CHAPTER SEVEN

SUMMARISED FINDINGS, IMPLICATIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

International research on the application of science process skills has focussed mainly on either preservice or inservice teachers' competence in these skills (Adey and Harlen 1986: 707; Bluhm 1979: 427; Brown 1977: 83; Jaus 1975: 439; Mattheis et al. 1992: 211; Strawitz 1989: 659; Swain 1989: 251; Riley 1979: 373; and Zeitler 1981: 189). By implication, the findings of these studies reveal that teacher training in the process skills could lead to their subsequent achievement and use of these skills in the classroom. Local research also reveals that science process skills' achievement in prospective teachers could significantly be improved if teacher training programmes include science process skills instruction (Mhlongo 1996: 233 and Van Aswegen et al. 1993: 10).

This study attempted to examine teacher and learner perceptions of the application of science process skills to the teaching of geography in secondary schools in the Free State province. In order to achieve this purpose, the following procedures were undertaken.

- A literature survey was conducted to answer the following questions:

  1. What are science process skills?
  2. Which science process skills are appropriate to the teaching of geography?
  3. What are the science process skills' outcomes?

4. What is the association between the science process skills and the learning outcomes of the natural sciences?

5. How should the science process skills be taught as outcomes?

☐ A Literature survey also tested the following two hypotheses:

Hypothesis 1. Science process skills are suitable and effective to the teaching of geography at secondary school.

Hypothesis 2. The science process skills link specifically to the learning outcomes of the natural sciences and can be realized and achieved as observable and demonstrable outcomes.

☐ A questionnaire survey was conducted among geography teachers and learners in all twelve education districts in the province. The survey was conducted to test the following null hypothesis:

Hypothesis 3. There is no relationship between the teaching approach used by the majority of geography teachers and science process skills.

☐ Interviews were conducted among geography teachers and learners at some secondary schools (cf. 5.2, 5.4 and 5.5). Interviews were conducted to establish or examine the following:

1. why geography teachers found it difficult to develop inquiry teaching;

2. problems which geography learners experienced when they were engaged in inquiry learning;

3. the problems geography learners experienced when science process skills were

applied to the teaching of geography;

4. the problems geography teachers experienced when they applied science process skills to the teaching of geography; and

5. to suggest how the identified problems could be alleviated.

7.2 SUMMARISED FINDINGS OF THE STUDY

The following section lists the findings which emanated from a literature survey, questionnaire survey and interviews.

7.2.1 Summarised Findings and Implications of Literature Survey

- Literature reviewed in Chapter 2 revealed that some geography researchers were of the opinion that the subject should be taught in such a way that learners developed an enthusiasm for further study and individual inquiry (cf. 2.2). The chapter argued that the teaching approaches, such as the holistic approach, the descriptive approach, the problem-solving approach, the thematic approach and the interdisciplinary approach were effective and suitable to the teaching of geography in secondary schools. Chapter 2 argued that geographic inquiry should become part of geography teaching and learning (cf. 2.3). It also argued that geographic inquiry could be realized through the adoption of inductive and deductive inquiry which could lead to the application of science process skills to the teaching of geography.

  Chapter 2 also revealed that inquiry approaches established skills and values such as being able to think, to solve problems, to collect, organise and analyse information, to

work in groups as well as independently, to communicate effectively and to make responsible decisions (cf. 2.4). These are science process skills which can be applied to the teaching of geography.

Figure 2.10, in Chapter 2 indicated that geography inquiry, science process skills and outcomes were linked which showed that science process skills were applicable to the teaching of geography (cf. 2.7). This information supported **hypothesis 1** *which stated science process skills are suitable and effective to the teaching of geography at secondary school.*

- Literature reviewed in Chapter 3 indicated that the nature and structure of geography implied that the subject has adopted the process approach (cf. 3.2 and 3.3). This justified the researcher's call for teacher application of science process skills to the teaching of geography.

