CHAPTER SIX

SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

In this chapter, the summary, conclusions and recommendations of the study are presented. The contribution of the study to the field of education is discussed, as well as suggestions for further research.

6.2 SUMMARY OF THE STUDY

This study set out to determine the relative effectiveness of context-based and traditional approaches to teaching life science in enhancing learner performance. The assessed learning outcomes included attainment of genetics content knowledge, science inquiry skills, problem-solving ability, decision-making capability, and improvement of learners' attitudes towards the study of genetics and life sciences. In addition, the significance of the interactive influences of gender and learners' cognitive preferences, and treatment on the achievement of the learning outcomes, if any, was assessed. Finally, the views of participating learners and educators on learner performance in genetics, and the efficacy of the approaches to teaching and learning genetics were explored.

The context-based approach involved the use of contexts (science and technology, society, personal benefits, and the environment) selected by the learners themselves as relevant, interesting and accessible to develop materials for teaching genetics. The materials were exposed to learners using a five-phase learning cycle, consisting of introduction of contexts (narratives depicting real-life situations), interrogation of contexts by learners, introduction of content, linkage of content and context, and assessment of learning. The traditional approach involved the use of materials and methods usually employed by the educators themselves to teach genetics (educators used textbooks and their own teaching and learning materials).

Quantitative data were collected from 190 learners, using six instruments, namely genetics content knowledge test, test of science inquiry skills, problem-solving ability test, decision-making ability test, life sciences attitude questionnaire and a science

cognitive preference inventory. The performances of the control and experimental groups in the achievement tests were compared to determine whether there were significant differences in learners' competence in the assessed learning outcomes. The science cognitive preference inventory was used to group learners according to their cognitive preferences in order to determine their influence on learners' attainment of the assessed learning outcomes.

The quantitative results showed that prior to the intervention, there were no significant differences between the performances of the experimental and control groups in the assessment tests. After the intervention, post-test mean scores showed significant differences between the performances of the two groups in almost all the learning outcomes assessed, in favour of the experimental group. No significant differences were observed between the performances of the groups in the inquiry skills of identification of variables, experimental design, and graphing.

The attitudes of learners towards the study of genetics and life sciences as a subject were found to be positive in both groups, although the attitudes of learners from the experimental group were found to be significantly more positive than those of the control group, after the intervention. Further, the quantitative results did not show significant interactive influences of gender and cognitive preferences, and treatment on the attainment of the learning outcomes, after the intervention.

Qualitative data derived from learner and educator interviews showed that the experimental group found the study of genetics fun, interesting and comprehensible. Learners and educators who were involved in the experimental group were appreciative of the context-based teaching approach, and recommended it for regular use in science classes.

Comments from the control group indicated that learners were interested in the study of genetics, but did not find the teaching methods used particularly helpful in making the learning of genetics accessible, relevant and comprehensible. Educators who taught the control group indicated that poor performance in genetics was a result of learners' unwillingness to participate in lessons and to study genetics.

6.3 CONCLUSIONS

In conclusion, the results of the study showed that:

- The context-based teaching approach was significantly more effective than the traditional approaches in improving learners' achievement in genetics content knowledge, problem-solving and decision-making capability, the ability to formulate hypotheses and to draw conclusions from results.
- There were no significant differences between the performances of the control and experimental groups in the inquiry skills of the ability to identify variables, design experiments, and to draw and interpret graphs.
- Learners from both the experimental and the control group indicated that the study of genetics was interesting.
- The quantitative data showed that learners from both groups had positive attitudes towards the study of genetics and life sciences, although the attitude of learners from the experimental group was significantly more positive than that of those from the control group.
- Neither the context-based nor the traditional approaches used in this study had significant interactive influences of gender and cognitive preferences, and treatment on the attainment of the genetics content knowledge, science inquiry skills, problem-solving, and decision-making ability.
- Learners and educators from the experimental group valued the context-based approach used to teach genetics, and they were of the opinion that it enhanced learner performance in the post-tests.
- The specific features of the context-based teaching approach that are likely to have contributed to the enhanced performance of the experimental group in the post-tests, as attested by participating educators and learners, include the following:
  - (i) The use of contexts (issues related to personal benefits, societal issues, environmental issues and scientific and technological innovations) selected by learners themselves to develop study materials.
  - (ii) The use of the five-phase learning cycle to implement the materials. The elements of the learning cycle that could have enhanced achievement comprise:

