CHAPTER 5

SUMMARY AND DISCUSSION OF THE FINDINGS, AND RECOMMENDATIONS

This chapter presents the limitations (factors that could decrease rigour) of the study, it also provides a summary and discussion of the research findings, and suggests some recommendations for further research and for teacher trainers and in-service providers.

5.1 DISCUSSION OF THE LIMITATIONS OF THE STUDY

In this study, as is the case in many other educational studies, there are limitations that were due to factors that were beyond my control which could have threatened the validity of the study. The reader needs to take these limitations into account when interpreting the findings and the conclusions. These factors threaten the validity of the study. The limitations may be minimised by steps taken by the researcher. Efforts to improve the validity so as to minimise the limitations of this study have been discussed in Chapter 3, section 3.6.

5.1.1 Lack of piloting of the instruments

Before conducting the actual study it is desirable for researchers to pilot the instruments in order to identify potential pitfalls in the proposed instruments. Piloting an instrument is advantageous as it helps to detect if the instructions and questions are understandable to the respondents. There were seven questionnaires administered in this study, none of which I piloted. However, one of them *(*the *"evolution quiz – true or false statements")* had been used, without problems, by Ngxola (2012). Despite the fact that these questionnaires had been used previously, the question asking the teachers to *explain what they think is meant by evolution in biology* seemed not to have been well understood by the teachers as instead of **explaining** all the teachers **gave definitions** of the term evolution (see Section 4.2.2, on pages 47-51). The rest of the questionnaires were specifically designed for this study, and were not piloted. This was because the workshops had already been scheduled and the instruments had to be ready for the workshops so there was insufficient time to pilot them, as explained in Section 3.6 on pp. 37-38. However, they had at least gone through iterative cycles of face validation by a science education expert when they were developed, in an effort to improve the quality of the instruments.

5.1.2 Use of convenience sampling

Data for this study were collected from a convenience sample made up of teachers who attended workshops for learning about how to teach evolution. The ideal situation for research is to use random sampling as it removes bias from the selection procedure thus resulting in samples which are more representative of the population being investigated, so the results are more generalizable (Leedy, 1989)). The sample in this study comprised two groups of teachers who voluntarily attended the workshops. Judging by the timing of the workshops, the teachers who attended these workshops may

have come because they were not well prepared to teach evolution and therefore felt pressured to seek help at the last minute. The results obtained from this sample should be generalised only with caution because the sample may not be representative of all South African *Life Sciences* teachers.

5.1.3 Possible problems with teachers' responses

One of the factors that may bias respondent's answers in a research study is the potential effect that answering truthfully may have on the respondents' self-image, as this may expose their lack of knowledge. Wallace and Louden (2000) point out that what teachers say they know is not always accurate, maybe because they feel embarrassed to admit that they do not know. I was able to verify the teachers' responses to a question on the teachers' self-rated knowledge about the teaching of evolution against their knowledge of the explanation of evolution and the misconceptions in evolution and found some inconsistencies, for example about 8% of the teachers had rated their knowledge of all the concepts of evolution as *"excellent",* but none of these teachers was able to give a correct explanation of what is meant by evolution in biology.

These inconsistencies may suggest that teachers may not have been honest about their responses to certain questions: as such the reader is cautioned to interpret responses to questionnaire on the teachers' self-rated knowledge about the teaching of evolution bearing in mind the discrepancies.

5.1.4 Use of small sample sizes

Although researchers do not agree on what an adequate sample size is that is required for a sample to be representative of the population, many agree that a larger sample size makes for better representativeness of results (Cohen & Manion, 1986; Fraenkel & Wallen, 1990). A sample of less than 80 *Life Sciences* teachers was used in this study and there are more than 700 high schools just in Gauteng. Assuming that *Life Sciences* is taught in all these high schools, with probably a minimum of one teacher in each school, the population of *Life Sciences* teacher in Gauteng only is more than 700. The intention of my study was not to generalise the findings, but my study was a case study of a convenience sample. However, others wishing to generalise the findings should do so with caution. The answers provided by the teachers in the study may not be typical of all the *Life Sciences* teachers, so the results obtained should not be generalized to all the *Life Sciences* teachers in South Africa or should be generalised with caution.

