DECLARATION

I declare that, this research report is my own unaided work, except as in the acknowledgements, the texts and the references. It is being submitted in partial fulfilment of the requirements for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other universities.

_______________________________  ___ day of _______________ 2013

Lehlohonolo Pauline Desiree Molefe
This study was motivated by the introduction of the topic of evolution in the Grade 12 Life Sciences curriculum in South African high schools in 2008. Many Life sciences teachers were concerned about their preparedness to teach evolution as this topic was new to them as well. They were worried about their ability to teach evolution as many felt that their content knowledge was inadequate to effectively teach evolution. The aim of this study was to investigate the nature and the extent of the pedagogical content knowledge of Life Sciences teachers who were going to teach evolution for the first time in South African high schools in 2008. This study used a five-category model of pedagogical content knowledge adapted from Shulman.

Data were collected from two different samples from teachers who were attending workshops which were aimed at alleviating the teachers’ concerns and fears about evolution and to help them prepare to teach the topic of evolution. The first workshop was held at the end of the second school term in 2008, just a few weeks before many teachers were meant to start teaching evolution. The second workshop was held during the period when all teachers were supposed to have started teaching evolution, and that was in August 2008. The first group of teachers comprised 39 teachers who attended the evolution workshop during the SAASSTE conference and the second group comprised 40 teachers attending the evolution workshop organised for NAPTOSA.

The questionnaires were designed to address the five categories in the pedagogical content knowledge model used in this study. Seven activity-based questionnaires were used to gather data from two convenience samples consisting of two groups of teachers. The questionnaires investigated the nature and extent of the teachers’ knowledge of the evolution content they were supposed to teach; their knowledge of the teaching and learning difficulties regarding evolution; knowledge of the preconceptions and misconceptions associated with evolution; knowledge of appropriate methods and strategies to teach evolution and their curricular knowledge. Open-coding and frequency counting were used to analyse the data. The data revealed that the some teachers over-estimated their knowledge of the evolution subject matter, many harboured misconceptions about evolution. Further analysis of data revealed that many did not know of different approaches and strategies they could use when teaching evolution and that they did not know of the different additional resources they could use when teaching evolution. In general the teachers’ knowledge levels for teaching evolution, in all the five categories of pedagogical content knowledge was low, an indication that the teachers were ill-prepared for teaching evolution.
ACKNOWLEDGEMENTS

I am deeply indebted to my supervisor, Professor Martie Sanders for her unwavering support, professional guidance and advice, unfailing patience and tolerance. Thank you.

A word of gratitude to the Life Sciences teachers who agreed to participate in the study, without whom this study would not have been possible.

I acknowledge the financial support given by the National Research Foundation and the Gauteng Department of Education.

To my special friends Thabo Khoali, Nonyameko Ngxola and David Mokgobanama, special thanks goes to you guys for your support in this long road.

To my family, my two girls Keitumetse and Ditirotsane le wena Rrabo Ratshitlho, thank you for being supportive and patient through this hard journey, for tolerating my being absent from your lives especially when you needed me. My sister Majaneng and my brother Tlhabang, thank you for cheering me along this journey. I will be forever be indebted to you all, thank you.
DEDICATION

This research report is dedicated to my loving mother the late Martha “Meisie” and my sweet grandmother the late Mamosala Pauline for inspiring and motivating me during my school days. Even when times were hard you believed in me.
CHAPTER 1: THE CONTEXT OF THE STUDY AND EXPLANATION OF THE RESEARCH PROBLEM

1.1 CONTEXT OF THE STUDY

1.1.1 The new curriculum in South Africa
1.1.2 Inclusion of evolution in the Life Sciences curriculum

1.2 THE IMPORTANCE OF TEACHING EVOLUTION

1.2.1 Evolution is unifying concept
1.2.2 Evolution is a powerful explanatory tool
1.2.3 Evolution is a contemporary problem-solving tool

1.3 THE PROBLEM THAT MOTIVATED THE STUDY

1.3.1 The controversial nature of evolution teaching
1.3.2 Teachers’ inadequate background knowledge
1.3.3 Inadequacy of teacher training by the Department of Education
1.3.4 Teachers have several other concerns about having to teach evolution