  Furthermore, Chapter 3 also argued that a paradigm shift to outcomes-based education in South Africa could indeed encourage the application of science process skills to the teaching of all subjects in general and geography in particular (cf. 3.9 and 3.10). This information supported **hypothesis 2** *which stated that science process skills linked specifically to the learning outcomes of the natural sciences learning area and could be realized and achieved as observable and demonstrable outcomes.*

- Literature reviewed in Chapter 4 disclosed that in the process approach learners became critical thinkers and were actively involved in seeking information that could be used to solve a problem or answer their questions. The process approach gave more meaning to the learning activities because learners saw a process as a vital part of

what they did in the geography class. Geography became an experience learners enjoyed, with the result that they were likely to be motivated to greater achievement (cf. 4.2).

Furthermore, Chapter 4 also revealed that consideration of Piaget's theory of learning could lead to the application of science process skills to the teaching of secondary school geography (cf. 4.3).

Chapter 4 also disclosed a hierarchy of science process skills and how these science process skills could be applied to the teaching of geography as outcomes in the class (cf. 4.4 and 4.5). The implication of literature reviewed is that South African education should prepare citizens who could apply their knowledge in diverse context through science process skills. The information from the reviewed literature was also utilized to construct the questionnaires. Following is the summary of the findings and implications of the questionnaire survey.

7.2.2 Summarised Findings and Implications of Questionnaire Survey

The following section highlights findings that were disclosed through the questionnaire survey. In this survey, descriptive statistics revealed that:

- some geography teachers perceived that they applied inquiry methods to the teaching of geography (cf. 6.2.2.1 and 6.2.2.2) which reinforced the assumption that the teaching of secondary school geography by means of inquiry and investigative methods could encourage the application of science process skills to the geography curriculum (cf. 1.3.2). It seemed as if this was possible because the means procedure

in the sample of teachers to the application of inquiry methods to the teaching of geography in secondary schools was 2.7. In the sample of learners the means procedure was 2.6. The means implied that on average some of the teachers perceived that they "often" applied different strategies of inquiry teaching methods, and some learners "agreed" that their teachers applied those methods.

- In the sample of teachers, the mean for teacher application of basic science process skills to the teaching of geography was 2.6 whilst in the sample of learners it was 2.7. These means implied that geography teachers who were sampled perceived that they "often" applied some basic science process skills to the teaching of geography (cf. Tables 6.10) whilst in the sample of learners, most learners "agreed" that their teachers applied these skills (cf. Tables 6.12).

- In the sample of teachers the mean for teacher application of integrated science process skills to the teaching of geography was 2.3 whilst in the sample of learners it was 2.6. These means indicated that there were perception differences between teachers and learners who were sampled. The means implied that according to geography teachers, they "sometimes" applied integrated science process skills to the teaching of geography whilst geography learners "agreed" that their teachers applied those skills.

As a result of the facts revealed by *the Means Procedure*, *the researcher concludes by rejecting the null hypothesis* (**hypothesis 3**) that stated that *there was no relationship between the teaching approach used by the majority of geography teachers and science process skills*. The null hypothesis is rejected on the basis of teacher and learner means (2.6 and 2.7 respectively) for the application of basic

science process skills and (2.3 and 2.7 respectively) for the application of integrated science process skills to the teaching of geography). On the basis of these means, the average mean for the application of science process skills to the teaching of geography in secondary schools in the Free State province is 2.5. *This average implies that teachers perceive that they "often" apply science process skills to the teaching of geography. It also implies that learners "agree" that their teachers apply science process skills to the teaching of geography hence it can safely be concluded that in the sample of teachers and learners, secondary school geography is taught by some teachers by means of science process skills.* Therefore, *there is a relationship between the teaching approach used by geography teachers and science process skills.*

On the basis of these important findings, it could be essential for teachers to emphasise integrated science process skills teaching because Peterson's (1978) study cited by Padilla, Okey and Garrard (1984: 278) reveal that the addition of some integrated process skill activities to a standard curriculum could results in increased abilities in learners. Furthermore, Padilla, Okey and Dillashaw (1983) cited by Padilla et al. (1984: 278) also found a significant and high relationship between the integrated science process skills and formal operational abilities. The study of Padilla et al. (1984: 283) also revealed that groups of learners increased in process skill achievement and logical thinking ability through integrated science process activities.

