

https://dspace.org/

Teaching evolution in a new curriculum: Life Sciences teachers' concerns and needs.

Ngxola, Nonyameko

2012-10-05
http://hdl.handle.net/10539/12054

Downloaded from a DSpace repository. https://dspace.org/

Teaching evolution in a new curriculum: *Life Sciences* teachers' concerns and needs

Nonyameko Ngxola



A research report submitted to the Faculty of Science in partial fulfilment of the requirements for the degree of Master of Science

Johannesburg, April 2012

DECLARATION

I declare that this research report is my own unaided work, except as indicated in the acknowledgements, the text 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 institute.

_____ _____ day of _____ 2012

Nonyameko Ngxola

ABSTRACT

This research was motivated by introduction of the topic of evolution in the Grade 12 curriculum in South African schools in 2008. Overseas research shows that evolution is a very controversial topic to teach, raising serious concerns for teachers. The need for appropriate professional development was urgent, but many *Life Sciences* had been dissatisfied with government workshops they had attended in preparation for the new curriculum. Furthermore, the teachers were sceptical about their ability to explain the theory of evolution because they did not have adequate content knowledge to teach the subject. Curriculum change theory dealing with 'stages of concern' suggests that teachers implementing a new curriculum move through a series types of concern, and that if their initial concerns are not addressed teachers will be slow to move on to more task-related matters.

This study aimed to identify the early concerns and needs of teachers who had to teach evolution for the first time in a new *Life Sciences* school curriculum, in order to provide crucial information for service providers who have to design appropriate support workshops.

Data were gathered using seven activity-based questionnaires, from a convenience sample of two groups of teachers (n = 45 and n = 74) from various districts in Gauteng, attending 2007 and 2008 in-service training workshops on the teaching of evolution. The data were analyzed using open coding and frequency counts. The data revealed that teachers had concerns on different levels, the majority of concerns identified being 'self-concerns' dealing with personal worries and need for information. Late concerns were less prevalent. A further analysis of self-assessed knowledge levels of teachers as well as actual levels (based on definitions of biological evolution provided by the teachers and results of an evolution quiz designed to diagnose possible misconceptions) was done. The data showed that the knowledge of most teachers was poor, and that many teachers over-estimated the adequacy of their own knowledge. This information is useful for the teachers themselves, curriculum developers and those involved in professional development.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Professor Martie Sanders for her unwavering support, time and tolerance through a very challenging journey, thank you.

A word of thanks goes to the *Life Sciences* teachers for willingly participating in the study. Without your contributions, this study would not exist.

To my friends, Thlogi Molefe, Thabo Khoali, and Majabulile Ndhlovu thank you for always being there to listen. Your moral support made this study possible, ndiyabulela!

My special gratitude goes to my family, my parents, three sisters Nozibaya, Zukiswa and Nondyebo, for your patience and constant support. To my lovely two nieces Bukeka and Paluxa, the support and love you gave my son during my academic journey is highly appreciated. My son Lizo, for tolerating my erratic availability and for making such huge sacrifices while I studied, I am eternally grateful.

I acknowledge the funding by the Biology Education Research Group of Martie Sanders and some financial support from the Gauteng Department of Education.

DEDICATION

I dedicate this research report to my parents, Mnyamezeli Ndoda Ngxola and Shona Ngxola whose continual encouragement and belief in my potential sustained me.

TABLE OF CONTENTS

Declaration ……. i
Abstract ……. ii
Acknowledgements ……. iii
Dedication …… iv
Table of contents ……. v
List of tables ……. ix
List of figures …… x
List of appendices ……..... xi

