A STUDY OF THE APPLICATION OF SCIENCE PROCESS SKILLS TO THE TEACHING OF GEOGRAPHY IN SECONDARY SCHOOLS IN THE FREE STATE PROVINCE

by

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ABSTRACT

A STUDY OF THE APPLICATION OF SCIENCE PROCESS SKILLS TO THE TEACHING OF GEOGRAPHY IN SECONDARY SCHOOLS IN THE FREE STATE PROVINCE

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The purpose of this study was 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. Based on the literature study, teacher (educator) and learner questionnaires on inquiry teaching and the application science process skills in the geography classrooms were developed. The questionnaires were administered to 150 teachers with 71 returns and 700 learners with 355 returns. Interviews were also conducted with 20 secondary school geography teachers and 50 grade 12 geography learners. Questionnaire data were analysed quantitatively whilst data gathered by means of interviews were analysed qualitatively,

A literature survey revealed that most researchers are of the opinion that science process skills were suitable and effective to the teaching of geography at secondary school level. It also established that there was a link between inquiry teaching and the application of science process skills. It also indicated that science process skills linked specifically to the outcomes of the natural sciences and could be realized and achieved as observable and demonstrable outcomes.

Items on science process skills in the teachers' questionnaire were submitted to a principal component analysis using a varimax rotation method. Two principal components were retained and rotated using the factor matrix solution. Factor 1 was called **Basic Science Process Skills** whilst Factor 2 was called *Integrated Science Process Skills*. This confirmed that the respondents distinguished mentally between the two constructs which implied that geography teachers were comfortable with the fact that science process could be grouped into two main clusters. The homogeneous clustering of items also satisfied that with the fact that science process skills could be applied to the teaching of geography. The empirical research revealed that teachers and learners were of the opinion that teachers apply *inquiry methods* and *basic science process skills* to the teaching of geography. However, the results also indicated that teachers and learners were of the opinion that teachers were not applying *integrated science process skills* to the teaching of geography.

Interviews also implied that teachers were not applying *integrated science process skills* because geography experiments were rarely conducted in the classroom. Geography learners are also 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.

Several recommendations were made, including that teachers should make provision for experiments in their lessons. Geography learning facilitators (subject advisors) could assist in the identification of materials which teachers might improvise from the environment to conduct geography experiments in their classrooms. 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. Some of 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.

KEYWORDS

Inquiry teaching, inquiry learning, outcomes-based education, outcomes, science process skills, basic science process skills, integrated science process skills, geography teaching, teaching approaches and teacher training.

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DECLARATION

I declare that

A STUDY OF THE APPLICATION OF SCIENCE PROCESS SKILLS TO THE TEACHING OF GEOGRAPHY IN SECONDARY SCHOOLS IN THE FREE STATE PROVINCE is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of references.

AM Rambuda — 02/08/2002

A.M. Rambuda — Date

This thesis is dedicated to my son, Hangwani.

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CHAPTER ONE

ORIENTATION

1.1 INTRODUCTION

Chapter one aims to provide an overview of the problem investigated. The chapter sets out the problem that was examined and emphasises the essential nature of the problem. Furthermore, the chapter also highlights the scope, objectives and hypotheses of the study. Some concepts are defined and explained and a brief discussion on the research methodologies which were used to collect data is also given. Lastly, the chapter ends by setting out the programme of the study.

1.2 GENERAL BACKGROUND OF THE PROBLEM

The South African education system is currently undergoing a major transformation process, from an education system which encouraged the transmission of information to an education system which supports the constructivist paradigm of thinking. The previous education system was mainly based on the principles of Christian National Education (CNE) which was "...used to divide and control, to protect white privilege and power - socially, economically and politically - and to ensure Afrikaner dominance" (Hartshorne 1989, cited by McGregor 1992: 20). This resulted in gross inequalities among schools which catered for different races in South Africa (Department of Education 2001a: 10 and Education and Training Act 1995: 18). As such, there is inadequate supply of resources to many schools and most teachers in historically black schools have low qualifications and poor morale (Christie and Collins 1984: 178; Harber 1989: 184; Hartshorne 1992: 79 and McGregor 1992: 24).

A perusal of various studies indicates that this sad state of affairs affects the practice of teachers who resort to survival teaching methods (Department of Education 2001a: 10; Harber 1989: 184; Hartshorne 1992: 79; Kallaway 1984: 25; Maree 1984: 153 and Mhlongo 1996: 3). It seems as if the emphasis is on teaching for examination without encouraging learners' participation in the lessons. Hence, the quality of teaching is not likely to foster the development of independent, critical and creative thinking in learners. It is likely that this problem affects all secondary school subjects in general. Research also indicates that in most geography classrooms, learners are taught geographical facts and concepts with minimal understanding (Ballantyne 1986: 33 and 39, Magi 1981: 152 and Rambuda 1994: 57).

After the dawn of the new political dispensation in 27 April 1994, the government sought to address educational problems such as these through Curriculum 2005 (cf. 3.5). Curriculum 2005 calls for the adoption of outcomes-based education (OBE) in South Africa. The adoption and implementation of Curriculum 2005 is trying to effect a paradigm shift from a content-based education system to an education system based on outcomes. This may imply a shift from the traditional product approach to a process approach. Hence, OBE focuses on what learners understand and are able to do (cf. 3.6). Bhengu aptly puts it:

> *Essentially, the new curriculum will effect a shift from one which has been content-based to one which is based on outcomes. This aims at equipping all learners with the knowledge, competencies and orientations needed for success after they leave school or have completed their training. Its guiding vision is that of a thinking, competent future citizen* (Department of Education 1997a: 1).

This statement implies that within the OBE frame of reference, teachers are required to teach the processes required by the learner for the construction of knowledge (cf. Chapter 4). Hence the researcher argues that science process skills can be achievable as outcomes (cf. 4.3.5). However, it is important to note that not all people are in favour of OBE (cf. 3.7).

Outcomes-based education has been phased-in in the General Education and Training band (GET) and Further Education and Training band (FET) (cf. 3.5.1 and 3.5.2) with effect from 1998. Before it was phased-in, the Department of Education released a White Paper on education which envisaged an education system that encourages independent and critical thought (Education and Training Act 1995: 22). According to the then Minister of the Department of Education, Prof S M E Bhengu, the new education system was expected to cultivate and liberate the talents of all people without exception (Education and Training Act 1995: 5).

Furthermore, the Education and Training Act (1995: 22) also maintains that learners should *"...develop the capacity to question, enquire, reason, weigh evidence and form judgements. achieve understanding, recognise the provisional and incomplete nature of most human knowledge, and communicate clearly."* This statement implies that teachers are required to teach processes through which knowledge develops. The learners are required to investigate and discover knowledge through observation, measuring, inferring, manipulating variables and so forth. These activities are the science process skills that both teachers and learners have to acquire and master in order to develop and expand their knowledge. It is important to note that most people follow these processes when solving problems and developing new knowledge.

Hence, it is envisaged that an introduction of science process skills to the teaching of geography is likely to enable learners to learn geographical phenomena with insight and understanding. As a result of this, it might not be easy for geography learners to forget the information they have investigated, discovered and 'felt'. Geography education at secondary schools is regarded as a burden to the memory because learners are expected to memorise too many facts (cf. 2.2.2). The application of science process skills is likely to reduce problems such as these as science process skills may encourage learning by doing. Furthermore, science process skills enable learners to learn how to learn by thinking critically and using information creatively (Martin, Sexton, Wagner and Gerlovich 1994: 11).

It is important to note that there is a link between science process skills and South African outcomes-based education. This link is also shown by the fact that science process skills are called lifelong learning skills (Carin and Sund 1989: 67) and Curriculum 2005 and outcomes-based education are also based on the idea of lifelong learning for all South Africans (Department of Education 1997a: 1 and Department of Education 2001a: 17). Furthermore, Curriculum 2005 also claims to encourage and develop critical thinking, rational thought and deeper understanding (Department of Education 1997a: 2) which are the basic elements of outcomes-based education which activates the minds of the learners. However, it is also important to note that there is of course the argument that science process skills are not easily transferable between different subjects and programmes (cf. 2.6).

This paradigm shift to outcomes-based education has to be supplemented by innovative teaching and learning processes in order to assist learners to achieve anticipated outcomes as outcomes-based education provides opportunities for logical, rational and critical thinking to learners (Department of Education 1997a: 7). Therefore, it is suggested that innovative teaching and learning strategies should include process skills of science which demand from learners more than mere memorization. The Department of Education (1997: 9) also states that:

> *...the main set of outcomes that every teacher needs to plan around are called the 'critical cross-field outcomes'. These are the outcomes that are essential to learning and include skills and values such as being able to think, to solve problems; to collect, organise and analyse information, to work in a group, as well as independently, to communicate effectively and to make responsible decisions. The curriculum is built on these critical outcomes.*

As a result of the above statement, the researcher is convinced that the application of science process skills to the teaching of all secondary school subjects in general may equip learners to achieve to such ends.

1.3 RESEARCH OUTLINE

The problem investigated in the study, the aims and objectives of the study and the questions investigated are outlined in this section. The section also lists the hypotheses and concludes with a brief discussion on the research methodology for the study.

1.3.1 The Problem Investigated in this Study

The present poor condition of geography teaching and learning in secondary schools led to this investigation. The researcher's experience and most studies show that the teaching of geography in the world in general is largely expository in nature (cf. 3.2). Perusals of various literature indicate that the teaching and learning of geography in countries such as the United Kingdom and Australia are also plagued by similar approaches which are seen as content-based and teacher-centred (Bailey 1987:13; Battersby 1997: 77; Fien 1983: 47; Lambert and

Balderstone 2000: 236 and Levy 1984: 211). In Japan, geography teachers are trained mainly to teach knowledge and understanding at the expense of geography skills (Nakayama 1995 - 1996: 26). There was also a call for Japanese teachers to learn and apply the activity-centred approach (geographical skills) to teaching. Trüper and Hustedde (1990: 109) also found that most American citizens demonstrated a weakness in geography skills and general knowledge.

In most schools serving the majority of the population in South Africa, there has been a sharp decline in the quality of educational performance in the 1980s and 1990s (Education and Training Act 1995: 21). Table 1.1 also confirms this gloomy state of affairs (cf. 1.4). In order to remedy the current situation of geography teaching and learning, the researcher calls for an inquiry-based, learner-centred approach which empowers learners to be "meaning-makers". This is likely to encourage learners to learn geographical knowledge with insight and understanding. Hence, learners are likely to be able to construct new geographical knowledge through the usage of science process skills.

At the moment, secondary schools in the Free State province use the 1996 Core Syllabus for Geography for Grades 10, 11 and 12 (Appendix 1). Its preamble and guidelines indicate that science process skills are supposed to be applied to geography teaching and learning (Guideline Document and Interim Syllabus for Geography 1996: 3). This is also supported by the critical and developmental outcomes of the new curriculum, that expects South African citizens to possess the elements of science process skills throughout their whole lives (Department of Education 1997a: 16 and Department of Education 2001a: 13). However, the review of literature on geography teaching in South Africa (cf. 1.4 and 2.2) and the researcher's observation of geography classroom practices (Rambuda 1994: 70) suggest that contrary to the requirements of the syllabus and Curriculum 2005, knowledge transmission by teachers still dominates the teaching-learning process in South Africa. As a result, few geography learners have inquiring minds and critical ability (Davies 1987/1988: 118). The research problem therefore, is to investigate teachers' perception of their application of the science process skills to geography education as science process skills were likely to encourage the development of inquiring minds and critical ability in learners.

1.3.2 Questions Investigated

The research questions that emanate from the research problem are likely to be answered by the literature study and the empirical investigation. A literature survey attempted 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?

Empirical investigation attempted to answer the following questions:

6. Why do geography teachers find it difficult to develop inquiring teaching and inquiry learning?

7. How can the problems geography teachers encounter when developing inquiry teaching and inquiry learning be alleviated?

8. How can the problems geography learners face when they are engaged in inquiry learning be alleviated?

9. What are the problems geography learners contend with when science process skills are applied to the teaching of geography?

10. How can the problems geography learners experience when science process skills are applied to the teaching of geography be alleviated?

11. What are the problems geography teachers meet when applying science process skills to the teaching of geography?

12. How can the problems geography teachers experience when applying science process skills to the teaching of geography be lessened?

1.3.3 Aims and Objectives

The aim of this study was to examine teachers' perception of their application of science process skills to the teaching of geography in secondary schools in the Free State province. It is assumed that the application of science process skills might develop inquiring minds and critical analytical skills in learners. It is also assumed that this was likely, only if geography teachers developed an inquiry teaching approach and encouraged inquiry learning in their learners, which in turn could lead to the application of science process skills.

In order to accomplish this aim, the following objectives should be realized by the study. These objectives are to:

1. establish geography teachers' and learners' perception of teachers' use of inquiry teaching methods.

2. examine problems which geography teachers encountered when they developed inquiry teaching.

3. establish difficulties which geography learners experienced when they were engaged in inquiry learning.

4. suggest how the problems experienced by geography teachers when engaged in inquiry teaching, could be alleviated.

5. suggest how the problems which geography learners experienced when engaging in inquiry learning could be alleviated.

6. establish the science process to be applied during the teaching of geography.

7. examine problems which geography learners encountered when science process skills were applied to the teaching of geography.

8. suggest how the problems experienced by geography learners, when science process skills were applied to the teaching of geography could be alleviated.

9. examine what problems do geography teachers experience when they apply science process skills to the teaching of geography.

10. examine how the problems experienced by geography teachers, when applying science process skills to the teaching of geography, could be alleviated;

11. determine the relationship between the science process skills and the learning outcomes of the natural sciences.

These objectives were likely to be attained through two main sources, namely, a literature survey and an empirical investigation. In addition to these objectives, the researcher was also prompted to list some hypotheses.

1.3.4 Hypotheses

A hypothesis (cf. 2.5.2.7 and 4.5.2) is a prediction, a statement of what specific results or outcomes are expected to occur (Fraenkel and Wallen 1996: 18). A hypothesis can also be defined as a tentative prediction of the results of the research findings (Gay and Airasian 2000: 71). Hypotheses state the researcher's expectations with regard to the relationship between the variables of the research problem (Ary, Jacobs and Razavieh 1990: 94; Gay 1992: 66; Gay and Airasian 2000: 71 and Van Dalen 1979: 196-197). The researcher formulated the hypotheses stated below in anticipation of the outcomes of this study.

First, the following two research hypotheses were tested on the grounds of a literature survey.

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

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.

Second, empirical investigations tested the *null hypothesis* below.

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

1.4 SIGNIFICANCE OF THE STUDY

The questions and hypotheses outlined above are important because they could be linked to poor teaching of secondary school geography and a high failure rate in the subject in the Free State Province. For example, Table 1.1 which follows below, indicates Grade 12 learners' performance in geography in 1998 and 1999 (Appendix 2).

Table 1.1 Grade 12 Learners' Performance in 1998 and 1999 Examinations in the Free State province

YEAR	1998	1998	1999	1999
GRADE	Higher Grade	Standard Grade	Higher Grade	Standard Grade
% PASS	50.36	51.3	29.09	44.62
% FAIL	49.64	48.7	70.91	55.38

(Free State Department of Education)

Table 1.1 clearly indicates that the state of secondary geography education in the Free State province is a matter of growing concern. Learners' poor performance in geography needs to be improved to guarantee the future existence the subject in the new curriculum.

As it has been mentioned before, this study argues for the application of science process skills to the teaching of geography. A question arises as to why science process skills should be applied to the teaching of geography? As already mentioned in section 1.3.1, some researchers on geography education in South Africa, such as Ballantyne (1986: 142); Davies (1987/1988: 118); Magi (1981: 150); Nicol (1979: 71) and Rambuda (1994: 71), claim that teacher transmission of geographical knowledge characterises the teaching of geography in South Africa. However, it is heartening to note that this poor state of affairs can be corrected. For instance, Radford (1988: 4) pleads for the teaching of science process skills in classes where lecturing is most dominant. It is claimed that this is indeed possible through a lecture-class discussion approach rather than a laboratory-centred approach. It appears as if the application of science process skills to the teaching of geography may suit the teaching styles of many teachers who "tell" the learning content (knowledge) all the time.

The adoption of science process skills is also appropriate to the material conditions which exist in most secondary schools in South Africa. The researcher's experience (Rambuda 1994: 6) is that most schools have inadequate learning materials and are impoverished and poorly resourced (Education and Training Act 1995: 18). Radford (1988: 4) claims that the lecture-class discussion approach *"...requires fewer material resources than* a *lab-activity based approach".* This implies that the lecture-class approach describes most secondary schools which offer geography, because most schools in South Africa have a shortage of teaching resources (Education and Training Act 1995: 18, and Rambuda 1994: 28).

Furthermore, it is argued that the use of the science process skills approach requires less instructional time and can be added to any curriculum quite easily (Radford 1988: 4). Science process skills are valuable to teachers who normally waste a lot of time at the end of the lesson in an effort to recap the learning content taught (Radford 1988: 4). Instead, time wasted could rather be used to teach process skills. Geography teachers should rather utilise the time wasted productively by teaching science process skills during the last few minutes before the end of each period.

It is envisaged that the outcomes of this study might influence geography teachers to integrate process skills' instruction in their practice. It is also envisaged that the application of science process skills to the teaching of geography could well contribute to the realization of the principles of outcomes-based education(cf. 3.6). This is indeed the case because Curriculum 2005 was structured around the realisation of critical and developmental outcomes (cf. 3.8) which are in turn linked to science process skills.

Science process skills are essential in the realisation of the critical and developmental outcomes outlined in South African OBE. Proponents of science process skills argue that science process skills are transferable and generalisable to other life situations (Funk, Fiel, Okey, Jaus and Sprague 1979: xii, and Kok and Woulnough 1994: 31), hence a knowledge of science process skills is essential to any person. However, some researchers oppose this view (cf. 2.6). The researcher, like proponents of science process skills, is convinced that the application of science process skills to the teaching of geography could contribute positively to the attainment of the skills needed for survival in life.

Furthermore, it was envisaged that the outcomes of this study might generate interest in teaching-learning activities that fostered the development of the outlined critical and developmental outcomes of South African OBE. These are teaching-learning activities that allow learners' involvement in the learning process. Participative methods such as discussion and problem-solving characterise such teaching and learning activities. Learners who are engaged in these activities are likely to acquire and master skills such as observing, communicating, classifying, measuring, inferring, predicting, hypothesising and controlling variables. These skills are more or less similar to Spady's Fundamental Life Performance Roles, namely, *"listeners and communicators, teachers and mentors, supporters and contributors, team members and partners, leaders and organisers, learners and thinkers, implementers and performers, problem finders and solvers, planners and designers, and creators and designers"* (Spady 1994b: 70 - 71). These are the life roles which American citizens are expected to possess in life (Spady 1994b: 70). South African citizens, through OBE are expected to possess more or less the same type of skills.

However, it is important to note that most of the critical and developmental outcomes of outcomes-based education are not new to secondary school geography education. Some of the elements of the critical and developmental outcomes are found in the preamble and guidelines to teachers of the 1996 Guideline Document and Interim Syllabus for Geography Grades 10 to 12. The syllabus points out that geography teachers must develop the intellectual skills and abilities of learners to promote life-long education. Amongst others, the aims and objectives of the interim syllabus are the following:

> *In lesson presentation teachers should bear in mind the higher abilities of comprehension, analysis, synthesis, evaluation and application;*
>
> *This subject should be taught in such a way that pupils develop eagerness for further study and individual inquiry* (Guideline Document and Interim Syllabus for Geography Grades 10 to 12 1996: 2).

Proper scrutiny of these aims and objectives indicates that as is the case in Curriculum 2005 and science process skills, the geography syllabus is also based on the idea of lifelong learning. Furthermore, in its teaching guidelines the syllabus recommends the adoption of science process skills. It is stated that learners should be educated in the scientific method of inquiry *(statement of hypothesis, collection and classification of information and the testing of hypotheses)* (Guideline Document and Interim Syllabus for Geography Grades 10 to 12 1996: 6). The recommended scientific method involves the process of inquiry. Millar (1989: 51) maintains that scientific inquiry ..."*involves the exercise of skill: in deciding what to observe, in selecting which observations to pay attention to. in interpreting and drawing inference, in drawing conclusions from experimental data, even in replicating experiments.*" This implies that a person cannot be engaged in scientific inquiry without applying one or more of the science process skills.

Therefore, it was also assumed that the outcomes of this study might encourage geography teachers to introduce scientific inquiry in their practice. Hence, the introduction of scientific methods of inquiry could enable geography teachers and learners to apply science process skills, which might empower their dealings with geographical knowledge in an organized manner.

Mastery of science process skills could also contribute to the development of a variety of functions, namely, oracy and literacy, numeracy, graphicacy, interpretation, problem solving and so forth. Oracy and literacy enhance peoples' communication skills. This implies that individuals may think logically, write concisely and speak with assurance and accuracy. Those who possess numeracy skills have the ability to quantify descriptions of objects and events. They also have the ability to draw graphs and tables of measured objects or events. Furthermore, people who possess graphicacy skills are able to draw, read and interpret graphs. Graphicacy skills empower them to understand trends and patterns of change of events or objects. Interpretation skills influence peoples' concept of space. Interpretation of pictures, photographs, statistics and maps is likely to enhance spatial conceptualization in people. According to the Department of Education (2001a: 13) education in South Africa should produce a kind of a learner who is equipped in dealing with some of these tasks.

Mastery of science process skills could provide opportunities for learners to respond to problem solving and decision-making situations through critical, divergent and creative thinking. These processes could empower geography learners to act upon evidence and to make decisions based on scientific understanding of reality.

It can also be argued that science process skills are likely to influence cognitive learning. Cognitive learning enhances discovery of new knowledge, processes, facts, concepts and evaluation. According to Farrant (1988: 107) "*cognitive learning is achieved by mental processes such as reasoning, remembering and recall.*" These mental processes are essential for learners to use basic and integrated skills of science process, while constructing new knowledge.

The syllabus also suggests that learners should undertake short independent projects throughout the year on work related to the curriculum (Guideline Document and Interim Syllabus for Geography Grades 10 to 12 1996: 4). An implementation of this activity could provide learners with ample opportunities to apply science process skills while investigating geographical significant problems through inquiry.

Rambuda (1994: 18) also noted that the nature of geography education in South Africa has changed from descriptive geography to geography which studies the interrelationship between people and their environment. Learners are expected to understand the cause and effect of this relationship through inquiry learning (Winter 1992: 141). However, some studies on the state of secondary school geography education in South Africa, indicate that inquiry teaching is rarely applied (Ballantyne 1986:116; Boqwana 1991: 105; Magi 1981:150; Mphaphuli 1992:

120 - 121 and Rambuda 1994:83). Geography learners memorize the content without insight and understanding and are seemingly not critical thinkers (Magi 1981: 151). If this regrettable state of affairs is not corrected, changed or improved, it may not be possible to realize the principles of OBE.

Subsequently, it is assumed that the outcomes of this study might promote inquiry teaching and learning in most geography classrooms. Inquiry teaching and learning might encourage learners to shift from rote learning to meaningful learning, as inquiry teaching and learning encourage active learning and the development of critical thinking skills in learners. Hence, these might create opportunities for learners to raise their level of thinking and understanding of geographical facts and concepts. Inquiry learning, according to Winter (1992: 142), is "*a learning process involving the investigation of a question, a problem or an issue, in which the interrelationship between people and their environment is studied.*" This stance correlates with that of Lambert and Balderstone (2000: 73), who argue that inquiry learning refers to situations where learners are actively inquiring into issues, questions, or problems rather than passively receiving information from teachers and other sources.

However, it is important to note that the researcher at no stage was under illusion that this work alone would bring about miracles to the identified problems in geography education. Various experts in the field of educational practice would need to work together to find solutions to these problems. What is important is that the outcomes of this study and the solutions propagated by other experts should indeed be implemented to improve the teaching of all secondary school subjects in South Africa. This in turn might equip future learners with skills that could enable them to confront socio-economic problems of the 21st century with confidence. The outcomes of the study are likely to play a role in empowering geography learners to participate as active citizens of South Africa who can compete internationally.

1.5 RESEARCH METHODOLOGY

This study implemented the following two research methodologies, namely literature survey and empirical investigation.

1.5.1 Literature Survey

The researcher reviewed literature that was related to the research problem. Literature reviewed is discussed in detail in Chapters 2, 3 and 4. The main purpose of literature study was to test hypotheses 1 and 2 (cf.1.3.4). For instance, Chapter 2 attempted to justify that science process skills were suitable and effective for the teaching of geography at secondary schools. Chapter 3 indicated that science process skills were linked specifically to the learning outcomes of the natural sciences. Furthermore, in this chapter it is also argued that science process skills could be realized and achieved as observable and demonstrable outcomes, whilst Chapter 4 took cognisance of the application of science process skills to the teaching and learning of geography. Literature reviewed also assisted the researcher to select research strategies, procedures and instruments that rendered the opportunity to conduct the empirical investigation under discussion.

1.5.2 Empirical Investigation

Both quantitative and qualitative research methods were applied to this research (cf. 5.2). Scott (1996: 59) maintains that the two research methodologies do not belong to separate research paradigms and thus can sensibly be used within the same investigation. Questionnaires (cf. 5.2.1) and interviews (cf. 5.2.3) were used to gather data. These research instruments were employed so that the results from one form of data could help to inform and refine the other data. Verma and Mallick (1999: 115) note that the process of using both research instruments ensures that the conclusions drawn are meaningful, precise and representative, hence the discussion in the next section.

1.5.2.1 Quantitative Empirical Study

In quantitative research, data was organised in non-experimental quantitative terms and expressed in numerical measures. Quantitative data analysis was applied in the closed items of the questionnaires because of its objectivity and context-free generalization. Responses on science process skills items were subjected to factorial analysis (cf. 6.2.3.1) which confirmed two groups of science process skills. In empirical research, interpretations and conclusions were drawn from evidence obtained from gathered data irrespective of the researcher's experiences and beliefs (McMillian and Schumacher 1993: 11; and McBurney 1994: 412).

Survey questionnaires were sent to randomly selected public and independent secondary schools in the twelve education districts in the Free State province (cf. 5.4.2). The questionnaires (Appendices 3 and 4) requested the participants to respond to questions relating to inquiry teaching and the application of science process skills to geography teaching. The evidence which was obtained from collected data was used to describe the application of science process skills to geography teaching, hence this is also a descriptive study.

A descriptive study simply describes an existing phenomena (McMillian and Schumacher 1993: 35; and Gay and Airasian 2000: 11). Furthermore, descriptive research is conducted to obtain information about the preferences, attitudes, practices, concerns, or interests of some people (Gay and Airasian 2000: 11). Mahlangu (1987: 14) maintains that descriptive research "*involves the description, recording, analysis and interpretation of the present nature,* *composition, or process of phenomena. It focuses on prevailing conditions, on how a person, a group or thing behaves or functions in the present.*" This study attempts to describe the application of science process skills to the teaching of geography in secondary schools.

Geography teachers and learners respectively rated their inquiry teaching and learning activities. Teachers rated their application of science process skills to the teaching of geography whilst learners indicated their responses to general statements about teacher applications, i.e. whether teachers apply science process skills. The SAS statistical program was used to compute and analyse the collected data (cf. 5.3). As it was already mentioned, quantitative research was complemented with qualitative research.

1.5.2.2 Qualitative Empirical Investigation

Qualitative research is used to obtain a more holistic picture of what goes on in a particular situation or setting (Fraenkel and Wallen 1993: 10). Qualitative methods are probably the best means for discovering educational problems and enable researchers to better understand the total environment in which education takes place (Borg and Gall 1989: 404). Hence in this study, qualitative research was used to attain objectives 2, 3, 4, 5, 8, 9,10 and 11 (cf. 1.3.2) and questions 7, 8, 9, 10, 11,12 and 13 (cf. 1.3.3). The researcher interviewed geography teachers and learners in order to find problems that they experienced when they taught and learned geography respectively (cf.5.2.2 and 6.4). Interviews also attempted to find solutions to the problems that were identified.

1.6 CONCEPTS AND DEFINITIONS

This section attempts to define concepts that were used in the study. Mhlongo (1996: 10) maintains that a given concept may have a different meaning to different people. Furthermore, the same concept may evoke more than one meaning to the same group of people depending on the time and the context in which it is used. Concepts that are defined in this section are: *Inquiry teaching, inquiry learning, science process skills, basic science process skills, integrated or advanced science process skills, outcomes and outcomes-based education.*

These concepts are defined more explicitly because it is assumed that they are associated. For example, inquiry teaching and inquiry learning are likely to lead to the application of science process skills. Furthermore, science process skills and the outcomes are closely associated (cf. 4.3.5) as indicated by the next paragraphs.

1.6.1 Inquiry Teaching

Inquiry teaching is a systematic way of teaching by giving learners inquiry tasks that develop learners' thinking skills to perform. Learners are taught how to confront questions and problems they could encounter in their environment. Children are able to discover something new as they are engaged in hands-on learning opportunities and appropriate materials to manipulate. Eggen and Kauchak (1988: 208) maintain that the General Inquiry Model of teaching strategy proceeds as follows:

- ☐ Question or problem identification
- ☐ Hypothesis generation
- ☐ Data gathering

- Assessment of hypotheses through data analysis
- Generalizing

These procedures involve the testing of ideas in the public arena (Fraenkel and Wallen 1993: 6). The teacher may guide learners to solve problems by making use of these five phases. The teacher becomes a facilitator in the teaching-learning process.

Hassard (1992: 21) also maintains that this method of instruction includes guided and unguided inductive inquiry, deductive inquiry and problem-solving. In inquiry teaching, learners are encouraged to learn how to investigate and solve problems (cf. 2.3). This process is called the scientific method. It appears as if inquiry teaching could lead to the application of science process skills to geography which are realizable as outcomes (cf. 2.4). It is likely that inquiry teaching might promote inquiry learning.

1.6.2 Inquiry Learning

According to Eggen and Kauchak (1988: 208) inquiry learning is ... "*viewed as a process for answering questions and solving problems based on facts and observations.*" This statement implies that inquiry learning is a systematic way of learning by investigating a problem or a question. Hence learners' critical thinking skills are developed through the application of science process skills.

Martin et al. (1994: 11) state that in inquiry learning, learners search for truth or knowledge that requires them to think critically. This implies that learners who are engaged in inquiry learning are likely to observe, to ask questions and to state conclusions.

Furthermore, Hassard (1992: 21) claims that learners who are engaged in inquiry learning learn about concepts and phenomena by using observations, measurements and data to develop conclusions. All these are elements of science process skills.

1.6.3 Science Process Skills

Science process skills are all activities which scientists execute when they study or investigate a problem, an issue or a question. These skills are used to generate content and to form concepts (Funk et al. 1979: ix).

Furthermore, Martin et al. (1994: 11) regard process skills as the way of thinking, measuring, solving problems, and using thoughts. This implies that thinking and reasoning are involved in inquiring teaching and learning. Hence teachers and learners could apply science process skills while developing inquiry teaching and inquiry learning.

Science process skills are classified into basic science process skills and integrated science process skills. Integrated science process skills are more advanced than basic process skills. Brotherton and Preece (1995: 5) argue that scientists are only able to effectively use integrated skills once they have first mastered basic skills.

1.6.4 Basic Science Process Skills

These are skills which are appropriate to elementary grades. They are the foundation of science which learners are required to possess before they could acquire and master integrated science process skills which are more advanced (Brotherton and Preece 1995:5). Funk et al. (1979: 1) maintain that basic science process skills are interdependent. This implies that an investigator may display more than one of these skills in any single activity.

For instance, to *measure* a distance between two points on a map, the investigator may start by *observing* the two points, then *measure* the distance and *communicate* the same distance by means of a symbol. Thereafter, the investigator may *predict* how long it may take a person to travel from one point to another. (S)he may then *infer* the best form of transport to use to travel between the two points. In this scenario, the investigator was involved in the skills of observing, classifying, predicting, measuring (metric), inferring and communicating (cf. 2.5.1).

It appears as if basic skills provide the intellectual ground work in problem solving. Children who can perform these skills are likely to show understanding of basic science processes (Martin et al. 1994: 11) and perform integrated science process skills.