5.1.5 Problems with loss of data

Some respondents did not answer some questions within the questionnaire and between questionnaires, thus making the data set incomplete. For example in the questionnaire where the teachers were asked to indicate the extent of their knowledge in the evolution topics they were expected to teach had twenty-four topics and some teachers indicated their knowledge extent in twenty two topics leaving out two topics. In the questionnaire about the teachers' curricular knowledge some did not respond to the question about their knowledge about the available curricular materials and others did not respond to the question about their level of confidence in the depth of the topic they were to teach whilst others did not respond to the question about their knowledge of the

grades and subject where aspects of evolution were taught. It was not clear whether the teachers did not answer the questions because of they did not understand them, or whether they did not know the answers or whether they were simply not interested. Lack of responses from individual teachers, for particular questionnaire items, decreases the sample size and therefore limits the chances of generalizing the results.

5.2 SUMMARY AND DISCUSSION OF THE FINDINGS

The aim of this study was to investigate the pedagogical content knowledge of *Life Sciences'* teachers who were going to teach evolution for the first time in South African high schools. The details of the results are provided in Chapter 4. In this section I will give a brief account of the research findings which answer the research questions. The main research question was *What was the nature and extent of the pedagogical content knowledge of Life Sciences teachers who will be teaching evolution for the first time in South African high schools?*

Figure 9 provides an overview of the factors investigated in this study.

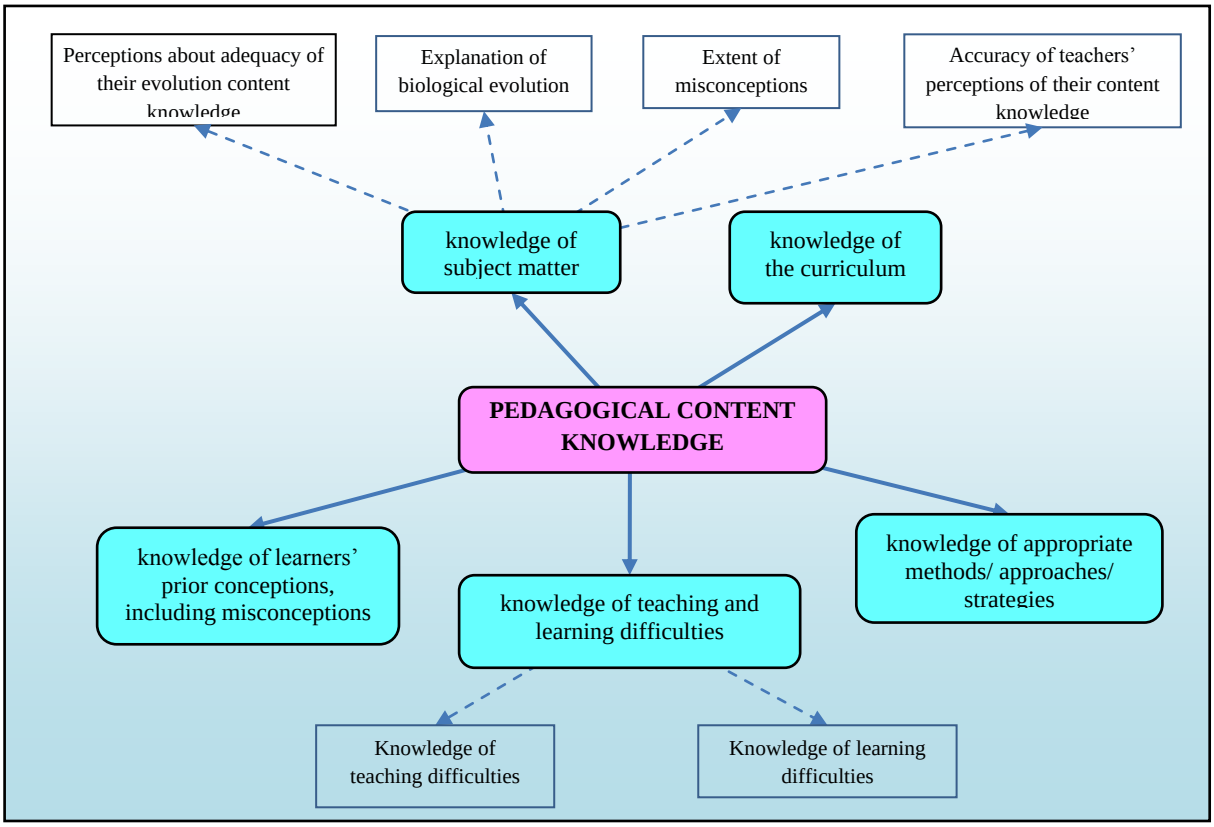

Figure 9: A summary of factors investigated in pedagogical content knowledge for teaching evolution