- Interrogation of situations and experiences before introducing relevant content, which focused learners' thinking, motivated them, and enabled preconceptions to be identified.
- Introduction of content in small quantities which reduced the load on learners' working memory.
- Revisiting content in different themes, increased familiarity with it.
- Linkage of content and contexts encouraged self-reflections on prior knowledge in light of new information. The reflective feedback facilitated reasoning, meaning making and motivation.
- Application of learned concepts to novel situations enhanced the transferability of learnt information to different contexts.

- Although learners from the control group indicated that they were interested in the study of genetics, they did not approve of the methods used to teach the topic.
- Learners and educators from the control group anticipated unsatisfactory performance in post-tests. According to the participants of the control group, the features of traditional teaching that could contribute to the anticipated poor performance of the group include:
  - Lack of active learner participation in lessons, such as class discussions, debates, which was not facilitative for minds-on experiences and which prevented educators from identifying learners' preconceptions.
  - Lack of hands-on activities to reinforce theory, especially with a topic like genetics that require application and reasoning skills.
  - Presentation of genetics as abstract concepts unrelated to the learners' real-life experiences, thus making the study of the topic seem irrelevant and difficult to them.

6.4 EVALUATION OF THE METHODOLOGY OF THE STUDY

Four aspects of the methodology used in this study need to be highlighted with respect to general problems and successes, as well as theoretical issues and possible limitations. These include the number of participants involved in the study, some data collection methods, the intervention, and data analysis procedures.

6.4.1. The number of participants

Although the number of learners who participated in the main study was fairly large (190), a larger number would have been preferred for generalization of the findings. Nevertheless, it was not practical to have a very large number of participants because of financial and logistic constraints. The study could accommodate only six schools (three schools each for the experimental and control groups) owing to the high costs of field work, training of educators, visiting schools, and acquiring teaching and assessment materials. The limitation of generalizing findings from a small sample should therefore be considered when applying the findings of the study to broader settings.

6.4.2 Data collection methods

The use of focus group interviews to determine learners' views and opinions on the study of genetics proved effective in obtaining the required information. Learners seemed relaxed and willing to share their views. As a result, useful insights into the effectiveness of approaches used to teach genetics were obtained. It is however possible that some lone voices could have been given less attention. Nonetheless, this concern might not have had a profound impact on the results because the researcher was mostly interested in the overall perceptions of the groups.

The use of 'one-to-one' interviews with educators was also useful, because most of the educators were quite comfortable to share their experiences of teaching genetics. The individual interactions of the researcher with the interviewees accorded her the chance to 'pick on' facial expressions and body language, which provided useful hints to participants' emotions. Educators from the experimental group seemed eager to voice their opinions and views on all aspects of the interview, whereas those from the control group seemed more inclined to give views on learners' behaviour and attitudes during the study of genetics, rather than their own contribution to the teaching and learning process.

6.4.3 The intervention

The educators who taught the experimental group were provided with teaching materials and trained on how to implement the materials, while those who taught the

control group were only given a list of genetics concepts to be taught. The provision of materials and training of one group of educators could have the ethical implication of the experimental group having an advantage over the control group, in terms of pedagogical practice. However, the interest of the researcher was to compare the effectiveness of a particular approach (context-based) to the teaching of genetics and the usually ways of teaching the topic, in improving learner performance. It was therefore not appropriate to interfere with what is normally done in traditional genetics classes.