1.6.5 Integrated Science Process Skills

These are immediate skills which are used in problem solving. Integrated skills include skills such as identifying variables, constructing tables of data and graphs, describing relationships between variables, acquiring and processing data, analysing investigations, constructing hypotheses, operationally defining variables, designing investigations and experimenting (cf. 2.5.2) (Funk et al. 1979: 83). As the term *integrated* implies, learners are called to combine basic process skills for greater power so as to form the tools they execute when they study or investigate phenomena. This process could lead to the realization and achievement of integrated science process skills as observable and demonstrable outcomes (cf. 4.5).

1.6.6 Outcomes

Various researchers (King and Evans 1991: 73; Spady 1994a: 18 and Spady and Schlebusch 1999: 44) define outcomes as what learners are able to do at the end of the teaching-learning process. Furthermore, King and Evans (1991: 73) regard outcomes as the end -products of the instructional process which may be observable or lead to internal changes in the learner. This implies that at the end of the learning process, learners should be able to demonstrate an ability to do something. This also implies that learners are likely to be seen thinking and behaving in a specific manner. Reflection on learners' actions and behaviour might indicate whether teaching and learning were successful or not.

This idea is also supported by Spady (1994a: 18) who maintains that outcomes are high-quality, culminating demonstrations of significant learning in context. Demonstration is the key word - an outcome is not a score or a grade, but the end product of a clearly defined process that learners carry out. Outcomes are the results of learning processes and refer to knowledge, skills, attitudes and values within particular contexts. Learners should be able to demonstrate that they understand and can apply the desired outcomes within a certain context (Department of Education 1997a: 32 and Department of Education 1997b: 4). This discussion implies that outcomes are statements of the significant things that learners should be able to demonstrate as a result of a period of instruction and learning.

Curriculum 2005 and Department of Education have identified three sets of outcomes, namely, critical and developmental outcomes (cf. 3.8), specific learning outcomes (cf. 3.9) and lesson's outcomes. Critical, developmental and specific outcomes were pre-specified by the Department of Education. The terms used to describe these outcomes are constantly changing as are the actual specific outcomes themselves.

Curriculum 2005 has seven critical outcomes and five developmental outcomes. Critical and developmental outcomes are generic, cross-curricular, cross-cultural outcomes that focus on the capacity to apply knowledge, skills and attitudes in an integrated way (Curriculum 2005 1997: 32; Department of Education 1997a: 3 and Pretorius 1998: 3).

Amongst others, examples of critical outcomes are problem solving, critical and creative thinking, efficient information processing and effective communication. Developmental outcomes include issues such as developing business opportunities, exploring education and career opportunities, and reflecting on and exploring a variety of strategies to learn more effectively. These are the qualities that the South African education and training system should attempt to inculcate in every citizen (Department of Education 2001b: 9).

Specific learning outcomes are knowledge, information, skills, attitudes and values that learners should know and be able to do in a learning area (Department of Education 2001a: 21). They do not prescribe content but focus on knowledge, skills and values that should be promoted in learning area.

Lesson's outcomes are demonstrated knowledge, skills and attitudes in a particular context or learning field (Department of Education 1997a: 32; Department of Education 1997b: 4; Pretorius 1998: 3 and Van der Horst and McDonald 1997: 48). They describe what learners should know and be able to do at the end of a learning process. Therefore, an education which focuses on the demonstrations of outcomes (knowledge, skills and attitudes), is known as an outcomes-based education.

1.6.7 Outcomes-based Education

Outcomes-based education (OBE) is an education system in which the curriculum, instruction and assessment are organised around and focused on outcomes (cf. 3.6). It is a learner-centred, results-oriented design, which relies on the assumption that all learners can learn (Department of Education 2001b: 17; Naicker 1999: 87; Department of Education 1997a: 17 and Spady 1994b: 9). What a learner is to learn is clearly identified. These are outcomes which are focused on life skills and context. In OBE, learning is supposed to be active and experienced-based for maximum application of knowledge, skills and values which are essential for life. Hence programmes of learning are designed to help learners to achieve the desired outcomes. The learners are expected to be able to contextually display learned knowledge, skills and values. Hence this process is likely to enhance the application of science process skills to most learning fields.

1.7 DEMARCATION OF THE STUDY

The study was undertaken in the field of school subject didactics and was confined to the application of science process skills to the teaching of geography in secondary schools in the Free State province. Hence the subjects of the study were secondary school geography teachers and learners.

1.8 CHAPTER OUTLINE

The chapter outline of this study can be represented diagrammatically as follows:

Figure 1.1 Programme of the Study

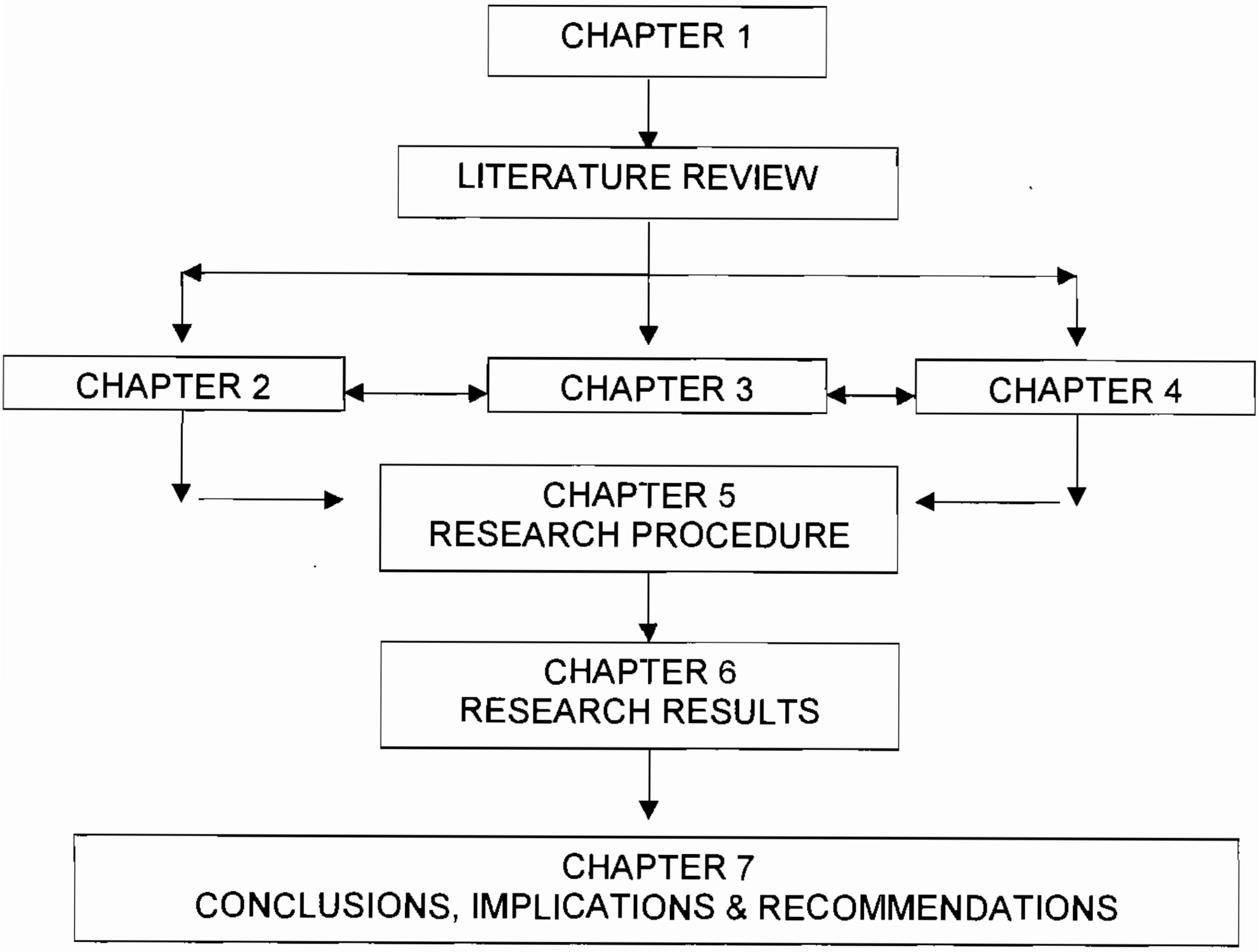


Figure 1.1 indicates that Chapter 1 gives an orientation of the problem investigated. The chapter also highlights the significance of the study.

Chapters 2, 3 and 4 review literature related to the problem investigated. Chapter 2 examines teaching approaches in geography education as recommended by the syllabus and Curriculum 2005. It also explains inquiry as an approach of teaching geography. Furthermore, the chapter reviews the nature and structure of the science process skills and concludes by explaining the applicability of science process skills to secondary school geography.

Chapter 3 discusses the nature and structure of geography. It also highlights the implications of the nature and structure of geography on the application of outcomes-based geography teaching.

Chapter 4 deals exclusively with the application of science process skills to the teaching of geography.

Chapter 5 reviews the data processing procedures and also describes the statistical techniques applied.

Chapter 6 presents the collected data on the application of science process skills to the teaching of geography.

Chapter 7 provides conclusions and implications of the study. It also highlights some recommendations and identifies possible topics for future research.

1.9 CONCLUSION

This chapter has provided an overview of the study. It also offered a review of the theoretical rationale, hypotheses tested were provided, and a summary of the research's methodological procedure employed was highlighted.

The following chapter reviews literature relevant to geography teaching approaches and science process skills.

CHAPTER TWO

GEOGRAPHY TEACHING APPROACHES AND SCIENCE PROCESS SKILLS

2.1 INTRODUCTION

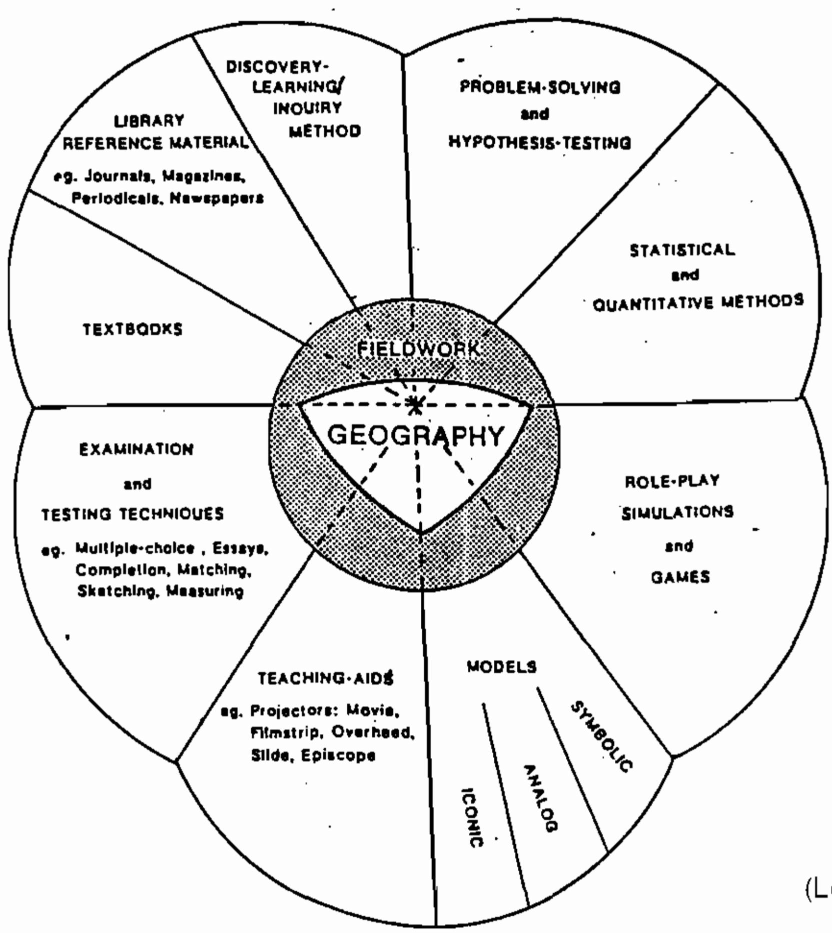
The previous chapter outlined and delimited the problem investigated in this study. This chapter reviews the literature that discusses teaching approaches in secondary school geography education with particular emphasis on South African secondary school geography. An inquiry teaching approach is described and justified as a method of teaching likely to improve and enhance the teaching of secondary school geography.

The chapter also argues for the adoption of inquiry teaching supplemented with the application of science process skills to the teaching of geography. Furthermore, the nature and structure of the science process skills with a focus on basic and integrated science process skills is explained. It also attempts to give a critical reflection of the importance of science process skills in the curriculum. In order to establish how science process skills can be integrated into secondary school geography, the applicability of science process skills to the teaching of geography is also highlighted.

2.2 TEACHING APPROACHES IN GEOGRAPHY EDUCATION

Teaching approaches indicate how teachers may develop effective learning experiences in their learners. This section discusses the importance of geography teaching approaches, because they are likely to reveal that geography should be taught in such a way that learners develop an eagerness for further study and individual inquiry. Figure 2.1 below clearly indicates a model of teaching strategies that could be applied to the teaching of geography in South Africa.

Figure 2.1Teaching strategies: A model for new geography in South Africa



(Ledger 1978: 11)

It is important to note that some sectors presented in Figure 2.1, especially the library reference material, discover-learning/inquiry method, problem solving and hypothesis testing, and statistical and quantitative methods represent strategies that include science process or inquiry skills. Figure 2.1 further shows that teaching and learning approaches proposed in Curriculum 2005 (cf. 3.5) are nothing new as they have been advocated about quarter of a century ago. One of the cornerstones of Curriculum 2005 is that teachers should make every effort to develop the affective domain of learners. This implies that every effort should be made to involve learners in environmental problems that affect their communities. Involvement in community matters entails decision making on the part of learners.

Proper decision making is possible only if inquiry teaching and inquiry learning, which raise learners' level of thinking and understanding, are adopted (Winter 1992: 141). The development of critical thinking skills is possible if geography teachers could arouse learners' interest and curiosity. This implies that geography learning should follow the issue-based approach (Bale 1983: 64) which is likely to enable learners to solve the communities' pressing social and environmental issues. For instance, the teacher may request learners to investigate pollution as an issue that affects their local environment. Learners would be compelled to investigate the interrelationship between people and their environment. In their investigation of the causes and effects of pollution, learners are likely to use some process skills. Issue-based approach facilitates inquiry into human values and attitudes (Bamber and Ranger 1990: 60). Learners are encouraged to always 'find out' on their own. If teachers adopt this approach effectively, they are likely to foster inquiry behaviours which are essential when learners seek information. The fostering of inquiry behaviours is likely to develop learners into better scientific inquirers.

It is further recommended in Curriculum 2005 (1997: 13 -27) that teachers should inter alia, adopt the holistic approach which involves learners in scientific investigations, use both the descriptive and the problem-solving approaches, the thematic approach and interdisciplinary approach.

The adoption of these approaches is likely to promote the development of geographical knowledge and science process skills which are necessary when learners study and seek information. This is likely to put less emphasis on "what" and more emphasis on "how" and "why". The discussion in the next paragraphs highlights the teaching approaches that a geography teacher is supposed to practice in his/her classroom.

2.2.1 The Holistic Approach

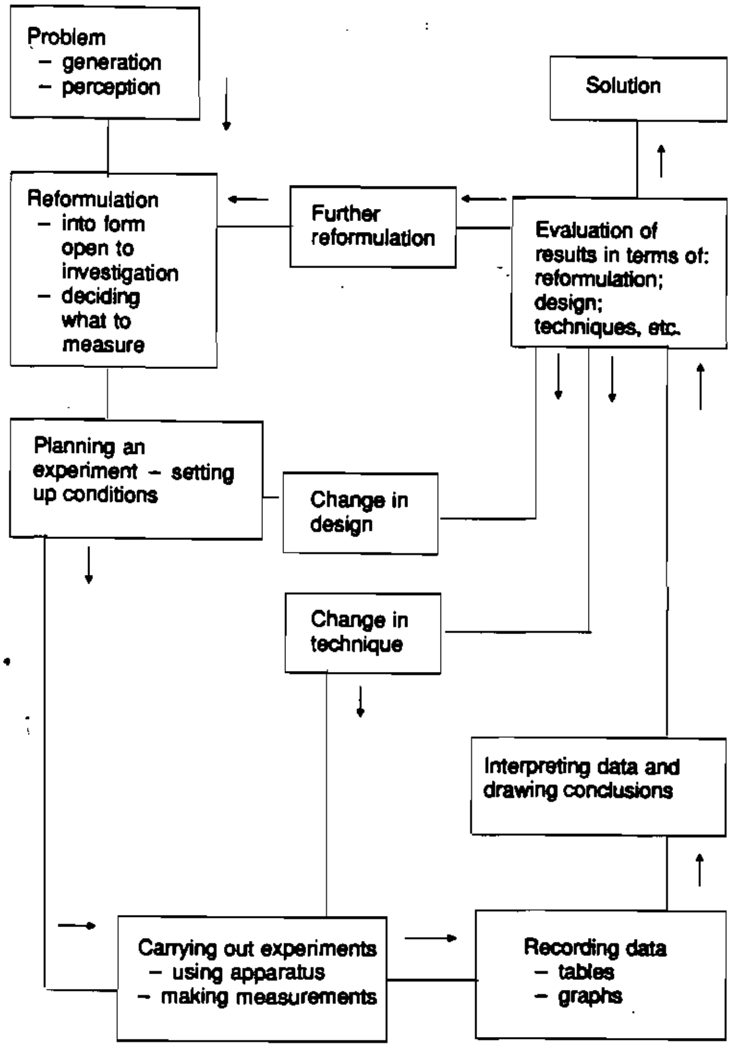
While following the holistic approach, the teacher should help learners to view different disciplines of geography as parts of the 'whole' geography. Furthermore, learners should be able to see the interrelationship and interaction between different disciplines of geography and other subjects. For example, wherever possible, learners should see the interrelationship between physical geography, human geography and ecology. Bailey (1987: 8) regards the purpose of teaching geography as enabling the growing child to conceptualise and set the dimension in which all human beings live in order. This implies that geography learners should be taught to realise that human actions have some impact on the environment and that the environment also has some impact on human behaviour. For instance, learners should realise that pollution of water sources affects the ecosystem as aquatic plants and animals may die as a result. Furthermore, learners should be aware that lack of adequate rainfall may affect subsistence farming. Hence, subsistence farmers could cultivate less crops and harvest low yields. The holistic approach helps learners to see knowledge in an integrated way, which in turn enable them to transfer and apply skills they learn in geography to other real life situations.

2.2.2 The Descriptive and The Problem-solving Approaches

Curriculum 2005 (1997: 29) states that both the descriptive and the problem-solving approaches have a place in the teaching - learning process although much emphasis should be placed on the problem-solving approach. Descriptive geography describes and interprets cultural and physical phenomena of the world (Rambuda 1994: 11). Davies (1987/1988: 118) contends that descriptive geography encourages rote learning which is unintelligent memorisation of concepts and facts. As a result, geography becomes a burden to learners' memory. Consequently, intelligent learners tend not to opt for geography studies at secondary school level. Able learners may become demotivated as this approach encourages learners to receive knowledge passively with minimal involvement in the learning process. A mixture of this style of teaching with a teaching style that challenges learners' intellect is essential. This is aptly supported by the substance and syntax of geography (cf. 3.3). The substance and syntax of geography show that because of its geographical facts, principles and laws, geography cannot be taught without creating and maintaining a sound body of knowledge. This implies that teachers should supplement descriptive teaching with problem-solving. This is likely to meet today's educational demands for reflective thinking, competence building and inquiry into the real world. Investigators may use Gott and Murphy's problem-solving model to follow some order in problem-solving. Figure 2.2 which is drawn on the next page depicts this problem-solving model.

Figure 2.2 indicates tasks which are carried out when a problem is investigated. In order to implement this model, the teacher should start from the left side to the right side. Boxes on the left represent the planning phase of problem-solving. A problem is identified and defined. The investigator decides and plans methods for carrying out the investigations. In the middle boxes the defined problem is reformulated, and designs and technique may also be changed. The investigation is carried out after this process. Boxes on the right represent the continuation of the implementation phase. Learners collect and interpret data with minimal teacher intervention. The teacher acts as facilitator and guide. Learners use their interpretation to reach conclusions. Figure 2.2 below illustrates the problem-solving model.

Figure 2.2 Gott and Murphy's Problem-solving Model



(Parkinson 1994: 117)

The discussion on Figure 2.2 clearly implies that in the problem-orientated approach, learners should be trained in the scientific method of inquiry *(statement of a hypothesis, followed by the collection and classification of information, and finally, the testing of the hypothesis)*. It also implies that learners should be afforded the opportunity to identify and resolve problems, which in turn equips learners with experience in conducting a form of inquiry investigation. Inquiry investigation is likely to help learners to be confident when engaged in processes such as observing, hypothesizing, experimenting and concluding.

Rakow (1985: 290) maintains that implementation of science process skills produces knowledge. Construction of knowledge needs a learning environment which promotes scientific literacy, the development of critical thinking skills and the opportunity to explore geographical phenomena using science process skills. However, Davies (1987/1988: 118) has noted that very few geography learners ..."*have enquiring mind and critical ability.*" The study of Rambuda (1994: 76-77) also found little evidence of inquiry teaching and inquiry learning in geography classrooms. Rambuda (1994: 78) observed thirty geography lessons and discovered that learners never questioned or disputed whatever their teachers told them. Learners were unable to distinguish between geographical facts and opinions. This practice suggests that geography learners appear not to understand geographical principles and concepts. Learners seem not to possess the ability to make objective judgements. The fact that learners generally possess inadequate problem-solving skills, could be attributed to the way geography is taught in schools.

This problem points to the need for constructive alternatives to this unsatisfactory state of affairs. Hence, it might be impossible to realise the aims and objectives of Curriculum 2005 in general and outcomes-based education in particular, if this problem is not redressed. One of the principles of outcomes-based education is to make inquiry behaviours the central focus of teaching and learning in South Africa, as it is hoped that this practice may develop citizens who can tackle and solve problems with confidence (Curriculum 2005 1997: 10).

Geography as a school subject is likely to provide opportunities to satisfy the goals of teaching responsible citizenship in South Africa. The teaching of geography is supposed to adapt and change in order to meet this challenge. Ballantyne (1989/1990: 124) points out that change in the nature of geography education should focus on the teacher rather than the subject. This implies that teachers have to adapt and improve the quality of their practice. In addition to this, learners should also be genuinely involved in the learning process. This study proposes that innovative teaching and learning in geography education should involve the application of inquiry teaching and science process skills in order to motivate learners to develop questioning attitudes and the habits of critical and reflective thinking.

Trowbridge and Bybee (1990: 194) are of the opinion that inquiry teaching needs a questioning teacher with good questioning practices. This idea is also supported by Hill (1994: 15) who states that teacher questions guide inquiry in order to merge the inquiry process with the conclusion drawn. Directly linking teacher questions and learner answers helps to achieve an intellectually satisfying understanding of a problem. Amongst others, a teacher classifies questions by using the processes of science to ensure that the basic structure of science and critical thinking is taught (Trowbridge and Bybee 1990: 195).

The teacher is likely to devise questions which examine skills which include observing, hypothesizing, designing an experiment, graphing, setting up equipment, reducing experimental errors and inferring. It is interesting to note that Davies (1987/1988: 110) questions the ability of geography learners to observe, measure, calculate and communicate reports. These are basic elements of science process skills which are important in problem-solving. Science process skills are likely to encourage learners to use data to draw conclusions, a process which may develop high-level thinking. The conscious application of science process skills to the teaching of geography is likely to regenerate geography classroom practices.

2.2.3 Thematic Approach

The International Charter on Geographical Education (1992) recommends the adoption of a thematic approach in geography teaching. The International Charter on Geographical Education (1992: 10-12) classifies this approach into systematic, issue-based and system approaches. Systematic approaches deal with physical and human geography, for example, physical geography may include broader fields such as climatology or geomorphology. The focus of study for human geography may include fields such as population geography or settlement geography amongst others.

In issue-based approaches, geographers deal with current issues or problems at local, regional, national or global scales (cf. 2.2 and 2.3). Amongst others, examples of issues which could be studied are hazards and disasters, conflict, developmental problems and strategies.

Systems approaches imply teaching about physical systems, human systems and ecosystems. Examples of physical systems include climatic systems, biotic systems and so on. Human systems involve social and cultural processes in human organisations such as agricultural systems, settlement systems and so on. Ecosystems include the study of human and natural systems' integration in an ecosystem.

The approaches discussed above are used in combination and regardless of the approach adopted, teachers should encourage learners to engage in questioning and enquiry. It is essential that learners develop the geographical skills of seeking solutions to current and future problems in the organisation of space. In this way, geography curricula play a substantial role within political, social, ethical, personal, humanistic, aesthetic and environmental education (International Charter on Geographical Education 1992: 12).

Geography learners may undertake inquiry as individuals or as members of a group on short independent study topics. Learners are supposed to undertake well planned and meaningful fieldwork. They are expected to be competent in the use of measuring instruments and other apparatus. Geography teachers and learners should make use of diagrammatic representation of statistics (cf. 6.2) to communicate the results of their investigations (Teaching Geography 1995: 96).

All these recommendations are related to science process skills in one way or another. It is inevitable that geography teachers who implement these recommendations need to include science process skills in their teaching practice. The application of systematic approaches, issue-based approaches and system approaches in thematic studies curricula, enhances the role for geography in the interdisciplinary approach. Davies (1987/1988: 117) claims that some geography learners are unable to transfer their knowledge of other subjects into their geographical studies. The researcher assumes that the transfer of knowledge can only be possible if geography teachers foster the development of inquiring minds and questioning attitudes in their learners. Inquiry learning and inquisitiveness are likely to help learners see knowledge as integrated rather than compartmentalised.

2.2.4 The Interdisciplinary Approach

Guideline Document and Interim Syllabus for Geography Grades 10 to 12 (1996: 6) states that:

- ☐ *concepts studied in Geography may overlap in with those of subjects such as biology science and economics*;
- ☐ *interdisciplinary studies should form part of the broad teaching strategy*;
- ☐ *notwithstanding the overlap with other subjects, studies should always be undertaken from a geographical perspective.*

It is interesting to note that the interdisciplinary approach recommended above plays a substantial role within Curriculum 2005. Subjects with related learning knowledge are grouped together in the same learning area. This has led to the classification of knowledge into eight learning areas, namely,

- *Language, Literacy and Communication*;
- *Human and Social Sciences*;
- *Technology*;
- *Mathematic Literacy, Mathematics and Mathematical Sciences*;
- *Natural Sciences*;
- *Arts and Culture*;
- *Economics and Management Sciences*, and
- *Life Orientation* (Department of Education 1997a: 15).

As geography mainly deals with the earth sciences, it falls within the Natural Sciences Learning Area (cf. 3.5.3). Curriculum 2005 and outcomes-based education are discussed in detail in Chapter 3.

The teaching approaches reviewed, imply that geographers study how human beings interact with each other and with their environment. The interrelationship between humans and the environment is bound to lead to environmental problems which human beings have to apply their inquiring minds to find solutions to such problems. The occurrence of environmental problems implies that development of process skills in geographic inquiry should characterise the teaching of geography. Process skills of science are likely to enable learners to make informed decisions when solving problems. Their solutions are likely to be supported by evidence which is collected through the application of science process skills. This could be possible if geographic inquiry is introduced in geography teaching.

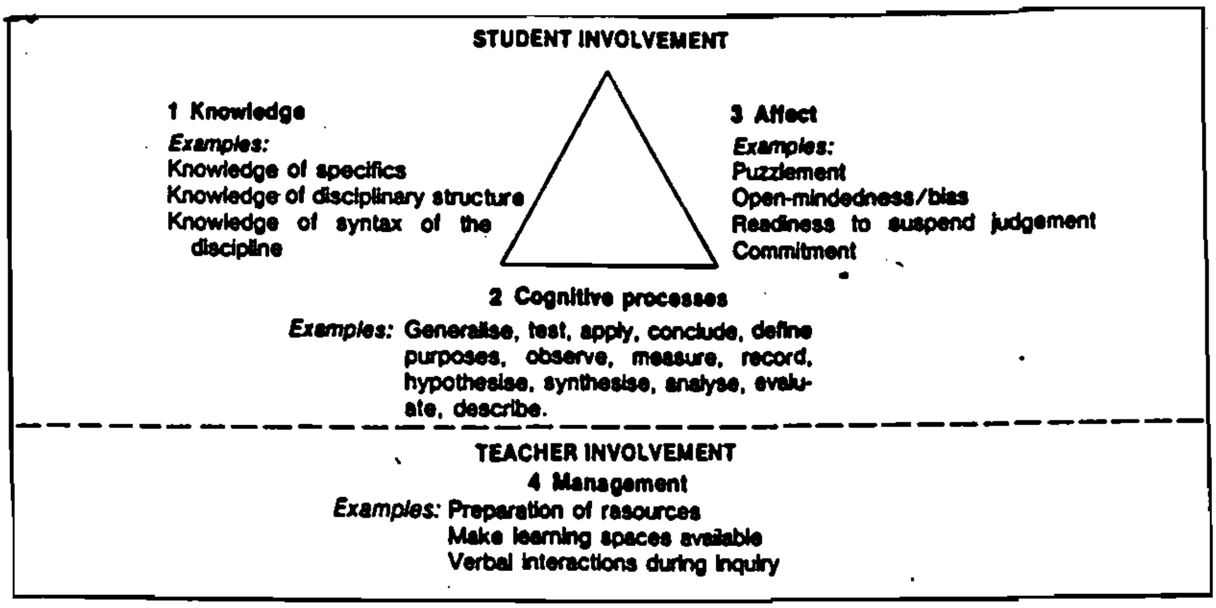
2.3 GEOGRAPHIC INQUIRY

Geographic inquiry became part of the methodology of school geography during the 1970s (Levy 1984: 201). The development of geographic inquiry may be encouraged through the adoption of issue-based geography (cf. 2.2 and 2.2.3). Issue-based geography inquiry fosters active learning and critical thinking (Hill 1994: 17). Inquiry is concerned with solving human and environmental problems. Bartlett (1982: 67) points out that geographic inquiry can be based either on the traditional method of observation and interpretation, or on systems analytic procedures. The steps of the traditional method of inquiry are to:

- Observe;
- Select and record;
- Describe and classify;
- Interpret: involving a combination of
  analysis
  synthesis
  evaluation
  explanation
  application; and
- Predict and control (Bartlett 1982: 67).

Bartlett's (1982: 67) steps of the traditional method of inquiry differ with Cox's (1984: 90) elements of classroom inquiry and are depicted in Figure 2.3 below.

Figure 2.3 The Elements of Classroom Inquiry



(Cox 1984: 90)

Analysis of these models of inquiry reveals that Bartlett has neglected the aspects of knowledge, affect and teacher involvement in classroom inquiry. However, Cox (1984: 92) declares that a productive classroom inquiry incorporates elements such as knowledge, cognitive processes, affect and teacher management which are interrelated.

However, it is important to note that these models of classroom inquiry have something in common. In both models, learners are likely to be involved in cognitive processes such as, observing a problem, selecting the methods they will use to solve it, collecting data, recording and interpreting their findings objectively.

Bartlett (1982: 67-68) further argues that successful inquiry is possible if steps of systems analytic procedures are developed and used. Steps of systems analytic procedures include the following:

- *Identify the problem or topic. Observation may be involved;*
- *Describe the system, its environment;*
- *Select alternative objects, linkages;*
- *Implement the system (draw a flow diagram, simulate ...);*
- *Evaluate and test the effectiveness of the designed model to improve it (i.e. predict changes); and*
- *Revise using one element to change the interrelationship among elements in system, continue implementation and test for understanding and accurate prediction.*

This implies that both the traditional method of observation and interpretation, and systems analytic procedures enable learners to be engaged in fruitful investigations and to offer reasons for their findings. This is also emphasised by Hill (1994: 17) who asserts that "*inquiry is essentially the method of science and of good detective work. It poses questions and proposes answers about the real world, and it tests its answers with real data.*" When applying geographic inquiry, teachers are more likely to supplement it with inductive and deductive inquiry, hence the discussion in the next section.

2.3.1 Inductive Inquiry

In this method, learning starts from the particulars (parts) to the whole, i.e. learning starts from facts to a law or principle. The following is a practical example for the application of inductive inquiry to geography. In a synoptic weather chart, learners may start by learning the elements of weather such as air temperature, humidity, air pressure, types of precipitation, dew point temperature, amount of cloud cover, wind speed and wind direction before they can interpret a synoptic weather chart. These elements of weather are the 'parts' and the synoptic weather chart is the 'whole'. After they have mastered the elements of weather, learners are able to interpret the synoptic weather chart (Appendix 13).