Five sub-questions were designed based on the five categories of pedagogical content knowledge, and were intended to target teachers' pedagogical content knowledge about evolution teaching in these

five specific areas (sections 5.2.1 to 5.2.5 below). The findings could be used by teachers themselves to improve on areas where their knowledge is inadequate and by teacher trainers to address the gaps during training of teachers.

5.2.1 Subject matter knowledge about evolution

Sub-question: What was the extent of the teachers' subject matter knowledge about evolution?

Subject matter knowledge incorporates knowledge of concepts and principles that are central to the topic and knowledge of how scientific facts and theories relating to a topic were arrived at (Shulman 1986; 1987). With regard to evolution, knowledge of mutations, variation and adaptation is important to the understanding of evolution. In addition to this, knowledge of the principle of evolution by natural selection is fundamental to the understanding of evolution. Several questions were posed to find out the subject matter knowledge of the teachers about evolution. First the teachers' perceptions about their evolution content knowledge were explored, followed by an analysis of their definition of the term 'evolution' and a review of their misconceptions associated with evolution.

Teachers' perceptions about the adequacy of their evolution content knowledge

The questionnaire consisted of 24 evolution concepts derived from the examination guidelines for Grade 12 *Life Sciences* for 2008. I found that with each item except for one (sources of variation) over 40% of teachers rated their knowledge of the concepts as either "satisfactory" or "poor".

- 32 teachers were categorised as having overall "poor" knowledge of the 24 evolution topics.
- a third (26 of the 78) teachers appeared to have "satisfactory" knowledge (based on their self-evaluations).
- 14 teachers were categorised as having a "good" self-perceived overall knowledge.
- six teachers appeared to have "excellent" knowledge.

Further analysis on the teachers' self-rated knowledge was done with regard to the actual topics regarding the teachers' perception of the adequacy of their content knowledge.

Topics that were particularly "poorly understood" (i.e. where **more than half** of the teachers said their knowledge of the topic was poor') included

- *Major events of eras of the geological time scale,*
- *Structure of the geological time scale,*
- *Eras divided into periods,*
- *Biogeography,*
- *Comparative biochemistry*.

Topics where above 40% of the teachers indicated "unsatisfactory" knowledge included

- *Arguments against evolution,*
- *Darwin's theory of evolution,*
- *Comparative anatomy,*
- *Phenotypic variation,*
- *Comparative embryology and*
- *Nature of science*.

The only topic where over 40% of the teachers indicated their knowledge confidence as "good" was

- *Sources of variation (mutation, meiosis, reproduction.)*

What is of concern in this case are the teachers who thought that their knowledge was adequate to teach evolution, because if this was not the case then something needed to be done to make them aware, hence the next questionnaire to give an explanation of what evolution is.

Teachers' explanation of biological evolution

A question requiring teachers to explain what they thought was meant by 'evolution' was aimed at finding out if teachers could correctly explain what evolution is as this could give an indication of their subject matter knowledge with regards to evolution.

- No teacher had a completely correct explanation.
- Only one teacher of the seventy-eight was classified as "having a general idea".
- 63 teachers (80%) had "unsatisfactory" definitions of the evolution.
- 14 teachers were categorised as "have no idea".

The results indicate most teachers (99%) in this study seemed not to have a good understanding of what biological evolution is. These teachers need to be supported to improve their understanding of evolution. The role of the workshop was to help the teachers realise their level of knowledge regarding the teaching of evolution, and what they needed to do after the workshop before they taught the topic.

The extent of the misconceptions (analysed by prevalence in the groups)

Analysis was done to identify the prevalence of specific misconceptions among the two teacher groups combined (Figure 7, on page 55). The misconceptions and their correct scientific explanation were listed in Chapter 2, Table 4, on page 24-25.

