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

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CHAPTER 5

Summary and discussion of the findings, and recommendations

5.1 OVERVIEW OF THE CHAPTER

This study focused on *Life Sciences* teachers' concerns and needs regarding having to teach evolution for the first time to Grade 12 learners. Understanding the nature and source of concerns teachers have, and addressing them, is important so those involved in managing the change process can begin to design relevant intervention programmes that better support teachers in their teaching of evolution. This chapter begins with a discussion of the limitations of this study. A summary of results related to the teachers' concerns is then discussed, followed by a summary of the teachers' needs. Finally, recommendations for further research and for in-service providers are presented.

5.2 LIMITATIONS OF THE STUDY

As with any research this study had limitations due to factors beyond the researcher's control. Such factors may turn out to be threats to validity of the findings and conclusions drawn from the findings. Sometimes factors which pose a threat to validity of a study may be minimized by steps taken by the researcher. The limitations of this study, and steps taken to minimize the effects of the limitations, are discussed below. It is important to point out these limitations so the reader can take the limitations into account when looking at the conclusions.

5.2.1 Lack of piloting of the instruments

Leedy (1989) and McMillan and Schumacher (2001) point out that it is highly desirable to pilot-test instruments designed by the researcher before the instruments are administered. Pilot testing research instruments helps the researcher to identify potential inadequacies before an instrument is used in the main study (Galfo, 1975; and Gay *et al*., 1996). It helps to identify if the instructions are clear, questions are understandable, and the language and grammar used are correct. Due to lack of time as the workshops approached I could not conduct a pilot test. The workshop was scheduled and the instruments had to be ready. There was no time to pilot them. However, during the design process all the activity-based questionnaires used in this study went through iterative cycles of face validation by the science education expert. Face validation helped in improving the quality of the instruments by checking all the aspects listed in section 3.3.5, page 37. Despite the fact that face validation was done, and possibly due to the lack of pilot testing instruments, the wording of item number seventeen in the evolution quiz was problematic, i.e. 'evolution results in an increase in variation within organisms', and was excluded in reporting the data. This is because people tend to focus on the first part of the statement 'evolution results in increase in variation' and miss the second part 'within organisms' which is what renders the statement incorrect. Evolution does not occur within organisms. Their genotype is fixed and cannot change.

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

During the analysis of answers to some open-ended questions there were a number of occasions where the same answers were obtained from teachers from the same group. The problem with this is that they might have talked together, so the answers were not representing personal ideas which would have been volunteered by individual teachers. This might affect the validity of claims about the frequency of various concerns voiced, because it includes concerns which would not otherwise have been raised. An effort was made at the beginning of the workshop to overcome this problem, as discussed in Chapter 4, section 4.2. At the analysis stage there was nothing I could do to address the problem, and I just had to bear in mind that when a respondent lists someone else's ideas, that affects the validity of the results.

5.2.3 Loss of subjects or data

The 2007 workshop was run over three Saturdays and the 2008 workshop was run over four Saturdays. Some of the respondents would attend one Saturday and skip the next Saturday because they had another commitment. I knew in advance, as they usually told me in advance they would not be able to attend. In some schools there were more than two *Life Sciences* teachers who had to teach evolution in 2008, and the teachers took turns (i.e. not all of them attended on one particular Saturday). As the workshops progressed, the number of teachers therefore fluctuated. This resulted in incomplete data sets for some questions, as indicated by the varying sample sizes in the analysis of different questions, from a maximum of 119 teachers to smaller samples.

Fraenkel and Wallen (1990) point out that losing subjects in a study is common and difficult to control. The authors point out that loss of subjects limits generalizability and introduces bias if the missing subjects would have responded differently to the rest of the respondents.