Eggen and Kauchak (1988: 109) maintain that inductive inquiry is "...*designed to develop the thinking skills of observation, comparing, finding patterns, and generalizing while at the same time teaching specific concepts and generalizations.*" An application of inductive inquiry requires the learner to start with an *observation* and then *formulate a hypothesis* (Van der Horst and McDonald 1997: 127) which (s)he uses to explain the results or the findings. Feibleman (1972: 83) regards induction as a logical term which is a general proposition in the form of a question suggested by a particular data. The question posed in the induction process may lead to a generalisation. Induction usually leads to hypotheses that are subsequently verified by observation, experiment, calculation, prediction and control. This statement correlates with Eggen and Kauchak's (1988: 112-113) model of the general procedure of inductive inquiry. The model is illustrated as follows:

PHASE ONE: THE OPEN-ENDED PHASE

- *Show the learners an example of the concept or generalization or a non example.*
- *Ask the learners to observe and describe the example.*
- *Show the learners a second example or non-example.*
- *Again have the learners observe and describe the second example.*
- *Continue the process using as many examples and non-examples as have been prepared.*

- *Ask the learners to compare the examples and non-examples.*

PHASE TWO: THE CONVERGENT PHASE

- *Prompt the learners to identify patterns in the examples.*

PHASE THREE: CLOSURE

- *Explicitly state the patterns in a definition.*

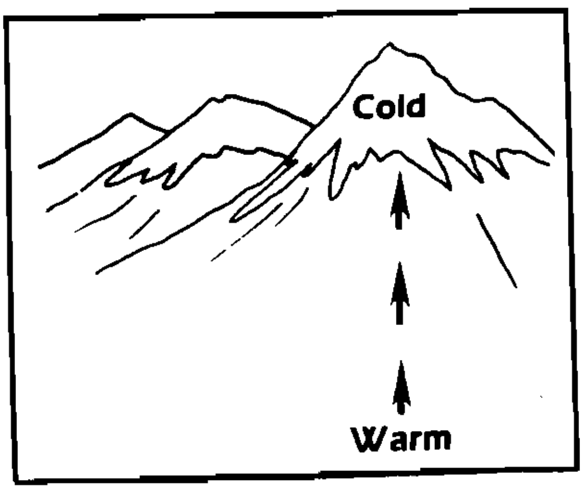
PHASE FOUR: THE APPLICATION PHASE

- *Apply the definition with additional examples.*

The model outlined above clearly shows that if it is followed properly, learners could be guided until they reach a universal rule. The following classroom scenario highlights the application of the inductive process in a hypothetical geography lesson on *condensation.* The teacher shows learners pictures of a snow-capped mountain (Figure 2.3) and a karst scenery (Figure 2.4) of a mountain. As illustrated below, (s)he uses the pictures to develop science process skills such as *observing*, *communicating*, *predicting*, *inferring* and *identifying variables* in the learners. The inductive lesson goes as follows:

Figure 2.4 If Warm Air Rises, Why is it Cold at the Top of the Mountain?

PHASE ONE: THE OPEN-ENDED PHASE



Snow-capped Mountain

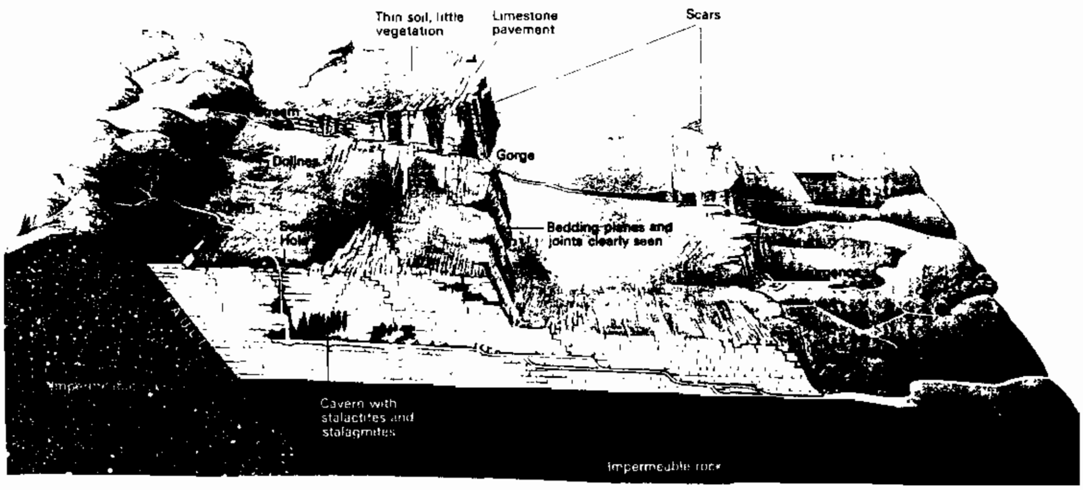
(Friedl 1991: 143)

Teacher: "*Could you describe what you see in this picture*?" (This question is likely to promote the development of basic science process skills of *observing* and *communicating* in learners).

Learners: "*We see a snow capped mountain peak, a rugged terrain, rocky outcrops and streams.*"

Thereafter, the teacher also shows the learners the second picture which depicts karst scenery of the mountain.

Figure 2.5 Karst Scenery of the Mountain



(Wiegand and Galbraith 1988: 39)

Teacher: "*What do you see in this picture*?" (*observation and communication*).

Learners: "*We see streams, thin soil with little vegetation, rocks, a plateau with a hole.*"

PHASE TWO: THE CONVERGENT PHASE

The outcome in this phase of the lesson is to enable learners to identify patterns in the pictures. This phase is likely to promote the development of basic science process skills of *classifying* and *inferring*. This is illustrated by the following dialogue between the teacher and the learners.

Teacher: "*Are the streams perennial or non-perennial*?" (*Classification*).

Learners: "*The streams are perennial.*" (Learners *infer* that the streams are perennial because they are represented by a solid blue line as a dotted blue line represents a non-perennial stream).

Teacher: "*What is the drainage pattern of this basin*?" (*Classification*).

Learners: "*The drainage pattern of the streams is radial.*"

Teacher: "*Why do you say it is a radial drainage pattern.*" (*Inference*)

Learners: "*It is a radial drainage pattern because streams start from the same source and flow to different direction.*"

Teacher: "*Why is the mountain peak covered with snow*?" (*Inference*)

Learners: "*It is cold on top of the mountain, condensation has taken place and temperature is very low.*"

Teacher: "*Why is the temperature low at the peak*?" (Inference)

Learners: "*It's low because the higher the altitude, the colder it becomes.*" (A general geographical rule).

PHASE THREE: CLOSURE

In this phase, the teacher explicitly states the pattern in a definition. The definition or rule is *the higher the altitude, the colder it becomes.*

Teacher: "*What are the variables contained in this rule*?" (Identifying variables)

Learner: "*Altitude and temperature.*"

This answer implies that altitude (height) and the rates of temperature are related. When moist air ascends the peak, it is cooled adiabatically and condensation takes place. Clouds and snow are also formed.

Teacher: "*What would happen if the snow at the mountain's peak melt.*" (Prediction)

Learners: "*The melting snow will fill up the streams and flooding could be a major problem in low lying areas.*"

PHASE FOUR: THE APPLICATION PHASE

The teacher and learners apply the definition with additional examples.

Figure 2.6 below illustrates diagrammatically the sequence of events that are involved in an inductive inquiry lesson.

Figure 2.6 Sequence of Events in Inductive Inquiry

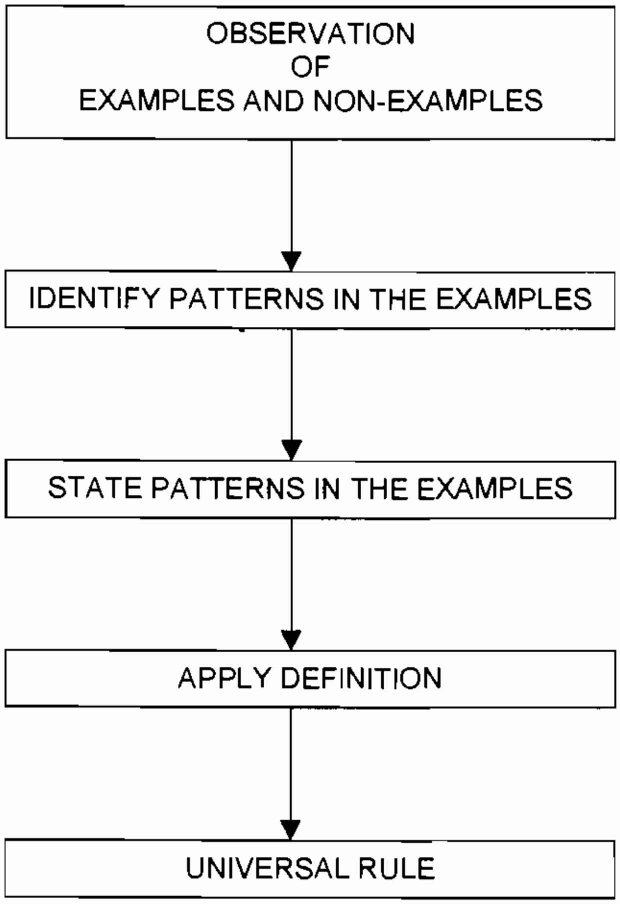


Figure 2.6 shows that to arrive at a universal rule, the teacher and his/her learners observe, identify patterns, state patterns, apply definition and state examples. Consequently, in this lesson, it is clear that science process skills such as *observation, communication, prediction, inferring and identifying variables* are developed. This lesson also implies that inductive inquiry promotes active learning and it is likely to increase learners' interest and motivation. It

develops learners' skills for discovering knowledge. These auger well for outcomes-based education although Davies (1987/1988: 118) claims that the quality for discovering knowledge is lacking amongst geography learners.

In this lesson, learners had to demonstrate mastery of these skills hence OBE focuses on what learners know and are able to do. Demonstration of learned knowledge and skills is what OBE requires (cf 3.6). Therefore, it is assumed that to realize the principles and objectives of Curriculum 2005 and OBE, geography teachers could develop interactive teaching through the general procedure of inductive inquiry. Furthermore, Inductive inquiry could be adopted in combination with deductive inquiry.

2.3.2 Deductive Inquiry

This method of inquiry is a counterpart of the inductive approach. However, according to Eggen and Kauchak (1988: 253) both approaches are similar because they teach concepts and generalizations, they rely on examples and they depend on active participation of the teacher in facilitating learning. Their difference is "*...in the sequence of events during the lesson, the thinking skills involved in the processing, the motivational features of the procedure, and the time involved*" (Eggen and Kauchak 1988: 253).

Deductive inquiry is a teaching strategy that encourages learners to apply a given statement or principle to specific contexts or situations. In deductive inquiry, learning starts from the general to the specific. Learners are required to first get a clear image of the topic or theme being studied. For example, to learn about physical features of a specific area. Learners may start by identifying the features in the topographical map of that area (whole) before they could learn the actual features in the environment (parts). The structure of deductive inquiry (Eggen and Kauchak 1988: 255) is as follows:

PHASE ONE: PRESENTATION OF THE ABSTRACTION

- ☐ *Defines the concept or states the generalization.*
- ☐ *Links the new material to the content previously covered.*
- ☐ *Clarifies the terms within the abstraction and explains the objective(s) for the lesson.*

PHASE TWO: ILLUSTRATION WITH EXAMPLES

- ☐ *Classifies examples as belonging or not belonging to the concept.*
- ☐ *Asks learners to do the same by relating the examples to the characteristics identified in the definition.*

PHASE THREE: APPLICATION PHASE

- ☐ *Asks learners to provide additional examples of a concept or apply a generalization to a unique situation.*

PHASE FOUR: CLOSURE

- ☐ *Asks learners to restate what they had learnt in the lesson.*

The following classroom scenario highlights the application of the deductive process in a hypothetical geography lesson. The lesson is on *permeability of rocks*.

PHASE ONE: PRESENTATION OF THE ABSTRACTION

The teacher explains the concept *permeability of rocks* to the learners. Permeability of rocks is the ability of rocks to allow water to pass through them. The outcome of this lesson is that learners should be able to *classify* rocks as either permeable or impermeable. Let assume that in the previous lesson, learners were requested to collect rocks around the school and to place them in a big pile. Learners were also asked to identify and *classify* the collected rocks into igneous, sedimentary and metamorphic rocks.

PHASE TWO: ILLUSTRATION WITH EXAMPLES

In this phase, the teacher requests learners to weigh pieces of rocks such as granite (igneous), limestone, sandstone (sedimentary), and marble (metamorphic). Learners *measure* and record the weights while the rocks are dry and then soak the rocks in water overnight. Learners are requested to *predict* what would happen to the weight of these rocks. They weigh the rocks again the next day. What has happened to rocks' weight? Learners discover that some rocks have gained weight whilst others remain unchanged.

PHASE THREE: APPLICATION PHASE

Learners *classify* the rocks as permeable or impermeable. For instance, limestone and sandstone would have gained weight. Learners *classify* them as permeable rocks. Granite and marble remained unchanged hence classify them as impermeable rocks.

PHASE FOUR: CLOSURE

The teacher asks learners to restate what they had learned in the lesson.

The essence of this lesson is that learners' investigations include the science process skills such as *predicting, measuring* and *recording* the weight of the rock before and after soaking them. They discover that some rocks are heavier after soaking but others do not change. This is because some rocks have pores (thus why they can absorb water) whilst others do not have pores (thus why they cannot absorb water). Consequently, the skill of *identifying and describing variables* is also developed. Learners are also able to *infer* that those rocks that gained weight have soaked up water. They conclude the activity by *classifying* the rocks as either permeable or impermeable.

These two lessons imply that both inductive and deductive inquiry approaches of teaching involve the study of examples or generalisations of an issue or a problem using the process of inquiry. Inquiry process encourages learners to identify questions and issues, to collect and structure information, to process data, to interpret data, to evaluate data, to develop generalisation, to make judgements, to make decisions, to solve problems, to work cooperatively in team situations, and to behave consistently with declared attitudes (Teaching Geography 1995: 96).

All these practices need application of inquiry as a teaching strategy. In the following section, the researcher justifies why inquiry should be adopted in the teaching and learning of secondary school geography.

2.4 REASONS FOR INQUIRY AS AN APPROACH OF TEACHING AND LEARNING GEOGRAPHY

Analyses of Curriculum 2005 (cf.3.7) and the 1996 Grades 10 to 12 geography syllabus (cf.2.2.4) indicate that inquiry teaching and inquiry learning should be adopted to solve current socio-environmental problems. Inquiry approaches build "...*skills and values such as being able to think, to solve problems, to collect, organise and analyse information, to work in a group as well as independently, to communicate effectively and to make responsible decisions*" (Department of Education 1997a: 9). In outcomes-based education, teachers are encouraged to facilitate learning, to guide learning, to assess learners to help them improve and to nurture and support learners through inquiry teaching.

By focusing on inquiry teaching and inquiry learning, and process skills, the researcher does not mean to be exclusive of knowledge and understanding. The researcher only wishes to show that the strength of inquiry teaching-learning is that it requires learners to project a range of science process skills onto a real world question or issue. Therefore, it is proposed that teacher transmission of knowledge and learner passive recipients of knowledge should be applied minimally to the teaching-learning process. Hence, inquiry geography demands teachers and learners to focus on interactive teaching and learning approaches which place learners in the central role and which lead to productive interaction inside and outside of the geography classroom. According to Greasley, Ranger, Winter and Williamson (1992: 3) within the classroom situation inquiry geography:

- ☐ *provides a focal point for the problem investigated;*
- ☐ *involves the adoption of different teaching and learning styles;*
- ☐ *provides stimuli and resource materials with which learners may use in their*

investigations;

- *provides with the opportunity to take their own learning initiative and to clearly demonstrate learning competence; and*
- *provides opportunities for decision-making and clarifying values and attitudes.*

Greasley et al. (1992: 3) also maintain that, inquiry geography within a fieldwork situation provides:

- *a clear focus for the fieldwork being undertaken;*
- *a clear structure for the fieldwork being undertaken;*
- *opportunity for individual and group work;*
- *opportunity for a flexible approach and the uses of a variety of techniques; and*
- *opportunity for variety of outcomes which are not predetermined.*

The inquiry-based learning approach creates the ideal opportunity for learners to become involved in geographical problems that affect their local environment. Stenhouse (1975: 38-39) and Winter (1992: 143) summarised the objectives of inquiry learning as to:

- *initiate and develop a process of question-posing in learners (the inquiry method);*
- *teach a research methodology where learners can look for information to answer the questions they have raised, used the framework developed in the course, and apply it to new areas;*
- *help learners develop the ability to use a variety of first hand sources as evidence from which to develop hypotheses and draw conclusions;*
- *conduct classroom discussions in which learners learn to listen to others as well as to express their own views;*
- *give sanctions and support to open-ended discussions where definitive answers to many questions are not found;*

- *encourage learners to reflect on their own experiences; and*
- *encourage the role of the teacher as resource manager rather than as an authority;*

Stenhouse (1975:39) regards these as objective principles of procedure to avoid confusing them with behavioural objectives or learning outcomes that should be attained at the end of a lesson. Geography teachers who follow the procedures listed above are more likely to improve their teaching practice. These procedures are likely to encourage learners to cease being passive recipients of knowledge. Opportunities are afforded to learners to get involved actively in the learning process. Vakalisa (1996: 4) points out that active involvement in the learning process allows learners the opportunity to:

- *ask questions, especially of the 'how' and 'why' type;*
- *answer teachers' questions which should be more of the inferential type than content-based;*
- *answer peers' questions to explain one's views on particular content;*
- *try out hypothetical solutions to problems related to content;*
- *consult texts or theory to get clarification on particular aspects in order to build their capacity to participate;*
- *seek information from experts (using people as resources);*
- *express their point of view and supporting it with plausible arguments;*
- *critique and evaluate learning content;*
- *apply learned content in solving problems related to it;*
- *discuss content with peers and soliciting feedback;*
- *undertake projects that reveal how content operates in real life;*
- *write positions papers for others to critique and to provide them with feedback that will enrich understanding; and*
- *keep reflective journals about learning experiences at particular levels of development.*

These activities are likely to develop the critical thinking skills of learners through inquiry. These activities are applicable to the teaching of geography, regardless of whether the school is well equipped with learning equipment or not. What is of great importance is for teachers to reduce teacher domination in the geography teaching-learning process. Furthermore, the researcher assumes that there is no any other teaching approach which empowers both less able learners and gifted learners more than the inquiry approach. Greasley et al. (1992: 5) argue that inquiry geography provides for less able learners because:

- *learning content is simple to understand;*
- *teaching starts form the particular to the general. The adoption of inductive inquiry motivates and stimulates the learners' interest. Less able learners are able to understand the learning material much more easily;*
- *it promotes individualized learning allowing learners to learn at their own pace; and*
- *the use of worksheets reduce memorisation and provides learners with the material they can use for revision.*

Less able learners find it difficult to master and understand abstract geographical concepts. They enjoy practical activities more than intellectual activities. Pick and Renwick (1984) have discovered that less able learners need learning essentials such as variety, active rather than passive learning, and inductive rather than deductive learning experiences, amongst others. A suitable teaching response to these learning needs is likely to be inquiry geography. Inquiry geography encourages learners to express their opinions. Learners realize that their inputs are important and valued. This is likely to boost their self-esteem and inspire them to 'find out'.

Inquiry geography is also suitable to gifted learners. Gifted learners "*gain pleasure from intellectual activity and show interest in inductive learning and problem solving*" (Laws 1984: 227). Greasley et al. (1992: 5) further maintain that inquiry geography also caters for gifted learners because:

- *learners study abstract geographical phenomena which suit their abstract reasoning;*
- *learners investigate and discover more knowledge with less teacher guidance;*
- *learners acquire skills for individual inquiry; and*
- *learners are able to identify and move on to investigate the next problem.*

It is important to note that inquiry geography could play an important part in the promotion of the principles of the country's constitution and the Department of Education. South Africa is supposed to be a non-sexist multicultural country (Constitution of the Republic of South Africa 1996: 3). Education has an essential role to play to realise these principles. The Education and Training Act (1995: 42) also recommends the development of multicultural education in South African schools. Inquiry geography could also play its part in the promotion of gender issues and multicultural education. Greasley et al. (1992: 5) maintain that inquiry geography provides for gender issues by:

- *demonstrating that women can also become engineers, farmers or hold positions of authority and active roles;*
- *starting case study material with the particular and small scale readily accessible to all and developing to the more general;*
- *carefully chosen inquiry instruction materials with a non-sexist approach in mind;*
- *providing clear advice on particular gender issues in the inquiry teaching guide: and*
- *encouraging both sexes to hold discussions and work together collaboratively as a unit.*

Furthermore, Greasley et al. (1992:5) maintain that inquiry geography provides for multicultural education by:

- *providing positive case study images of people from a variety of ethnic backgrounds;*
- *carefully chosen inquiry instruction materials which promote a positive multi-cultural image;*
- *providing opportunity for students to study topics relevant to multicultural education: e.g. population dynamics, urbanisation, inequalities of communities, cultural knowledge other than their own;*
- *providing opportunity and suggestions in the inquiry teaching guide for learners to pursue issues which promote multiculturalism; and*
- *developing inquiry activities that engage all learners from different cultural backgrounds in a variety of learning situations.*

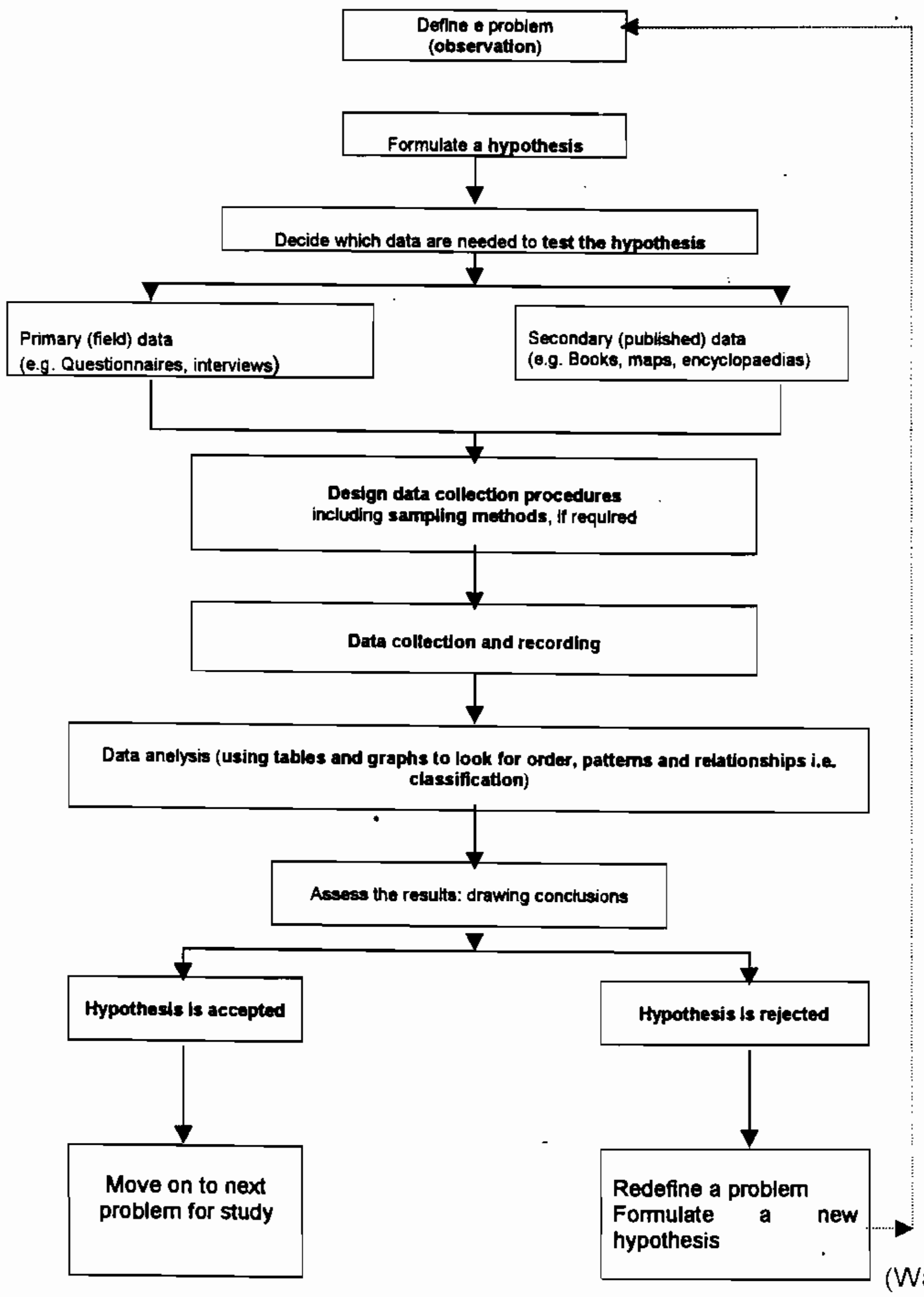
This discussion implies that inquiry geography has an important role to play in the development of the aims and principles of the country's constitution and Curriculum 2005. Its role cannot be less emphasised. It is imperative that geography teachers and learners should change and adapt they way they teach and learn respectively. Battersby (1995) as cited by Lambert and Balderstone (2000: 73) argues that inquiry can provide the most appropriate vehicle through which to develop a sense of place for learners. This implies that through inquiry, learners can contextualise issues and begin to see the interrelationships of places.

Figure 2.7 on the page 61 indicates that involvement in inquiry may also encourage learners to employ verbal, quantitative and symbolic data forms such as text, pictures, graphs, tables, diagrams and maps to communicate solutions to investigated problems. Furthermore, inquiry also needs skills in field observation, interviewing people, interpreting secondary sources and applying statistics. Thereafter, learners are supposed to assess the results and draw conclusions. This task may be performed in two ways. This may happen when learners tie up loose ends which are related to the hypotheses (cf. 2.5.2.7 and 4.5.2). Sometimes the teacher may ask learners to study the hypotheses and establish whether the hypotheses fit into the collected data. These processes enable learners to retain a hypothesis or to reject or revise it. Sometimes learners may think that they have collected enough data whilst the gathered data are not enough. When a teacher realises that this is the case, (s)he should prompt learners to ask further questions that will lead to the collection of sufficient data. It is possible that the learners may request the teacher to confirm their explanations.

Figure 2.7 also demonstrates how inquiry teaching activities develop learners' inquiry into questions, issues and problems. Inquiry teaching and inquiry learning foster the development of observational skills, recording skills and communication skills. These skills afford learners the opportunity to be able to identify geographical significant problems and variables of the same problems. Learners are able to understand the nature of the problems, analyse and interpret the problems and take appropriate decisions.

The teacher who adopts inquiry teaching may give a problem for investigation or may give learners opportunities to identify their own problems. Learners would speculate, create new concepts, apply old concepts and infer, test, reject, and accept their tentative solutions to the problem (Bateman 1990:18). These activities promote cooperative learning, a principle which outcomes-based education supports. Following is Figure 2.7.

Figure 2.7 Scientific Inquiry: Hypothesis Testing



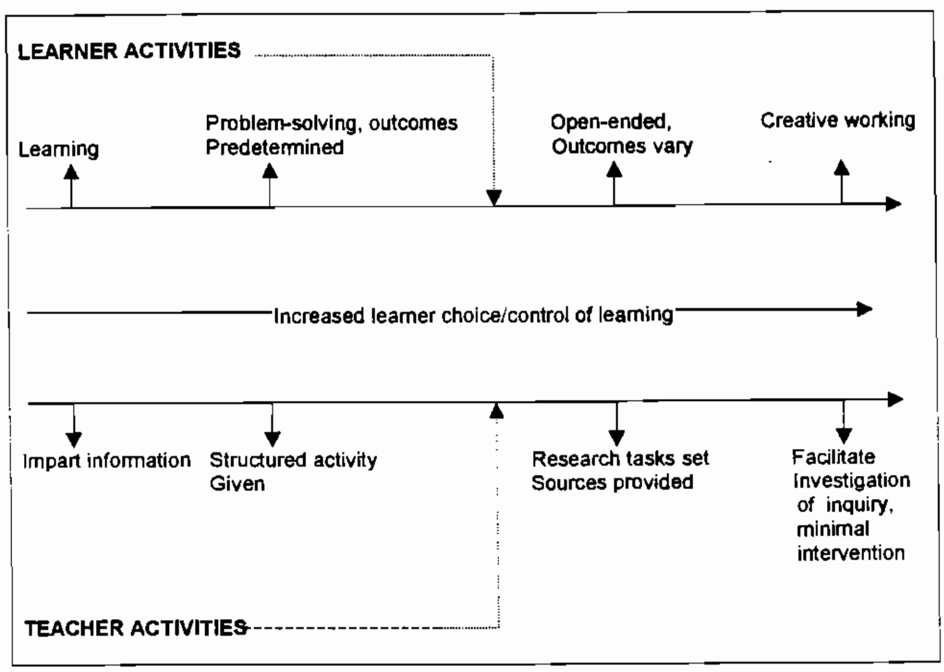
(Waugh 1990: 285)

In any inquiry-based classroom the characteristics of outcomes-based education, an educational approach which is discussed in the next chapter, are likely to be found. According to Greasley et al. (1992: 7) the characteristics of inquiry-based learning are:

- *knowledge and understanding are developed by a structured questioning approach;*
- *an emphasis on problem solving;*
- *collaborative group work;*
- *decision making;*
- *the identification and development of values and attitudes;*
- *the exploration of a range of viewpoints; and*
- *open-ended outcomes to inquiry.*

These activities develop discovery and inquiry thinking abilities and process skills of science that enable learners to obtain information. Following is Figure 2.8 which expresses inquiry teaching and learning approaches as a continuum. Inquiry geography places much emphasis on learners' activities which are at the top of the continuum.

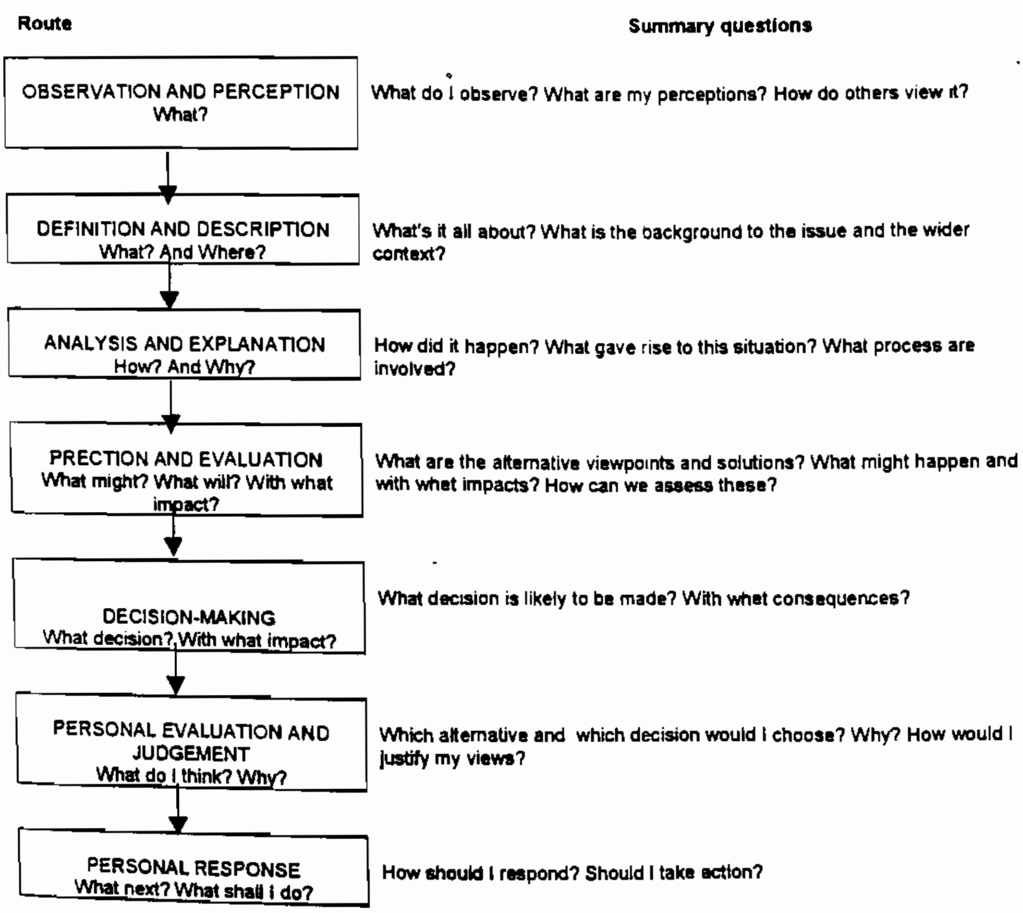
Figure 2.8 Inquiry Teaching and Learning Approaches



(Adapted from Greasley et al. 1992: 7)

In Figure 2.8, learners are encouraged to solve problems to which the answers are different and open-ended. Learners are able to arrive at different solutions as they make use of their own initiative and are creative in order to produce original reports. The role of the teacher is to set research tasks, to help learners to locate relevant sources and to guide and facilitate the investigations. It is important that the teacher should also encourage the learners to identify and define their own problems with his/her accompaniment. This is likely to stimulate learners' thinking processes, divergent and creative responses, hence Figure 2.9 below which illustrates a summary of the route of inquiry and inquiry questions.

