FACULTY OF SCIENCE

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG

DEVELOING PEDAGOGICAL CONTENT KNOWLEDGE FOR THE TEACHING OF MEIOSIS: A SELF-STDY

BY

DAVID KASEKE

(510143)

A Research Report submitted to the Faculty of Science, University of Witwatersrand, Johannesburg, in Partial Fulfilment of the Requirements for the Degree of Master of Science (Science Education)

Supervisor

Eunice Nyamupangedengu

Declaration

I declare that the research report is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

..... Date: March 2015

David Kaseke

Abstract

In my Honours degree, I researched on learners' understanding of meiosis after I had taught them the topic. The study was done on three schools. The results of the study revealed that the majority of learners from my school were unable to identify and explain some concepts in meiosis. The failure of the learners to understand the topic prompted me to reflect on my content knowledge of meiosis and its teaching. To investigate my own content knowledge in this self-study, I used concept maps and CoRes. Concept maps were seeking to develop my content knowledge and CoRes were seeking to develop both content knowledge and pedagogy of teaching meiosis. The aim of the self-study was therefore to improve my content knowledge and pedagogical content knowledge (PCK) of meiosis through the use of concept maps and CoRes as planning tools. The development of content knowledge and pedagogy was done with the help of collaborative friends.

Of the two planning tools I used (concept maps and CoRes), three concept maps and three CoRes were constructed. Each of the concept maps was analysed using number of concepts identified and the number of propositions. Both qualitative and quantitative methods were used to analyse the concept maps. The number of both concepts and propositions gave an indication of the development of content knowledge from one concept map to the other. CoRes were analysed qualitatively using a framework. The framework used focused on curricular saliency, student prior knowledge, what makes the topic difficult or easy, teaching strategies and representations. From these aspects of the framework, the teachers' content knowledge and pedagogy was identified to see whether there was development from one CoRe to the other.

The study revealed that both concept maps and CoRes when used as planning tools can develop the teachers' content knowledge and pedagogy on meiosis. Concept maps helps to indentify content gaps and misconceptions. CoRes helped me in the identification of the big ideas for the teaching of meiosis, the content which learners need to know and the identification of teaching strategies which can help the topic to be understood better.

Recommendations from the study were that teachers should read about what they teach to improve content knowledge. Teachers should team up to produce teaching tools like CoRes.

Key Words: Content Knowledge, Pedagogical Content Knowledge (PCK), Content Representation (CoRe) and Concept map

Acknowledgements

I would like to gratefully acknowledge my supervisor Eunice Nyamupangedengu who provided her support without hesitation, giving constructive comments and suggestions all of which provided a strong backing for this Masters Research work. I would like to further thank her for her time and the intellectual energy she gave to this report. You stood by my side in the long journey of researching and writing of this academic report.

Secondly, I also heartfelt thank my critical friend Shawn Lawrence who scarified his time to make this project a success.

Thirdly, I would also like to thank the Principal of Thuto-Lehakwe Secondary School who provided with moral support and for his unwavering patience and tolerance for the whole period of study.

Finally, I am forever indebted to my wife Kiliana and our children for their understanding and patience with me throughout the study. I salute you for your tolerance.