- **Extensive -** Three misconceptions were held by more than 80% of the teachers. The two most prevalent misconceptions are associated with misunderstanding the mechanism of evolution.

  Individual organisms evolve in response to environmental changes - held by 95% of the teachers.

  Evolution results in an increase in variation within organisms in a population - held by 94% of the teachers.

  Evolution explains how life began - held by 85% of teachers.

- **Frequent** – four misconceptions were held by about two-thirds of the teachers. All these misconceptions are associated with misunderstanding the mechanism of evolution.

  Evolution is when physical features in a population change to suite the available food source - held by 69% of teachers.

  Evolution "betters" organisms and increase their complexity, resulting in steady progress upward - held by 66% of teachers.

  Evolution occurs when organisms develop features they need to survive - held by 66% of teachers.

  Survival of the fittest means that only organisms that are physically strong survive - held by 65% of teachers.

- **Common –** four misconceptions were category classified as "common" amongst the teachers.

  Evolution explains that people evolve from apes, chimpanzees or monkeys - held by 59% of teachers

  Life began when the Earth was formed - held by 57% of teachers.

  Ancient humans (cavemen) once hunted dinosaurs - held by 49% of teachers.

  Evolution explains how the Earth was formed - held by 42% of teachers.

- **Occasional -** *Evolution has taken place in order for humans to evolve* - held by 37% of teachers.

- Two misconceptions were rated as **"rare"**. Misconceptions were considered "rare" if they were held by fewer than 20% of the teachers. The most common misconception in this category was held by only 14% of the teachers (*that life appeared on Earth less than 10,000 years ago*). The second misconception (*that all species evolved simultaneously*) was held by only 9% of the teachers.

For at least 11 of the 14 misconceptions, more than 40% of the teachers appeared to have the misconception.

Teachers' misconceptions associated with evolution (analysed by prevalence per teacher)

In the twenty-statement quiz about misconceptions about evolution, fourteen that had to do with evolution content were analysed. This activity served as another question in determining the teachers' actual knowledge of evolution as compared to their knowledge claims. Of the 79 teachers who returned the questionnaires

- none of the teachers was without misconceptions.
- only one teacher was categorised as having "rare" misconceptions (one or two misconceptions out of the fourteen possible misconceptions).
- seventeen teachers (22%) were categorised as having "occasional" misconceptions (between three and five misconceptions).
- thirty-six teachers (46%) were categorised as having "frequent" misconceptions (between six and nine misconceptions).
- just over a third of the teachers (32%) had "extensive" misconceptions (between ten and fourteen).

Most teachers (99%) had misconceptions ranging from three to fourteen misconceptions per teacher. The majority of the teachers (68%) appeared to have high levels of misconceptions (erroneous ideas) about evolution as they were classified in the misconception categories "frequent" and "extensive". Feedback on the misconceptions was given later during the workshop and the misconceptions were addressed. However, the literature on dealing with misconception indicates that some misconceptions are difficult to change as they are deeply rooted and may require more intervention to correct (Hausfather, 2001). These teachers may probably need more support to better understand why these statements are said to be misconceptions.

Accuracy of teachers' perceptions about their content knowledge of evolution

In order to determine the accuracy of the teachers' perceptions about their evolution content knowledge, the results of the misconception quiz were compared with the claims of the teachers' adequacy of their evolution content knowledge for 73 of the teachers (those who completed both questionnaires).

- Of the 73 teachers, 35 were judged to have accurately estimated their knowledge (45%).
- 14% of the teachers (10 teachers) were judged to have underestimated their knowledge
- Approximately 38% of the teachers (28 teachers) were judged to have overestimated their knowledge.

Teachers who acknowledge their challenges regarding subject matter knowledge are more likely to take steps to remedy the challenge than those who belief their knowledge is adequate. Of concern is the 28 teachers (38%) who have overestimated their knowledge of evolution content. The way teachers understand the subject has a powerful influence on the way they teach it (Stodolsky & Grossman, 1995; Ball & Bass, 2000; Berry *et al*., 2008). According to Hashweh (1987) inadequate knowledge and poor in-service training in teachers may result in the teachers having the same misconceptions as the students they teach. It is imperative that teachers are aware of potential deficiencies in their knowledge level with regards to the teaching of evolution, especially knowledge about their own misconceptions, so that they can address them and not pass them on to learners.