Figure 2.9 The Route of Geography Inquiry



(Lambert and Baldersone 2000: 61)

Figure 2.9 shows a summary of the route for inquiry and inquiry questions. The implication of this summary is that inquiry teaching and learning, science process skills and outcomes-based education are associated and linked as illustrated on the next page.

Figure 2.9 also illustrates that route for geographical inquiry incorporates science process skills and outcomes. This route for inquiry also provides a framework within which learners can develop and demonstrate science process skills which are useful when investigating a problem or an issue.

A review of Figures 2.9 and 2.10 indicate key questions which geography teachers can ask of their learners. Answering each and every question would inevitably involve some consideration of science process skills. Engagement in any science process skill may lead to an outcome as shown in Figure 2.10. Hence, Figure 2.10 supplies a framework within which teachers can apply science process skills to the teaching of geography. Furthermore, the figure also provides learning experiences for learners by involving them in science process skills. As shown in Figure 2.10, these inquiry skills could be demonstrated and achieved as outcomes.

It is also implicitly implied by Figure 2.10 that the skills, inquirers use are probably science process skills. These skills are probably at the heart of inquiry teaching and inquiry learning. Therefore, science process skills or inquiry skills should be included in all lessons irrespective of the subject (Carin and Sund 1989: 67). Following is Figure 2.10.

Figure 2.10 The Route for Geography Inquiry, Science Process Skills and Outcomes

Science Process Skills	Route for Geographical Inquiry and Key Questions	Outcomes Learners should able to
Identifying and **observing** a question, issue Or problem arising from interaction of people and their environment.	OBSERVATION AND PERCEPTION What?	Identify and **observe** a question, issue or problem arising from interaction of people and their environment.
Define and **communicate** the question, issue or problem. **State hypotheses** where appropriate. Decide on data and evidence to be collected. **Collect**, **classify** and describe data and evidence.	DEFINITION AND DESCRIPTION What? and Where?	Outline and define the question, issue or problem. **State hypotheses** where appropriate. Decide on data to be collected. Collect, **classify** and describe data and evidence
Organise and analyse data. Move towards providing answers and explanation. Attempt to **accept, reject or modify hypotheses.**	ANALYSIS AND EXPLANATION How? and Why?	Organise and analyse data. Provide answers and explanation. **Accept, reject or modify hypotheses.**
Evaluate results of inquiry. Attempt to make **predictions**, to formulate generalisations and if possible to **infer** and **construct theories**. Propose alternative courses of action, and **predict** possible consequences.	PREDICTION AND EVALUATION What might? What will? With what impact?	Evaluate results of inquiry. Make **predictions**, formulate generalisations and if possible to **infer** and **construct theories**. Propose alternative courses of action, and **predict** possible consequences.
Recognise the likely decision given the factual Background of the problem **(identifying & controlling variables, acquiring & processing data, analysing the investigation).** Identify the probable environmental and spatial consequences **(Prediction and reject, accept or modify the hypotheses).**	DECISION MAKING What decision? With what impact?	Recognise the likely decision given the factual Background of the problem. Identify the probable environmental and spatial consequences.

PERSONAL EVALUATION AND JUDGEMENT
What do I think? Why
Determine which solutions are important.
Access the impact of the solutions on the situation.
Consider how one would defend and justify the solutions.

PERSONAL RESPONSE
What next? What shall I do?

DECIDE WHETHER AS A RESULT OF THIS INQUIRY
- to take individual or group action.
- to help initiate action on this issue by contacting those in positions of power.
- to take action to change aspects of personal behaviour which may affect future actions.
- to take no immediate action, but to follow further inquiries in order to test out one's feelings.

(Lambert and Balderstone 2000: 74)

As Figure 2.10 has indicated that science process skills can be achieved and demonstrated as outcomes, the researcher is compelled to ask the following questions:

- ☐ *What are science process skills?*
- ☐ *Are science process skills applicable to geography?*

The following sections attempt to provide answers to these important two questions.

2.5 SCIENCE PROCESS SKILLS

Millar and Driver (1987:39) have identified three domains for 'process science'. These domains are the processes applied to investigate phenomena of the world, intellectual processes applied to learn science and teaching processes that are adopted in the classroom. This study is concerned with science process skills that are applied when a problem or an issue is investigated. It is also concerned with the application of these skills to the teaching of geography in the classroom.

An investigator uses the science process skills to find solutions to the investigated problems. This research encourages teachers to apply science process skills to the teaching of geography because processes develop learners' scientific skills through engaging them in scientific activities. Proponents of science process skills claim that knowledge-based curriculum has failed (Wellington 1989: 8). It is argued that the content-led approach has failed because only few science learners can master scientific knowledge as the world is experiencing an explosion of information. Opponents of content-based curriculum question the ability of teaching facts in the age of information technology. They propose that learners should be taught how to retrieve information from information technology data bases instead of facts.

They claim that facts become outdated quickly. Learners should be taught transferable practical skills which are more relevant than knowledge (Wellington 1989: 7-15). Millar (1991: 51) has classified 'practical skills' into three categories, namely, *general cognitive skills* which some researchers claim cannot be taught, *practical techniques* and *inquiry tactics* which can be taught and improved. Figure 2.11shows the differentiation of the general category of 'practical skills'

Figure 2.11 Sub-categories of 'Practical Skills'

Practical skills'

General cognitive *processes*	Practical *techniques*	Inquiry *tactics*
(* observe, * classify, * hypothesise, ...)	(Measure temperature, air pressure, wind speed, wind direction, air humidity, ...)	* repeat measurements, * draw graph to see trend in data, * identify variables to alter, measure, control, ...)

←(cannot be taught) → ← (can be taught and improved) →

(Millar 1991: 51)

The research study propagates for the application of all these 'practical skills' (cf. Chapter 4). These skills are collectively known as science process skills (cf. 1.6.3, 1.6.4 and 1.6.5). Funk et al (1979: 1) and Rezba, Sprague, Fiel, Funk, Okey and Jaus (1995: 1) have noted that these skills are either classified as basic skills or integrated skills.

The basic science process skills are observing, classifying, communicating, measuring, predicting, and inferring. The integrated science process skills are identifying variables, constructing tables of data, constructing graphs, describing relationships between variables, acquiring and processing data, analysing investigations, constructing hypotheses, operationally defining variables, designing investigations and experimenting.

It is therefore imperative that learners should master basic skills before they can learn integrated skills. For example, learners may not be able to describe the relationship between variables such as temperature and rainfall, without being able to observe the temperature of the day through any of the senses. This is because a basic skill such as *observing* is the foundation of all other skills (Millar 1991: 46). Both basic and integrated skills provide opportunities to the learners to apply critical thinking activities in whatever way they do. The following section briefly explains basic and integrated science process skills. Chapter 4 has highlighted, by means of examples, how these skills could be applied to the teaching of geography

2.5.1 Basic Science Process Skills

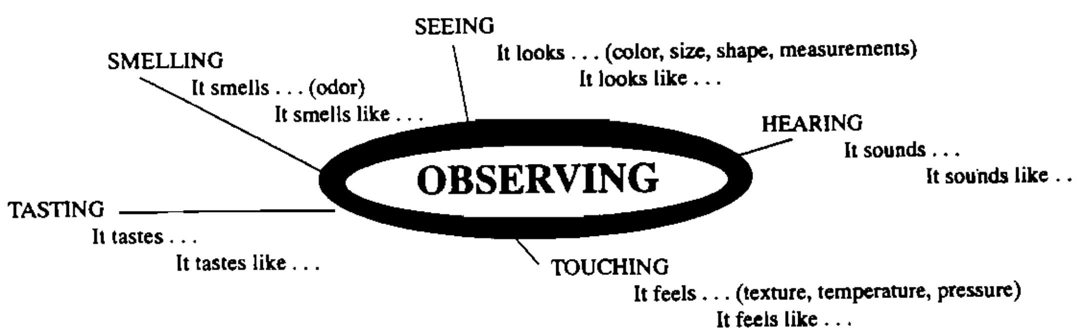
From the foregoing paragraph it is clear that basic science process skills involve less reading of content and more sciencing and doing. Such skills also enable learners to be actively involved in the learning process. Learning becomes interesting and learners become more stimulated and motivated. All other science process skills are based on the skill of observing (Rezba et al. 1995: 1).

2.5.1.1 Observation

Observation is the primary way in which people obtain information about their environment through the five senses, namely, sight, smell, touch, taste and hearing (Rezba et al. 1995: 3). which is classified as qualitative observation. Sometimes learners can use a standard unit of measure for more precise information than the senses alone can provide. This is quantitative information which helps in the communication of specifics and provision for comparisons. This type of observation requires instruments such as rulers, metre sticks, balances, calibrated cylinders or beakers, and other instruments, and it is called quantitative observation. The knowledge acquired through observation leads to the development of inquiry and questioning attitudes about the environment. Learners start to investigate environmental problems or issues. Observation may lead to the development of other basic skills such as communicating, predicting, inferring and classifying which are done qualitatively and measuring which is done quantitatively.

Millar (1991: 47) argues that observing is a skill that every individual possesses. (S)he therefore, questions why observation needs to be taught *per se*. The researcher, however, is of the opinion that the most important factor is to encourage learners to make relevant observations in order for them to become scientific observers. Thus, the ability to make relevant observations must be developed through engaging learners in observation activities. Furthermore, learners engaged in observational activities are likely to develop the ability to observe geographical phenomena critically. Figure 2.12 indicates senses that are used when properties of an object are observed.

Figure 2.12 Five Senses Used to Observe Objects



(Rezba et al. 1995:4)

A review of Figure 2.12 indicates the five senses that people apply when exploring the properties of any object or substance. These senses understandably could also be used to observe geographical features (cf. 4.4.1). After observing, individuals are like to classify the observed features, hence the discussion in the next section.

2.5.1.2 Classification

The environment comprises a number of objects, events and living things. Classification requires people to organize their observations in ways that carry special meaning (Martin et al. 1994: 12). People classify these in order to comprehend them. Classification takes place through observing similarities, differences and interrelationships (cf. 4.4.4). Consequently, classification is likely to lead to concept formation and communication.

2.5.1.3 Communication

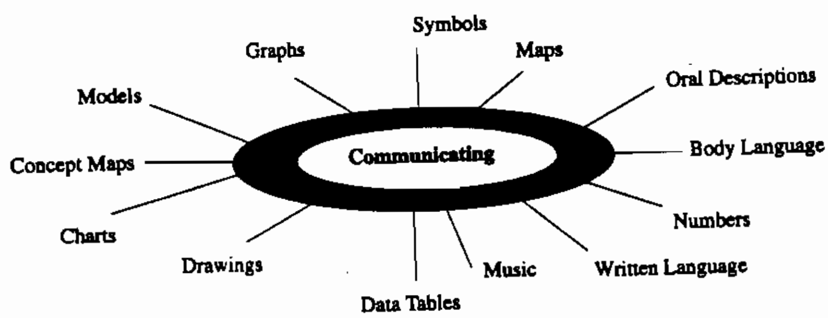
Communication is important in whatever people do. Teachers communicate knowledge, ideas and instruction to their learners. Learners also communicate knowledge and ideas to their teachers and peers. Figure 2.13 in the next page depicts communication tools such as graphs, charts, maps, symbols, diagrams, mathematical equations, visual demonstration and written and spoken words which are used to communicate vital information. These tools of communicating can be applied to the geography curriculum (cf. 4.4.6). Teachers encourage their learners to use these forms of communication to convey the findings of the problem investigated clearly, precisely and concisely. Funk et al. (1979: 26) maintain that for one to communicate effectively one should:

- ☐ *describe only what one observes (see, feel, smell, hear and taste) rather than what one infers about the object or event;*

- *make ones description brief by using precise language;*
- *communicate information accurately using as many qualitative observations as the situation may call for;*
- *consider the point of view and past experience of the person with whom one is communicating;*
- *provide a means for getting "feedback" from the person with whom one is communicating in order to determine the effectiveness of their communication; and*
- *construct an alternative description if necessary.*

Following is Figure 2.13 which shows some instruments which learners can employ to communicate the results of their inquiry.

Figure 2.13 Communication Tools



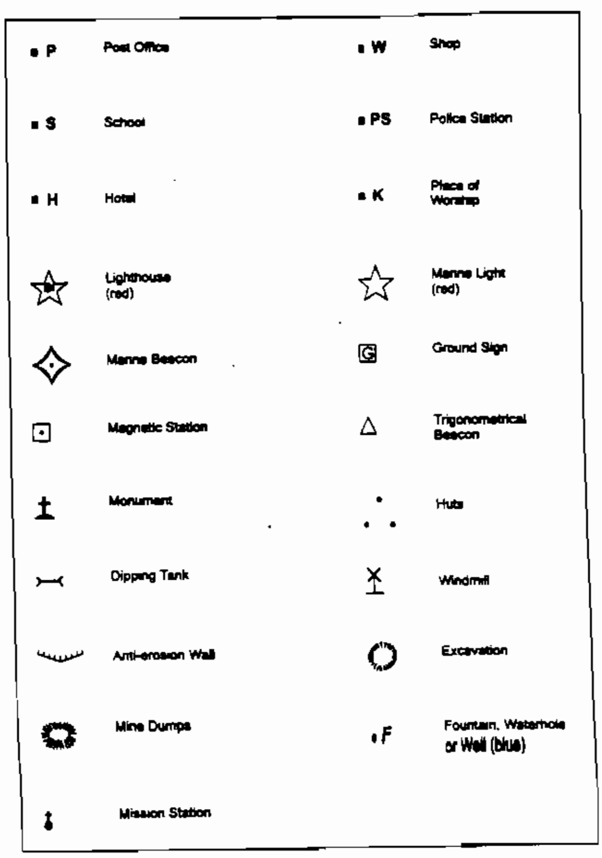
(Rezba et al. 1995: 19)

Figure 2.13 depicts communication instruments which are essential in geography education. For instance, learners need to master map work skills which are important in any map interpretation (cf. 4.6). Maps communicate important information about a country, region or an area as they are symbolic representation of reality on the actual ground. Geographers use the conventional map symbols to communicate the most significant geographical information found on the actual ground.

These symbols are used in the South African 1 : 50 000 topographical map series. A topographical map is a map showing physical and man-made surface features (Blackbeard 1992: 3). There are three types of map symbols, namely, point symbols, line symbols and area symbols (Carstens 1991: 137 and Liebenberg 1989: 61). Different colours are conventionally used for the different symbols. For instance, green represents vegetation, blue is for water, brown is for natural or physical features and black is for any man-made feature. The reader is requested to compare these symbols with the ones appearing on 3318CD Cape Town topographical map for the actual colours used (Appendix 14). Following are point symbols which are drawn on topographical maps.

- **Point symbols**

Figure 2.14 Point Symbols

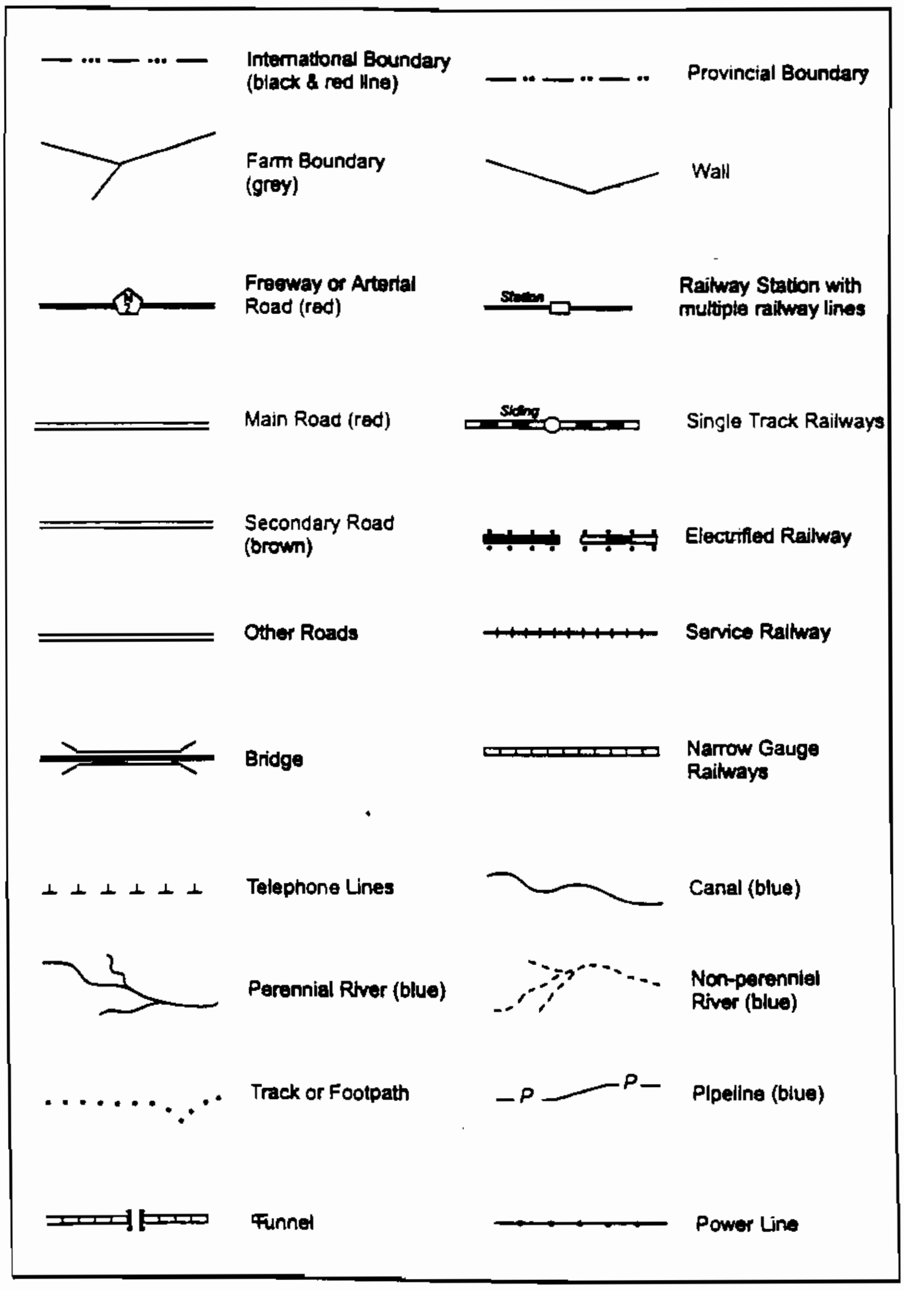


(Carstens 1991: 138)

Figure 2.14 shows the most important point symbols which appear on 1 : 50 000 South African topographical map series. The position of the symbol on the map corresponds with the actual location of the feature on the ground. Following are line symbols which are found in topographical maps.

- ☐ **Line symbols**

Figure 2.15 Line Symbols

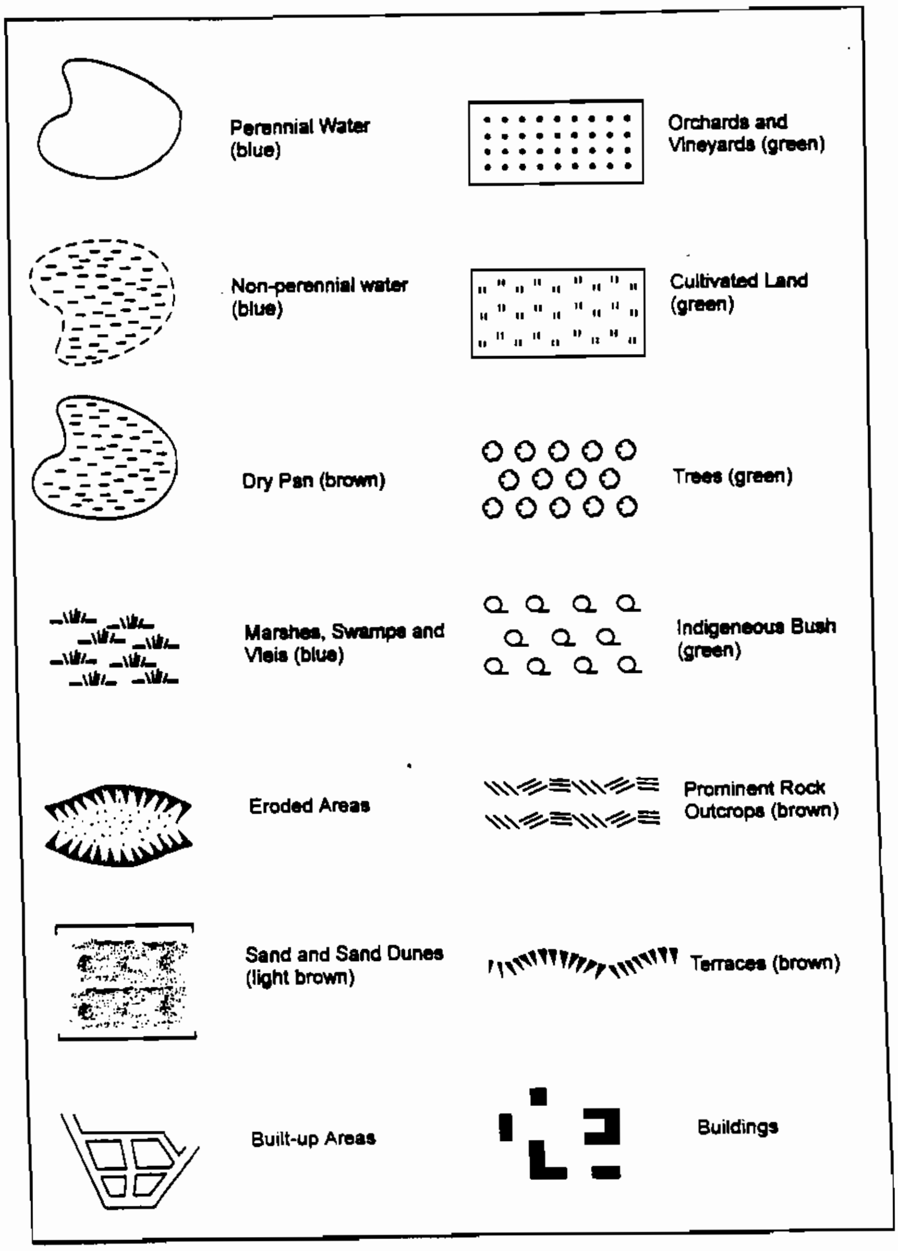


(Carstens 1991: 139)

Figure 2.15 depicts examples of the most important line symbols which appear on 1 : 50 000 South African topographical map series. Line symbols illustrate linear phenomena such as roads, power lines, telephone lines, canals railway lines and boundaries. Following are area symbols which are found in topographical maps.

- **Area symbols**

Figure 2.16 Area Symbols



(Carstens 1991: 140)

Figure 2. 16 shows examples of the most important area symbols which appear on 1 : 50 000 South African topographical map series. Area symbols depict phenomena such as lakes, dams, pans, cultivated fields or pans.

Geography learners should be able to make a rough sketch of a map and draw all these symbols. Furthermore, the colours used for these symbols on the topographical make these symbols easier to spot. After mastering these conventional symbols, geography learners are also expected to measure and calculate distances amongst various symbols in metres and kilometres, hence the discussion in the next section.

2.5.1.4 Measurement

People do different kinds of measurement in their environment daily. They measure angles, numbers, sizes, lengths or distances, volumes and mass. The learning and practice of skills needed to do these measurements are essential for learners to be able to think in metric terms.

Measurement enhances thinking by adding precision to observations, classifications and communication (Martin et al. 1994: 13). Some of the measuring activities applicable to geography are calculation of map scales, distances, directions, bearing, declination; the measuring of air pressure, air temperature, dew point temperature, amount of precipitation, amount of cloud cover and so on (cf. 4.4.2 and 4.6.2).

Measuring makes it possible for a person to make a prediction about the occurrence of geographical phenomena. For instance, observing and measuring the weather conditions which prevail in a specific area may enable a meteorologist to predict if it would be hot, cool or cold and if it would rain or not. Hence *observing* and *measuring* are demonstrable and achievable as outcomes.

2.5.1.5 Prediction

Funk et al. (1979: 57) define prediction as ..."*a forecast of what a future observation might be*." Predictions are types of thinking that require peoples' best guesses based on the information available to them (Martin et al. 1994: 13). Geographers are supposed to be able to forecast weather and the occurrence of other phenomena like drought, floods, tornadoes, volcanoes and hurricanes. Meteorologists predict weather in advance of its actual occurrence. They base their predictions on accumulated observations, analysis of information, and prior information. These are the foundations of prediction.

Thus, one should be able to predict after the mastery of other skills such as observing, inferring and classifying. Information gained through the senses (observation) and inference enables one to forecast what a future observation will be (prediction).

Observation of similarities or differences of geographical phenomena enables people to impart order in their environment. It is argued that "*order in our environment permits us to recognize patterns and to predict from the patterns what future observations will be*" (Funk et al. 1979: 57). Prediction is a skill which can be applied to the geography curriculum (cf. 4.4.5).

Prediction is interconnected with inference as they are all based on information gained through the senses. For instance, a prediction is a focus of what a future observation will be, whilst an inference is an explanation for the observation (Rezba et al. 1995: 91). The following section discusses inferences.

2.5.1.6 Inferences

Inferences are conclusions about the cause of an observation. Direct observation of objects or events enables people to suggest something, to interpret and explain things and activities happening in the environment. For instance, an explanation or interpretation of an observation is indeed an inference (Funk et al. 1979: 72). Furthermore, inferences enable one to formulate hypotheses which may influence one's understanding of one's observations. In order to infer, people use their past experiences and link them with the new ones. For instance, a person is able to infer that it rained with thunder and lightning by reflecting on the size and type of the cloud. This implies that inferring is an everyday activity which can be applied to the geography curriculum (cf. 4.4.3 and 4.6.3).

Mastery of basic science process skills prepares the learner to learn new skills that may lead to experimenting (Rezba et al. 1995: 117). These are integrated science process skills that enable learners to explore, investigate and discover knowledge. Hence, investigation tasks are likely to promote the development of integrated science process skills in learners.

2.5.2 Integrated Science Process Skills

Integrated science process skills rely on learners' capabilities to think at a higher level and to consider more than one thought or aspect at a time (Martin et al. 1994: 13). These skills are more complex than basic skills. Just as in basic science process skills, integrated science process skills are used in problem solving. They are the immediate tools which could be used when seeking solutions to problems (Funk et al. 1979: 83). The following section briefly discusses the skill of identifying variables.

2.5.2.1 Identifying Variables

What is a variable? Fraenkel and Wallen (1996: 51) point out that "a *variable is a concept - a noun that stands for variation within a class of objects, such as chair, gender, eye colour, achievement, motivation, or running speed.*" It is something that can vary or change (Fraenkel and Wallen 1996: 51 and Rezba et al. 1995: 123). Liebenberg (1986: 156) regards a geographical variable as a geographical phenomenon, whose characteristics change from place to place or time to time. For example, *"The temperature for an area (Welkom) is influenced by the time of the day."* For instance, on the same day it can be -2°C at 02:00 and 18°C at 14:00.

The skill of identifying variables is essential when one is conducting an investigation. For a person to be able to plan and carry out an investigation, (s)he has to identify variables as an independent (manipulated) variable or a dependent (responding) variable and as a categorical or a quantitative variable (Gay and Airasian 2000: 148; and Fraenkel and Wallen 1996: 51-55). In the example given above, *time* is the **independent variable** whilst *temperature* is the **dependent variable**.

A quantitative variable assigns number to different geographical phenomena. For instance, today's temperature is 25°C and yesterday's rainfall was 20 mm. Categorical variables are always qualitative in nature. They do not vary in degree, amount, or quantity (Fraenkel and Wallen 1996: 52). For example, dark grey clay soil, light brown loam soil and red brown sand soil are categorical variables. Identification and manipulation of variables is a skill that can be applied to the geography curriculum (cf. 4.5.3). Learners who can identify variables should also be able to construct a table which shows data for the relevant variables, hence the discussion in the next section.

2.5.2.2 Constructing a Table of Data

When identifying the variables, the information on the variables can be presented in tables. One is able to establish trends and patterns by analysing the tables (Rezba et al. 1995: 153), which could be the measurements of temperature, rainfall, time or volume. What is important. is that when constructing a table of data, a person should record the independent variable on the first row and the dependent variable on the second row. If manipulated variables are listed in order of magnitude, one is able to establish their pattern of change. This is also applicable to the responding variables. The following is an example of a table for hypothetical mean annual rainfall amounts in Cape Town:

Table 2 .1 Mean Annual Rainfall in Cape Town over a Period of 12 Months

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Annual Rainfall in mm	12,6	10,3	18,4	60,6	77,1	82,4	94,8	68,9	43,0	28,6	20.3	10,2

In Table 2.1, months are independent variables whilst the mean annual rainfall figures are dependent variables. Furthermore, in order to have information as indicated in Table 2.1, learners should initially be able to demonstrate their ability to observe a rain gauge and record the amount of rainfall daily. Secondly, they should be able to calculate the monthly means of rainfall. Ultimately, the outcome is that learners should be able to observe and record the measurements of time, temperature, rainfall or volume.

Furthermore, when given a written description of the measurements made during an investigation, learners should also be able to construct a table of data. They should also be able to write pairs from a table of data, and ultimately to match data pairs with points on a graph. As illustrated in Table 2.1, this skill of organizing data in a table can be applied to the geography curriculum. The skill of organizing data in a table can also in turn promote the skill of plotting a graph.

2.5.2.3 Plotting a Graph

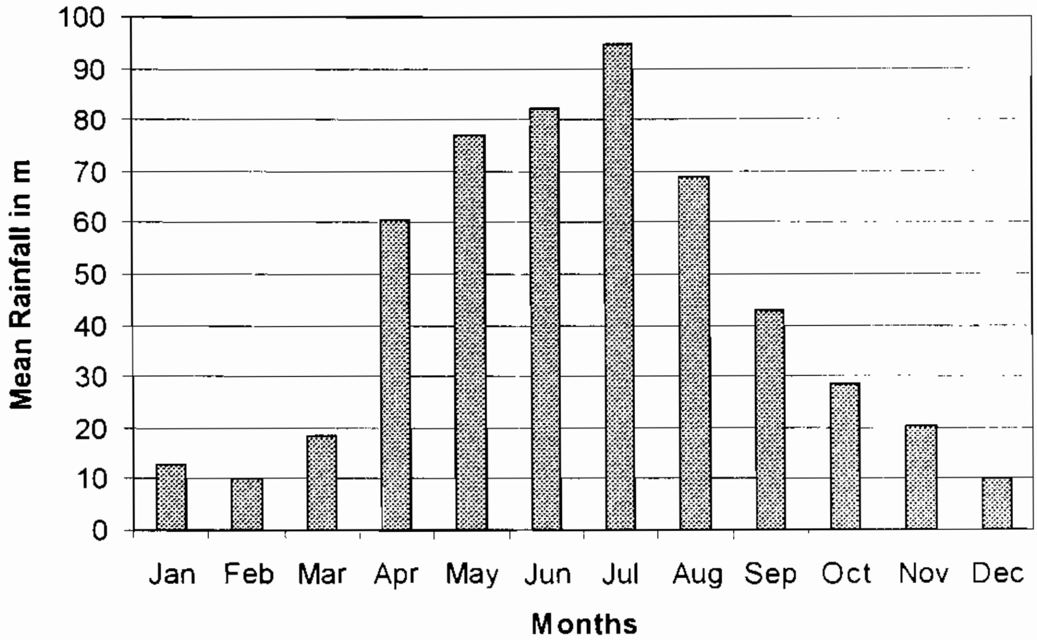
It has already been established that one can employ various forms of communication to report the findings of an investigation (cf. 2.5.1.3). One of these forms of communication involves drawing a graph instead of using a spoken or written message. A person is able to construct a graph when provided with a description of an investigation and a table of data.