In addition, inferential statistics of the questionnaire survey also revealed the following interesting information on teacher and learner perceptions of the application of **inquiry methods** (cf. 6.3.1.1) to the teaching of geography:

In the sample of teachers investigated,

- male teachers perceived that they applied inquiry methods to the teaching of geography in secondary schools more than female teachers (F-value= 6.12 and Pr > F = 0.158);

- teachers who took geography as a subject to matric had a higher perception of their application of inquiry teaching methods than teachers without matriculation geography (F-value= 3.58 and Pr > F = 0.0663);

- Grade 10 teachers perceived that they applied inquiry teaching methods more than teachers of other Grades (F-value= 2.35 and Pr > F = 0.0807);

- teachers in urban schools had a higher perception of their application of inquiry teaching methods than teachers in rural schools (F-value= 0.96 and Pr > F = 0.3312).

In the sample of learners investigated,

- more female learners than male learners agreed that their geography teachers applied inquiry teaching methods (F-value= 1.19 and Pr > F = 0.2768);

- learners in all Grades agreed that their geography teachers applied inquiry teaching methods although Grade 11 learners showed a higher mean score of agreement (F-value= 9.26 and Pr > F = 0.001); and

- learners in independent schools showed a higher mean score on their teachers' application of inquiry teaching methods than learners in public schools (F-value= 3.52 and Pr > F = 0.0613).

Inferential statistics also revealed the following similar trend on the application of **basic science process skills** (cf. 6.3.1.2) to the teaching of geography:

In the sample of teachers investigated,

- male teachers had a higher perception score of their application of basic science process skills than female teachers (F-value= 5.46 and Pr > F = 0.0224);

- teachers who took geography as a subject to matric had a higher perception score of their application of basic science process skills than teachers without matriculation geography (F-value= 8.98 and Pr > F = 0.0038);

- Grade 10 teachers perceived that they applied basic science process skills more than teachers of other Grades (F-value= 2.90 and Pr > F = 0.0414);

- teachers in urban schools had a higher perception score of their application of basic science process skills than teachers in rural schools (F-value= 4.38 and Pr > F = 0.0400).

In the sample of learners investigated,

- more female learners than male learners agreed that their geography teachers applied basic science process skills (F-value= 1.22 and Pr > F = 0.2705);

- learners in all Grades agreed that their geography teachers applied basic science process skills although Grade 11 learners showed a higher mean score of agreement

(F-value= 9.27 and Pr > F = 0.001); and

- learners in independent schools showed a higher perception score of their teachers' application of basic science process than learners in public schools (F-value= 3.14 and Pr > F = 0.0770).

Inferential statistics revealed the following interesting facts on the application of **integrated science process skills** (cf. 6.3.1.3) to the teaching of geography:

In the sample of teachers investigated,

- male teachers had a higher perception of their application of integrated science process skills than female teachers (F-value= 5.95 and Pr > F = 0.0173);

- teachers who took geography as a subject to matric had a higher perception of their application of integrated science process skills than teachers without matriculation geography (F-value= 6.12 and Pr > F = 0.0158);

- Grade 10 teachers perceived that they applied integrated science process skills more than teachers of other Grades (F-value= 2.35 and Pr > F = 0.0807);

- teachers in urban schools had a higher perception of their application of integrated science process skills than teachers in rural schools (F-value= 0.73 and Pr > F = 0.3943).

In sample of learners investigated,

- more female learners than male learners agreed that their geography teachers applied integrated science process skills (F-value= 2.68 and Pr > F = 0.1024);

- learners in Grades 9, 10 and 11 agreed that their geography teachers applied integrated science process skills whilst learners in Grades 10 and 12 disagreed that their geography teachers applied integrated science process skills (F-value= 5.41 and Pr > F = 0.0003). It is important to note that the scientific method which integrates science process skills forms part of a Grade 12 geography syllabus but it seems as if it is taught in some classes. Analysis of the interviews' results has also revealed that most geography teachers did not teach the scientific method because they claimed that the syllabus was too extensive and knowledge on the scientific method was not tested in the examinations (cf. 6.4.2.7); and

- learners in both public and independent schools agreed that their geography teachers applied integrated science process skills. However, quite interestingly, learners in public schools showed a higher perception score than learners in independent schools (F-value= 0.47 and Pr > F = 0.4918).

The implication of these results is that some geography teachers perceive that they apply inquiry teaching methods in their classrooms, which is conducive to the application of science process skills to the teaching of geography . Hence the introduction of outcomes-based education which involves the application of activities to the lessons could also provide the foundation for the usage of process skills in most geography classrooms.