CHAPTER 1: An introduction to the study and its context ……..... 1

1.1 OVERVIEW OF THE STUDY ……. 1

1.2 THE INTRODUCTION OF THE NEW SCHOOL CURRICULUM IN SOUTH AFRICA … 1

1.2.1 A brief history ……..…… 1

1.2.2 Inclusion of the new topic of evolution in the *Life Sciences* curriculum ……... 2

1.3 WHY EVOLUTION IS IMPORTANT IN BIOLOGY ..…….. 6

1.3.1 Evolution as a unifying theme ……. 6

1.3.2 Evolution has broad explanatory powers ……..... 7

1.3.3 Evolution underpins technological advances .……. 8

1.3.4 Evolution is a powerful problem-solving tool ...……..... 8

1.4 WHY EDUCATORS WANT EVOLUTION INCLUDED IN BIOLOGY CURRICULA ….. 8

1.5 PROBLEMS WITH TEACHING EVOLUTION ...…….. 9

1.5.1 Evolution is a controversial topic to teach .…… 9

1.5.2 Teachers' poor content knowledge ...……..... 11

1.5.3 Teachers are inadequately trained to teach evolution ..……. 13

1.5.4 Teachers' concerns about teaching evolution ..……. 14

1.6 THE SPECIFIC PROBLEM WHICH MOTIVATED THE STUDY ...……... 14

1.7 AIM OF THE STUDY....……...14

1.8 RESEARCH QUESTIONS ……... 14

1.9 CONCLUDING REMARKS ..……..... 15

CHAPTER 2: The theoretical framework for the study ……... 16

2.1 OVERVIEW OF THE CHAPTER 16

2.2 THEORETICAL FRAMEWORKS AND THEIR IMPORTANCE IN RESEARCH..... 16

2.3 CHOOSING AN APPROPRIATE THEORETICAL FRAMEWORK FOR RESEARCH IN EDUCATION 17

2.4 STAGES OF CONCERN THEORY 17

2.4.1 Fuller's introduction of the theory 17

2.4.2 Expanded stages of concern theory 19

2.4.3 Implications of the stages of concern theory 22

2.5 SUBJECT MATTER KNOWLEDGE 23

2.5.1 The importance of teachers' subject matter knowledge 23

2.5.2 Subject matter knowledge – the structure of the construct 25

2.6 CONCLUDING REMARKS 25

CHAPTER 3: Research methods and design 26

3.1 OVERVIEW OF CHAPTER 26

3.2 RESEARCH DESIGN 26

3.2.1 Research paradigm 28

3.2.2 Research approach used in this study 29

3.3 DATA-GATHERING INSTRUMENTS: Activity-based questionnaires 29

3.3.1 Advantages of questionnaires 30

3.3.2 Disadvantages of using questionnaires 30

3.3.3 Advice about designing effective questionnaires 31

3.3.4 Development of the activity-based questionnaires for this study 33

3.3.5 Face validation of the questionnaires 37

3.3.6 Pilot testing 38

3.3.7 Administration of the questionnaires 38

Context of data collection 38

How administration of the questionnaires was done 40

3.4 SAMPLING 40

3.5 DATA ANALYSIS 41

3.6 RIGOUR 42

3.6.1 Reliability 42

3.6.2 Validity 42

3.7 ETHICAL ISSUES 43

3.8 CONCLUDING REMARKS 43

CHAPTER 4: Results and discussion 45

4.1 OVERVIEW OF THE CHAPTER 45

4.2 PROBLEMS ENCOUNTERED WHEN ANALYZING THE TEACHERS' CONCERNS 45

4.3 IDENTIFYING TEACHERS' CONCERNS 46

4.3.1 Teachers' positive feelings 47

4.3.2 Teachers' negative feelings 50

4.3.3 Feelings continuum about teaching of evolution 52

4.3.4 What the teachers were worried about 53

4.4 IN WHAT 'STAGE OF CONCERN' DO TEACHERS' CONCERNS CLUSTER? 62

4.4.1 Non-concerns 63

4.4.2 Self-concerns 63

4.4.3 Task concerns 64

4.4.4 Impact concerns 64

4.5 IDENTIFYING THE TEACHERS' NEEDS 65

4.5.1 The teachers' needs 65

4.5.2 Teachers' change of concerns 68

4.6 TEACHER'S UNDERSTANDING OF THE CONCEPT OF EVOLUTION 70

4.6.1 Teachers' perceptions about the adequacy of their content knowledge 71

4.6.2 Teachers' explanation of biological evolution 72

4.7 TEACHERS' MISCONCEPTIONS ABOUT EVOLUTION 76

4.7.1 Misconceptions contained in the definitions 76

4.7.2 Misconceptions identified from the quiz 77

4.7.3 The extent of misconceptions held by each teacher 81

4.8 THE ACCURACY OF TEACHERS' PERCEPTIONS ABOUT THE ADEQUACY OF THEIR CONTENT KNOWLEDGE 82

4.9 CONCLUDING REMARKS 83

CHAPTER 5: Summary and discussion of the findings, and recommendations 85

5.1 OVERVIEW OF THE CHAPTER 85

5.2 LIMITATIONS OF THE STUDY 85

5.2.1 Lack of piloting of the instruments 85

5.2.2 Possible problems of teachers responding with ideas that were not their own 86

5.2.3 Loss of subjects or data 86

5.2.4 Use of convenience sampling 86

5.2.5 Time as a constraint in gathering information 87

5.3 SUMMARY AND DISCUSSION OF THE FINDINGS 87

5.3.1 Teachers' concerns about having to teach evolution 87

What teachers said they were worried about 87