5.2.4 Use of convenience sampling

In this study data was gathered from a convenience sample (i.e. teachers who volunteered to attend the workshop). This type of sample is probably not a true representation of the target population. Two possible "atypical" groups may have attended the workshops in this study: i) committed teachers with professional attitudes who are keen to learn more, or ii) teachers who were not committed but who became anxious as the time to teach evolution approached and who were desperate for help. This makes them different from non-volunteer teachers. These two contrasting groups would have biased the sample in different ways. For example, the results on content knowledge of the first group of teachers might not be as inadequate as that of the second group of teachers, thus either increasing or decreasing estimates of the whole samples content knowledge. Their answers may not be typical of all *Life Sciences* teachers, so generalizing the results to all South African *Life Sciences* teachers could be problematic. Any generalizations need to be cautiously worded.

5.2.5 Time as a constraint in gathering information

Data for this study was gathered during in-service training workshops set for prescheduled dates. Due to time constraints it is possible that some valuable information I could have got was not obtained. The workshop facilitator and I were concerned about not wasting too much of the teachers' time, as they had come for teacher development and help, not to allow me to do my research. So I tried to reduce the written activities because of time constraints. Furthermore, it is possible that the teachers did not respond in as much detail as they might have if more time had been allocated for each activity.

5.3 SUMMARY AND DISCUSSION OF THE FINDINGS

A detailed discussion of the results is given in Chapter 4. This section provides a summary and discussion of the findings obtained when seeking answers to the research questions below

- What were *Life Sciences* teachers' concerns and needs regarding having to teach evolution to Grade 12s in 2008, as part of a new curriculum?
- To what extent did teachers who had to teach evolution understand the fundamental evolution concepts they were required to teach?

The second research question was designed to find out how adequate the teachers' content knowledge was, so the information could be used to see if there was a need to improve teachers' content knowledge, as teachers may not be aware of knowledge deficiencies and may not have expressed this need. The reader is reminded to take the above-mentioned limitations into account when considering the results of the study.

5.3.1 Teachers' concerns about having to teach evolution

What teachers said they were worried about

It is important that the teachers' concerns about having to teach evolution are clear to Department of Education and in-service providers, so they design appropriate interventions. A question focusing on the teachers' concerns was asked to elicit what the teachers were worried about. Ninety-one teachers from both workshops voiced their worries, and 226 comments about their concerns were made. The analysis indicated concerns relating to

Teachers' lack of knowledge: Half of the comments, 113 of the 226 (50% of all the concerns), had to do with the teachers' lack of knowledge. Of the 113 comments

- Forty-nine (43%) related to teachers lacking content knowledge, referring mainly to knowledge of evolution and of different religions.
- Thirty-nine (35%) had to do uncertainty about what approach to use when dealing with controversy and learners' attitudes in class.
- Twenty-five (22%) referred to uncertainty about what to teach. The common themes of the teachers' responses were concerns about what to teach, what depth to teach at, what would be assessed, and where to start.

The above mentioned concerns indicate that teachers need opportunities to deepen both their content knowledge and to learn about appropriate approaches to use when teaching evolution. Shulman (1986) emphasizes both areas of knowledge as critically important for good teaching: firstly, subject matter knowledge, and secondly, pedagogical content knowledge, which refers to how teachers blend content and pedagogy to determine the most effective means to teach particular topics consistent with the students' interests and abilities. However, learning opportunities such as professional development workshops run by the Gauteng Department of Education seem hardly ever coordinated or sustained over time so that teachers get both depth and breadth of what they need to know and be able to do. Hall and Hord (2006) point out that long-term in-service training, not just single training events, is required to support teachers in their attempt to adopt an innovation. That is, teachers need to attend a series of workshops spaced throughout the year where they experience, for example, evolution concepts as students, and reflect during the workshops on the success and problems experienced so they can receive further assistance. Such teacher development programmes are recommended by Barnett and Bell (1997) in a model they used in New Zealand when a similar new outcomes-based curriculum was introduced a few years prior to the South African curriculum innovation.