Teachers and learners in the sample investigated pointed out some problems they encountered when they were involved in inquiry tasks and science process skills. The following section gives a summary of the identified problems and their suggested solutions.

7.2.3 Summarised Findings and Implications of Interviews

The following section highlights a summary of the findings which resulted from the interviews conducted with geography teachers and learners. Interviews reveal that with regard to teacher application of inquiry methods (cf. 6.4.2.1 and 6.4.2.3) to the teaching of geography the following problems are encountered in the geography classrooms:

- there is lack of learner involvement as a small number of learners are willing to participate in inquiry activities, especially in activities which involve oral communication;

- learners who participate in inquiry discussions are scorned by other learners if their ideas or questions are irrelevant to the problems or issues under investigation;

- learners command of English as a medium of instruction is inadequate, with the result that a small number of learners are willing to voice their opinion in class because their peers scorn them if their English is not perfect;

- learners lack independent thinking because they are used to teacher domination in class. Resources, content and problems are still selected by geography teachers;

- learners fail to understand and implement the processes and techniques involved in geographic inquiry. This problem is compounded by the fact that geography teachers

fail to provide their learners with guidance about the methods and sequence of inquiry;

- learners do not read widely as most schools do not have functioning libraries;

- the Grade 12 geography syllabus is very long and most teachers find the application of inquiry methods to the teaching of geography a waste of teaching time;

- learners find it difficult to generate their own questions. They are unable to identify an issue or a problem that they may use to generate questions that may guide their inquiry individually or in groups; and

- learners lack the ability to give logical reasoned solutions and to justify their recommendations.

Interviews have also revealed the following suggested solutions (cf. 6.4.2.2 and 6.4.2.3) to the problems highlighted above:

- geography teachers should teach learners how to think by devising activities and exercises that develop learners' thinking skills;

- geography teachers should ask of their learners why certain geographical phenomena do or do not happen, i.e. they should ask probing questions;

- geography teachers should encourage learners to identify and state geographical problems, individually or as a group;

- geography teachers should guide learners when they investigate issues or problems. They should also assist learners in finding suitable data from sources in and out of school. Teachers and learners should discuss methods of analysis and interpretation of data together;

- learners should report their findings orally and in writing in order to improve their communication skills. Oral sessions should form part of activities in the geography classrooms and each learner should be afforded an opportunity to speak in every geography lesson;

- teachers should point out the inadequacy of the questions or ideas to the learners and help them to formulate their questions or ideas properly; and

- the implementation of OBE may encourage teachers and learners to design and create their own teaching and learning materials respectively. Hence complaints such as schools lack teaching and learning materials could be greatly reduced.

Interviews also reveal that with regard to teacher application of science process skills (cf. 6.4.2.5) to the teaching of geography the following problems are found in the geography classrooms:

- it seems as if most teachers are not comfortable with mapwork activities which means that the section on mapwork is only taught at a small number of schools;

- geography learners find it difficult to measure distances on the map in centimetres or millimetres and convert the measurements to metres or kilometres;

- ☐ geography learners are not afforded opportunities to handle equipment which is used to observe meteorological elements such as atmospheric pressure, air temperature, precipitation, wind speed and direction, and humidity. As a result, a large number of geography learners is not exposed to the process skills of making quantitative observations, recording of data and interpreting data;

- ☐ most geography teachers do not demonstrate simple geography experiments in their lessons. This implies that learners are not afforded opportunities to *experiment*, to *formulate hypotheses*, to *identify variables*, to *define variables operationally*, to *design investigations*, to *analyse investigation*, to *record and interpret* data;

- ☐ some geography learners observe geographical phenomena and fail to interpret what they have observed. Furthermore, they are able to *observe* but fail to *infer* or make *predictions* on what they have observed. They claim that this is because they are taught to reproduce facts rather than to show insight and understanding;

- ☐ geography teachers do not teach science process skills as a separate theme or topic in their lessons. Teachers claim they develop basic science process skills in their learners only when they teach other themes or topics of the syllabus;

- ☐ teachers also claim that science process skills are not examined in Grade 12 geography examinations. Teachers argue that it would be a waste of time to teach these skills as the syllabus is too long; and

- ☐ there is lack of facilities and equipment which could hinder geography teachers from conducting certain geographical experiments.