Geographers draw graphs and diagrams to represent temperature figures, population figures, economic production figures or rainfall figures. These types of graphical representation may also appear in newspapers and magazines. In order to understand and attach meaning to what is happening around them, people should be able to interpret graphs. Liebenberg (1986: 156) argues that graphs and diagrams enlighten the hidden qualities of the data and make the message easier to understand. Three types of graphs or diagrams which geographers may use to depict the data in a table have been identified. Examples of diagrams and graphs are the bar graph or histogram, the line graph and the segmented circle or pie diagram.

□ **The bar graph**

The data in Table 2.1 can be used to compile the following bar graph.

Figure 2.17 Bar Graph: Mean Annual Rainfall in Cape Town over a Period of 12 Months



Liebenberg (1986: 156) maintains that in geography, the bar diagram is used for:

- *comparing the subdivisions of the same geographical variable with one another;*
- *comparing a geographical variable in terms of different time intervals or periods; and*
- *comparing a geographical variable in terms of different places.*

A review of Figure 2.17 indicates that the wettest month in Cape Town is July. The month with the lowest rainfall is December and rainfall decreases from July to December. In geography bar graph are usually used to plot rainfall figures.

- **The line-graph**

In geography, the line-graph is used to indicate changes in a geographical variable over a period of time (Liebenberg 1986: 156). In geography, it usually used to plot temperature figures. For example, the following table which shows average monthly temperatures for Bloemfontein can be used to draw a line graph.

Table 2.2 Average Monthly Temperatures in Bloemfontein over a Period of 12 Months

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temperatures in °C	27	24	25	15	11	8	7	10	17	20	24	29

The line graph can be plotted as follows:

Figure 2.18 Line Graph: Average Monthly Temperatures in Bloemfontein over a Period of 12 Months

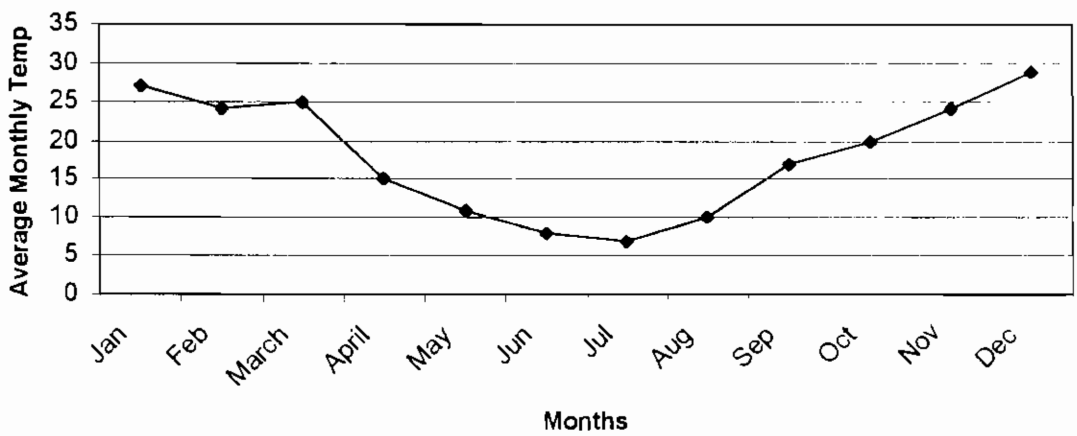


Figure 2.18 clearly indicates that December is the hottest month in Bloemfontein and July is the coldest month. It is also apparent that the temperature increases from August to December.

Furthermore, as illustrated in both Figures 2.17 and 2.18, the learner should be able to decide where independent and dependent variables must be placed on the axis of the graph. The independent variables are written along the x - axis, i.e. along the horizontal line of the graph. The dependent variables are written along the Y - axis, i.e. along the vertical line of the graph. Once this has been done, one should determine an interval scale for each axis that is suitable for the data to be graphed. After that, in a bar graph one plots the bars on a graph whilst in a line graph one plots data pairs as data points on a graph and draw a best-fit line which can be either a straight line or a smooth curve.

- **Pie diagram**

According to Liebenberg (1986: 160) a pie diagram in geography is also used to:

- *compare the subdivision of the same geographical variable with one another, and to*
- *compare a geographical phenomenon occurring at different places.*

A pie graph is used to show a proportion of a whole. For instance, Table 2.3 shows an estimation of South Africa's mineral production in 2001.

Table 2.3 South Africa's Mineral Production in 2001

Minerals	Gold	Platinum	Diamond	Copper
Quantity in Kilograms in millions	958	1 849	678	246

Using the information in this table, a pie diagram can be represented as follows:

Figure 2.19 Pie Diagram: South Africa's Mineral Production in 2001

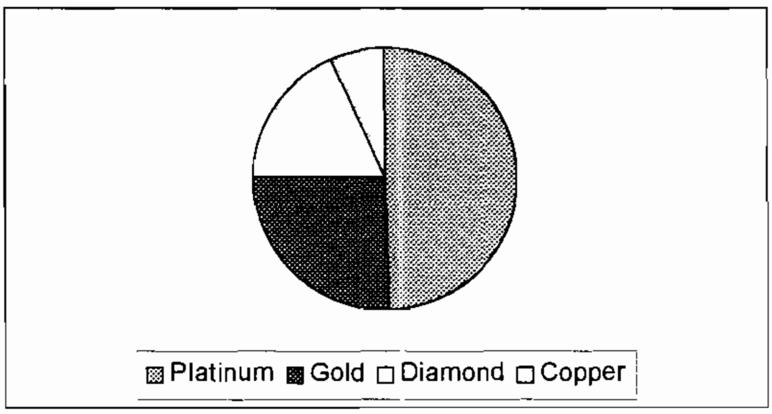


Figure 2.19 compares the subdivisions of mineral production in South Africa in 2001. It is apparent that the production of platinum was the highest, hence it is represented by the largest sector. Copper has the smallest sector of the circle as its production was the lowest.

Learners should be taught how to construct a pie diagram in Figure 2.19 using the following step-by-step approach.

- Step 1

Learners should calculate the total that is to be represented by each circle. The size of the circle equals 360°

- Step 2

Learners should calculate the sizes of the different sectors of the circle using the following equation:

$$\text{Size of sectors in degrees} = \frac{\text{Quantity of a mineral} \times 360°}{\text{Total quantity of all mineral produced in South Africa in 2001}}$$

The size of the sector representing platinum would be as follows:

$$= \frac{1\,849 \quad X \quad 360°}{3\,731}$$

$$= 178.4$$

$$= 178°$$

Learners should show the calculations for all months.

- Step 3

Learners should add the various answers. The total should add up to **360°**. If it does not add to **360°**, there could be a calculation error and the learners should check each calculation on its own.

- Step 4

Learners should draw a circle of any convenient size. Subdivide the circle using a protractor and a ruler starting at the 12 o'clock position and marking off the sectors in a clockwise direction.

- Step 5

Learners should shade the respective circles' sectors in different colours or colour patterns so that they should be easily distinguishable.

- Step 6

Learners should write down key and legends

- Step 7

Lastly, the circle should be supplied with an appropriate heading.

The educative value of plotting these graphs is that graphing makes it possible for learners to convert measurement into a diagram to show the relationship between the measurements (Martin et al. 1994: 15). Hence they might be able to read and interpret the trends or patterns depicted in the graphs. An interpretation of trends or patterns could influence learners to describe the relationship between the variables on graphs.

2.5.2.4 Describing Relationships between Variables

Once a graph has been constructed, one may realize that the graph is a coded message which needs to be interpreted. The description should give a summary of the relationship between the manipulated and the responding variables. Using Figures 2.17, 2.18 and 2.19, the learner should indeed be able to interpret the trends and patterns revealed by the graphs. By merely glancing at Figure 2.17, it is immediately apparent that July is the month with the highest mean rainfall (94,8 mm) and December the month recording the lowest mean (10,2 mm). It is clear too that Cape Town has a Mediterranean climate because most of the rain falls in winter. From the overall trend of the bars from left to right, learners can *infer* on the whole that the amount of rainfall in Cape Town starts to increase from March to July. Investigators describe the relationship between variables when processing data as they may acquire different kinds of information on the subjects of their research (Fraenkel and Wallen 1996: 115). Hence, the following section discusses the skill of acquiring and processing data.

2.5.2.5 Acquiring and Processing Data

Investigation requires researchers to observe, to collect and analyse data, and to draw conclusions in order to solve a problem (Martin et al. 1994: 15). Consequently, an investigator should be able to conduct an investigation and compile a table related to the data. If an investigation involves the measurements of mass, length, temperature, force and volume, the researcher should be able to construct a table of data using the measuring units of these elements.

After acquiring and processing data the investigator should be able to use the table of data to construct any kind of graph or diagram (cf. 2.5.2.3). The graph should consist of a title which conveys the purpose of the graph (Rezba et al. 1995: 195). This should also be accompanied by a statement of the relationship between the manipulated and the responding variables. Data processing is related to the skill of analysing investigations.

2.5.2.6 Analysing Investigations

Before one conducts an investigation one should determine the variables under study (Fraenkel and Wallen 1996: 48). One should then formulate the hypotheses being tested (Gay and Airaisian 2000: 71). The investigator could also use a supplied description of an investigation to identify the hypotheses being tested (Rezba et al. 1995: 205).

Analysing investigations enables the investigator to identify the manipulated and responding variables (Gay and Airasian 2000: 151; Fraenkel and Wallen 1996: 54; and McMillan and Schumacher 1997: 88). The manipulated variable should be the only variable affecting the responding variable. If there is a constant factor that may affect the investigation, it should be kept from doing so (Rezba et al. 1995: 206).

Analysing investigations also enables the investigator to test, accept or reject and revise hypotheses (Gay and Airasian 2000: 77; Fraenkel and Wallen 1996: 212 and McMillan and Schumacher 1997: 358). If the hypotheses are accepted, the investigator may move to the next problem (cf. Figure 2.7). A revision of the hypotheses may compel the investigator to redefine the problem and gather new data that are needed to test the constructed hypotheses.

2.5.2.7 Constructing Hypotheses

An inquiry involves an investigation of a question, a problem or an issue (cf. 2.3). This entails that the investigator should strive to obtain a solution to the problem. Finding a solution to the problem involves decision making (Lambert and Balderstone 2000:74). Before an inquiry is conducted, the investigator should suggest tentative answers to the problem. These tentative solutions are hypotheses (Gay and Airasian 2000: 71; Fraenkel and Wallen 1996: 56; and McMillan and Schumacher 1997: 95). Hypotheses are predictions about the relationships between variables (Rezba et al. 1995: 219). They guide the researcher on what data to gather (cf. 1.3.4). Sometimes a problem is provided and the researcher is expected to find a solution to it. The researcher may also identify a problem and make predictions about the relationship between variables. Rezba et al (1995: 222) maintain that "... *prediction can be based on fact, opinion, hunch, or whatever resources one may possess.*" Martin et al. (1994: 15) also claim that forming hypothesis is similar to prediction although hypothesising is more controlled and formal.

Subsequently, it is imperative to formulate a testable hypothesis which guides the way the investigation should be designed and take place. The gathered information should be used to make a best educated guess about the expected outcome of the investigation (Martin et al. 1994: 15). Gay and Airasian (2000: 73) have identified four types of hypotheses, namely, inductive, deductive, declarative and null hypotheses.

An inductive hypothesis is a generalization based on observed relationships (Gay and Airasian 2000: 73). For instance, a geographer may generalise that in Southern Africa, rainfall increases from west to east. This observation could become the basis for an inductive hypothesis as the geographer observes that the western side of the subcontinent (Northern

Cape) is dry and has sparse vegetation whilst the eastern part of the subcontinent (Kwazulu Natal) is wet in summer and has dense vegetation.

Deductive hypotheses are generally derived from theory (Gay and Airasian 2000: 73). For instance, the bid - rent theory (land value model) which states that the most expensive or prime sites in the cities are in the Central Business District (CBD). Hence a geographer may hypothesise that departmental stores would be found in the CBD because they are able to conduct their business in a relatively small amount of ground space and build skyscrapers.

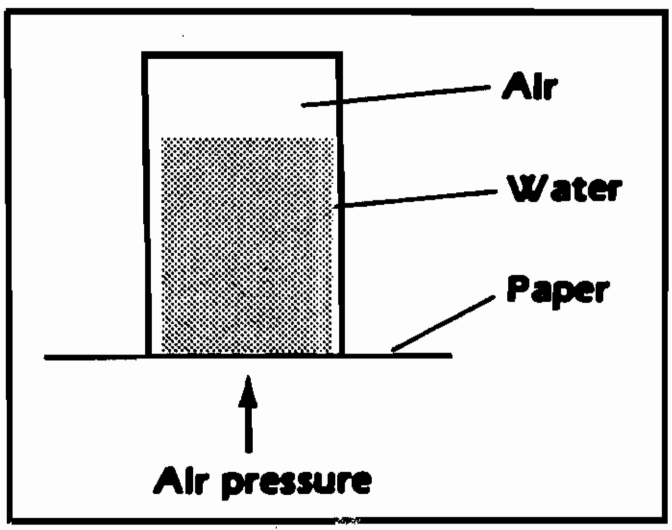
A research hypothesis states an expected relationship or difference between two variables (Gay and Airasian 2000: 74). For example, as air pressure decreases, the ability of the atmosphere to hold heat also decreases. Hence a researcher may verify this hypothesis in a research study or experiment.

The null hypothesis is the hypothesis of choice when there is limited research or theoretical support for a hypothesis (Gay and Airasian 2000: 74). For example, the polar front jet stream varies between latitudes 40° and 60° in the Southern Hemisphere. Jet streams are extremely fast-moving air which can exceed speeds of 230 km per hour. Hence there could be little research or theoretical support for this hypothesis. Constructing hypotheses is a skill which can be applied to the geography curriculum (cf. 4.5.2). The construction of a hypothesis is influenced by the variables of the research problem.

2.5.2.8 Defining Variables Operationally

A definition that attributes meaning to a concept by specifying the procedures that must be conducted in order to measure or manipulate the concept is an operational definition (Ary, Jacobs and Razavieh 1990: 29; Borg and Gall 1989: 26 and McMillan and Schumacher 1997:89). Variables can be defined operationally by applying some kind of a measurement (*a measured operational definition*) or by listing the steps taken in an experiment to produce research conditions (*an experimental operational definition*) (Ary et al 1990: 35). Figure 2.10 illustrates an experiment which can be used to develop the skill of defining variables operationally.

Figure 2.20 Air Pressure



(Friedl 1991: 130)

Using Figure 2.20, the concept air pressure could be defined operationally. For instance, by filling a tumbler with weightless water, covering it with a sheet of paper, and turning it upside down, learners may expect the water to pour out. Asking the learners why the water does not spill out may enable them to realize that it does not spill because air pressure pushes against the paper. Hence learners could define air pressure as the weight of air that exerts pressure.

Operational definition is essential to research because data is collected in terms of observable events and characteristics. The outcomes of operational definitions are that investigators are likely to *observe* and *measure* abstract concepts. to carry out research and gather data relevant to the concepts and to take steps to produce certain experimental conditions (Ary et al. 1990: 29-30).

In the air pressure activity highlighted above, learners' investigations may include the science process skills such as *observing* that the sheet of paper and water do not fall, *experimenting* with tumblers containing different amounts of water and discovering that they all work, and forming a theory about the force that holds the water in the tumbler (Friedl 1991: 130). All these could happen after this investigation has been designed.

2.5.2.9 Designing Investigations

After constructing hypotheses, the investigator designs an investigation to test the hypotheses. The designed investigation should be simple to enable the researcher to collect usable data. The collected data should be able to either support or reject the formulated hypotheses. Rezba et al. (1995: 245) point out that the design of an investigation should include:

- *a description of how the manipulated variable is operationally defined;*
- *a description of how the responding variable is operationally defined;*
- *a description of what factors are kept constant; and*
- *the values of the manipulated variable selected for the investigation.*

An investigator is able to proceed with investigations after they have complied with these processes, which should enable him/her to produce certain experimental conditions.

2.5.2.10 Experimenting

An opportunity to practice all the science process skills which have been discussed, is provided by experimenting. Experiments are a way of learning something by varying some conditions and observing the effect on something else (McMillan and Schumacher 1997: 313). An experiment is a scientific investigation in which the researcher controls some independent variables and observes the effects of these manipulations on the dependent variables (Ary et al. 1990: 298).

The investigator starts with a question which needs to be solved. The first step to find solutions to the problem will be to identify the variables, to formulate the hypotheses, to identify the factors that should be held constant, to define variables operationally, to design an investigation, to rerun trials, to collect data and then interpreting data (Ary et al. 1990: 298; McMillan and Schumacher 1997: 315; and Rezba et al .1995: 251). All these activities include all science process skills that have been discussed in this chapter.

Researchers are expected to employ these science process skills (cf. 2.5.1) as they plan and conduct investigations. After the investigation has been concluded, the investigator writes a report which Rezba et al. (1995: 252) maintain should include:

- *the statement of the question or problem investigated*;
- *the statement of the hypothesis tested;*
- *a written description of the design of the investigation used to test the hypothesis;*
- *a report of the data in a table form* ;
- *a graph of the data;*
- *a statement of the relationship observed between variables*; and

- *a comparison of the findings with an initial hypothesis to see the hypothesis is accepted or rejected by the investigation.*

Experimenting involves verifying a hypothesis through the application of all science process skills. These processes are useful and should be applied when a problem or an issue is investigated. However, researchers such as Jenkins (1989a: 21); Millar and Driver (1987: 51-52); and Millar (1989 47-60) criticise the application of science process skills to the curriculum.

2.6 CRITIQUE OF SCIENCE PROCESS SKILLS

Millar (1989: 47-49) questions if it is possible to teach according to the scientific method because general cognitive processes are not transferrable. It is difficult to prove if skills such as observing, classifying and hypothesising can be taught and transferred to a new situation different from the original one (Millar 1991: 51). Process skills of science are possible to transfer only horizontally, i.e. process skills are transferrable to a situation similar to the original one. This happens because when transferring process skills, learners use reasoning by analogy rather than the application of general rules of procedure to understand (Millar and Driver 1987: 51-52).

Millar (1991: 51) further claims that only a practical technique such as measuring and inquiry tactics such as drawing graphs and identifying variables can be taught and improved. The researcher holds the view that learners can be taught to observe, classify and hypothesise scientifically. For instance, learners are taught to make qualitative and quantitative observations, i.e. they are taught to carefully explore all properties of an object. This may include properties such as weight, volume, temperature, colour, odour, shape and texture. Hence the researcher concludes that it is possible to teach and develop the application of science process skills in problem-solving, if learners are afforded opportunities to always engage science process skills in whatever learning activities they do.

Jenkins (1989: 33) also regards the process-led approach as flawed because some skills such as accuracy, neatness and observing do not transfer. Jenkins (1989) cited by Wellington 1989: 9) further argues that scientific knowledge can become appealing and accessible if it is taught in an exciting and interesting context. Millar (1989: 52-56) criticises the idea that learners can be taught to observe, classify, infer and hypothesise, because these skills are present in infants since birth. Children can observe, classify, infer and hypothesise without being taught. They are able to observe and classify different faces and identify their mothers.

It is further argued that these skills cannot be practised in isolation of knowledge or experience. People use their knowledge and experiences whenever they observe, classify, infer and hypothesise. Knowledge gives meaning and value to science process skills as general intellectual skills are applied during the life-cycle of a person (Millar and Driver 1987: 42) as formal instruction implies progress and development.

Millar and Driver (1987: 42) also claim that proponents of science process skills do not have any idea of how to teach these skills because what constitutes the growth or progression in science process skills is not known. This argument is flawed because not all science process skills can be practised without receiving formal instructions. It is not that simple for a person to draw tables and graphs, recognize variables, interpret data or define operationally without learning how to perform these skills. Progress or growth in process skills of science is visible when people apply all the science process skills they have learnt. If investigators, when answering questions, identify variables, formulate hypotheses, identify factors to be held constant, define variables operationally, and collect and interpret data, it shows that they are capable of planning and conducting investigations on their own. This proves maturity and growth in conducting scientific investigation that is supported by evidence. Hence, the researcher argues that it is possible for geography teachers to develop their learners' growth and progress in science process skills (cf. Chapter 4).

2.7 CONCLUSION

Examples given in this chapter indicate that science process skills are applicable to the teaching of geography. This is also supported by the fact that there are many geographical questions which need to be tackled and solved. The International Charter on Geographical Education (1992: 5) maintains that geographers asks the following questions:

- *Where is it?*
- *What is it like?*
- *Why is it there?*
- *How did it happen?*
- *What impacts does it have?*
- *How should it be managed for the mutual benefit of humanity and the environment?*

Finding solutions to these problems requires investigating the location, situation, interaction, spatial distribution and differentiation of phenomena on earth. Consequently, geographers are required to possess skills in:

- *using verbal, quantitative and symbolic data such as text, pictures, graphs, tables, diagrams and maps;*
- *practising such methods as field observation and mapping, interviewing people, interpreting secondary resources and applying statistics; and*

- *using communication, thinking, practical and social skills to explore geographical topics on a range of scale from local to international. Such a process of inquiry will encourage students to identify questions and issues; to collect and structure information; to process, interpret and evaluate data; to develop generalisations; to make judgements and decisions; to solve problems; to work cooperatively in team situations; and to behave consistently with declared attitudes* (Smit and van der Merwe 1992/1993: 149).

The Guideline Document and Interim Syllabus for Geography Grades 10 to 12 (1996: 4) encourages learners to develop skills listed above. Almost all secondary school geography textbooks used in South Africa have chapters on science process skill activities (Hurry, Hart and De Montille 1991: 322-333; Ranby 1994: 52-78; Swanevelder, Van Huyssteen and Kotze 1987: 3-49; Swanevelder, Kotze and Roos 1986: 3-40; Swanevelder, Van Kradenburg and Hatting 1985a: 3-28; Swanevelder, Kotze and Myburgh 1985b: 1-21 and Swanevelder, Kotze and Van Kradenburg 1985c: 1-21). Contents and activities in the cited sources require learners to possess scientific skills of analysis. It is imperative for geography teachers to encourage learners' development in these skills. In this way, geography education may contribute towards the development of outcomes-based education principles of developing people who can communicate, solve problems, are confident, can work with others, possess life skills and take part in economic and social life with confidence.

Furthermore, geography learners are expected to acquire and possess skills in advanced analysis of photographs and maps, fieldwork and statistical techniques. Swanevelder et al. (1987: 3-48) maintain that advanced analysis of photographs and maps should include the following:

- *Advanced interpretation of a section of an oblique aerial photograph (Calculating the scale: Why? What? How? - Identifying geographical phenomena - Formulating the problem and the hypothesis and applying scientific method to interpreting oblique aerial photographs);*

- *Advanced interpretation of a stereopair of vertical aerial photographs (Advanced interpretation of vertical aerial photographs by means of stereoscopic vision - Problem solving in geography: applying a more detailed procedure of analysis);*
- *Advanced interpretation of a 1 : 50 000 topographical sheet (Identifying and interpreting physical features and cultural features);*
- *Advanced interpretation through the integrated use of photographs and maps (Formulating the hypothesis, i.e. statement of probability; analytical techniques. i.e. observations, collection of data, analysis and interpretation of the physical environment);*
- *Fieldwork in an urban area; and*
- *Techniques of collecting and processing data: the statistical method (Problem and hypothesis formulation: obtaining quantitative data, tabulating data, sampling and testing the hypothesis).*

All the listed skills involve the application of both basic and integrated science process skills to the teaching of geography. It is the researcher's assumption that the teaching and learning of geography cannot happen without applying some science process skills in one way or the other. The next chapter discusses the nature and structure of geography education and their relations to outcomes-based education.

CHAPTER THREE

THE NATURE AND STRUCTURE OF GEOGRAPHY AND ITS IMPLICATIONS ON THE APPLICATION OF OUTCOMES-BASED GEOGRAPHY TEACHING

3.1 INTRODUCTION

A discussion on the application of science process skills to the teaching of geography necessitates a reference to the nature and structure of geography. This chapter attempts to explore the nature and structure of geography and relates these to the South African outcomes-based education (OBE) framework. The chapter continues to justify the incorporation of science process skills into the teaching of geography.

Furthermore, the chapter highlights the implications of the nature and structure of geography on the teaching of outcomes-based geography. An attempt is made to also explore the implications for the critical and developmental outcomes and the Natural Sciences learning area's outcomes on the teaching of geography. The following section highlights the nature of geography.

3.2 THE NATURE OF GEOGRAPHY

Dreckmeyr, Maarschalk and McFarlane (1994: 11) believe that the nature of a discipline influences the way in which that discipline's knowledge is structured and processed. Hence, the nature of the subject also influences the way the subject is taught and learnt, which necessitates the following two questions:

- *What is geography?*
- *What does a geographer do?*

Marran (1994: 7) asserts that geography is a body of knowledge which has its own field of study and field of investigation. Like other natural sciences, geography has to do with direct experience of natural phenomena, human phenomena and with the collection of information and acquisition of knowledge. Geography can be described as a scientific body of knowledge which also organises and interprets geographical information collected through logical means. This method of investigation is known as the process of science (Van Aswegen, Fraser, Nortje, Slabbert and Kaske 1993: 2). Geography also attempts to explain and understand nature in all its phases, i.e. geography is a way of trying to understand nature. It should be noted that geography does not investigate fauna and flora extensively, as does biology. Shortle (1975: 286-293) observes that geography has three different dimensions, namely, the body of knowledge (substantive structure), the process by which the knowledge is obtained (syntactical structure) and the way of thinking that lead to a better understanding of nature.

It is clear from the foregoing text that without the process skills of science (syntactical structure) there could be little discovery of new geographical knowledge because science process skills are utilised to collect, organise and interpret information.

However, it is important to note that geography as a discipline of knowledge is ever-changing because its contents and methods have changed over years (Graves and Moore 1972: 18; James 1969: 475-476; Kohn 1982: 44-45 and Naish 1992: 53). The following paragraphs describe how geography moved from factual knowledge about the earth's surface, i.e. 'cape and bays'- 'state and capitals' approach and to a science of spatial correlations (cf. Figure 2.1), i.e. the study of relationships between different distributions on the earth's surface (Graves and

Moore 1972: 18) and more recently to contemporary geography that seeks to reveal the underlying connections that exist between knowledge, power and human interest (Unwin 1992: 1).

Kohn (1982:44) notes that geography in the 1920s studied man-land relationships or human ecology. At that time, it was believed that geography bridged the natural sciences and the social sciences. The geography of the 1920s was extremely explanatory and descriptive, and environmental determinism in its various forms dominated much geographical thinking. It was argued that the environment had dominance over people (Magi 1990: 4). Environmental determinism asserted that human actions were influenced by the environment. Environmental determinists espoused the view that the people's activities on earth were largely determined by the nature of the physical environment (Unwin 1992:92). In the 1940s and 1950s, the philosophy of probabilism which advocated the influence of people over the environment dominated geographical thinking (Magi 1990: 4-5).

In the 1950s and 1960s, the study of man-land relations was replaced by the study of the areal differentiation of the earth's surface. The study of geography became regional in its approach. Geographical content of this period described the variable character of the earth's surface (Kohn 1982: 44-45 and Unwin 1992: 98-116). At that time, the regional approach competed with the systematic approach for dominance. The systematic approach entailed the study of a single geographical phenomenon like rainfall or a group of related geographical phenomena like temperature, atmospheric pressure, cyclones, winds, and so on which determine the climate of a region. This method of study influenced geography to be divided into a number of systematic fields, which meant reorientation to economic, urban and human geography, including social, political and ecological geography. Geographers were also keen to formulate laws and theories of the spatial structure and human phenomena during this period (Kohn

1982:44-45) .

By the late1960s and early1970s geographers started to place much emphasis on topical geography and the introduction of the scientific method. This was the onset of the demise of regional geography. Geography adopted a positivistic school of thought, and it was argued that geographical knowledge could only be collected through using scientific procedures (Magi 1990: 5). Its central claim was that science was the only legitimate form of knowledge and that noticeable facts are the only possible phenomena of knowledge. Geography emerged as an empirical-analytical science (Unwin 1992: 106-135), claiming that experience instead of reason is the fountain of all knowledge. Empiricism emphasised the importance of observations to theoretical statements.

In the 1970s the scientific method began to loose favour as it was believed that it was impersonal, mechanical and displayed a lack of concern for individuals, and the contemporary social issues (Magi 1990: 5). This period was marked by the development of behavioural geography or historical-hermeneutic geography (Unwin 1992: 136 -157) which regarded an individual as a decision maker. There were two groups of behavioural geographers, namely, those who continued to use the spatial-scientific methodologies and humanists who studied unique events such as equality and justice (Kohn 1982:45).

This period in the development of geography emphasized geographical phenomenology. Magi (1990: 5) maintains that "*this school of thought argues that geographical knowledge can also be acquired through experience, intuition, introspection and behavioural procedures. It emphasizes man-land relationships by focussing on human experience and human actions, memories and perceptions.*"

For example, information and knowledge about causes of soil erosion in a village, may be given fairly accurately by people who have themselves never gone to school, but who have vast experience of the local causes of erosion, in opposition to people acquiring the information on the causes of erosion through scientific and conventional procedures.

When the changing nature of geography is considered, it is natural that the teaching and learning of geography should adapt to the changing nature of the discipline. The International Charter on Geographical Education (1992: 5) aptly describes the nature of **contemporary geography** as follows:

> *"Geography is the science which seeks to explain the character of places and the distribution of people, features and events as they occur and develop over the surface of the earth. Geography is concerned with human-environment interactions in the context of specific places and locations. Its special characteristics are its breadth of study, its span of methodology, its synthesis of work from the disciplines including the physical sciences and the humanities and its interest in the future management of people-environment interrelationships."*

The nature of contemporary geography implies that the subject has adopted the **process approach** which should be supplemented with active inquiry as the main style of teaching and learning, hence the next section discusses the structure of geography.

3.3 THE STRUCTURE OF GEOGRAPHY

Degenaar (1985) cited by Mhlongo (1996: 121) explains the structure of a discipline in terms of its concepts and classified system of knowledge. Geography as a field of knowledge also has a substantive structure of facts, concepts and generalisations, and a syntactical structure of skills or techniques (Shortle 1975: 290-293).

3.3.1 The Substantive Structure of Geography

Van Aswegen et al. (1993: 4) point out that "*the substantive structure is the content structure (the body of knowledge) and contains the facts, concepts and generalisation of the subject.*" Some of the conceptual building blocks peculiar to geography are:

- *location;*
- *spatial association;*
- *spatial distribution; and*
- *spatial systems* (Chapman 1966: 137).

These conceptual building blocks are similar to the central concepts of geographical studies listed by the International Charter on Geographical Education (1992:5) which are:

- *location and distribution;*
- *place;*
- *people-environment relationships;*
- *spatial interaction; and*
- *region* (International Charter on Geographical Education 1992: 5).

Chapman (1966: 137) further asserts that concepts and characteristics associated with location are site, situation, place and locality. Spatial distribution is allied with continuity, discreteness, contingency, pattern, and density. Spatial association allied concepts are integration, interdependence, coherence, ensemble, coincidence, and complementary. Spatial interaction is associated with accessibility, linkage, and flows whilst spatial systems are associated with connectivity, order and hierarchy.

Geography, therefore is a field of study with its own ideas, laws, theories and models which geographers use to seek an understanding of the spatial structuring of the universe. In sections 2.5.1, 4.4, 4.5 and 4.6 of this study, it is aptly shown how science process skills could be applied to the teaching of secondary school geography.