Controversial nature of the topic: The research literature from America and the United Kingdom shows the controversial nature of the topic of evolution to be a major problem when it comes to teaching evolution (for example, Rutledge and Warden, 2000; Wuerth, 2004; and Moore, 2008). In this study 49 of the 226 comments (22%) listed concerns relating to controversial nature of the topic.

- Twenty of the 49 (9% of the 226) comments mentioned the potential evolution / creation conflict, although the majority did not spell out what specifically was worrying teachers.
- Ten of the comments (4% of the 226) related to potential problems which might be caused by parents' beliefs, a very delicate, sensitive and touchy matter according to overseas research into teaching of evolution (Wilbert and Rusch, 1984; Asghar, Wiles and Alters, 2007).
- Eight comments (3% of the 226) mentioned problems learners might experience when learning the concept of evolution.
- A further 3% of the 226 comments related to potential conflict between teachers' own beliefs and evolution.
- A few comments (1% of the 226) referred to the problems the topic of evolution might cause in religious schools.

The wording of most of the concerns teachers expressed relating to the controversial nature of the topic suggested that the teachers seemed to be saying "help us deal with the potential evolution / creation conflict". However, some of the teachers seemed to see clashes as inevitable and that there was no way around them. In the workshops the facilitator was aware that the teachers were worried about the controversial nature of the topic. She had invited an ordained Anglican priest who has a PhD in biology to give a talk so the teachers would see that evolution and religion are two ways of knowing and one can hold both worldviews. After the talk the facilitator tried to help the teachers by giving them ideas of how they could address the problem in class. Barbour's four strategies were discussed during the workshops. The four strategies are "conflict", "independence", "dialogue" and "integration" (Anderson, 2007). The teachers were warned to avoid the first strategy "conflict", as it

forces one to choose what one believes and may cause students to doubt their own worldviews. It is unethical for teachers to use such strategies. The second strategy, "independence" emphasizes that science and religion are two ways of explaining the world (i.e. religion is based on belief systems and science is based on empirical evidence). Teachers using this approach suggest the two ways of knowing should not be taught in one subject. In science classrooms teachers should focus only on science and not on religion, although this approach may leave teachers and learners with burning questions. The third approach "dialogue", encourages open and critical discussion of conflicting issues, usually when the topic of evolution is first introduced (Sanders, 2010). The fourth strategy, "integration", lets teachers deal with misconceptions associated with creation and evolution during biology lessons, and allows the teacher to address questions on potential controversy as they arise during the whole period of teaching evolution.

Feeling inadequate: Thirteen of the 226 comments listed (i.e. 6%), referred to teachers feeling inadequate about teaching evolution.

- Twelve comments mentioned that teachers were feeling inadequate because they lacked confidence.
- One comment dealt with the teacher being unprepared and needing help to teach evolution.

Feeling inadequate is an indication that no adequate training had been provided for these teachers up until that point, on how to handle the topic of evolution in class, and that they needed help. The Gauteng Department of Education has a responsibility to provide relevant workshops that address teachers' immediate concerns, which was inadequate knowledge at the time. Failure to do so encourages teachers to teach new topics superficially. Some of the teachers mentioned during the workshops that a GDE workshop intended to cover evolution had instead focused on ideological matters to do with the new curriculum.

Before the teachers attended the workshops in this study they were feeling inadequate and unprepared to teach evolution. After attending the workshops many of them felt more confident and prepared to teach evolution. For example:

> "*I now understand evolution better than before, because the workshop was planned concerning the content, the facilitator has explain it, in such a way that, I think no one who has attended the workshop has a problem*" [#16.7].

While some teachers claimed that their attitudes had changed, one has to bear in mind that the confidence displayed by the teachers may possibly be misplaced. Hall and Hord (2006) contend that concerns cannot be resolved over a short space of time, and that teachers need long-term training followed up with on-going assistance and monitoring.