The following are suggested solutions (cf. 6.4.2.8) to the problems that were highlighted above:

- ☐ teachers claim that they would consider teaching science process skills if Grade 12 geography examiners include questions on the scientific method in the final examinations;

- ☐ geography syllabus *content* should be reduced in order to shift the emphasis to the *process* approach;

- ☐ Free State Department of Education should provide schools which offer geography with facilities and equipment which would enable teachers to design and conduct experiments. Meteorological equipment would also provide learners with opportunities to observe meteorological elements; and

- ☐ Free State Department of Education should organise workshops or short courses in which teachers are trained to teach science process skills. Teachers should also be trained how to be creative and improvise equipment from their environment which could be utilised to conduct simple geography experiments (cf. 4.4.3, 4.5.1 and 4.5.3). The interviewed teachers suggested that universities located in the Free State should be approached to provide workshops as part of their engagement with the communities they serve. Furthermore, some teachers suggested that the Free State Department of Education should encourage them to improve their qualifications by linking teacher qualifications with salaries. These teachers claimed that they were not keen on furthering their studies because a once-off merit payment is effected by the department after they have improved their qualifications.

7.2.4 Summarised Findings and Implications of Factor Analysis

Teacher responses on science process skills items were subjected to factor analysis (cf. 6.2.3.1) which revealed the following information.

- ☐ two factors which were identified as basic science process skills and integrated science process skills were retained by the NFACTOR criterion. This confirmed that the respondents distinguished mentally between the two constructs which implied that geography teachers were comfortable with the fact that science process skills could be grouped into two main clusters. This supports a high construct validity of the questionnaire;

- ☐ the homogeneous clustering of items also implied that geography teachers were also satisfied with the fact that science process skills could be applied to the teaching of geography;

- ☐ items 48, 49 and 50 load on very highly in Factor 1 (basic science process skills) as well as in Factor 2 (integrated science process skills) which implies that performance in one skill leads to performance in other skills. The loadings in Factor 1 imply that *classifying* features (item 48) may lead to *communicating* the classification of the features through *maps, charts, symbols, graphs and diagrams* (item 50).

- ☐ teachers who encourage learners to *communicate* information through graphs also teach learners to *construct tables of data* (item 65), *to construct graphs* (item 66), and *to identify and describe the relationship between variables on a graph* (items 68 and 72). This information explains why items 48, 49 and 50 associate very highly in

Factor 2;

- items 61 and 62 also loaded very highly in Factor 1 and Factor 2 which corroborates the fact that teachers encourage learners to also use graphs to communicate investigated or learned information.

In conclusion, from literature reviewed it can be claimed that there is a link between inquiry, science process skills and outcomes. Reviewed literature also confirmed that science process skills are applicable to the teaching of geography. Following are the recommendations of this study.

7.3 RECOMMENDATIONS

The findings of the study have some implications for the teaching of geography, curriculum development, learning facilitators (subject advisers), geography learners, provincial education policy and geography teacher education. Consequently, the following recommendations are made because they may significantly improve the development of science process skills in secondary school geography classrooms.

7.3.1 Incorporation of Science Process Skills in OBE Training

The results of this study highlight the need for providing secondary school geography teachers with training in the process skills. It seems as if teachers were not trained in science process skills' instruction. Jaus (1975: 445) established that pre-service and in-service teachers trained in science process skills accomplished competence in these skills. This also improved learners' competence in these skills because trained teachers were provided with both the will

and the skill to teach these skills. Furthermore, teachers who were competent in these skills designed instructional materials and activities that provided for similar process skill acquisition by learners.

Bluhm (1979: 431) suggests that teachers should be trained in process skills using a manipulative "hands-on" approach which include activities designed to teach these skills. This implies that teachers' knowledge and ability to use science could be integrated with teacher retraining programmes in OBE and should be implemented by the Free State Department of Education. OBE supports the application of activities in the classroom and most of the activities which are applied can integrate science process skills.