The discussion in these sections indicates that it is possible for one or more science process skills to be developed in each and every geography lesson regardless of the content. The development of skills is part of the syntactical structure of geography which may contribute to the discovery of new geographical knowledge.

3.3.2 The Syntactical Structure of Geography

Mhlongo (1996: 122) maintains that syntactical structure of a discipline indicates processes or epistemology of that discipline. The syntactical structure also plays a role in the formation of new concepts and generation of new knowledge. Gardner (1975) cited by Van Aswegen et al. (1993: 6) describes the syntactical structure in terms of competencies such as the sensorimotor skill, the cognitive domain and the use of techniques that should be mastered. Table 3.1 attempts to illustrate how each of these competencies could encourage the development of some science process skills in learners.

Table 3.1 Association of Competencies and Science Process Skills (continues)

COMPETENCY	EXAMPLE
1. The sensorimotor skill It involves the primary acceptance of issues (sensory) from the environment. This entails all five senses and the execution of the most basic spontaneous motor movement (Mhlongo 1996: 123 and Van Aswegen et al. 1993: 6).	The learner may *observe* the process of the fluvial cycle of erosion and then draw the youth, mature and old stages of this cycle. By *observing* and drawing the cycle the learner develops his/her sensorimotor skill (cf. 4.4.1). *Observing* the fluvial cycle of erosion and *communicating* by means of diagrams (sketches) are basic science process skills which are developed in this activity.
2. The cognitive domain It contains a variety of cognitive skills. These skills develop when a sensorimotor skill is guided by thinking (Mhlongo 1996: 123 and Van Aswegen et al. 1993: 6).	An activity which involves the *classification* of models of slopes into gentle, steep, concave, and convex slopes could involve cognitive skills such as *observing*, *inferring*, and *predicting*. This process may entail *observing* and touching the slopes, *inferring* what forces of nature could have shaped the slopes and *predicting* a kind of slope resulting from a particular force. This implies that *observing*, *inferring* and *predicting* are related cognitive skills which enable learners to *classify* the slopes (cf. 4.4.4). This activity clearly indicates the development of the basic science process skills such as *observing, inferring and predicting* in learners.

Table 3.1 Association of Competencies and Science Process Skills

COMPETENCY	EXAMPLE
3. The use of techniques A technique is executed when a scientific device is used as an extension of the human body.	The use of a climatological instrument such as an anemometer to *observe* the speed of wind may include the **sensorimotor skill** of *measuring*, the **cognitive skills** of *observing* and estimating the speed of the wind and *predicting* and *communicating* the kind of weather that may prevail within the next 24 hours. It also involves the **technique skill** of manipulating, operating and reading the anemometer to *measure* the wind speed. This activity contributes to the development of basic science process skills such as *observing, measuring, predicting and communicating.*

Table 3.1 indicates that geography has indigenous skills and techniques which are associated with science process skills. Geographers employ these skills and techniques when concerned with the *where*?, the *what there*? and the *why (how) there*? types of questions about spatial patterns (cf. 2.7). Seeking answers to these questions requires exploring the location, situation, interaction, spatial distribution and differentiation of phenomena on earth. An investigation of these geographical questions needs learners to explore and develop knowledge and understanding of geographical skills and science process skills as suggested (cf. 4.2).

Studies (Marran 1994: 8; Proctor 1987: 224 and Rawling 1992:295) indicate a rapidly growing debate on whether either concepts or skills should be the focus of geography. There seems to be no general consensus as to the focus of geography. However, in recent years there have been increasing calls by some geography education researchers (Graves 1992: 27; Roberts 1992: 43-46 and Hawley 1992: 83-86) for greater attention to be paid to skills and outcomes so that the subject continues to retain its status in the curriculum and contribute to the development of modern economy which needs people who are highly skilled.

Some authors (De Souza and Munroe 1994:46; Salter and Riggs-Salter 1993: 154) in the United States of America have called for the implementation of standards-based geography that requires learners to demonstrate their knowledge. The researcher believes that the focus on standards is significant as it is concerned with what learners actually retain from their formal schooling. Standards are set of qualities or measures by which performance, skills, or other types of knowledge are judged (Spady 1994b: 192). This implies that learners would have to show the ability to understand and apply what they have learned. It also implies that the implementation of geography standards would require learners to master competencies such as the sensorimotor skills, cognitive skills and geographical techniques. Mastery of these skills is therefore being stressed and could be described as an outcome for the teaching of **contemporary geography**. This new development in the geography curriculum has rooted in Britain as well, where geography teachers cater for variations in the rate of learning among learners through outcomes-based teaching (Battersby 1997: 72-75).

In the South African education system, there is also a move towards the outcomes-based approach (cf. 3.4). The following paragraphs explain the factors behind this paradigm shift in some western countries in general and in South Africa in particular. It also explores some implications of outcomes-based education for the teaching of geography.

3.4 REASONS FOR A PARADIGM SHIFT TO OUTCOMES-BASED EDUCATION

Countries such as Australia, New Zealand and the United States of America (USA) started to experience a shift to outcomes-based education (OBE) in the 1980's (Killen 1999: 4). The move towards outcomes-based education in Australia was a by-product of the competency-based training (CBT) approach which had its roots in a desire to take a more national perspective on education by politicians, business leaders and educators (Killen 1998: 2). It seems as if the shift to outcomes-based education in Australia was a result of community's pressure for accountability in education. For instance, Killen (1999: 4) maintains that the shift rests on the simple notion that if education is achieving predetermined outcomes, all is well with education and, some would suggest, all will be well with the economy and with the future of the society. The shift to OBE was also experienced in the United States of America (USA). Spady (1994b: 29) has pointed out that three broad interrelated pressures affected the direction and intensity of school reform initiatives in the USA, namely,

- *the nature of Information Age economy and workplace;*
- *the changing demographic of society; and*
- *the rate and intensity of change affecting all social and political institutions.*

Subsequently, Spady (1994b: 28) argues that this complex, technologically dominated, multicultural, constantly changing world demands far higher learning results from schools than they have ever produced. It is believed that OBE has the inherent potential to meet these demands.

Analyses of various reports of the Department of Education indicate that South Africa has also joined the 'bandwagon' on OBE, as advocated in Australia and the USA (Department of

Education 1997a, Department of Education1997b, Department of Education 1997c, Department of Education 2001a and Department of Education 2001b).

A thorough analysis of the old and new South African education systems is beyond the scope of this study. The following discussion is confined to some historical, political and educational factors that contributed to the paradigm shift in the South African education system. The change from the old education system to the new education system based on outcomes, was necessitated by several factors which are discussed in the next paragraphs.

At the outset, it is necessary to point out that after the National Party came into power in 1948, it introduced an education system which was shaped largely by apartheid and underdevelopment (Hofmeyr and Buckland 1992: 20; and Department of Education 1997b: 8). The education system was largely fragmented and compartilised. There were separate subsystems of education for the 'White', 'Indian', 'Coloured' and 'Black' population groups. This resulted to different nineteen education departments in South Africa (Department of Education 2001a: 10). Eleven of these departments administered 'black' education. These subsystems of education led to disparities and inequalities in education for different racial groups. It also led to disparities in the educational standards of different education departments. This crisis was as a result of Christian National Education (CNE) philosophy of the National party's government. In 1948, the Institute for Christian National Education released a document of which Article 15 laid policy on 'black' education. Article 15 states:

> *We believe that the calling and task of white South Africa with regard to the native is to Christianise him and help him on culturally, and that this calling and task has already found its near focussing in the principles of trusteeship, no equality and segregation... We believe that the teaching and education of the native must be grounded in the teaching in life- and world-view of the white trustee... (and that the native must* accept*) the Christian and national principles in our teaching...* (Hartshorne 1989: 110-111).

Careful analysis of this statement indicates that the education system sought to develop Afrikaner language, beliefs, culture, history and religion. Education was used to foster loyalty to the Afrikaner nation. This implies that Christian National Education legalised separate development and the 'own affairs departments' in education. This policy encouraged the development of attitudes, beliefs and values that did not promote interaction among different cultural groups.

Thus, it can be argued that the "old" education system had to change because it was an inequitable system. The best way to remove inequality is to insist that all educational activities should focus on helping learners to learn things that will be useful to them. Outcomes-based education is regarded as an instrument for learners to learn what they would be able to demonstrate.

Van der Horst and McDonald (1997: 5) maintained that educational change was necessary because learners were not encouraged to value aspirations and perspectives of other cultural groups, and that most learners' educational training opportunities were inadequate. After the African National Congress (ANC) came into power in 1994, a new national ministry of education and nine provincial education departments were established. The national ministry of education sought to overhaul the education system of the country. In 1995 a South African Qualifications Authority (SAQA) was instituted by the Department of Education to embark on curriculum review. One of its tasks was to establish the guidelines for education in South Africa. SAQA recommended the adoption of an education system that would promote lifelong learning. It was believed that the new education system would "*...meet the economic and social needs of South Africa and its people*" (Department of Education 1997a: 2) and enable the citizens to compete globally. In order to meet these challenges, SAQA suggested the development and implementation of the new curriculum, namely Curriculum 2005. The new curriculum advocated for a transformed educational approach which focussed on what was learnt and whether learning was successful rather than on when and how learning took place.

This educational approach is known as outcomes-based education (OBE). In this approach, the learners demonstrate what they can do with what they know and understand (Spady 1994b: 49), which is a change in the education system from a content-based approach to an outcomes-based approach (Department of Education 1997a: 5). In South Africa, OBE has taken an approach (cf. 3.5) that emphasises outcomes that relate to learners' future life roles (Killen 1999: 2). The new education system is required to break down class, race and gender stereotypes (Department of Education 1997a: 2). It is believed that Curriculum 2005 would promote critical thinking, rational thought and deeper understanding through outcomes-based education.

3.5 CURRICULUM 2005

In order to eliminate the legacies of the past education system which was fragmented and inadequate, the Department of Education decided to embark on Curriculum 2005 that was strengthened by a revised National Curriculum statement for schools (Department of Education 2001a: 4). This is a national curriculum framework which is based on outcomes-based qualification's framework.

The South African Qualification Authority (SAQA) was established to set the standards and the quality of educational outcomes. The South African Quality assurance Act of 1995 legitimised SAQA. The National Qualifications Framework (NQF) provides lifelong learning opportunities utilising nationally recognised levels of the South African Qualifications Authority.

Malan (1997: 3) has pointed out that the development and maintenance of a national, outcomes-based qualifications framework in South Africa would

- *create opportunities for all South African to become lifelong learners;*
- *remove artificial boundaries between education and training by integrating theoretical and practical learning and teaching;*
- *make education and training relevant to the needs of individual learners and of the country as a whole;*
- *establish credible standards and qualifications which would be recognised and accepted nationally and internationally;*
- *make education and training accessible to all those who wished to learn; and*
- *establish a flexible education and training system which would offer different routes (or learning pathways) by means of which learners could accumulate credits and gain qualifications.*

Table 3.2 indicates the structure of the National Qualifications Framework (NQF). It is just a description of how education qualifications are organised, classified and accredited in South Africa. The NQF which registers national standards and qualifications has eight levels and three main bands, namely, the General Education and Training band (GET), the Further Education and Training band (FET) and the Higher Education and Training band (HET).

Table 3.2 National Qualifications Framework

School Grades	NQF Level	Band	Types of Qualifications & Certificates	
	8	Higher Education and Training Band (HET)	Doctorates Further Research Degrees	
	7		Higher Degrees Professional Qualifications	
	6		First Degrees Higher Diplomas	
	5		Diplomas Occupational Certificates	
Further Education and Training Certificates (FETC)				
12	4	Further Education and Training Band (FET)	School/College/NGOs Training certificates, Mix of Units	
11	3		School/College/NGOs Training certificates Mix of Units	
10	2		School/College/NGOs Training certificates Mix of Units	
General Education and Training Certificates (GETC)				
9	1	General Education and Training Band (GET)	Senior Phase	ABET LEVEL 4
8				
7				ABET LEVEL 3
6			Intermediate Phase	
5				
4				ABET LEVEL 2
3			Foundation Phase	
2				
1				ABET LEVEL 1
R			Reception Phase (Pre-school)	

(Department of Education 1997b: 16)

3.5.1 The General and Training Band

The General and Training Band which accommodates pre-school to Grade 9 represents nine years of compulsory education. It consists of the reception phase (pre-school), the foundation phase (Grades 1-3), the intermediate phase (Grades 4-6) and the senior phase (Grade 7-9). A learner who attends formal schooling receives the general education and training certificate at the end of Grade 9.

An adult or a youth not attending school receives the same certificate after working through adult basic education and training programmes (ABET levels 1-4). Level 4 of ABET is equivalent to Grade 9. The learning outcomes for Grade 9 are identical to the learning outcomes for ABET level 4. At the end of this band, the learner is expected to be:

- ☐ *confident and independent*;
- ☐ *literate, numerate and multi-skilled*; and
- ☐ *compassionate, with respect for environment and ability to participate in society as a critical and active citizen* (Department of Education 2001c: 5).

After this phase, the learner may move to the Further Education and Training Band.

3.5.2 Further Education and Training Band

The Further Education and Training band accommodates Grade 10 to Grade 12. Grade 12 represents the end of formal schooling and learners who achieve the learning outcomes for this band are awarded the further education and training certificate. Some learners may reach this level through non-formal and informal education. These learners are also awarded the further education and training certificate. It is likely that geography would also be incorporated in this band. The next phase of the NQF is the Higher Education and Training band.

3.5.3 Higher Education and Training Band

This band accommodates qualifications offered by universities, colleges of education and technikons. Learners who achieve outcomes set out in programmes offered by these institutions are awarded degrees, diplomas or certificates. Geography is offered at universities and colleges of education, but technikons do not. In most South African universities, the Department of Geography are housed in the Faculties of Natural Sciences.

All programmes offered in these bands are based on outcomes (cf. 3.8) which are formulated in terms of standards, hence the next section discusses the nature of outcomes-based education.

3.6 THE NATURE OF OUTCOMES-BASED EDUCATION

Killen (1999: 4) pointed out that in Australia the stimulus for outcomes-based education was political. The Federal government wanted economic efficiency and accountability, which is a means of evaluating the quality and impact of teaching in a specific school (Jansen 1997: 1). There were also calls for schools to produce measurable 'outputs' commensurate with the public moneys invested in them. Spady (1994b: 28) and Manno (1995: 1) also noted that some States in the USA implemented OBE which demanded higher learning results from schools to give parents, politicians, educators, future employers and the general public an accurate picture of learners' capabilities. Furthermore, outcomes-based education enabled these groups of people to determine whether their investment in public education was resulting in improved learning and achievement at higher levels. This implies that Australia and the USA implemented OBE to enable taxpayers to hold educators accountable for higher learning results.

In outcomes-based education programmes, the focus is on the learning results and performance expectations (Van der Horst and McDonald 1997: 7 and Spady 1994b: 2). Learners are supposed to acquire and master knowledge, skills and values. What is of importance is what the learners know, can do and the attitudes and values they display. Learners should be able to demonstrate their understanding of knowledge and transfer and apply the desired outcomes to new areas and context. In OBE, the most important activity it seems is the use of content to perform or demonstrate a task.

OBE has its foundation on competency-based learning and mastery learning. Competency education has all elements of OBE. It is built around the integration of outcome goals (in terms of skills), instructional experiences (to teach the outcomes) and assessment tasks (to determine whether learners have mastered the outcomes) (King and Evans 1991: 74; Van der Horst and McDonald 1997: 10, and Fraser 1999: 4). Van der Horst and McDonald (1997: 10) argue that competency education

> *... supports the idea that all learning is individual and the individual (whether the teacher or the learner) is goal-oriented. Furthermore, the teaching-learning process is facilitated if the teacher knows what he/she wants the pupil to learn and if the learner knows exactly what he/she is required to learn. Additionally, personal responsibility or accountability for learning is emphasised.*

This is similar to the premises on which OBE is based which are listed on page 117. As it has already been mentioned, another root for OBE is mastery learning. The general aim of mastery learning is to ensure that learners are granted opportunities to be successful at most activities, by supplying suitable learning conditions, materials and back-up guidance (Van der

Horst and McDonald 1997: 11). Furthermore, Bloom (1984: 4) maintains that in mastery learning:

> *Students learn the subject matter in a class with about 30 students per teacher. The instruction is the same as in the conventional class and is usually with the same teacher. Formative tests (the same tests used with the conventional group) are given for purposes of feedback followed by corrective procedures and by parallel formative tests to determine the extent to which the students have mastered the subject matter.*

This implies that in mastery learning, the teacher strives to enquire why learners fail to master the content. Subsequently, the teacher provides the learners with more learning time, different learning media or materials, or diagnose the prerequisite knowledge or skill the learners should gain to master the content (Van der Horst and McDonald 1997: 11). Mastery learning process is a method of improving the learners' learning from the same teaching over a series of learning tasks (Bloom 1984: 7). This implies that mastery learning also has aspects which relate to OBE.

Spady (1988: 5) maintains that outcomes-based education means organizing for result as teachers based what they do instructionally on the outcomes they want to achieve. Teachers determine the knowledge, competencies and qualities they want learners to demonstrate when they finished school and face the opportunities of an adult world. Spady (1994b: 9) also points out that OBE is based on the following three premises:

- ☐ *all students can learn and succeed, but not on the same day in the same way;*
- ☐ *successful learning promotes even more successful learning; and*
- ☐ *schools control the conditions that directly affect successful school learning.*

These premises imply that OBE is learner-centred and is based on the belief that all people can learn, as Baron and Boschee (1994: 193) and Killen (1999: 5) assert that in broad terms, outcome-based education is:

- *a commitment to the success of every learner;*
- *a philosophy that focuses educational choices on the needs of each learner; and*
- *a process for continuous improvement*

Furthermore, Baron and Boschee (1994: 193) and Spady (1994b: 10) explain that the strategy for outcomes-based education implies that:

- *what a student is to learn is clearly identified;*
- *each student's progress is based on demonstrated achievement;*
- *each student's needs are accommodated through multiple instructional strategies and assessment tools; and*
- *each student is provided time and assistance to realize his or her potential.*

In OBE, the outcomes are the starting point of educational planning and all teacher activities are focussed on helping learners to achieve these outcomes. Teachers' choice of content, teaching methods, assessment and resources, all come after they have decided what is that learners should be able to do as a result of teachers efforts to help learners learn.

When planning a lesson the teacher should start by formulating *outcomes*, for his or her lesson. Outcomes are statements of intention, written in terms of learner learning. Killen (1999: 4) defines outcomes as "*statements of intent, or statements of desired educational outcomes, focus attention on the purpose of instruction, rather than on the content or learning experiences that are the vehicles for instruction... OBE gets us to think about why we are teaching what we* *are teaching, and why we are teaching it in* a *particular way."* This implies that outcomes are statements of the significant things that learners should be able to demonstrate as a result of a period of instruction and learning.

However, it is important to note that not all people (Schlafly 1993: 1-8 and Jansen 1997: 1-9) are in favour of OBE. Some researchers disagree with the outcomes that have been prescribed whilst others disagree with the whole outcomes-based education approach.

3.7 SHORTCOMINGS OF OUTCOMES-BASED EDUCATION

Researchers such as (Baron and Boschee 1994: 195; Brandt 1994: 1; Burron 1994: 74; Manno 1995: 721; O' Neil 1994: 8 and Zitterkopf 1994: 78) point out that some OBE critics claim that most prescribed outcomes are too vague, attitudinal and relate to values that are not sufficiently academic. It is argued that outcomes-based education only emphasises affective outcomes at the expense of cognitive outcomes or academic skills such as reading, writing and arithmetic (Schlafly 1993: 1). It is claimed that OBE is likely to lead to the lowering of standards and academic decline. This criticism is a naive because it is based on the assumption that nothing academic is never done in OBE. It is possible for teachers to set challenging tasks in their programme. Consider an outcome like *learners will use process skills to investigate phenomena related to geography.* This outcome entails learners collecting, analysing, organising and evaluating information, and understanding the world as a set of related systems. These activities are all academic in nature as the use of science process skills is academic. Zitterkopf (1994: 76) is of the opinion that the schools whose focus is on the achievement of results are likely to attain the results and a higher level of the quality in the process and the product.

Furthermore, opponents of OBE claim that outcomes which describe learners as 'effective communicators' or 'problem solvers' are ill-defined, nebulous and result in less academic rigour (O' Neil 1994:8). Zitterkopf (1994: 78) advises that affective outcomes should be integrated with academic outcomes to achieve the highest level of student learning in both areas, which implies that affective outcomes should be rooted in the academic framework.

According to Boschee and Baron (1994: 195) and Zitterkopf (1994: 76) some Christian critics of OBE claim its outcomes in social/affective areas are value-laden, challenge traditional family values and take the role of parents in moral education. It is also claimed that some textbooks are morally offensive as they condone homosexuality.

Besides academic and moral complaints about OBE, other complaints are political. For example, it is claimed that a critical outcome such as *learners should work effectively with others as members of a team, group, organisation and community* conditions learners to be cooperative and pliable workers and citizens of the New World Order (Bonville 1996: 2).

Opponents of OBE further contend that group problem solving and cooperative learning which are instructional vehicles of OBE are flawed as they undermine children values, individuality, and commitment to personal responsibility (Burron 1994: 74). It is further argued that high achievers suffer as they must wait until their peers exhibit mastery of desired outcomes (ASCD Update 1994: 1 and Bonville 1996: 3). This implies that opponents of OBE favour a competitive model under which learners compete with each other. ASCD Update (1994: 2) also notes that opponents of OBE claim that learners' motivation suffers as they know that they have multiple opportunities to pass a test, hence there is no pressure to study.

In his paper entitled *Why OBE will fail*, Jansen (1997: 1-9) has identified ten reasons why OBE will fail in South Africa, which are:

- the language associated with OBE is too complex and inaccessible. Therefore, most teachers may not be able to give OBE's policy papers meaning through their classroom practices;

- OBE as curriculum policy is lodged in problematic claims and assumptions about the relationship between curriculum and society. Proponents of OBE in South Africa claim that its implementation could lead to a high economic growth. Jansen (1997: 3) notes there is no evidence which suggests that a change in school curriculum leads to an improvement in national economies;

- OBE will fail because it is based on flawed assumptions on what happens in schools, classroom organisation and the kinds of teachers who are within the system. The type of OBE implemented in South Africa requires highly skilled and qualified teachers who are in the minority in South Africa, hence teachers call for more time and training before it is implemented;

- OBE is undemocratic because outcomes are specified in advance. There is a fundamental contradiction when insisting that students use knowledge creatively only to inform them that the desired learning outcomes are already specified;
- there are important political and epistemological objections to OBE as curriculum policy. The motive of the African National Congress (ANC) and alliance partners who predicated their politics on the notion of 'process' and organise their policies on a platform of 'outcomes' are questioned. Educational and political struggle of the 1980's valued the processes of learning and

teaching as ends in themselves. Few teachers participated in OBE's committees. As a result, the majority of teachers have little information and understanding of OBE;

- OBE with its focus on instrumentalism - what a student can demonstrate given a particular set of outcomes - sidesteps the important issues of values in the curriculum. Jansen (1997: 6) notes that core values such as combatting racism and sexism, which are relevant to the South African transition are not evident in the reports of learning area committees;

- the management of OBE will multiply the administrative burdens placed on teachers. For instance, teachers would be required to reorganise curriculum, increase the amount of time allocated for monitoring individual student progress against the outcomes, administer appropriate forms of assessment and maintain comprehensive records (Jansen 1997: 7). These conditions will not be conducive for OBE's success;

- OBE trivialises curriculum content even as it claims to be a potential leverage away from content coverage which besets the current education system. This implies OBE neglects curriculum content at the expense of outcomes;

- it requires trained and retrained teachers and principals who would be able to implement it, new forms of assessment such as performance assessment or competency based assessment, new forms of learning resources and teachers' cooperation when they learn the process of implementation; and

- it requires a radical revision of the system of assessment. For instance, the policy of continuous assessment which is difficult to apply to the matriculation examination, hence OBE would be implemented in a traditional assessment education system. As a result of this, OBE's principles may not be realised.

The Department of Education in South Africa should seriously take note of these criticisms and attempt to retrain practising teachers on OBE principles and strategies and also introduce OBE programs that could stimulate teachers' interest in OBE. As a result, teachers could appreciate and embrace the new curriculum and implement it in their classrooms with enthusiasm (cf. 7.3).

Notwithstanding the shortcomings of outcomes-based education mentioned above, McGhan (1994: 70) points out that OBE:

- *reduces rote learning;*
- *increases learners' ability to appreciate and deal with real life situations;*
- *eliminates permanent failure as learners who have not achieved the standard are given the opportunity to do so; and*
- *eliminates compromised learners as they are expected to master and demonstrate the identified outcome before moving on.*

The South African Qualifications Authority emphasises that learning should focus on critical outcomes that "*will ensure that learners gain the skills, knowledge and values that will allow them to contribute to their own success as well as to the success of their family, community and the nation as a whole*" (Department of Education 1997b: 10). The envisaged skills, knowledge and values are based on the critical and developmental outcomes espoused by the Department of Education.

3.8 CRITICAL AND DEVELOPMENTAL OUTCOMES

The critical and developmental outcomes were identified specifically for the South African scenario. Spady (1994b: 70-71) maintains that the critical and developmental outcomes are life roles which are a set of responsibilities that define an individual's position within a society's economic, political, and social relationships. In the South African OBE system, critical and developmental outcomes are broad, generic, cross-curricula and cross-cultural. They are general outcomes which are applicable to all learning areas (cf. 2.2.4).

These outcomes are the ultimate desired result of education in South Africa and they are related to learners' future life roles. The critical outcomes are more or less identical to Spady's (1994a: 21-22 and 1994b: 70-71) life performance roles (cf. 1.4). The actualisation of critical and developmental outcomes in learners is deemed to be the responsibility of teachers. One way of preparing learners for these life roles is to "*continually engage students in both individual and team activities that explore important issues or phenomena, use multiple media and technologies, create products that embody the results of students' explorations, and call for students to explain their work and products to adults and students audiences*" (Spady 1994a: 22). Therefore, teaching and learning activities in all learning areas in South Africa are to develop and promote the following critical outcomes to enable learners to:

- *Communicate effectively using, mathematical and language skills*;
- *Identify and solve problems by using creative critical thinking*;
- *Organise and manage activities responsibly and effectively*;
- *Work effectively with others in a team, group, organisation and community*;
- *Collect, analyse, organise and critically evaluate information*;
- *Use science and technology effectively and critically, showing responsibility*

towards the environment and health of others; and

- ☐ *Understand that the world is a set of related systems.*

Furthermore, teaching and learning activities in all learning areas are to promote the following developmental outcomes to enable learners to:

- ☐ *Reflect on and explore a variety of strategies to learn more effectively;*
- ☐ *Participate as responsible citizens in life of local, national and global communities;*
- ☐ *Be culturally and aesthetically sensitive across a range of social contexts;*
- ☐ *Explore education and career opportunities; and*
- ☐ *Develop entrepreneurial capacities* (Department of Education: 1997a: 17; Department of Education 1997b: 24 and Department of Education 2001a: 17).

In Chapter 4, it is illustrated that some of the outcomes mentioned above are associated with science process skills and can be realized and achieved as observable and demonstrable outcomes. Therefore, science process skills are actually effective outcomes and should be taken into consideration in the teaching of geography.

These critical and developmental outcomes form the foundation for learning area outcomes. Learning areas outcomes are more specific outcomes which are applicable to a specific learning area only, and need to be emphasised by teachers in their daily work. As geography falls within the Natural Sciences (NS) learning area (cf. 3.7.3), learning outcomes for this learning area which are associated with science process skills are discussed in the section that follows.

3.9 NATURAL SCIENCES LEARNING AREA'S OUTCOMES THAT ARE ASSOCIATED WITH SCIENCE PROCESS SKILLS

In South Africa, knowledge has been integrated into eight learning areas (cf. 2.2.4). Each learning area has its own outcomes which include skills, abilities and values which every learner is supposed to know, understand and perform. The rationale for the eight learning areas is found in the document of the Department of Education (1997b: 22-238). It describes the rationale of the Natural Sciences as follows:

> *The Natural Sciences, comprising the physical, life and earth sciences, involve the systematic study of the material universe - including natural and human-made environments - as a set of related systems. A variety of methods, that have in common the collection, analysis and critical evaluation of data, are used to develop scientific knowledge. Learners need to know that Science is a human activity, dependent on assumptions which change over time and over different social settings.*
>
> *The development of appropriate skills, knowledge and attitudes and an understanding of the principles and processes of the Natural Sciences:*
>
> - *enable learners to make sense of the natural world;*
> - *contribute to the development of responsible, sensitive and scientifically literate citizens who can critically debate scientific issues and participate in an informed way in democratic decision-making process;*
> - *are essential for conserving, managing, developing and utilising natural resources to ensure the survival of local and global environments; and*
> - *contribute to the creation and shaping of work opportunities.*
>
> *In view of its potential to improve the quality of life, learning in the Natural Sciences must be accessible to all South Africans.*
>
> *The investigative character of knowledge acquisition in the Natural Sciences should be mirrored in education. Learners should be active participants in the learning process in order to build a meaningful understanding of concepts which they can apply in their lives.* (Department of Education1997b: 22-238).

This rationale forms the foundation of this study as analyses of the learning outcomes for the natural sciences support the application of science process skills to the teaching of secondary school geography.

Following are learning outcomes for the natural sciences (Department of Education 2001b: 18 - 22) that are associated with science process skills:

- *Use process skills to in a variety of settings*

This outcome involves the development of investigative process skills. Learners conduct investigations in which a variety of process skills are applied, namely, questioning; observing; hypothesising; predicting; the collection, recording, analysis, evaluation and interpretation of data; and the communication of findings and/or conclusions (cf. 4.4 & 4.5).

In any investigation, phenomena are identified and questions are posed, situations are analysed and investigative questions are formulated, observations are made, hypotheses are formulated, predictions are made, investigative plans of action are formulated, evidence is collected and recorded, evidence is analysed, evaluated and interpreted, and conclusions are communicated.

- *Apply scientific knowledge and understanding*

This outcome develops the capacity of learners to work on problems using scientific knowledge and skills. The learners are expected to be able to answer questions about the nature of the world and to make verifiable predictions

- *Gain an appreciation of the relationship and responsibilities between science and society*

This outcome addresses issues such as environmental degradation, better ways of communicating, improved way of transport and so forth.

The need to apply science process skills to the teaching of geography is explained in section 4.2. The following section attempts to explain the implications of critical and developmental outcomes and the Natural Sciences learning area's outcomes on geography education.

3.10 THE IMPLICATIONS OF THE CRITICAL AND DEVELOPMENTAL OUTCOMES AND THE NATURAL SCIENCES LEARNING AREA'S OUTCOMES ON THE TEACHING OF GEOGRAPHY

What do all these outcomes mean to a geography teacher? The kinds of skills, knowledge and values put forward in the critical and developmental outcomes and the Natural Sciences learning area outcomes have implications on teacher and learner practices. Wessels and Van der Berg (1998: 11) assert that both sets of outcomes demand proactive and critical learners who are able to take control of their learning, rather than passive recipients of knowledge or information. This suggests that learners should be able to apply skills and outcomes rather than reproduce facts or ideas. It also implies that the learner learns by combining and practising a variety of science process skills connected to a real-life problem or context. If most learners are not able to demonstrate the designated skills, the researcher surmises that it could be difficult for them to address social and environmental issues that may appear in the 21st century. The promotion of social development and social justice is likely to be difficult as people could find it hard to use a range of skills and techniques in problem solving.

People who have learned outcomes-based geography should be able to identify and define the social and environmental issues they want to address, which would require them to formulate hypotheses, to observe, to decide on what information to collect, to classify the collected information and so forth. After these processes have been done, the people would be required to apply skills and techniques required for data analysis such as tables (cf. 2.5.2.2) and graphs (cf. 2.5.2.3). These may enable them to look for order, patterns and relationships in their natural world. By doing these, it should be easy to draw conclusions and address the social and environmental problems with critical understanding. Natural Sciences learning area's outcomes were designed to equip learners with skills that may enable them to make sound judgements and take appropriate social and environmental actions that could benefit South African society.

Therefore, OBE suggests that before deciding to teach particular geographical skills such as science process skills, teachers should be absolutely clear about what they want learners to learn. Then, teachers should select activities that are the best way to assist learners to learn the process skills of science.