Lack of resources: Relatively few teachers at this stage were worried about the lack of resources: 12 comments were made (5% of the total listed). A small number of teachers mentioned different things, of some of which did not seem pertinent to the teaching of evolution specifically but to the general need in their schools (see Table 14, page 54).

Other concerns: Table 14 shows other concerns expressed by the teachers (e.g. concerns relating to **learners**, **lack of time**, and **lack of support for teachers**), but only a few comments were made under each issue.

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

Concerns theory (Hall and Loucks, 1978) asserts that individuals have different kinds of concerns about their involvement in a curriculum change at different times during an innovation. The theory predicts that at the initial stage of a new innovation the majority of concerns tend to be 'self-concerns', which Fuller (1969) categorizes as 'early concerns'. According to Hall and Hord (2006) 'self-concerns' need to be resolved properly before teachers' concerns will progress from 'self concerns' to 'task concerns' and 'impact concerns' (which are extremely important in the classroom).

To remind the reader of the stages of concern and explanations, a duplicate of an earlier table (i.e. Table 4) from Chapter 2 is inserted below. This repeat table is not numbered.

The expanded stages of concern theory of Hall and Loucks (1978)

Stages of concern			Explanations and typical expressions of concern
Unrelated concerns	0	awareness	Teachers' concerns do not relate to the innovation.
Self concerns	1	informational	Teachers show interest or express a need to learn more.
	2	personal	Concerns are expressed in an egocentric way, e.g. worrying about how they will cope with the innovation.
Task concerns	3	management	Concerns focus on the processes and tasks of using the innovation and the appropriate use of information and resources.
Impact concerns	4	consequence	Concerns relate to relevance, or impact of the innovation on pupils.
	5	collaboration	Teachers focus on working with others regarding the innovation.
	6	refocusing	Teachers focus on alternative, more appropriate methods.

In this study

- Eight of the 226 comments analyzed were judged to be ***'non-concerns'*** as they did not apply specifically to the teaching of evolution (see Section 4.4.1 in page 62).
- Just above a half of all the comments 118 or (52% of the concerns) were judged to be ***'self-concerns'***.
  - Seventy-four (33% of all the concerns) related to concerns about content-related information, as well as concerns to find out more about appropriate teaching strategies, a stage which Hall and Hord (2006) categorize as 'informational'.
  - The 44 remaining self-concerns (19% of all the concerns) were classified as 'personal' as they were worded in an egocentric way, often expressing fears or lack of confidence in the teachers' ability to teach evolution.
- Only 37 of the 226 comments (16% of the concerns) were categorized as ***'task concerns'***, which indicated that teachers were concerned about the best way to utilize the innovation for maximum teacher effectiveness.

- Forty-nine (i.e. 22% of all the concerns voiced) related to **'*late concerns*'**, as the concerns focused more on the learners, a stage which Hall and Hord (2006) categorize as 'impact'. This was unexpectedly high, as discussed below.
- None of the concerns expressed by the teachers clustered into the two highest stages of concern (i.e. collaboration and refocusing stages).

With one exception, teachers' concerns in this study followed the trends predicted by the 'theory of concerns' model. As expected, most concerns were primarily '*self-concerns*'. The high number of '*self-concerns*' was about lack of information and not knowing how teaching of evolution would affect the teachers' daily activities.

The unexpected finding in this study was the higher than expected number of impact concerns. Stage 4 concerns (i.e. consequence) were the second highest in number in this study. Impact concerns indicate that the teachers had concerns about the effects the teaching of evolution might have on the learners. At an early stage of an innovation one would not expect so many of these concerns. The higher number of impact concerns in this study could be because the religion/evolution controversy is something predicted to raise people's anxieties (i.e. to have an impact). Many of these concerns stemmed from the teachers' discomfort levels with the prospects of teaching of evolution, but the source of the concerns seemed to be how this would impact on learners or their parents. It is an important consideration when planning for professional development to be aware of the teachers' concerns, so training can be aligned with each stage of concern, as discussed in section 5.4.2. Teachers will need to be helped with strategies to alleviate any perceived conflict by learners or parents.