In general most of the teachers' subject matter knowledge regarding evolution was not adequate enough to effectively teach a topic as difficult as evolution.

5.2.2 Knowledge of misconceptions learners are likely to bring to class

Sub-question: What common misconceptions associated with evolution did the teachers know about?

Smith (2010) points out that much of what learners know about evolution is riddled with erroneous ideas and misconceptions. Misconceptions are known to impede learning, and with regards to the teaching and learning of evolution, they contribute significantly to the controversy. Shulman (1986) says that teachers need to have knowledge of the concepts and preconceptions that learners bring to class. Thirty-one teachers indicated that they were aware of misconceptions learners are likely to have and between them identified eleven misconceptions that they were aware of. The misconception identified by most teachers (12 of the 31) was that *"evolution explains that people evolve from apes, chimpanzees or monkeys"*. One of the factors causing the controversy surrounding evolution teaching is that evolution accounts for some of the events that are central to religion (National Academic of Sciences, 2008). These results have some implications for the in-service providers to establish what the teachers already know before they design programmes to assists teachers in the effective teaching of evolution, as misconceptions that are religion-based may be personal and can be a barrier. Such beliefs need to be respected, so dealing with misunderstood science concepts can be very difficult, and the matter needs to be dealt with sensitively (Foster, 2012).

5.2.3 Knowledge of teaching and learning difficulties

Sub-question: What did the teachers know about likely learning and teaching difficulties they could anticipate when teaching evolution?

Shulman (1986) points out that pedagogical content knowledge includes *"understanding of what makes learning of specific topics easy or difficult"* hence the inclusion of this sub-category. Evolution is one of the most challenging topics to teach (Besterman & Baggott laVelle, 2007) so teachers need to be aware of what makes this topic difficult to learn as well as to teach.

Knowledge of teaching difficulties – Shulman did not have this sub-category in his explanation of PCK (he only mentioned knowledge of learning difficulties). This was an idea by Sanders (2008) who indicated that is important that teachers are aware of the difficulties they may encounter when teaching a topic as controversial as evolution in order that they can take appropriate steps to deal with the potential controversy**.**

When asked to list the teaching difficulties that they thought they might encounter when teaching evolution, seven categories relating to teaching difficulties emerged from the data analysis.

Teachers' inadequate knowledge - Without adequate knowledge of subject matter knowledge it is impossible for the teachers to deliver content effectively and efficiently. Forty of the 42 teachers (95%) indicated that their knowledge of evolution content was inadequate. Stears (2006) points out that South African teachers at the time when evolution was introduced in the *Life Sciences* curriculum were ill prepared to teach it.

Even though many of the teachers (38) claimed to have attended in-service training workshops relating to the teaching of evolution, it is clear from the results that they still required additional workshops, perhaps workshops that are reflective, where they could freely communicate their successes or challenges when teaching evolution.

Controversial nature of the topic - The controversy surrounding the teaching of evolution in American high schools has been reported by many researchers (Osif, 1997; Rutledge & Warden, 2000, Good, 2003; Wuerth, 2004, Moore, 2008). Most of the controversy surrounding the teaching of evolution stems from the fact that evolution deals with events which seem to counter religious beliefs about creation. The second most common teaching difficulty the teachers anticipated (67%) was the conflict between evolution and religion coming from the learners which were in conflict with evolution. Rutledge and Warden (2000) point out those teachers who do not accept evolution tend to deemphasise it when they teach. Some of the teachers (5) clearly indicated that evolution conflicts with their religious beliefs.

Problems with resources – Fourteen of the 42 teachers (33%) anticipated the lack of resources to be a potential teaching difficulty. Most South African teachers rely on textbooks for information, especially because their training on evolution training was inadequate. It is possible that teachers were not aware of the available teaching resources other than the textbooks. However, in the workshops where the data for this study were collected, the facilitator provided teachers with a list of resources available in South Africa for teaching evolution and this included books, DVDs, magazines and websites containing evolution-related material.

Time-related problems – Thirteen teachers (31%) felt that too little time was allocated for the teaching of all the evolution content that was spelled out in the examination guideline. Because evolution was a new topic in the curriculum, and to many of them, and because of the inadequate in-service training that they received, the teachers probably felt overwhelmed by the amount of content they were expected to teach in space of six weeks.