The same process is also applicable to the teaching of geographical content. OBE encourages teachers to first decide outcomes that learners should achieve and then select the content that would help learners to achieve the envisaged outcomes. This approach is much more likely to result in learners learning knowledge, skills and values that are relevant and useful to them in the 21st century.

Geography lessons' outcomes should always focus on significant learning. The learners should learn knowledge, skills and values that they would be able to use after they have finished their formal education. Therefore, effective outcomes-based geography teaching is only possible if geography is presented as a subject that equips learners with knowledge, skills (competencies) and qualities that are needed to be successful after they have exited the education system.

It could also be stressed that geography teaching activities should be structured in such a way that outcomes can be achieved and maximised by all learners. Hence, the teaching of geography could equip learners with competencies and qualities needed to face the economic, social and political challenges of the country.

3.11 CONCLUSION

Geography as an independent subject is firmly entrenched in the South African schools' curriculum. The implications of Curriculum 2005 on geography education are based on the principles of Curriculum 2005. Some of these principles are innovative teaching, development of skills, teamwork, co-operative learning, problem-solving, creativity, and active learning. These principles imply that Curriculum 2005 is learner-centred. Furthermore, the principles imply that geography teachers should not encourage learners to memorise geographical knowledge without insight and understanding. Geography teachers should encourage learners to do things, to discover knowledge and to communicate what they have discovered.

Geography teachers are also expected to guide and facilitate learning and to nurture and support learners. This does not mean that teachers should discard everything they have been doing in the past. Traditional teaching strategies would still have a role to play provided that the teaching of geography focusses on assisting learners to actualise the critical and developmental outcomes and the outcomes for the Natural Sciences learning area.

The principles of Curriculum 2005 thus provide for active and participatory learning. Learners should become investigative and work co-operatively. This process could motivate learners and increase their self-esteem and chances of success. Thus the aim of Curriculum 2005 is to develop people who can communicate and solve problems with confidence, and possess good interpersonal skills and life skills.

Geography teachers and learners should improve and adapt their activities and practices to the outcomes-based approach. They way to implement this in geography is explained in chapter 4 that attempts to describe the application of science process skills to the teaching of geography.

CHAPTER FOUR

THE APPLICATION OF SCIENCE PROCESS SKILLS TO THE TEACHING AND LEARNING OF GEOGRAPHY

4.1 INTRODUCTION

Chapter three has highlighted the nature and structure of geography. It also discussed the implications of the structure of geography on the application of outcomes-based education to the teaching of geography. This chapter attempts to explain how geography teacher consideration of Piaget's theory of intellectual development can contribute to the development of the critical and developmental outcomes and science process skills in geography classrooms. The relationship between the development of cognitive functioning and the development of science process skills in learners receives attention. The chapter also reviews how geography teachers can develop science process skills in their learners through geographical activities. It seems as if there is no research in South Africa on the application of science process skills to the teaching of geography (Appendix 5). This chapter also attempts to address this situation.

It is assumed that geography lessons in most schools in South Africa will in future take place in geography rooms, where teachers and learners will be able to carry out practical investigations and demonstrations (cf. 7.2.3). Thus, the emphasis of this chapter is on learner activities which promote the acquiring and mastering of the science process skills. It is hard to imagine the study of geography without a strong emphasis on the development of process skills. Geography is a practical subject, which requires teachers to promote tasks that develop the application of science process skills. These skills are likely to enhance the discovery and learning of new geographical knowledge.

The researcher also assumes that the application of science process skills could develop learner competence in procedures of scientific inquiry. It is likely to empower learners to have an opportunity to 'feel' for geographical phenomena, to develop practical skills and techniques and to tackle open-ended tasks as problem-solving scientists. Lastly, the chapter also attempts to highlight how basic science process skills could be developed through mapwork activities. Mapwork is an essential part of the secondary school geography curriculum in South Africa. It is also important note that this is just an example of how mapwork activities can promote the learning of basic science process skills. It does not imply that mapwork is the only section of the geography syllabus that can be used to develop the learning of basic science process skills.

4.2 THE NEED TO APPLY SCIENCE PROCESS SKILLS TO THE TEACHING OF GEOGRAPHY

Van Aswegen et al. (1993: 18) have discussed the implications of the process approach for the teaching of biology which is also applicable to the teaching of geography. The advantages are listed as follows:

- ☐ learners become critical thinkers and are actively involved in seeking information that can be used to solve a problem or answer their questions;

- ☐ a process approach gives more meaning to the learning activities because learners see processes as a vital part of what they do in the geography class; and

- geography becomes an experience learners enjoy, with the result that they are motivated to greater achievement.

It is also assumed that teachers' consideration of Piaget's theory of cognitive development is likely to enhance the development of science process skills in learners, which suggests that there is a relationship between Piaget's stages of development and the acquisition and performance of science process skills.

4.3 PIAGET'S THEORY OF LEARNING AND SCIENCE PROCESS SKILLS

Kagan (1980) cited by Wolfinger (1984: 40) indicates that Jean Piaget's theory of intellectual development is based on the following three assumptions:

- the main source of a child's knowledge is an activity. By engaging in activities, a child is likely to learn something and to gain knowledge about that activity;

- the major function of knowledge is adaptation. This means that a child who has acquired knowledge through an activity should be capable of adapting and using the knowledge in different contexts; and

- the structures that are created through the action of a child form an uninterrupted and invariable cycle. This assumption forms the basis for Piaget's four developmental stages.

These four developmental stages occur gradually, and continuously in an invariant sequence from birth through adulthood. In these stages of development, children also show a gradual development of mental processes. Piaget's four stages of development are:

- the sensorimotor stage which starts at birth to eighteen months;
- the preoperational stage which begins at eighteen months through six and one-half years;
- the concrete operational stage which begins at six and one-half years through eleven or twelve years; and
- the formal operational stage which onsets at eleven years through to adulthood.

Sections 4.3.1 to 4.3.5 discuss Piaget's stages of cognitive development and their implications for the teaching and learning of geography. The following paragraphs discuss the sensorimotor stage.

4.3.1 The Sensorimotor Stage

Children in this stage of development are at a preverbal stage as they cannot speak. This is a reflex stage in which children express their thoughts through actions and not words (Piaget 1952: 25-29; Piaget 1964: 9; and Piaget and Inhelder 1969: 3-4). Furthermore, Piaget (1980: 11); Piaget (1981: 14); and Piaget and Inhelder (1969: 4) refer to this stage as the stage of practical and sensorimotor intelligence which includes reflexes and instinct present at birth.

Children learn and understand their world through physically manipulating the objects around them. For example, to grasp a stick in order to pick up a remote object is an act of intelligence. McCown, Driscoll and Roop (1996: 36) and Slavin (1997: 34) point out that infants learn and interact with their environment by using their senses and motor skills. Children who are in this stage may cry whenever they need attention or when they are hungry.

Wolfinger (1984: 41) maintains that children use their reflexes and are engaged mainly in tasks that need physical movement or jumping such as building blocks until the entire structure topples over. Hence, these activities are psychomotor in nature. Children learn first through accidental learning and then through more intentional trial-and-error learning (Slavin 1997: 34). One of the benchmarks of the sensorimotor stage is imitation (Piaget and Inhelder 1969: 53-56; Piaget 1981: 40 and McCown et al. 1996: 36). Imitation is a systematic effort to copy new gestures from a model (Piaget 1981: 40 - 41; Piaget and Inhelder 1969: 53) and it is believed to be the ability of the child to copy behaviours and sounds. The child starts to copy behaviours and sounds that are part of his or her everyday observation. For example, if the mother always smiles at her baby, the child is likely to smile back whenever the mother plays with him /her. Piaget (1929: 153) calls this act involuntary imitation, i.e. the child smiles without seeing any difference between his/her mother's smile that it is independent of him/her and the sound (s)he has produced. Sometimes, imitation may start after the disappearance of the model, i.e. the child may continue to repeat a gesture after someone has stopped the gesture. Piaget and Inhelder (1969: 53) call this type of action deferred imitation which constitutes the beginning of representation of action.

Children who are less than eighteen months old have no sense of object permanence (Esler and Esler 1981: 22, McCown et al. 1996: 36 and Wolfinger 1984: 41). They think that a concept or object that is not in the immediate environment does not exist. However, when children reach the age of eighteen months, they start to realize that concepts, objects or people that they cannot see, do not disappear, but still exist somewhere (Piaget and Inhelder 1969: 14, and Esler and Esler 1981: 22). Object permanence enhances advanced thinking because once children realize that objects exist even when they are out of sight, children are able to use symbols to represent the absent objects in their minds (Piaget 1964: 13 and Slavin 1997: 34). For instance, a child can imagine what his/her toy or milk bottle looks like even when it is out of sight.

It is important to note that in this period, children are able to *observe* and recognize their mothers or other family members. This act relates to the basic science process skill of *observing* where they are also able to distinguish their mothers' voices or faces from the voices or faces of other people, it relates to the skill of *classifying*. Children in this stage are able to perceive objects in terms of relations of similarities and dissimilarities (Inhelder and Piaget 1958: 5). This process relates to the basic science process skill of *classifying*. The end of this stage culminates at about two years of age or when the child starts to speak. The preoperational stage is reached at this point of onset of language (Wolfinger 1984: 42). By the end of the sensorimotor stage, children have progressed from the trial-and-error approach to problem solving to a more planned approach (Slavin 1997: 34). For example, if a child needs to play with a toy which is on top of a cupboard, (s)he will think about the problem of reaching the toy. Then, (s)he will figure out possible solutions to the problem. (S)he may drag a chair to the cupboard, climb the chair and reach out for the toy. This process indicates that the child has sought to solve the problem by following a planned approach until (s)he could reach the top of the drawer and retrieve the toy.

The process mentioned above is an intellectual process because the child uses his/her intelligence to get hold of the toy. Hence, the whole act links very well with the critical outcome of *identifying and solving problems by using creative and critical thinking* (cf. 3.8). Furthermore, the act of using the chair to reach the toy also demonstrates the critical outcome of *understanding that the world is a set of related systems, i.e. problem-solving contexts do not exist in isolation*.

4.3.2 The Preoperational Stage

The preoperational stage is the stage at which children learn to represent things mentally (Slavin 1997: 35). This stage has two substages, namely, the preconceptual stage and the intuitive stage (Wolfinger 1984: 41). The preconceptual stage lasts from the beginning of language until about four and one-half years of age. At this substage, children are also able to think and speak. However, their thinking process is restricted by perceptual limitations as children can focus only on one dimension of an object at a time (Piaget 1964: 17-18 and Esler and Esler 1981: 22). This implies that the child's thought does not get reversible (cf. 4.3.2.4).

A preoperational child lacks conservation skills (Donald, Lazarus and Lolwana 1997: 46; Esler and Esler 1981: 22; and Slavin 1997: 35). Conservation (cf. 4.3.2.2) is the ability to understand the concept that certain properties of an object (such as weight) remain the same despite changes in other properties (such as length) (Piaget and Inhelder 1969: 98; and Slavin 1997: 35). This limitation prevents the child from understanding transitions in shape, size, time and number.

In the intuitive substage, the child may experience a transitional stage in which (s)he gives a correct answer to a conservation task without providing a reason (Esler and Esler 1981: 22). For instance, if an equal amount of water is poured into two glasses of the same volume but different heights, the child would be able to infer that the glasses have an equal amount of water without providing their volumes as a reason. This example shows that a child who is at this substage, can perform the basic science process skill of *inferring* without providing adequate reasons for his/her inference.

The thinking processes of preoperational children differ from those of the adult in six crucial ways, namely, egocentrism, conservation, reversibility, centring, transduction and concreteness (Wolfinger 1984: 43). Mwamwenda (1995: 92) and Piaget 1929: 194, 203 and 279) discuss animism as another major characteristic of the preoperational stage. In the next paragraph each of these characteristics and their association with science process skills and critical outcomes are briefly discussed.

4.3.2.1 Egocentrism

Mwamwenda (1995: 93); Piaget (1964: 14) and Wolfinger (1984: 42) maintain that a child is egocentric as (s)he sees everything as revolving around himself/herself. It is difficult for a child to appreciate another person's point of view if it does not agree with his/her own thinking. Egocentric children use words whose referent is mostly clear only to them. For instance, the child may say, "*she climbed it with me*". In this statement, it is impossible for the listener to understand what is meant by such a statement.

The child is only able to consider other people's point of view through repeated interaction with people who have different views with his/hers (Mwamwenda 1995: 93 and Wolfinger 1984: 42). Repeated social interaction should be encouraged because it decreases egocentrism and relates well with the critical outcome of *working effectively with others in a team, group, organisation and community.* The child realizes that his/her views can be questioned and challenged (Mwamwenda 1995: 93). From the age of four, children find that their judgements are contracted by others (Inhelder, Sinclair and Bovet 1974: 20). Children gradually start to understand that other people do not have the same knowledge or idea that they have. It is interesting to note that they begin to understand that their mothers are not there to cater only for their needs.

At this stage a kindergarten teacher can start to introduce basic science process skills' activities such as *observing, communicating* and *classifying*. Children use their senses to *observe* objects and events. They also look for patterns in their observations (*classification*). The questioning and challenging of other children's ideas is likely to encourage children to form new concepts by searching for similarities and differences which relates to the basic science process skill of *classification.* The process of questioning and challenging other children's ideas also implies that children are likely to *communicate* orally what they know or are able to do. This process of social interaction could be linked to the critical outcomes of *working effectively with others*, and demonstrating the ability to *communicate effectively using language skill in the modes of oral presentation*. As Mwamwenda (1995: 93) has suggested, group discussions and activities play essential roles in helping children to become less egocentric.

4.3.2.2 Conservation

Conservation is the ability of an individual to realize and understand that a change in the form of an object does not necessarily change the quantity of that object (Piaget and Inhelder 1969: 98). A preoperational child is a nonconserver as (s)he cannot do the majority of the conservation tasks correctly. The main reason for the child's inability to conserve is his/her inability to *coordinate variables* (Wolfinger 1984: 42) which implies that a preoperational child is unable to perform integrated science process skills such as *describing the relationship between variables*.

Preoperational children tend to concentrate on the given condition, not taking into consideration what has already taken place or considering previous experience (Mwamwenda 1995: 94). Subsequently, preoperational children have difficulty with *inferring* some explanations or *predicting* possible outcomes before they are actually *observed*.

Mwamwenda (1995: 94) also points out that some preoperational children experience difficulties with *classification* activities as they concentrate on one member of the class at a time, paying little attention to other members of the class. These children are unable to grasp the similarity between the members which constitute the definition of a superordinate or universal class (cf. 4.3.3.3). This implies that the intellect of these children has not fully developed yet as overt *classification* is beyond their reasoning.

4.3.2.3 Centring

Centring is the process whereby a preoperational child focuses on one property or dimension at the expense of others (Dembo 1991: 53 and Wolfinger 1984: 43). The child pays attention to only one aspect of an object or situation at a time (Slavin 1997: 36). This tendency makes the child incapable of shifting his or her attention from one attribute to another while retaining the memory and use of the first characteristic (Wolfinger 1984: 43), thus failing to decentre (Mwamwenda 1995: 94). Decentralisation permits the mastery of the present situation by connecting it to former situations and by anticipating future ones (Piaget 1981: 63). This implies that it could be difficult for a child who cannot decentre to *predict* future outcomes. Distorted reasoning is the reason why the child fails to answer conservation questions. Mwamwenda, Dash and Das (1984) cited by Mwamwenda (1995: 94) argue that the child is unable to take other features of an object which might counteract or compensate the twisting and distorting effects of his/her tendency to centre on a single dimension into account.

For instance, a child observes two small glasses of the same size and shape which contain equal amount of water. The water from one of the glasses is poured into a third glass, which is taller and narrower. The preoperational child is likely to conclude that the third glass contains more water than the other glass because it is "taller". The child therefore, recognizes qualitative identity, but rejects conservation of quantity (Piaget 1972: 6). In this example, the child focuses on one dimension (length) and forgets about the other dimension (width). Therefore, the child bases his/her assertion on the static perceptual configuration, i.e. (s)he has perceived each state of the system individually instead of envisaging the situation in terms of reversible transformation which leaves the quantity constant (Inhelder and Piaget 1958: 247).

4.3.2.4 Reversibility

Reversibility is "*the ability to return to the point of origin, to do and undo, to go in one direction and compensate for it in another direction*" (Dembo 1991: 51). Reversibility of thought allows an individual to start at point A, move through the thought processes to point B, and then back to point A (Piaget and Inhelder 1969: 20; and Wolfinger 1984: 43). This is the ability of the child to change his/her thinking in order to return to the starting point (Slavin 1997: 36). The preoperational child is incapable of reversible thinking (Inhelder and Piaget 1958: 247).

For example, every mathematical or logical operation is reversible. Adults are likely to know that 3 x 3 = 9, then 9 ÷ 3 = 3 but a preoperational child may not be able to solve the division problem of 9 divided by 3.

4.3.2.5 Transductive Reasoning

A preoperational child does not think inductively and deductively like adults do. Inductive reasoning begins from the specifics and moves to the general (cf. 2.3.1) whilst deductive reasoning starts from the general to the specifics (cf. 2.3.2). The preoperational child thinks from specific to specific without touching on the general (Dembo 1991: 54). For instance, the child may conclude that every object that (s)he can take to his/her mouth is edible without considering that not all objects are edible.

Transduction is characterised by syncretisms or the linking together of unrelated things and juxtaposition which is the giving of successive unrelated judgements (Piaget 1929: 181 and Wolfinger 1984: 43). A child who is employing syncretic reasoning, places together objects which do not belong to the same class (Mwamwenda 1995: 94). As such, the child's skill of *classification* is illogical. The child is also likely to change the criterion for *classification* from time to time. For instance, a child may *classify* stones first on the basis of their colour and then *classify* the same stones on the basis of their shape.

4.3.2.6 Concreteness

Wolfinger (1984:43) observes that adults think in terms of words and symbols. Preoperational thought processes also differ from adult thought as a result of the child's requirement of concreteness or reality which implies that preoperational children are unable to learn concepts through the use of words instead of objects. Preoperational children develop new concepts through the use of real objects instead of the use of words. For example, adults can read about dew point temperature as the point at which condensation takes place. Children may learn the same concept, i.e. dew point temperature by placing ice cubes into a container of cold water and *observe* the point at which dew is formed outside of the glass by inserting a thermometer in the container. It is important to note that the teacher should demonstrate this activity for children to *observe* and understand the abstract concept 'dew point temperature'. This example indicates that children in this stage are able to be engaged in integrated science process skill such as *experimenting* which means that the use of a thermometer can also be linked to the critical outcome of *using science and technology effectively and critically*.

4.3.2.7 Animism

Animism describes the tendency to regard objects as living and endowed with will (Piaget 1929: 194). Piaget's (1951) cited by Mwamwenda (1995: 92) mentions that a preoperational child is unable to differentiate between living and non-living things, assuming that animals can talk like people, that rocks have life and that trees are capable of thinking. If a child sees a stone and a feather thrown upwards and the stone falls to the ground, whilst the feather floats in the air, the child may say this is because the stone wants to fall to the ground, whilst the feather prefers to float. This also confirms that children at this stage cannot give meaning to what they *observe*, i.e. they cannot make sense of things which implies that they fail to *infer*. They fail to *infer* that the stone falls to the ground because it is heavy and the feather floats in the air because it is light in weight.

Animism is promoted by children's story books where animals are depicted as capable of talking (Mwamwenda 1995: 92). Adults also tell stories that portray animals as being able to speak, an act which does not happen in reality. The same perception is also portrayed by television cartoons that show animals talking to one another.

4.3.3 The Concrete Operational Stage

The concrete operational stage starts from about seven years and lasts until approximately eleven to twelve years of age and it is marked by the acquisition of elementary operations of classes and relations (Piaget 1981 14). Furthermore, Piaget (1964: 47) and Slavin (1997: 38) note that this is a stage at which children develop skills of rational reasoning and conservation, however, children can use these skills only when dealing with familiar situations. Wolfinger (1984: 44) has identified four characteristics of this period, namely:

- *the appearance of operations*. For instance, a child in this stage may be able to do the calculation one plus one equals to two;
- *an inability to use verbal reasoning;*
- a *decrease in egocentricity* (cf. 4.3.2.1); and
- *the appearance of reversibility* (cf. 4.3.2.4).

Esler and Esler (1981: 25) and Seifert (1983) cited by Mwamwenda (1995: 95) point out that this period is known as the concrete operational stage because the child can use logical processes of reasoning on the basis of concrete evidence. For instance, (s)he may be able to deduce that water used to wash clothes is undrinkable because it is dirty or it is foamy (*inference*). This example highlights the consequences of polluted water which is part of the geography curriculum.

Similar to an adult, the child is capable of assessing objects and situations in a realistic manner (Mwamwenda 1995: 95). However, unlike an adult, a concrete operational child has difficulty with abstract thought (Slavin 1997: 38). As a result of logical reasoning, the concrete operational child is likely to be capable of comprehending great number of objects, events, and living things in his/her environment. The child is also likely to impose some kind of order in his/her world by observing similarities, differences, and interrelationships between objects which implies that the child is capable of *classifying* objects and events on the basis of their *observable* characteristics (Inhelder and Piaget 1958: 248).

Inhelder and Piaget (1958: 248-249) and Mwamwenda (1995: 95) note that the concrete operational child is capable of exercising logical skills in conservation tasks of quantity, length, area, number, weight and substance. This stage differs from the preoperational stage because the concrete operational child uses the principles of identity, reversibility and compensation which enhance mental development.

The principle of identity (cf. 4.3.2.2) entails that the amount of water stays the same despite any perceptual change, unless some amount is added or taken away. This implies that the child is capable of *identifying and describing variables* that remain constant or that are manipulated.

According to the principle of reversibility (cf. 4.3.2.4), if two identical tall beakers are filled with an equal amount of water and the contents of one beaker are poured into a wide container, a concrete operational child is likely to recognize that the amounts of water in the beaker and the flat container remain the same. If the water is poured back to the beaker, it will contain its original amount. This example is associated with the critical outcome of *collecting, analysing, organising and critically evaluating information*. Furthermore, this process can be linked to the integrated science process skill of *experimenting*.

The principle of compensation (cf. 4.3.2.3) entails that a change in one dimension is balanced by a compensating or reciprocal change in another dimension (Good and Brophy 1995: 39).

For instance, in the example given above, the length of the beaker is compensated by the width of the container, hence the child may be able to identify and describe length and width of the containers as the variables that are likely to affect the perceived amount of water.

Another difference is that the preoperational child responds to perceived appearances, whilst the concrete operational child responds to *inferred* reality which is the meaning of stimuli in the context of relevant information (Slavin 1997: 38). Consider the following example, in cities most workers commute between their homes and places of employment by public transport. If a concrete operational child is asked why workers use public transport, (s)he is likely to *infer* that it is because public transport is cheaper than driving a car, public transport is faster, the use of public transport reduces air and noise pollution or most workers do not have their own motor vehicles. All the mentioned reasons are *inferred* reality as the child *infers* situations which are real.

Slavin (1997: 39) has also noted that concrete operational children can acquire and master abilities such as seriation, transitivity and class inclusion. The following section emphasises how these abilities are associated with science process skills.

4.3.3.1 Seriation

Seriation is the ability to arrange objects in a logical progression from least to most according to size, weight or volume (Good and Brophy 1995: 39; Piaget and Inhelder 1969: 101; and Slavin 1997: 39). It is also the product of a set of asymmetrical transitive relations connected in series (Inhelder and Piaget 1958: 5-6).

Concrete operational children are capable of seriation from the ages of four to seven (Piaget 1972: 8). Such children are capable of ordering and *classifying* things according to some criteria or other dimensions.

For instance, the teacher may ask learners to use information in Table 4.1 on the next page to arrange settlement types from the smallest to the largest in terms of size and complexity. Learners may then use the given squares, dots or open circles to arrange the settlement types. These symbols have not been linked to their descriptions. Then, the learner puts the name of the relevant settlement type next to each symbol.

Instruction: Arrange the following symbols of settlement according to their sizes from the smallest to the biggest.

Table 4.1Types of Settlement

Town, City, Farmstead, Village. Megalopolis, Metropolis, Rural hamlet, Conurbation

Table 4.2 below, links the symbols to their correct descriptions. It shows how the learner is likely to respond to this seriation task by using the criterion of size of the symbols.

Table 4.2 Seriation of Settlements

Farmstead
Rural hamlet
Village
Town
City
Metropolis
Conurbation
Megalopolis

The purpose of this task in Tables 4.1and 4.2 is to help learners to *classify* the settlements on the basis of size as an *observable* characteristic. This implies that in this task, learners will be involved in the basic science process skills of *observing* and *classifying*. Furthermore, the process of *classifying* may lead to concept formation as learners would be required to link the settlement with its relevant descriptor. Engagement in this task is likely to develop the critical outcome of *communicating effectively using visual, mathematical and language skills. Classification* of the settlements on the basis of size as an *observable* characteristic could also develop the critical outcome of *identifying and solving problems by using creative and critical thinking*. Thus mastering of seriation tasks enhances the development of the transitivity skill (Piaget 1972: 8 and Slavin 1997: 39).

4.3.3.2 Transitivity

Transitivity refers to the ability of the child to *infer* a relationship between two objects on the basis of knowledge of their respective relationship with a third object which means that the child can mentally arrange and compare objects.(Piaget 1972: 6 and Slavin 1997: 39). For instance, a teacher informs learners that Johannesburg is larger than Pretoria and Pretoria is larger than Bloemfontein. Only concrete operational children should be able to comprehend logical *inferences* such as these. It may not be that simple for preoperational children to realize that in this statement Johannesburg is larger than Bloemfontein.

Furthermore, a concrete operational child is also likely to comprehend statements such as "*What will happen if...*". For example, if the teacher asks *"What will happen if a large number of people migrate from rural areas to the cities"*. The concrete operational child is likely to explain how rural depopulation will affect both rural areas and the cities. Transitivity can be linked to the integrated science process skill of *constructing hypotheses*. This is also likely to contribute to the critical outcome of *collecting, analysing, organising and critically evaluating* *information.* Sometimes, learners might be required to *conduct investigations* and do research to test their *hypotheses.*

After this process, learners are likely to *communicate* effectively their findings, which *is a critical outcome which involves communicating effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation.* The whole process may also contribute to the development of the critical outcome of learners *managing themselves and their activities responsibly and effectively.* Learners might be required to conduct the research in the city, in the rural area or in the library, hence they may be required to manage their times and programmes well. Furthermore, the teacher may group learners in pairs to collect data. The grouping of learners might contribute to the development of the critical outcome of learners being able to *work effectively with others* as a *member of a team, group, organisation or community.*

4.3.3.3 Class Inclusion

Class inclusion refers to the ability of the child to think concurrently about a whole class of objects and relationships among its secondary classes (Slavin 1997: 39). The following classroom scenario is used to explain how class inclusion can be taught in the geography classroom. The teacher informs the learners that there are 20 apricots and 10 oranges in the refrigerator and asks the following questions:

Teacher: *"How many apricots are in the refrigerator?"*

Learners: *"Twenty."*

Teacher: *"How many oranges are in the refrigerator?"*

Learners: *"Ten."*

Teacher: *"Are there more apricots than oranges in the refrigerator?"*

Learners: *"More apricots."*

Teacher: *"Which is the most - apricots or fruit?"*

Some learners: *"More apricots."*

Other learners: *"More fruit."*

In this example, fruit is considered as a whole class and the subordinate classes are apricots and oranges. Children who answered that there were more apricots than fruit lacked the ability to think simultaneously about the whole class and the subordinate class. They are thus unable to make comparisons between classes. Hence, it could be difficult for those children to apply some *classification* tasks fully. Children who answered that there were more fruit than apricots, show reversibility of thinking which implies that they are able to recreate a relationship between a part (apricots) and a whole (fruit). This also implies decentred thought because they can focus on two classes simultaneously. These children are at a concrete-operational stage as their thinking is not limited to reasoning about part-to-part relationships but about part-to-whole relationships (Slavin 1997: 39). Hence, these children are likely not to experience major problems with some *classification* tasks.

This example can be related to the critical outcome of developing learners who should be able to *identify and solve problems by using critical and creative thinking skills.* In this example, learners are required to think about the whole class and the subordinate class, hence, learners are required to solve the problem of class inclusion by using critical and creative thinking skills.

4.3.4 Formal Operational Stage

The formal operational stage is the final stage of Piaget's theory. It starts from approximately eleven years of age and continues into and throughout adulthood. Its hallmark is abstract reasoning (Good and Brophy 1995: 40 and McCown et al. 1996: 47) and the ability to think in symbolic terms and comprehend abstract content meaningfully without requiring physical objects or even imagery based on past experience with such objects (Good and Brophy 1995: 40-41). It is characterised by thought employing the logic of propositions freed from the content (Piaget 1981: 14). Learners in this stage can be engaged in basic science process skills such as *communicating* abstract phenomena. They might be able to use conventional signs and other geographical symbols to *communicate* or interpret geographical contents in topographical maps and synoptic weather maps (cf. 2.5.3 and 4.6.1). This process could contribute to the development of the critical outcome of *communicating effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation*.

McCown et al. (1996: 40) and Slavin (1997: 39) argue that learners who are in this stage are capable of thinking logically about tangibles and they should also be able to deal with possibilities. They can think in terms of a *hypothesis* as they can see beyond the 'here and now'. They are also capable of thinking about '*if - then*' situations (cf. 4.3.3.2) which involve abstract relationships (Donald et al. 1997: 47). For example, learners are able to consider that if '*Coriolis Force is nought at the Equator, then the particles moving in the Equator cannot be deflected either to the right or to the left.*' This example is likely to develop the following integrated science process skills in learners:

- *Identifying variables*: Learners identify variables such as Coriolis force and particles moving in the Equator.

- *Constructing hypotheses*: If Coriolis force is nought at the Equator, then the particles moving in the Equator cannot be deflected either to the right or to the left.

- *Describing relationships between variables*: There is a relationship between Coriolis force and the movement of particles in the Equator. If Coriolis force is nought, then the particles moving in the Equator cannot be deflected either to the right or to the left.

Furthermore, Biehler and Snowman (1993: 66) note that formal operational learners are engaged in mental 'trial and error' in order to *test hypotheses* consciously. Learners, thus are able to examine abstract problems systematically and generalize about the results (Eggen and Kauchak 1997: 43). For example, learners may consider that if Mount Everest is higher than Mount Kilimanjaro, and if Mount Kilimanjaro is higher than Mount Aux Sources, then Mount Everest is higher than Mount Aux Sources. Formal thinkers are able to think abstractly and generalize that, of the three mountain peaks, Mt Everest is the highest.

Biehler and Snowman (1993: 66) also maintain that "*the term 'formal' reflects the ability to respond to the form of a problem rather than its content, and to form hypotheses*". For example, the formal operational thinker can solve the following map scale analogies. Suppose the teacher asks learners to convert the following word scales into ratio scales; which are:

- 1cm = 50 000 cm, and
- 1cm = 0,5 km.

The learner is likely to realize that regardless of the different content, the form of the two problems is the same as both analogies are based on ratios. Thus, the learner may hypothesize that 1 cm on the map represents 50 000 cm or 0,5 km in reality.

Adolescents are also capable of handling problems that involve many factors (Pressley and McCormick 1995: 150) and they are able to *isolate and control variables* in forming conclusions (Eggen and Kauchak 1997: 44). For example, the learners may be asked to explain why the western part of South Africa is dry and sparsely populated. Formal thinking learners may be able to isolate the fundamental influences of this problem and be able to consider *variables* such as the influence of the sea, the central plateau of southern Africa and the location of the subcontinent. Systematic analysis of both *variables* and discarding of those that are not applicable (Mwamwenda 1995: 99) empower the learners to attempt to solve the problem by forming hypotheses, mentally sorting out solutions, and systematically testing the most promising leads (Biehler and Snowman1993: 66). For the learners to be able to perform these tasks, they should be able to perform the integrated science process skill of *describing relationship between variables*.

In view of this, it is not surprising that mastery of formal thought equips learners with powerful intellectual skills. As such, the learners can *infer* "invisible forces" and thus they can solve problems involving such forces. *Inferring* is a basic science process skill which enables people to appreciate their environment and interpret and explain things which happen around them (Rezba et al. 1995: 69). For instance, to explain why the western part of South Africa is dry and sparsely populated, learners may consider the fact that the western part of South Africa is surrounded by the Atlantic ocean which has the cold Benguela current. As the air which blows from the sea to Namaqualand is cold and dry, the area will experience little rainfall and the western part is sparsely populated because arable farming is virtually impossible.