5.3.2 Teachers' needs regarding having to teach evolution

The needs analysis was conducted to find out what the teachers' needs were, so relevant support could be provided. The teachers were asked to list the support they needed in order to feel confident about teaching evolution. Four categories of needs emerged from the data analysis.

Support material for teachers

Nearly three quarters of the 47 needs listed or (70% of the needs) were requests for support materials for teachers. Of the 47 comments

- fourteen comments (30% of all the needs) were to do with different visual aids such as charts, videos, CDs, DVDs, and models.
- nine (19% of the needs, listed by 24 teachers) were requests for assessment material e.g. question papers, rubrics and memos, and assessment activities.
- small numbers of requests were for worksheets (n = 3), educators guidelines (n = 2), reading material (n = 2) and relevant internet sites (n= 1).

These needs by teachers could serve as a basis for the designing of relevant teacher support material, with accurate and complete information, in order to develop teachers' skills and understanding, as discussed in the recommendations to curriculum developers in section 5.4.2.

Support material for learners

Only five comments made (11% of all the needs listed) related to support material for learners, four to do with textbooks and one for study guides.

Help with improving knowledge

Only four of the 47 comments (9%) indicated that the teachers needed help with improving their knowledge, one of which was a request for information on religious beliefs.

Adequate content knowledge is crucial for maximum teacher effectiveness. The low number of requests for information was unexpected because at the beginning of the study 113 of the 229 comments (49%) indicated that teachers were worried about their inadequate knowledge compared to only 9% of needs listed at the end of the workshop indicating that help was needed to improve knowledge. It is possible that the information they received at the workshop may have addressed the earlier concerns of many of the teachers. The workshop series dealt with content and also provided a lot of help on addressing potential controversy. The teachers went through numerous hands-on activities so they could "walk in the learners' shoes". Extensive handouts were provided, both on content and ideas for activities, and a number of misconceptions relating to evolution were worked on. Basic notes on content not covered in the workshops were given to the teachers to take home and read. A handout was provided listing relevant books, magazines and internet sites, which may have satisfied the "need to know" of many teachers.

In-service training

Four comments (9% of all the needs listed) indicated the need for more workshops. However, the specifics of what should be covered on those workshops were not spelled out.

5.3.3 Teachers' understanding of the concept of evolution

The second research question was designed to determine whether the teachers' lack of content knowledge was a need which had to be filled. To achieve this goal teachers' **perceptions** about the adequacy of their content knowledge were first explored, followed by an analysis of their definitions of biological evolution and a review of their misconceptions about evolution to ascertain their **actual knowledge**.

Teachers' perceptions about the adequacy of their content knowledge

Based on the teachers' self-ratings of their knowledge on each of the 16 evolution concepts listed in the national curriculum statement

- three teachers appeared to have an "excellent" knowledge of the 16 evolution concepts.
- 18 teachers appeared to have "good" knowledge.
- almost a third (22 of 70 teachers) were categorized as believing they had "satisfactory" knowledge.
- just above a quarter (19 of the 70 teachers) were categorized as acknowledging they had "poor" knowledge.
- eight teachers bridged categories (one "excellent to satisfactory", five "satisfactory to good", and two "satisfactory to poor").

An additional analysis was done to find out if the teachers' perceptions of their knowledge were accurate. The focus was not on the teachers who were aware that their knowledge was poor, as they might have done something about it. More worrying was those teachers who thought their knowledge was adequate, because if this was not an accurate perception they needed to be made aware of this so they could do something about it.