In what 'stage of concern' do teachers' concerns cluster? 90

5.3.2 Teachers' needs regarding having to teach evolution 91

Support material for teachers 91

Support material for learners 92

Help with improving knowledge 92

In-service training 92

5.3.3 Teachers' understanding of the concept of evolution 92

Teachers' perceptions about the adequacy of their content knowledge 92

Teachers' definition of biological evolution 93

Teachers' misconceptions about evolution (analyzed by frequency per teacher) 94

The extent of teachers' misconceptions (analyzed by frequency of misconceptions in the sample) 94

Accuracy of teachers' perceptions about the adequacy of their content knowledge 95

5.4 RECOMMENDATIONS 95

5.4.1 Recommendations for service providers 96

In-service workshops 96

5.4.2 Recommendations for curriculum developers 97

5.4.3 Recommendations for further research 98

5.5 CONCLUDING REMARKS 98

REFERENCE LIST 99

LIST OF TABLES

Table 1: Evolution-related content extracts from the *Natural Sciences* Revised National Curriculum Statement Grade R-9 (Department of Education, 2002) ..……..... …… 3

Table 2: A summary of evolution-related concepts covered in different content areas in the *Life Sciences* (Department of Education, 2005) …… 5

Table 3: Common misconception related to evolution …… 12

Table 4: The expanded stages of concern theory of Hall and Loucks (1978) ……..…… 20

Table 5: Advice on the general layout and format of the questionnaires ……..…… 32

Table 6: Advice on wording questions for questionnaires ……...…… 32

Table 7: Advice about the order of the questions in questionnaires ……...……. 33

Table 8: Advice on how to ensure appropriateness of the questionnaires ……...……..... 33

Table 9: Questionnaires and information related to the questionnaires ……...…… 35

Table 10: Problems encountered during classification of concerns …… 45

Table 11: Summary of teachers' positive feelings about having to teach evolution (n = 52) ……. 47

Table 12: Summary of teachers' negative feelings about having to teach evolution (n = 47) ……..... 51

Table 13: The positive/negative feelings continuum …….. 53

Table 14: Summary of teachers' concerns about having to teach evolution (n = 91) …… 54

Table 15: Stages of concern associated with 229 comments from 91 teachers ……. 62

Table 16: Summary of teachers' needs about having to teach evolution (n = 24) ……...…… 66

Table 17: Change of concerns associated with 30 comments from 28 teachers ……..…. 69

Table 18: Summary of teachers' self-assessed content knowledge (n = 70) ……...… 71

Table 19: Accuracy of the teachers' biological explanations of evolution (n = 86) ……..….. 73

Table 20: Thirteen errors incorporated in the definitions of biological evolution of 86 teachers …… 76

Table 21: Extent of teachers' misconceptions (n = 86) ……..... 81

Table 22: Accuracy of teachers' perceptions about adequacy of their content knowledge (n = 56) …… 83

LIST OF FIGURES

Figure 1: Representation of Fuller's stages of concern …….. 18

Figure 2: Changing concerns of teachers with different levels of experience, as an innovation progresses (Hall and Hord, 2006: 143) ……... 22

Figure 3: Flow chart showing the overall research design of the study ……..... 27

Figure 4: Example of the "speech-bubble" format used to solicit teachers' concerns …….. 35

Figure 5: The Likert-response format used for Activity-based questionnaire 2 …….. 36

Figure 6: An outline of aspects covered in the September 2007 and February 2008 workshops …… 39

Figure 7: The frequency of misconceptions in the 2007 and 2008 groups of teachers ……... 77

Figure 8: Summary of steps taken to develop three categories used to judge teachers' self-rated knowledge ……... 82

LIST OF APPENDICES

Appendices follow immediately after the list of references after page 106

Appendix A: Explanations of the requirements of the new South African curricula

Appendix B: A summary of evolution-related concepts covered in different content areas in the revised FET *Life Sciences* curriculum

Appendix C: Activity-based questionnaires

Appendix D: Workshop invitation letter (2008)

Appendix E: Ethics clearance letter

Appendix F: Evolution definitions from six biology dictionaries and the comments of an "evolution expert'