Other teaching difficulties listed included attitude-related problems, difficulty with the topic itself, and learners' existing misconceptions. However, less than 30% of the teachers mentioned these. It seems that most teachers were not aware of these three difficulties, and this may be a potential source of stress as they may go to class being ill-prepared to deal with such challenges.

Knowledge of typical learning difficulties

Amongst the three categories of PCK that Shulman (1986) mentions is knowledge of the typical learning difficulties learners may encounter when learning a particular topic, in this case learning evolution. Between them the teachers listed ten difficulties that individual teachers anticipated learners would experience. The learning difficulty most teachers (72%) anticipated had to do with dealing with the controversial nature of evolution, maybe due to the emotions and attitudes attached to religion and evolution. A little less than half (46%) of the teachers anticipated problems associated with the difficulty of the topic itself, whether learners would be able to understand evolution and the

amount of unfamiliar terminology and content to learn. Fewer than 20% of teachers mentioned the other learning difficulties (Chapter 4, Table 14, pp 66).

It is encouraging that almost three-quarters (72%) of the teachers were anticipating difficulty with the controversy of evolution, as they were likely to address this challenge and prepare in advance. However, that over half of the teachers seemed not to be aware that evolution is one of the difficult topics to learn, and may not even be aware of the strategies to develop to make it accessible to the learners is of concern as they may go to class unprepared for the challenges that may be lying ahead unless they realised that in the workshop.

5.2.4 Knowledge about curricular matters

Shulman (1986) describes curricular knowledge as knowledge of the depth and the breadth of what to teach, how the topic links to topics taught in previous and future grades, how they integrates with topics taught in other subjects, and knowledge of the range of programmes designed to teach a particular topic, and the available curricular instructional alternatives. Only about a third of the teachers-were aware that aspects of evolution were taught in *Natural Sciences* (Grades 7-9) and *Social Sciences* (Grade 7), at the time it was not taught in Grades 10 and 11 curricula. For evolution to make sense to learners, it should not be taught in isolation. The implication of the results is that the two-thirds of teachers who are not aware of the evolution aspects taught in other subject areas were likely to teach evolution as an isolated chapter and miss the opportunity to link some of the aspects taught in other grades and subjects to show relevance.

Only one teacher was confident about the depth of the evolution content the teachers were expected to teach. Half of the teachers (18 of the 36) indicated that they were not sure of the depth at which the content needed to be taught. The examination guidelines just lists the concepts to be taught, it does not indicate the depth and breadth at which each concept was to be taught. Sanders (2008) mentions that textbooks are an important resource for teachers, especially where teachers are inadequately trained, as was the case in South Africa. One teacher indicated that books were different and that she did not which one to use. The content in the available textbooks then, when the curriculum was introduced, was organised differently in different textbooks, which added to the teachers' problem as the content depth and breadth varied. Ngxola (2012) suggests that carefully planned work schedules which indicate the depth and breadth to teach need to be provided to teachers to guide them on what to include when planning lessons.

Half of the teachers (18 of the 36) indicated that they knew of books containing information on evolution. About 28% of the teachers mentioned that they were not aware of the different textbooks available, from which they could get more information about evolution. Almost 67% of the teachers indicated that they did not know of videos/DVDs and models that they could use as additional resources for teaching evolution. The majority of the teachers (86%) mentioned that they did not know of interactive internet activities that they could use as teaching resources for evolution. According to Shulman (1986) it is important that teachers are clued up on the variety of instructional materials available. One of the nine requirements of the new curriculum is that teaching should be learner-centred. Teachers should take into account that learners learn in different styles and therefore

use different methods to teach. To be able to accomplish this, teachers must be aware of the different teaching resources that are available.

5.2.5 Knowledge of appropriate teaching strategies

According to Besterman and Baggott la Velle (2007) and Nadelson (2009), teachers need to explore new teaching approaches and strategies to enhance understanding of evolution, as it is a conceptually challenging topic to teach and learn. The responses of the teachers to the question where they were asked to indicate their knowledge of the teaching and learning difficulties associated with evolution were used to extrapolate data of their knowledge of the teaching strategies for teaching evolution.