Furthermore, the researcher suggests that geography methodologies' modules at universities and other teacher training institutions should be structured in such a way that pre-service secondary school teachers should be able to understand how science process skills can be used in inquiry situations and in OBE. The modules should also provide activities for student-teachers to engage in such a way that they may experience the use of science process skills in inquiry or problem-solving contexts. Jaus (1975: 446) notes that few teachers are willing to teach learners skills in which they have little competence themselves. Hence the role of teacher-training institutions is very essential with regard to the development of these skills.

7.3.2 Provisioning of Self-instructional Material

Free State Department of Education could enlist the services of university researchers to compile self-instruction materials that in-service geography teachers may use in the classrooms. Jaus (1975: 445) found that science process skills' achievement of prospective elementary teachers could be significantly improved by studying self-instructional materials in

the integrated science process skills. Thus, it is assumed that provisioning of science process activity books, teacher handbooks and other science process skills teaching aids may enable in-service teachers to provide instruction in these skills with confidence. These materials would also be valuable for OBE activities.

7.3.3 Encourage Teacher Improvement of their Qualifications

Free State Department of Education should encourage all teachers to improve their qualifications at institutions of higher learning. This process should include both underqualified and adequately qualified teachers who have studied before the implementation of OBE in South Africa. Almost all South African universities have introduced or are in the process of introducing OBE modules in their Faculties of Education. Hence, if the department encourages in-service teachers to further their studies at universities, these teachers would receive some form of training in OBE which may in turn equip them with skills in science process skills.

The process mentioned above would require the government to revise its policy on monetary incentives. It seems as if most teachers are not willing to further their studies because there is only a once-off merit payment after a teacher has obtained a new qualification (cf. 6.4.2.8). The government should revert to a system which was practised in the 1980s where a teacher who improved his/her qualifications was given a higher salary notch. If this could be implemented again, most teachers are likely to improve their qualifications. This could play a significant role in teacher retraining programmes of the government. The cost in terms of money and time which the Free State Department of Education is likely to spend on the retraining of teachers is likely to be reduced as individual teachers are likely going to finance their own studies.

7.3.4 Introduction of Geography Experiments in the Classrooms

Geography teachers should make provision for experiments in their lessons. Experiments are applicable mostly in climatology and geomorphology sections of the syllabus. The use of experiments is likely to lead to the application of almost all science process skills as shown in Chapter 4 of this study. Geography learning facilitators should assist teachers with ideas on how experiments can be introduced in the teaching and learning of geography. If geography learning facilitators do not have sufficient knowledge with regard to this, they should be encouraged to liaise with academics who may suggest ways of demonstrating experiments without spending large amounts of money on facilities and equipment.

The Free State Department should request geography learning facilitators to identify topics in Grades 8 to 12 that might be taught by means of simple experiments. Learning facilitators should also identify materials which teachers can improvise from the environment which could be used in geography experiments. For instance, to teach the water cycle the following materials are needed.

- ☐ heat resistant glass or plastic;
- ☐ metal plate;
- ☐ crushed ice;
- ☐ hot water; and
- ☐ a small amount of smoke;

Teachers, together with their learners can collect these materials and demonstrate the water cycle experiment without the use of any specialized equipment. The Free State Department of Education should indicate to teachers that they must be innovative and attempt to improvise

some materials from their environment.

7.3.5 Teacher Knowledge of Science Process Skills and the Examination of These

The scientific method is part of the Grade 12 geography syllabus. Some secondary geography textbooks have a section on general geographical techniques (cf. 2.7). In this section learners use topographical maps and aerial photographs or orthophotos to *identify geographical phenomena, to formulate problems and hypotheses, and to apply the scientific method to interpret maps and photographs*. Learners are also taught advanced interpretation of maps and photographs which involves *formulation of hypotheses, observations, data collections, tabulating data and testing of hypotheses*. These are science process skills that are supposed to be learned and tested in the mapwork's examination paper.

The claim by certain teachers that science process skills are not examined in Grade 12 is unfounded. Teachers might not be aware that skills which are taught in mapwork activities are science process skills. The department should make teachers aware that these skills are science process skills and are examined annually. This may enable teachers to emphasise the development of these skills in learners. Geography learning facilitators should empower teachers who cannot teach this section of the syllabus. If learning facilitators also experience problems in these skills, the Free State Department of Education should make arrangements with academics who lecture geography or geography methodology modules at universities in the Free State to assist learning facilitators and teachers in these skills.

