for any mathematics presented on the MaST Programme that is beyond the primary stage.

2. Provide support on how to effectively manage a connectionist approach to teaching mathematics.

3. Include research skills throughout the MaST Programme so that the participants are able to analyse and evaluate any study they carry out or research paper they read.

Issues for further research linked to this study could include the following:

Can the *Deep Subject Knowledge* model be used effectively for other areas of the curriculum and at KS3/4?

The revised model (Figure 5.1) could be used as an observation framework for mathematics teachers at KS3/4 to identify strengths and weaknesses in their subject knowledge. This would help consolidate the accuracy of the elements of the model that help to identify deep subject knowledge. This can be repeated in other subject areas at KS3/4 and in primary schools.

What form of CPD is the most suitable to develop deep subject knowledge?

Further detailed analysis of the MaST Programme could identify the impact on the attainment of pupils in the participants' schools. This could be compared with other CPD focussing on subject knowledge to identify the characteristics and content that develops deep subject knowledge.

Why is a high qualification in mathematics seen as an irrelevant factor in the effective teaching of mathematics by some teachers in primary schools?

Further research could aim to identify and analyse the attitudes of primary teachers towards high mathematics qualifications, and the impact that academic qualifications have on the effectiveness of primary teachers in teaching mathematics.

Impact of the research process on my personal and professional development

As a former tutor on the MaST Programme, I initially expected this to be an evaluation of the impact of the programme on the participants. It was evident that the research needed to be tighter, hence focussing on participants' subject knowledge. I also needed to consider the evaluation model that would best answer the research questions. What I had not expected was that the nature of deep subject knowledge would actually become the driving force of the research process. The review of literature was a catalyst for this and was certainly a rewarding stage of the research process. It raised questions about the meaning of deep subject knowledge and gave me the impetus to design my own framework, the *Deep Subject Knowledge* model. This was used as an analysis template for the observation and informed the interview, supporting the layered evaluation model so that the data collected could be analysed and findings discussed and synthesised.

This research process has been a revelation to me as it is my first major academic study for almost 25 years. Each layer of the process from the introduction to the conclusion has been important in its own right, but rather than being isolated steps, each built upon the previous and caused me to re-read, alter the emphasis and carry out more analysis. Everything was connected, and that has had a real impact on my understanding and use of research in my work as an author and maths consultant.

Recent courses I have held for teachers on aspects of subject knowledge have included the *Deep Subject Knowledge* model and the research process involved with developing that model. I now read more research articles, and I question the assertions when reading them. This has improved my own textbook writing and course delivery. Most importantly, my confidence in discussing and writing about the more academic aspects of teaching and learning mathematics has grown. I still see myself as a primary teacher rather than an academic, but now feel comfortable with a foot in both camps.