Of the 40 teachers

- twenty-seven (64%) said did not know how to deal with the controversy,
- thirteen teachers (31%) were unsure about what to teach,
- five teachers (12%) were unsure about what activities to include when teaching evolution.

The majority of teachers (64%) mentioned that they did not know of ways of dealing with the controversy surrounding the teaching of evolution. The controversy around the teaching of evolution in public schools is largely due the misconception that evolution contradicts religion, which tends to come from people who believe the literal interpretation of the biblical accounts of creation. Sanders (2008) indicates that teachers should accommodate the differences in their learners (learner-centredness) which includes their different cultures and religions. She (Sanders) suggests that debates about evolution and creation are inappropriate and should be avoided in the evolution classroom.

5.3 RECOMMENDATIONS

The results show low levels of knowledge and potential gaps in all areas of PCK. Certain recommendations are made based on the findings of this study. These recommendations are made to three audiences; in-service training service-providers, curriculum developers, and science education researchers.

5.3.1 Recommendations for curriculum material developers

Hall and Hord (2006) point out that during curriculum changes even experienced teachers become novices, and they therefore need adequate support to implement the curriculum effectively. Collopy (2003) says that curriculum materials play a crucial role in the teacher's daily practice in the classroom. Well-developed curriculum materials can act as tools which teachers who are struggling to implement new curriculum can use (Ottevanger, 2001). When the new curriculum which included the teaching of evolution was implemented in South Africa in 2008, the support materials for teaching evolution provided by the Department of Basic Education (the NCS for *Life Sciences* Grades 10-12, Learning Programme Guideline, School Assessment Guideline and Grade 12 examination guidelines) did not provide much support to teachers. The evolution content in the approved *Life Sciences*

textbooks also did not follow a common sequence, and the content depth and breadth was also different in the different textbooks. The fact that the former South African school system did not adequately prepare learners to deal with insights of contemporary science, especially the evolution of life, needed to be considered when the *Life Sciences* curriculum was developed. The materials developed for evolution teaching need accurate and complete information that would help to ease the teachers into the new content for the benefit of the learners. The curriculum material developers need to caution teachers of the potential pitfalls or conflicts and suggest teaching strategies and approaches to address such. Resource materials provided to teachers need more information about specific teaching resources available (books, videos, DVDs, models, interactive activities) to enhance understanding of evolution.

5.3.2 Recommendations for in-service trainers

The results of this study indicate low levels of the teachers' pedagogical content knowledge for teaching evolution, suggesting that the teachers need more adequate training in effectively teaching of evolution.

The Department of Basic Education organised a one-day workshop for the *Life Sciences* teachers late in Term 3 of the year prior to the implementation of the new curriculum (before the data for this study were collected). This workshop was meant to introduce the *Life Sciences* teachers to the new content (of evolution) they were required to teach. What the service provider failed to do was to recognise that the majority of teachers were encountering this content for the first time as they were never trained in it. The workshop was more of a talk shop than a workshop, where the facilitator was talking about evolution. It is recommended that when new content (like evolution) is introduced to the teachers, the workshops are not only for one day, but stretch over several days, and that they address all the five categories of the pedagogical content knowledge for teaching evolution. It is also recommended that the workshops be activity-based (hands-on and minds-on) to actively engage the teachers. Ngxola (2012) proposes that the workshops be designed around the concerns of the teachers so that they are relevant and to ensure effective and successful implementation process.

5.3.3 Researchers

The study was restricted to keep within the scope of a Masters research report. However, it would be interesting to follow up the teachers who participated in this study to see how the extent of their pedagogical content knowledge changed as they continue to teach evolution. It would be interesting to conduct further research on the pedagogical content knowledge of the *Life Sciences* teachers teaching evolution, six years after implementation of evolution in South African high schools.

5.4 CONCLUDING REMARKS

This study looked at the level of the pedagogical content knowledge of two groups of *Life Sciences* teachers who were to teach evolution for the first time in South African high schools. The findings revealed low levels of pedagogical content knowledge for teaching evolution at the time of

implementation of the new content. This is an indication that the teachers were ill-prepare to teach evolution. This information may assist in conducting a follow up study to find out if six years down the line there has been an increase in the *Life Sciences* teachers' pedagogical content knowledge in the teaching of evolution.