1.4 AIM OF THE STUDY

1.5 RESEARCH QUESTIONS

1.6 CONCLUDING REMARKS
CHAPTER 2: THEORETICAL FRAMEWORK FOR THE STUDY

2.1 THE ROLE OF A THEORETICAL FRAMEWORK IN RESEARCH

2.2 THE THEORETICAL FRAMEWORK FOR THIS STUDY - PEDAGOGICAL CONTENT KNOWLEDGE

2.3 PEDAGOGICAL CONTENT KNOWLEDGE AS A FRAMEWORK FOR TEACHING EVOLUTION

2.3.1 Subject matter knowledge for teaching evolution

2.3.2 Knowledge of the curriculum

2.3.3 Knowledge of teaching and learning difficulties associated with teaching evolution

2.3.4 Knowledge of learners’ preconceptions (misconceptions)

2.3.5 Knowledge of appropriate teaching strategies for evolution

2.4 CONCLUDING REMARKS

CHAPTER 3: RESEARCH DESIGN AND METHODS

3.1 RESEARCH DESIGN

3.2 RESEARCH PARADIGM

3.3 RESEARCH APPROACH

3.4 SAMPLE

3.5 DATA-COLLECTION INSTRUMENTS: QUESTIONNAIRES

3.6 ENSURING RIGOUR IN THE STUDY

3.7 ADMINISTERING THE QUESTIONNAIRES

3.8 ANALYSIS OF DATA FROM THE QUESTIONNAIRE

3.9 ETHICAL ISSUES

3.10 CONCLUDING REMARKS
CHAPTER 4: RESULTS AND DISCUSSION

4.1 DEMOGRAPHICS OF THE SAMPLE: TEACHER QUALIFICATIONS

4.2 SUBJECT MATTER KNOWLEDGE

4.2.1 Teachers’ own knowledge estimates about basic concepts to be taught in evolution

4.2.2 Teachers’ explanations of evolution

4.2.3 Teachers’ misconceptions about evolution

4.3 KNOWLEDGE OF MISCONCEPTIONS LEARNERS ARE LIKELY TO BRING TO CLASS

4.4 KNOWLEDGE OF LIKELY TEACHING AND LEARNING DIFFICULTIES

4.4.1 Knowledge of difficulties teachers might encounter

4.4.2 Knowledge of typical learning difficulties

4.5 KNOWLEDGE OF APPROPRIATE TEACHING STRATEGIES FOR EVOLUTION

4.6 KNOWLEDGE ABOUT CURRICULAR MATTERS

4.7 CONCLUDING REMARKS

CHAPTER 5: SUMMARY AND DISCUSSION OF THE FINDINGS, AND RECOMMENDATIONS

5.1 DISCUSSION OF THE LIMITATIONS OF THE STUDY

5.1.1 Lack of piloting of the instruments

5.1.2 Use of convenience sampling

5.1.3 Possible problems with teachers’ responses

5.1.4 Use of small sample sizes

5.1.5 Problems with loss of data

5.2 SUMMARY AND DISCUSSION OF THE FINDINGS

5.2.1 Subject matter knowledge about evolution

5.2.2 Knowledge of misconceptions learners are likely to bring to class

5.2.3 Knowledge of teaching and learning difficulties

5.2.4 Knowledge about curricular matters

5.2.5 Knowledge of appropriate teaching strategies
5.3 RECOMMENDATIONS............................................................................................................. 81
  5.3.1 Recommendations for curriculum material developers .............................................. 81
  5.3.2 Recommendations for in-service trainers ............................................................... 82
  5.3.2 Recommendations for in-service trainers ............................................................... 82

5.4 CONCLUDING REMARKS .................................................................................................. 82

REFERENCES .............................................................................................................................. 84
**LIST OF TABLES**

| Table 1: | Summary of evolution content to be covered in Grade 12 Life Sciences | 2 |
| Table 2: | Scientifically incorrect ideas associated with religious beliefs | 21 |
| Table 3: | Misconceptions about evolution potentially associated with a misunderstanding of the nature of science | 23 |
| Table 4: | Misconceptions associated with the mechanism of evolution | 24 |
| Table 5: | Misconceptions about evolutionary theory | 26 |
| Table 6: | Teachers’ qualifications and whether they remembered learning about evolution at tertiary | 41 |
| Table 7: | Teachers’ knowledge estimates about basic concepts of evolution | 43 |
| Table 8: | Summary of categories of teachers’ self-rated content knowledge | 47 |
| Table 9: | Correctness of teachers’ explanations of evolution in biology | 49 |
| Table 10: | Errors incorporated in the teachers’ explanations of evolution | 52 |
| Table 11: | The extent of the teachers’ misconceptions | 53 |
| Table 12: | Misconceptions that teachers say learners have about evolution | 60 |
| Table 13: | Summary of teaching difficulties teachers thought they might encounter when teaching evolution | 61 |
| Table 14: | Summary of learning difficulties teachers anticipated from learners when learning about evolution | 65 |
| Table 15: | Summary of teachers’ knowledge about other subjects/learning areas in which aspects of evolution are taught | 68 |
| Table 16: | Teachers’ level of confidence about the amount of detail they should include when teaching evolution | 69 |
| Table 17: | Summary of teachers’ knowledge about the available instructional material for teaching evolution | 69 |
LIST OF FIGURES

Figure 1: Pedagogical content knowledge – the amalgamation of content and pedagogical knowledge (Mishra & Koehler, 2006) ................................................................. 11

Figure 2: Shulman's categories of content knowledge and sub-categories of pedagogical content knowledge (based on Shulman, 1986) ................................................................. 13

Figure 3: Five sub-category model of pedagogical content knowledge, adapted from Shulman (1986) by Sanders (2008) ................................................................. 14

Figure 4: Summary of the research design ........................................................................... 29

Figure 5: Topics where “poor” was the most frequent self-rated knowledge level ........... 44

Figure 6: Topics where "satisfactory" was the most frequent self-rated knowledge level .......... 46

Figure 7: The percentage of teachers with various misconceptions ........................................ 54

Figure 8: The frequency of misconceptions in the NAPTOSA and SAASTE groups of teachers ...... 58

Figure 9: A summary of factors investigated in pedagogical content knowledge for teaching evolution ................................................................. 73
LIST OF APPENDICES

Appendices follow immediately after the list of references after page 95 (pages unnumbered)

Appendix A: The revised Life Sciences content framework summary document

Appendix B: List of resources to teach evolution available in South Africa

Appendix C: Activity-based questionnaires

Appendix D: Consent form

Appendix E: Ethics clearance letter