A major challenge in implementing the study was to motivate the learners and educators to remain committed to the study, given the high administrative and educational demands placed on them in South African schools. To counteract this challenge, the researcher instituted several measures, which included, first, giving thorough explanations of the necessity and importance of investigating possible ways of improving performance in genetics, and the likely benefits of the study to the participants and the education system as a whole. Second, a certificate of participation was issued to individuals who attended all the study sessions. These measures encouraged the participants to be committed to the project, with insignificant experimental mortality.

6.4.4 Data analysis procedures

The main inferential statistic used in the study was the analysis of covariance (ANCOVA). According to Field (2009), one of the assumptions of an ANCOVA that is commonly ignored or misunderstood by many researchers is the independence of covariate and treatment effect. Field suggests that this assumption could be checked using an analysis of variance (ANOVA), to find out whether the treatment groups differ on a given covariate before running an ANCOVA. If the ANOVA results show that the treatment groups do not differ significantly, then the covariate could be used in ANCOVA. This method of checking the independence of covariate and treatment was followed in this study (section 3.10.1).

Another factor that was of concern was the selection of representative responses from the interview protocols for discussing the results, which posed the threat of

researcher bias in choosing the representative responses. Selecting responses was necessary because several hundreds of transcripts were transcribed from the interviews. Hence including every transcript in the discussion of results would probably have resulted in thousands of pages for the thesis. To counteract the threat of researcher bias, the transcripts were categorized into themes, from which the general views or opinions of the groups were determined. Researcher prejudice in determining the general views of groups for each theme was alleviated by using a research assistant to provide a 'second opinion' (section 3.10.2). Selecting representative responses, and using a judge to review these responses, was envisaged to provide the advantage of presenting the findings in a succinct and economical way, and still be reasonably inclusive of the interviewees' views, as well as reduce researcher bias.

On the whole, the methodology used in the study served the purpose for which it was intended, which was to systematically gather empirical data on the comparative efficacy of context-based and traditional teaching approaches in enhancing learner performance. However, it must be conceded that the use of a mixed method approach turned out to be time consuming and expensive in the long run.

6.5 Possible contribution of the study to academic knowledge

It is hoped that this study will make a number of contributions towards contemporary research in science education, especially in the development, implementation and the effect of context-based teaching approaches on learner performance.

First, in previous studies, contexts used to develop context-based materials were solely determined by curriculum developers and educators, without finding out from the learners themselves what they find interesting, important and accessible for studying a particular topic. In this study, the use of contexts whose relevance to learners is informed by empirical evidence has provided more insight into the extent to which the aspirations of using context-based approaches to the teaching of science are met. It is hoped that the use of contexts considered important by learners themselves will provide a useful approach to the development of context-based materials.

In addition, it is anticipated that this study will contribute towards the knowledge of contexts which are currently regarded by South African learners as appropriate and effective for the study of genetics (section 3.5.2.3).

Second, previous researchers (Bennett & Lubben, 2006; Hofstein & Kesner, 2006; Schwartz, 2006) have acknowledged the motivational effect of contextualized teaching. However, their effect on conceptual understanding and the development of higher-order thinking skills had not been unequivocally ascertained. The results from this study have shown that the amalgamation of contextualized teaching and the five-phase learning cycle can motivate learners, enhance their content knowledge in genetics and improve some inquiry-related skills, problem-solving and decision-making abilities. It might well be that the instructional approach developed in this study could prove to be not only an effective tool for teaching genetics, but also for teaching other science topics and subjects considered difficult for learners to learn.

Third, the findings of this study provide evidence in support of assertions by researchers (Lubben et al., 1996) that the use of real-life situations and increased interest in lessons alone might not be sufficient for conceptual understanding and the development of higher-order thinking skills, such as science inquiry skills, decision making and problem solving. The results of this study suggest that active minds-on and hands-on engagement of learners, in addition to the use of familiar authentic situations (as stated in sections 5.2.1 and 5.2.2) may be necessary for enhanced achievement in science.