Table of contents

Declaration ii

Abstract iii

Acknowledgements iv

Table of contents v

List of tables viii

List of figures ix

CHAPTER ONE 1

Introduction 1

1.1 Introduction 1

1.2 Context of study 2

1.3 Research problem 3

1.4 Aim of study and Research questions 3

1.5 Self-study 3

1.6 Theoretical framework 6

1.7 Outline of research report 6

CHAPTER TWO 8

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction 8

2.2 CoRes 8

2.3 Concept maps 11

2.4 Teaching and learning of meiosis 14

2.5 Pedagogical Content Knowledge 14

2.5.1 Other researcher's perspectives on PCK 15

2.5.2 Domains of teacher knowledge 20

2.5.3 Manifestations of teacher knowledge 22

2.6 Topic Specific PCK 24

2.7 Conclusion 27

CHAPTER THREE 28

REASERCH DESIGN AND METHODOLOGY

3.1 Introduction 28

3.2 Research design 28

3.3 Participants 29

3.4 Reflective Journal 30

3.5 Data collection 31

3.5.1 Data collection instruments 31

3.5.2 Data collection through concept maps 31

3.5.3 Data collection through CoRes 32

3.6 Data analysis 34

3.6.1 Analysis of concept maps 34

3.6.2 How I analysed my first concept map 35

3.6.3 Data analysis of CoRes 36

3.7 Ethical Issues 36

3.8 Validity 36

3.9 Conclusion 37

CHAPTER FOUR 38

PRESENTATION OF FINDINGS AND DISCUSSION 38

4.1 Introduction 38

Section A

4.2 Analysis of and presentation of findings from concept maps 38

4.2.1 Concept map 1.....39

4.2.2 Discussion of concept map 1 with team 40

4.2.3 Reflection from the discussion 40
4.2.4 Concept map 2 42
4.2.5 Discussion of concept map 2 with the team 43
4.2.6 Reflection from the discussion 44
4.2.7 Concept map 3 45
4.2.8 Discussion of concept map 3 with team 45
4.2.9 Reflection from the discussions 46
4.2.10 Final discussion on concept maps.....46
4.3 Quantitative data for the three concept maps 47
4.4 Concepts as a measure of content knowledge 48
4.5 Correctness 50
4.6 Relationships as a measure of content knowledge 51
4.7 Conclusion on concept maps 51
Section B
4.8 The analysis of CoRes 52
4.8.1 Construction of CoRe 1.....53
4.8.2 Discussion of CoRe 1 (big ideas) with team.....58
4.8.3 Reflection from discussion on big ideas 58
4.8.4 Analysis of CoRe 1 59
4.8.5 Discussion of CoRe 2 with team 67
4.8.6 Reflection from the discussion 68
4.8.7 Construction of CoRe 3 69
4.8.8 Discussion of CoRe 3 with team 75
4.8.9 Reflection and discussion on CoRe 3 77
4.8.10 Conclusion 78

CHAPTER FIVE 80

REFLECTIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction 80

5.2 Concept maps and PCK 80

5.2.1 The content gaps 80

5.2.2 Insights from the construction of concept maps 80

5.2.3 Concept maps and learning – implications.....81

5.3 CoRes and PCK 83

5.3.1 Identification of big ideas.....83

5.3.2 The first four prompts in a CoRe 84

5.3.3 The last four prompts of my CoRes 85

5.3.4 Insights from the use of CoRes 86

5.4 Self-study as a methodology.....86

5.5 Reflections on concept maps 87

5.6 Reflections on CoRes 87

5.7 Recommendations 88

References 90

APPENDIX A: Samples of commented concept maps 98

APPENDIX B: CoRes..... 101

APPENDIX C: Study consent documents 110

GDE Research Approval letter 110

Ethics clearance (University of Witwatersrand) 112

List of Figures

Fig 1: Model for PCK 19

Fig 2: Amalgamation of two models of PCK 25

Fig 3: Part of concept map showing concepts and propositions 34

Fig 4: Concept map 1 39

Fig 5: Concept map 2 42

Fig 6: Concept map 3 44

List of Tables

Table 1: CoRe template 9

Table 2: Components of pedagogical content knowledge from different from conceptualizations 18

Table 3: CoRe components adapted from Mavhunga and Rollnick (2013) 33

Table 4: Concept map scores 48

Table 5: Some correct concepts from concept maps 1, 2 and 3.....49

Table 6: Results showing comparison of links forming propositions 50

Table 7: Overview of the five components and their explanations 53

Table 8: CoRe 1 55

Table 9: CoRe 2 62

Table 10: CoRe 3 69