7.4 PROBLEMS EXPERIENCED WITH THIS STUDY

The researcher experienced a number of problems with regard to both the literature survey and

the empirical research.

7.4.1 Problems Experienced with the Literature Study

The researcher experienced a lack of literature on the application of science process skills to the teaching of geography in South Africa (Appendix 5). Although there were many international studies and sources on science process skills in other subjects in the natural sciences, these sources were either outdated or irrelevant to South African situations. Furthermore, literature on South African OBE was not adequate as OBE was a new system in South Africa. Research on OBE focussed mainly on theories about OBE. Few publications existed on the link between OBE, inquiry teaching and inquiry learning, and science process skills.

7.4.2 Problems Experienced during Empirical Research

Some teachers were reluctant to complete the questionnaires. They returned the questionnaire uncompleted and supplied the following reasons.

- ☐ they claimed that the questionnaire was too long and they did not have time to complete it as they were overburdened with work at school;

- ☐ some mentioned that they had already completed many other questionnaires and they could not assist the researcher in any way; and

- ☐ others believed that completing the questionnaire meant advancing the education level of the researcher at their expense and mentioned that the researcher was using them

to further his interests at their expense. This implies that some geography teachers could not realise the value of research to the development of geography knowledge.

Furthermore, most schools did not adhere to the researcher's request that they should hand questionnaires to ten learners per Grade. Instead, they handed the questionnaires to learners in lower Grades. Most of the learners did not have a sound command of English hence they did not know or understand some inquiry teaching methods' and science process skills' concepts. Some schools returned batches of learners' questionnaires uncompleted.

The majority of teachers and learners did not complete open-ended questionnaire items which fortunately could be counter-acted through the use of interviews. Regarding interviews no problems were experienced, except that some concepts had to be explained and clarified to some learners in Sesotho.

7.5 LIMITATIONS OF THE STUDY

The research was confined to the application of science process skills to the teaching of geography in secondary schools in the Free State province. Therefore, its results cannot be generalised beyond secondary schools because primary schools, teacher training colleges, technikons and university were not represented.

The views of twelve geography learning facilitators (subject advisors) in the province were requested and ten did not return their questionnaires even after several reminders. Statisticians who helped the researcher in the computation of data suggested that the information from the two learning facilitators who showed interest could be regarded as statistically invalid. As a result, data gathered from the two learning facilitators were not used

in the study.

Only seventy-one out of a hundred and fifty teacher questionnaires were returned. A greater number of returns would have benefited this study. Furthermore, both teacher and learner questionnaires were not standardised.

The study did not attempt to cover the actual teaching, learning and assessment of science process skills in geography at secondary schools. It concentrated mainly on teacher and learner perceptions of the application of these skills to the teaching of geography. However, despite these limitations, interesting findings were revealed by the study.

7.6 FUTURE RESEARCH

The following suggestions are made for future research on aspects of concern in the application of science process skills to secondary school geography:

- the actual teaching and learning of science process skills in geography at secondary schools;
- the development of a framework for the assessment of science process skills in learners;
- investigate ways of enhancing learners' abilities in geography with an individual science process skill;
- research is needed to determine which factors influence learners' capabilities in

science process skills;

- ☐ the effects of process skills instruction on learners ;
- ☐ the effects of process skills testing on learners; and
- ☐ development of a science process skill achievement test.

7.7 CONCLUSION

Literature reviewed has revealed that the nature and structure of geography supports the adoption of inquiry teaching and the application of science process skills. Reviewed literature also established that inquiry teaching, outcomes-based education and science process skills were associated and linked.

It was established through empirical research that some secondary school teachers perceived that they applied inquiry methods to the teaching of geography. According to the perception of teachers and learners, some geography learners were exposed to a limited number of science process skills although experiments were rarely conducted in most geography classrooms. This is one area of teaching and learning which the Free State ministry of education should prioritise in order to meet the expectations and principles of Curriculum 2005 which advocates outcomes-based education. Experimental activities in geography are likely to comply with the practice suggested in Curriculum 2005 which could contribute to the development of citizens who might conduct their lives with confidence in the 21st century.