Teachers' definition of biological evolution

The analysis provided insights about what biological evolution meant to the teachers in this study

- Only one of the 86 teachers who provided a definition gave a completely correct definition of what biological evolution means. The definition included all the three features required for a correct definition, as discussed in section 4.6.2, page 72, and had no misconceptions.
- A further two of the 86 teachers had a "general idea", as they alluded to at least two out of three features required to explain biological evolution, although one definition had an error.
- More than half of the teachers (i.e. 56 of the 86) had "unsatisfactory" definitions of biological evolution. This is because their definitions were vaguely worded, or alluded to only one of the three necessary criteria, or included more than one misconception. Table 20, page 76, outlines a variety of misconceptions that were incorporated in the teachers' definitions of biological evolution.
- Twenty-seven of the 86 teachers, based on their definitions, were judged to have no idea of what biological evolution is. Their definitions were either incoherent because the definitions were simply a collection of jargon words (often a sign of confusion), or off-track because they had nothing at all in common with the correct biological definition of evolution, or were both incoherent and off track.

The findings based on the teachers' definitions indicate that 83 of the 86 teachers (i.e. 96%) in this study seemed confused and did not understand what biological evolution is, and really needed support to improve their understanding of evolution. It should be noted, however, the analysis of the definitions was done after the workshop so teachers did not get direct feedback on this aspect of their content knowledge. They would, however, have realized it from the discussions of evolution in the workshop.

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

This particular section of the investigation was done so as to identify the extent of misconceptions held by the teachers, as well as to provide them with feedback in the workshops. Twelve misconceptions that dealt with subject matter knowledge were analyzed, but one was excluded (i.e. item seventeen) because the potentially problematic wording of the item was misleading, as explained in section 4.7.2, page 76.

Out of 88 teachers

- only two teachers (2%) did not have any misconceptions.
- eleven teachers (13%) had few misconceptions (i.e. one or two out of the potential 11).
- seventeen teachers (19%) had several misconceptions, three or four misconceptions.
- over a third of the teachers (34 or 39%) had numerous misconceptions i.e. five to seven erroneous ideas about evolution.
- twenty-four teachers (27%) had extensive misconceptions, (eight or more).

Teachers were given feedback on the extent of their misconceptions, and each misconception was briefly addressed in the workshops. Because the workshops were so short, and because misconceptions are very difficult to change (Wandersee *et al*., 1994), teachers will probably need more help.

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

- Two of the misconceptions were **extensive** among the teachers in this study. The first misconception, held by 82% of the teachers, is that *individual organisms evolve in response to environmental changes*, indicating lack of understanding of the mechanism of evolution. The second misconception, held by 75% of the teachers, is that *evolution occurs when organisms develop features they need to survive*. Holding such an erroneous idea shows misunderstanding of the three fundamental aspects discussed in the definition in section 4.6.2, page 72.
- Three of the misconceptions were rated as **numerous** in the sample of teachers in this study. A misconception that *evolution "betters" organisms and increases their complexity, resulting in steady progress upward from lower animals to humans* was held by 59% of the teachers. The second misconception that *evolution is when physical features in a population change to suit the available food source*, was held by 57% of the teachers. The third misconception, held by 55% of the teachers, is that *evolution explains how life began*. These problematic ideas are discussed in more detail on page 79.
- Two of the misconceptions were rated as **common** in the sample. The first common misconception i.e. *life began when the earth was formed*, was held by 47% of the teachers. The second common misconception, held by 43% of the group, is that *evolution explains that people evolved from apes, chimpanzees or monkeys*.

- Three of the misconceptions were **several** among the teachers in this study. The misconception that *evolution explains how the Earth was created* was held by 31% of the teachers. The second misconception i.e. *evolution has taken place in order for humans to develop* was held by 29% teachers of the group. Twenty-five percent of the teachers held the third misconception that *ancient humans (cavemen) once hunted dinosaurs*.
- Only one misconception i.e. *all individuals of a species evolve simultaneously* was rated as **few** in the sample. It was held by 16% of the teachers.

It is important that in-service providers plan appropriate workshops to address these misconceptions so they are not passed on to learners.