Fourth, the study is likely to benefit life sciences educators by providing them with a prototype for developing context-based teaching materials. This is particularly significant because the current South African life sciences curriculum (NCS and CAPS) emphasizes the applications of life sciences and indigenous knowledge systems (DoBE, 2011; DoE, 2008), which invariably require educators to develop and use context-based teaching materials.

Lastly, the results of the study showed that the materials did not have significant interactive influences of gender and treatment on learners' attainment of the learning outcomes. This finding provides support to assertions that context-based teaching

approaches could reduce gender discrepancies in learner performance in science (Wierstra, 1984; Yager & Weld, 1999).

In the same vein, the study showed that the materials did not have significant bias on the attainment of the assessed learning outcomes by learners of different cognitive preferences. Given the scarcity of literature on the interactive influences of cognitive preferences and contextualized teaching on learner performance, these findings might provide empirical evidence for the inclusivity of context-based teaching approaches with regard to learners' cognitive preferences.

6.6 RECOMMENDATIONS

Based on the findings of this study, the following recommendations for the development of instructional materials and classroom practice are made.

- The results of the study showed that the use of contexts that are familiar and relatable to learners, especially contexts determined by learners themselves, could enhance their performance in genetics and the development of higher-order thinking skills (Tables 4.15a; 4.18a; 4.19a; 4.23a). It is therefore recommended that curriculum developers and educators try to increase the socio-relevance of science and science education by involving learners in decisions about the context of curriculum materials, in order to increase their accessibility and motivational value to learners.

- The findings of the study also showed that providing learners with the opportunity to explore authentic situations related to the scientific concepts to be taught, particularly topics perceived difficult, before teaching the concepts, could improve conceptual understanding, expose learners' alternative conceptions and enhance higher-order thinking skills, such as problem-solving and decision-making ability. In addition, exploration of contexts at the beginning of lessons helps to arouse learners' interest, focus their' thinking and encourages them to participate in lessons, which seems to be lacking in traditional teaching approaches. It is thus recommended that educators

provide learners with opportunities to explore applicable socio-scientific issues before teaching concepts considered difficult for them to learn.

- The results of the study further showed that attempts by learners to link learnt content and the context introduced earlier in the lesson, enabled them to evaluate their prior conceptions regarding a given scientific phenomenon. The self-reflections enhanced learners' reasoning skills, including inquiry skills, problem-solving and decision-making abilities. To this end, it is recommended that educators make deliberate efforts to encourage learners to make self-reflections through evaluation of previously held views regarding scientific ideas and principles, after learning the relevant content, for enhanced understanding and the development of higher-order thinking skills.

- Furthermore, the introduction of scientific concepts to learners in small manageable quantities helped learners to comprehend the content for improved performance, probably due to reduced memory load. It is consequently recommended that, when teaching abstract science topics, educators should introduce content in small quantities which could be easily grasped by learners.

- Finally, given the potential of the developed materials and approach to enhance both conceptual understanding and the development of higher-order thinking skills, and the critical role played by educators in implementing curriculum innovations, it is recommended that teacher training institutions incorporate, in their science education curricula, the development and implementation of the context-based teaching materials and approach developed in this study, for improved learner performance.

6.7 SUGGESTIONSFOR FURTHER RESEARCH

The findings of this study present some further research opportunities, which include the following:

- The context-based teaching approach developed in this study has proven to be effective in enhancing learner performance in genetics and in the development of science inquiry skills and ability in problem-solving and decision-making. It would be important to find out whether the approach could be effective in enhancing performance in abstract physical science topics, which may not have explicit socio-cultural applications.

- A longitudinal study to investigate the potential of the developed context-based approach in motivating young people to pursue science courses, and in particular life science-related courses, beyond the school level would be necessary, to determine the long term motivational effect of the approach.

- Research focusing on ways to increase the use of context-based materials and approaches, such as developed in this study, in schools for improved performance in science subjects is required.

- An investigation on how to empower educators in the development and implementation of context-based materials in schools.