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

A comparison between the individuals' teacher self-assessed knowledge and the extent of their misconceptions was made for those teachers who completed both questionnaires, to see if the teachers' perceptions about the adequacy of their content knowledge were accurate. This judgement was made based only on the extent of their misconceptions. The results indicated that

- just below a third of the group (17 of 56 teachers or 30% teachers) had estimated their knowledge fairly accurately.
- three of the teachers (5%) seemed to have underestimated the level of their knowledge.
- almost three out of every five teachers (i.e. 64% of the teachers) had probably over-estimated their knowledge, ten of the teachers 'seriously', i.e. to a great extent.

5.4 RECOMMENDATIONS

This study provided a great deal of useful information about the teachers' concerns regarding having to teach evolution for the first time to Grade 12 in the year the new curriculum was first taught at that level. Information about the assistance the teachers said they needed so they could feel confident about teaching evolution was also identified. Interesting was the finding that the perceptions of more than half the teachers about the adequacy of their content knowledge were not accurate. There are several implications that can be drawn from the findings of this study: the need to

- reconsider the nature of intervention programmes carried out with teachers,
- acknowledge teachers' concerns as important input when designing in-service programmes,
- offer continuous support when teachers are in the process of adopting and implementing an innovation, so intended innovations may have a lasting presence.

Based on the results of the study, several recommendations are made below. These recommendations are viewed as necessary to consider in an attempt to sustain the innovation. However, it is important that the reader be aware that the recommended strategies were not investigated when the study was conducted to see if they would have a positive effect. They are based on solutions suggested in the research literature. The effects of the recommended strategies could be explored further through research, as discussed in section 5.4.3.

5.4.1 Recommendations for service providers

The data gathered in this study revealed that teachers had concerns on different levels, with early concerns being the most common (52% of all the concerns) as the teachers were approaching the adoption of the innovation (the inclusion of evolution in the new FET curriculum, which also required new classroom practices). Late stage concerns (as predicted by the theory about the stages of concern) were less prevalent. It is an important consideration when planning professional development programmes to be aware of the teachers' concerns, so training can be aligned with the particular stage of concern, if it is going to be perceived by the teachers as relevant and meaningful (Hall and Hord, 2006).

In-service workshops

Prior to the implementation of evolution as a new topic to be taught, teachers in this study were concerned about their inadequate knowledge and they were not sure about the best teaching approach to use to deal with the potential controversy they anticipated would arise.

- In-service providers should recognize that teachers involved in an innovation have a wide variety of different concerns at different times that will affect the success of the implementation process, as was the case with teachers in this study. It is recommended that in-service provider recognize this fact and attend to the most intense concerns at the time those concerns are raised. Over-emphasis on other concerns that are not intense at that stage may be counter-productive. For example, if teachers are concerned about their inadequate knowledge of the topic (as was the case with many teachers in this study), intervention programmes should have focused on content knowledge. Based on my experience, and talks to teachers in my cluster, in the three years since the data were gathered for this study only one once-off training on content knowledge about evolution was provided (in 2010, repeated in 2011 as the attendance was poor in 2010). The amount of content teachers need to master is enormous, and certainly cannot be covered in one workshop. This suggests that more workshops should have been provided on content at that stage, when teachers felt they needed it.

  Another concern raised by teachers was that they had no knowledge of appropriate strategies to use when teaching the topic of evolution in class and handling potential religious conflict. Discussions with colleagues confirm that no such workshop has been provided for teachers by the Gauteng Department of Education. *Life Sciences* teachers were left on their own to equip themselves regarding how to teach the topic of evolution.

  It is therefore recommended that in-service providers find out whether teachers still require assistance in these areas, and that they provide further workshops. One could speculate that teachers acquire the necessary subject matter knowledge as they prepare to teach the topic of evolution, and that the problem of inadequate content knowledge about evolution might have been resolved in the three years since the data for this study were collected. However, a local university professor reports that misconceptions held by *Life Sciences* teachers completing postgraduate studies in evolution in 2009 and 2011 remain "extensive", a problem also reported by another lecturer at a second local university. It therefore seems that there is still a need for content-based workshops for teachers.

- In-service providers should also recognize that needs change, and that they should address needs when they arise. This means conducting needs analyses and designing workshops to suit those needs. The type of workshops to effectively address teachers' concerns and needs should be extended over an extensive period, rather than concentrated in one short in-depth workshop. Hall and Hord (2006) warn that typical one-shot workshops will not adequately support the implementation process. It is recommended that in-service providers adopt teacher development programmes similar to Barnett and Bell's (1997) model used in New Zealand. Their programmes are made up of two parts: Firstly, 'cluster in-service days' where teachers from different districts are provided with information relevant to the teaching of specific topics and teaching strategies to use in class. The strategies are then tried out in class and the teachers keep personal records on the success and problems experienced to discuss with in-service trainers during the second phase of the cycle. The second part involves 'in-school visits' by subject facilitators to check on the progress and provide help where necessary. The visits are scheduled for a minimum of half a day. The workshop or test-with-support strategy is then repeated several times until teachers are confident and competent.

5.4.2 Recommendations for curriculum developers

A lesson arising out of my research is the importance of consulting teachers to identify their concerns and needs to provide appropriate professional development and support materials. Although there might be some consultations with the teachers, in my experience none of the *Life Sciences* teachers from my cluster were consulted. The new curriculum revised by the Department of Education did not look at the teachers' needs and concerns. The support material provided to teachers prior to implementing evolution was not helpful. As discussed in Chapter 1 page 4, the structure of *Life Sciences* content as laid out in the Learning programme guideline Grade 10 – 12 (Department of Education, 2005) was not useful (i.e. it gave teachers little direction because the sequence of basic concepts learners have to know was presented as fragmented bits, under three different learning outcomes, and was difficult to follow). The National Curriculum Statement document for *Life Sciences* did not provide a list of misconceptions associated with evolution, ideas of how to handle the misconceptions and potential conflict, or recommended textbooks and teaching aids. The revised learning programme guideline issued to schools prior to introduction of evolution (Gauteng Department of Education, 2007) was also not discussed with teachers.

Curriculum developers must first consult with teachers and then design appropriate teacher support materials. My study suggests the need for materials

- with accurate and complete information, so it is useful.
- which make teachers aware of the potential conflict and some ideas of how to handle it.

The Education Department should provide teachers with resource materials they require, which includes suitable reference books for teachers which address methods of teaching this controversial topic, as well as textbooks for learners which have error-free content (i.e. free of misconceptions) and activities in which students can engage. Such activities proved very successful in the workshops during which data were gathered for this study, but many teachers did not attend the workshops, and

so did not have this support. In addition, revised documents should be discussed during teacher development training, so teachers are aware of the changes.

5.4.3 Recommendations for further research

For a further study an interesting question is thrown up by this study. According to the stage of concern theory, teachers using an innovation can be expected to show a pattern of change in concerns over time, as they get familiar with the innovation. It is important

- to look at what has happened three years down the line, and whether teachers' needs have changed based just on their experiences, and **how** the needs have changed.
- to identify factors affecting the changes, because if these are known to in-service providers they could be targeted by providing relevant help to accelerate change and help more teachers to move their concerns from *self concerns* to *impact concerns*, which Hall and Hord (2006) say are more important in the practice of effective teaching.
- to find out whether teachers still need help and what kind of help they still require.

5.5 CONCLUDING REMARKS

This study has revealed that *Life Sciences* teachers were not adequately prepared to teach the topic of evolution, and their subject matter knowledge was very weak. This knowledge would not only assist service providers and curriculum designers in properly addressing the situation, but would also establish a basis for future tracking of teaching evolution.