Flavell (1963) cited by Dembo (1991: 56) and Mwamwenda (1995: 98 -100) identified four main types of reasoning that are characteristics of formal operations namely, propositional, proportional, hypothetico-deductive and combinatorial reasoning. These types of reasoning are likely to contribute to the development of the critical outcome of *demonstrating an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation*. The following paragraphs attempt to show how these characteristics are associated with science process skills and the critical outcomes.

4.3.4.1 Propositional Reasoning

Mwamwenda (1995: 98) regards a proposition as a statement that may be true or false and may be centred on fact or ingenuity, which may be dealt with rationally and impartially. The researcher also concurs with Mwamwenda (1995: 99) who reckons that some operational children are unlikely to apply propositional reasoning because they find it difficult to reason logically when they are faced with many *variables*. Furthermore, these children are manipulated by the first *hypothesis*, which makes them unable to deal with other *variables*. For instance, the children may find it problematic to deal with the following scenario.

Mount Kilimanjaro is higher than Mount Aux Sources. Mount Kilimanjaro is lower than Mount Everest. Which has the highest peak?

Some formal thinkers are likely to think abstractly and generalize that, of the three mountain peaks, Mount Everest is the tallest, Mount Aux Sources is the lowest and Mount Kilimanjaro is 'in between'. However, other concrete operational children may reason that Mount Kilimanjaro and Mount Aux Sources are higher than Mount Everest.

4.3.4.2 Hypothetico-deductive Reasoning

The bench mark here is the ability to reason about hypothetical conditions. A supposition is made regarding a position which does not exist in reality, and then the learner is supposed to face the problem as if it were genuine (Mwamwenda 1995: 99). For example, the learner may be asked a hypothetical question such as, *"Suppose you are a farmer - explain factors you will consider before cultivating your fields."* A concrete operational child is likely to say (s)he is not a farmer. The main reason for this type of answer is that the concrete operational child's thinking is limited to concrete objects or events (Dembo 1991: 56). However, Elkind (1968) in Dembo (1991: 56) notes that the formal thinker has no trouble accepting contrary-to-fact suppositions and reasoning. This opinion is echoed by Slavin (1997: 42) who maintains that *"the adolescent can accept, for the sake of argument or discussion, conditions that are arbitrary, that are not known to exist, or even that are known to be contrary to fact"*. In this scenario, the formal thinking child is likely to say that (s)he will consider the season and the type of crops (s)he wants to plant and so forth.

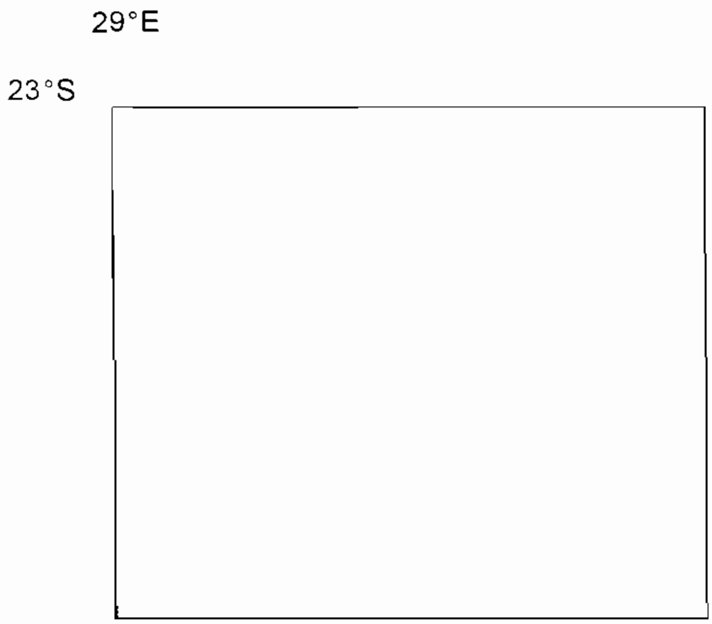
This situation indicates the development of the critical outcomes of *understanding that the world is a set of related systems.* It also promotes the developmental outcome of enabling the learner to *develop entrepreneurial capacities* of farming. Furthermore, the child is likely to *predict* and *infer* the factors (s)he would consider before cultivating the crops.

4.3.4.3 Combinatorial Reasoning

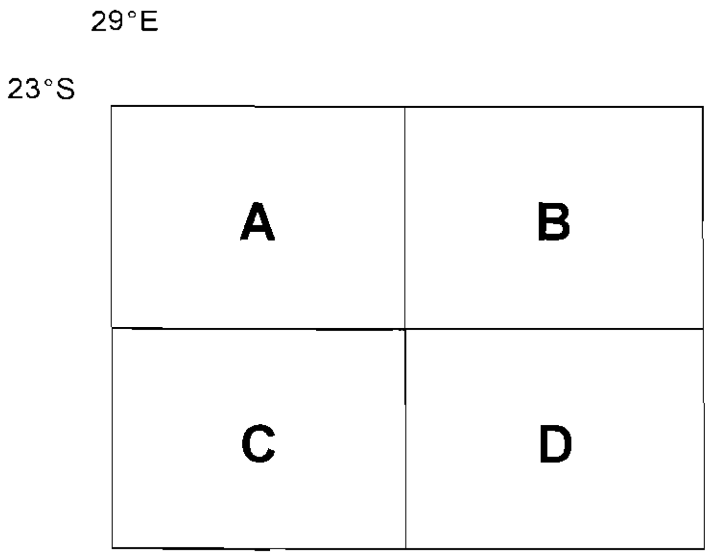
In combinatorial reasoning, all possible answers to a problem are investigated impartially and precisely (Mwamwenda 1995: 99). This is done by keeping some combinations or variables constant while one element is varied. If, after this process a solution cannot be found, another variable is examined while others are held constant. This process will continue until a solution to the problem is arrived at. If this process does not yield the results, it may be essential to explore more than one factor at a time until all possible combinations have been exhausted

(Dembo 1991: 56 and Mwamwenda 1995: 99).

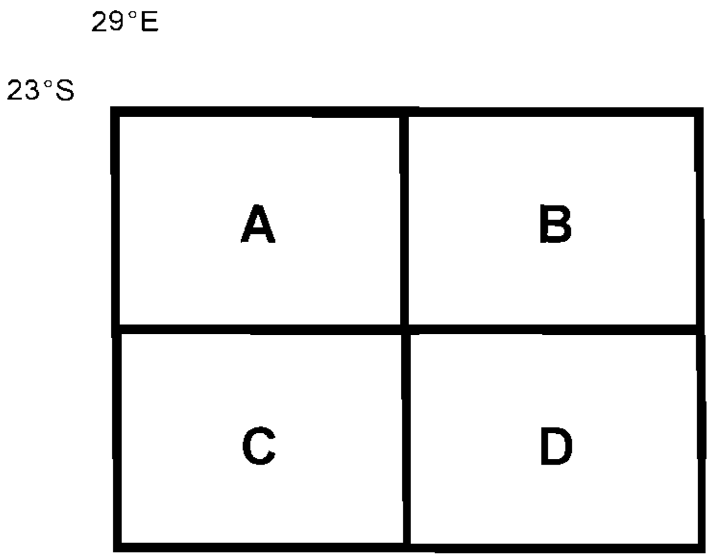
Consider the following example - learners may be requested to employ combinatorial reasoning to use the given four map strips to work out this map code - Louis Trichardt 2329CD which is on the next page.



In order to work out the map code, learners should divide the block into four map strips, i.e. A, B, C and D as indicated in the following diagram.

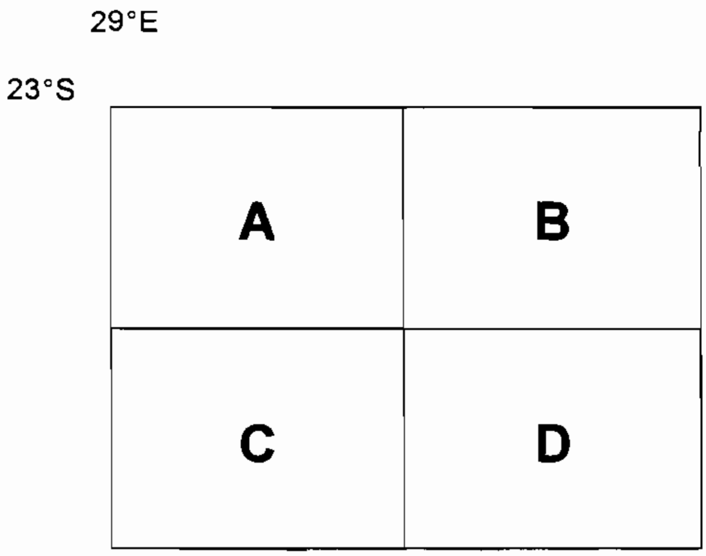


Each of the four blocks should be subdivided into four smaller blocks as indicated on the next page.

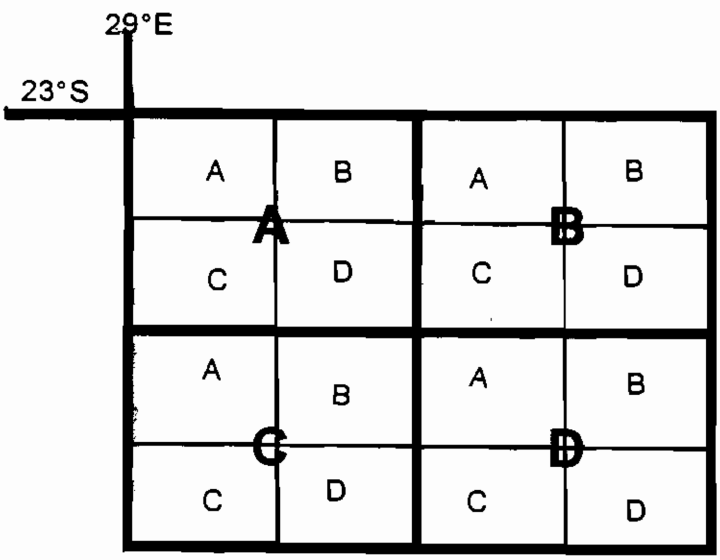


As such, the shaded block is Louis Trichardt 2329CD. This map code may be broken down as follows:

- 23 = 23° South
- 29 = 29° East



Each of the four blocks should be subdivided into four smaller blocks as indicated on the next page.



As such, the shaded block is Louis Trichardt 2329CD. This map code may be broken down as follows:

- 23 = 23° South
- 29 = 29° East

- C = Big block C
- D = Small block D in big block C

This task develops the critical outcome of *identifying and solving problems by using creative and thinking* as the child goes through the process of dividing the blocks and locating the correct location of the map code. This task enables learners to engage in science process skills such as *drawing and observing* the blocks, *classifying* the blocks, *interpreting data* inside the blocks, *predicting* the block which would represent the map code and *communicating* the prediction to the teacher.

4.3.4.4 Proportional Reasoning

Mwamwenda (1995: 99) maintains that proportional reasoning is mathematically based and one mathematical relationship is used to arrive at another mathematical relationship. For instance, this can be useful in the calculation of the time it may take a person to travel a given distance at a given speed. For example, a man wishes to climb a mountain peak which is 1 850 m above sea level. He has already scaled a 900 m peak and he took 80 minutes to reach its top. If he had used a cable car, he would have spent only 20 minutes. The question then is asked - *How many minutes will he spend climbing the peak on foot and by cable car?* What should be determined in this problem is the relationship between the height of the peak and the minutes it takes to climb it on foot and by cable car. A formal thinker will be capable of using the information that the man has climbed a 900 m peak and took 80 minutes on foot and 20 minutes by cable car to solve the problem. The adolescent is likely to approach the equation as follows:

on foot: 1 850 x 80 = 148 000 ÷ 900 = *164 minutes 44 seconds*

or

1 850÷900 = 2, 0555555 x 80 = *164 minutes 44 seconds*

by cable car: 1 850 x 20 = 37 000 ÷ 900 = *41 minutes 11 seconds*

or

1 850÷900 = 2, 0555555 x 20 = *41 minutes 11 seconds*

An equation like this contributes to the development of the critical outcomes of:

- ☐ *communicating effectively using visual, mathematical and language skills*;
- ☐ *identifying and solving problems by using creative and critical thinking*; and
- ☐ *Understanding that the world is a set of related systems.*

Examples given in 4.3.1 to 4.3.4.4 have clearly indicated that Piaget's theory of learning, supplies the capacity to enhance the development and application of science process skills to the teaching of geography. The following section discusses the application science process skills to the geography curriculum.

4.3.5 Application of Science Process Skills to the Teaching of Geography

Consideration of Piaget's theory of learning could enhance the development of science process skills in the teaching of geography. Geography teachers should facilitate and enhance the development of learners' thinking skills through science process skills. This can be developed by exploration, inquiry and discovery learning. Teachers could provide learners with opportunities to discover geographical knowledge through abstract reasoning and active manipulation of concrete materials. The discussion on Piaget's theory (cf. 4.3) has revealed that children are active discoverers, inventors and problem solvers. This implies that learners should be encouraged to interact with their environment and discover knowledge for themselves.

Learners' self-acquisition of knowledge compels teachers to provide opportunities in which learners experience and manipulate geographical phenomena, which implies that content-based teaching should be supplemented with process-based teaching which is likely to develop and promote intellectual activities that may enhance learners' cognitive development.

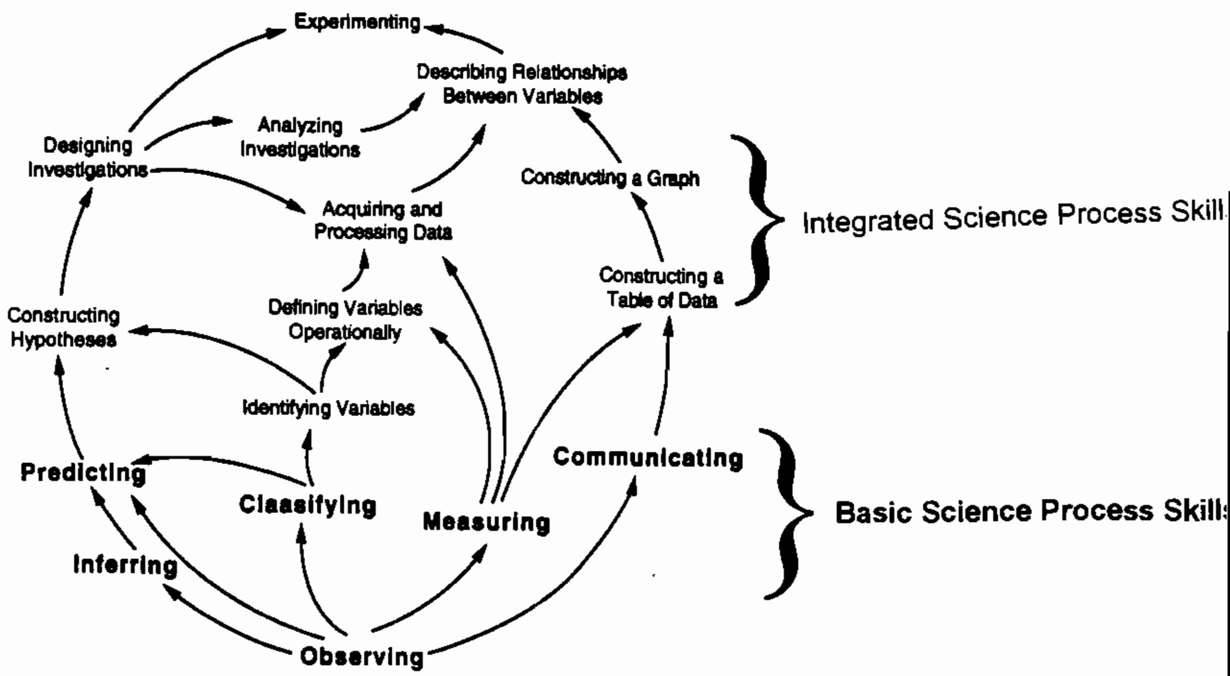
Eggen and Kauchak (1997: 47) and Mwamwenda (1995: 101) claim that most adolescents as well as adults do not function at the formal operational level. As most learners still operate at the concrete operational level, geography teachers should give learners opportunities to master such mental processes as *observing, classifying, communicating, measuring, inferring and predicting*.

Once learners have acquired and mastered these basic science process skills, teachers should introduce exercises that involve *theorizing, hypothesizing* or *generalizing* about abstract geographical ideas. These should be followed by activities that promote propositional reasoning, hypothetico-deductive reasoning, proportional reasoning and combinatorial reasoning in learners. These activities are likely to develop high order thinking skills in geography learners that may enhance reflective thinking, analysis, synthesis and evaluation. Hence learners are also likely to be equipped with skills that may empower them to solve problems more systematically in the 21st century. The following paragraphs examine how science process skills can be introduced and applied in geography classrooms.

4.4 BASIC SCIENCE PROCESS SKILLS AND THE TEACHING OF GEOGRAPHY

Science process skills are arranged in a hierarchical order. Figure 4.1 depicts a hierarchy of science process skills.

Figure 4.1 A Hierarchy of Science Process Skills



(Rezba et al. 1995: 117)

In Figure 4.1, the foundation of all the skills is the observing skill. As the diagram indicates, the development of one skill in the hierarchy depends on the formation of other skills. These skills are classified as either basic science process skills or integrated science process skills.

It is possible to apply these skills to the teaching of geography (cf. 2.7). Friedl (1991: 137-216) has designed geographical experiments which geography teachers should demonstrate in their classrooms. This is likely to encourage geography learners to apply science process skills in their investigations. The learning of basic science process skills may empower learners to be active when they do geography. The basic science process skills that can be applied to the teaching of geography are observing, measuring, inferring, classifying, predicting and communicating.

4.4.1 Observing as a Process Skill Applied to the Teaching of Geography

Zeitler and Barufaldi (1988: 94) assert that observing is a basic skill of scientific inquiry (cf. 2.5.1.1 and 4.6.1). People observe through all their senses, namely, sight, touch, smell, taste and hearing. Sometimes a source of air pollution may not be visible, but we can smell it. People observe in order to obtain information about the world (Trowbridge and Bybee 1990: 49) or to identify features or changes in phenomena and to interpret those changes (Zeitler and Barufaldi 1988: 94). For instance, learners may observe that temperature gradually rises while entering the city centre from a surrounding rural area and they will realize that the city is a 'heat island'. In this example, changes in temperature are identified through feelings.

Friedl's (1991: 143) experiment for recording 'dew point temperature' on different days shows the use of sight in *observation*. The teacher may request learners to *observe* and record dew point temperature on different days. In this activity, the teacher places a few ice cubes into a jug of water. Learners are asked to insert a thermometer into the water and to carefully observe the temperature at which dew is first noticed on the outside of the jug. This activity is repeated several times on different days. Learners are expected to answer the following question every day of this experiment. *At what temperature does dew form on the outside of the glass?* Learners are likely to discover that the dew point is not at the same temperature every day.

As Van Aswegen et al. (1993:15) have observed, the examples of *observation* discussed in the previous paragraphs indicate that there are two forms of observation, namely, natural observation and experimental observation. The observation of changes in temperature while travelling from a surrounding rural area to the city's centre is a natural observation. The measuring of dew point temperature in the beaker of ice is an experimental observation. Van Aswegen et al. (1993:15) also maintain that the ability of learners is likely to improve in experimental observations if teachers and learners adhere to the following principles:

- ☐ *accuracy - the phenomenon should be accurate to make accurate observations.*
- ☐ *relevancy - learners should be prepared to make relevant geographical data.*
- ☐ *realism - learners should be provided with opportunities to observe geographical reality, i.e. they should observe the actual geographical phenomena.*
- ☐ *comprehensibility - the experiment, procedure, demonstration should be brought to the developmental level of the learners. It is more likely for learners not to comprehend observations that are beyond their level.*

Studies (Hanson 1958 cited by Miller and Driver 1987: 42; Friedl 1991: 143; Van Aswegen et al. 1993:15 and Zeitler and Barufaldi 1988: 94) indicate that observation is theory-laden. What individuals observe depends on proven theories. Theory guides observation, and without it one is incapable of deriving any useful knowledge. Millar and Driver (1987: 42) aptly put it, "*a theory provides guidance on what we expect to see in certain situations, on which feature of the event being observed, we should focus attention. Without a theory to guide, all manners of distracting and irrelevant data would necessarily be amassed*". The examples which were discussed above clearly support this line of argument. Observation is theory dependent. It is important to note that *experimental observations* need some sort of *measuring* in order to make accurate *observations*.

4.4.2 Measuring as a Process Skill Applied to the Teaching of Geography

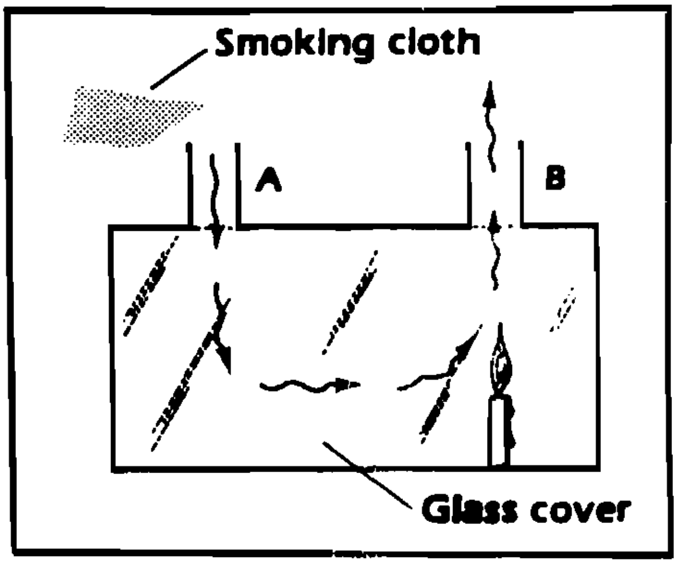
Van Aswegen et al. (1993: 16) contend that scientists are able to convey their observations in more precise terms through measuring (cf. 2.5.1.4 and 4.6.2). As indicated in Carin and Sund (1989: 69) and Mhlongo (1996: 100) measuring is explained as a skill for quantitative observations, comparing and classifying objects and for communicating effectively with others. Zeitler and Barufaldi (1988: 97-98) maintain that measuring quantifies through numbers. Objects or events are quantified with standard or non-standard units. For instance, to apply the standard unit of measuring, the teacher may ask learners to use a thermometer to measure temperature readings every day. The teacher may also apply the use of a non-standard unit of measuring by requesting a learner to touch a beaker full of water and then report to him/her if the beaker is warm, hot or cold.

Sauvain (1989: 26) suggests that measuring, depends on the topic, the type of hypothesis to be tested, the measuring time at one's disposal and the measuring instruments. After the measuring process, learners may be forced to explain or give meaning to what they have observed. This act of making sense of observation is an inference (Rezba et al. 1995: 77).

4.4.3 Inferring as a Process Skill Applied to the Teaching of Geography

Inferring (cf. 2.5.1.6 and 4.6.3) is the creation of explanations or drawing conclusions based on *observations* and a system of *classification* ((Trowbridge and Bybee 1990: 49). Learners may be requested to distinguish which statements are observation based and which ones are inferences. Friedl's (1991: 138) curious currents experiment (Figure 4.2) can be useful in the explanation of these processes.

Figure 4.2 Curious Currents



(Friedl 1991: 138)

Suppose, for instance, the teacher puts a convection box with two chimneys (i.e. chimneys A and B) and a sliding glass for viewing. Then the teacher lights a candle in the box below chimney B and closes the glass cover. The teacher holds a smoking piece of cloth over the top of chimney A. The teacher then holds the same piece of cloth above chimney B. Learners are likely to *observe* the smoke going down in chimney A, and at chimney B the smoke will go up. As such, learners are likely to *infer* that warm air rises and cold air descends.

After this demonstration, the teacher may write the following statements based on the information derived from the experiment and request learners to indicate if the statements are observation or inference:

> *The smoke goes down chimney A and goes up chimney B.* (observation)
>
> *Warm air rises and cold air descends.* (inference)

In this activity learners *classify* statements as either *observation* or *inference*. This example shows that the skill of *observing* is also linked to the skill of *classifying*.

4.4.4 Classifying as a Process Skill Applied to the Teaching of Geography

Classification roots can be traced back to the sensori-motor schemes (Piaget and Inhelder 1969: 102). Classification implies a relation of resemblance between members of the same class, and one of dissimilarity between members of different classes (Inhelder and Piaget 1958: 5). The classifying skill was explained as a process skill that involves the arrangement or ordering of objects or events into different classes or groups (cf. 2.5.1.2 and 4.6.4). Each classified group may have objects or events which have common features. Classification is used for convenience and to further understanding. Geographers frequently utilise classifications (Waugh 1990: 151) while studying types of climate, soil and vegetation, forms and hierarchy of settlement, and types of landform. Geographical phenomena are classified according to their characteristics, properties or criteria.

Learners should be made aware that in principle, every geographical phenomenon they observe, is slightly different from the same type of phenomenon they have encountered. This is because of the variable character of the earth surface. For instances, the mountains or rivers which one passes from Johannesburg to Cape Town are not the same. They differ as they are located at different places with different climatic conditions.

Learners may also observe familiar geographical phenomena acting in unfamiliar ways. For example, learners' previous observation may be that air temperature usually decreases with an increase in altitude, but there are certain circumstances when air temperature increases with altitude. The process whereby warm air overlies cold air is classified as temperature inversion.

Millar (1989: 53) argues that all people possess the ability to classify. We classify unconsciously and routinely. People have the capacity to classify unproblematically and to notice similarities and differences. Kuhn (1977) cited by Millar (1989: 53) that all learning depends on learner capability to classify. For example, when applying the classifying skill to the teaching of geomorphology, the teacher may list the following geographical phenomena and request learners to *classify* them. These are:

> *arch, braided river, corrie, delta, esker, hanging valley, knickpoint, moraine, raised beach, rapids, spit, and wave-cut platform.*

This example shows the syntactical structure of geography (cf. 3.3.2) and learners have to perform a classification task as a competency they should be able to demonstrate. Hence, the outcome of this activity is that learners should be able to *classify* the features formed as a result of *erosion* or *deposition*. They should also be able to *classify* the features according to whether *they were formed under a previous climate* or whether *they are still being formed today*. Another outcome of this activity is that learners should be able to divide the phenomena into *coastal*, *glacial*, and *fluvial* landforms.

The teacher may ask learners if they can think of at least three different ways in which the listed geographical phenomena may be categorised. In order to classify the phenomena, the learners may make use of some of the possibilities listed below:

- the classification may be based upon whether the phenomena result from *erosion* or *deposition*;
- the phenomena may be reclassified into those formed under a *previous climate* (relict features) and those *still being formed today*, and
- the phenomena may also be divided into *coastal; glacial; and fluvial landforms*.

This example indicates the importance of knowledge to the development of science process skills and outcomes. For instance, for learners to perform this classification task correctly, they should be able to distinguish between erosion and deposition. Hence, they will be able to list features which are formed through erosion and those which are formed through deposition. This may not be possible if learners do not know what erosion and deposition are.

Furthermore, the basis for 'correct' or 'best' classification, is the use of criteria. Geography teachers may also develop the skill of classifying in the learners by articulating the criteria on which the classification is based. For example, the teacher may ask learners to classify the following economic activities for an urban settlement such as Welkom:

> *mining, farming, teaching and training, banking, manufacture of jewellery from gold, medical services, wool processing, buying and selling.*

The teacher asks learners to classify these activities according to whether they are *primary, secondary or tertiary* activities. In order to do this, learners should consider the characteristics of each type of activity. Hence knowledge of these characteristics is essential for learners to perform the task. For example, one characteristic of a primary activity is that it extracts raw materials (natural resources) from the environment. The extracted raw materials are not changed or processed into new products. A secondary activity characteristic is that a raw material is processed and changed into another product. Tertiary activities provide services to both primary and secondary industries. Without this information, some learners may not be able to attain the outcome of the lesson.

Millar (1989: 53-54); Millar and Driver (1987: 43-44) and Waugh (1990: 151) point out that when determining the basis for any classification, care must be taken to ensure that:

- *learners are capable of using a particular classification system;*
- *learners know the purpose of classification and are able to choose relevant criteria for classification;*
- *only meaningful data and measures are used;*
- *within each group or category, there should be the maximum number of similarities;*
- *between each group, there should be the maximum number of differences;*
- *there should be no exceptions, i.e. all the features should fit into one group or another; and*
- *there should be no duplication, i.e. each feature should fit into one category only.*

Carin and Sand (1989: 31) believe that classification abilities in children develop during the concrete-operational stage of development. Miller and Driver (1989: 43) maintain that classifying skill lies at the root of all cognition. Children who have developed classifying skills are capable of ordering and locating information in the mind which implies that children are likely to determine the properties, structure and function of different geographical phenomena. It can be safely concluded that once children are able to code geographical phenomena mentally, they are able to interact with their environment in a better way. Giving order to the environment is also likely to enable learners to recognize geographical patterns and to *predict* from these patterns what future *observations* might be.

4.4.5 Predicting as a Process Skill Applied to the Teaching of Geography

Zeitler and Barufaldi (1988: 101) maintain that prediction is based on background experiences (cf. 2.5.1.5 and 4.6.5). For instance, people may predict that an approaching tropical cyclone may cause damage to property and infrastructure because the cyclone is always accompanied by strong winds, heavy showers and flood waves along the coast. As such, they may take precautions that may minimize damage to property and lives. Prediction entails identifying the possibility rather than the assurance of the event.

Van Aswegen et al. (1993: 16) recommend that teachers should develop the skill of prediction in learners by asking questions such as "*What will happen if...*" (cf 4.3.3.2 and cf 4.3.4). This type of questioning stimulates and encourages learners to think about their *observations* and *experiments*. For instance, the teacher may ask learners to consider the following question: "*What will happen if moisture-laden warm air ascends a mountain*"? Learners are likely to *predict* that air will be cooled, condensation will take place, cloud formation will occur and that it may rain. This explanation is likely to assist learners to form a mental picture for the formation of orographic (relief) rainfall. The process by which the teacher asks learners to substantiate their answers is reflective teaching. The teacher qualifies the learners' answers by asking: *Why do you say that?* Hence learners may *communicate* their reasons to the teacher.

4.4.6 Communicating as a Process Skill Applied to the Teaching of Geography

Communicating is a skill which is much more complex (cf. 2.5.1.3 and 4.6.6). For instance, the South African Qualification Authority (SAQA) has accepted a critical outcome in which learners should be able to *communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation.*

In support of this complexity, Zeitler and Barufaldi (1988: 100) claim that people need good understanding of scientific terminology to communicate effectively. If learners understand the meaning of terms, used in context, they are likely to explain interaction between objects or the results of actions. Learners could feel comfortable using the skill of *operational definitions*.

Sometimes, geographers communicate their ideas or findings through graphs. A Graph communicates a relationship between two variables or conditions (cf. 2.5.2.3). Van Aswegen et al. (1993: 16) state that learners should be given opportunities to think and to communicate their thoughts into spoken and written words, diagrams, drawings, graphs, maps, pictures and mathematical equations. The role of topographical maps in the development of some science process skills in learners is explained in section 4.6 of this chapter.

The skills reviewed above form the foundation for the application of integrated science process. These skills are known as integrated science process because they are used as a unit in *experimenting* (Rezba et al. 1995: vii).

4.5 INTEGRATED SCIENCE PROCESS SKILLS AND THE TEACHING OF GEOGRAPHY

This section attempts to highlight how teachers could introduce integrated science process skills in their teaching. Rezba et al. (1995: 117) suggest that learning these skills qualifies learners to answer many of their own questions which implies that learners may be able to interpret geographical phenomena they observe and to design geographical experiments to test their ideas.

Integrated science process skills which geography teachers should apply to the teaching of geography are - Defining variables operationally, hypothesizing, manipulating and controlling of variables, interpreting data and experimenting (cf. 2.5.2). Other science process skills such as constructing a table of data, plotting a graph, acquiring and processing data, designing investigation and analysing investigations are likely to be developed when the skills mentioned above are developed and promoted in geography lessons. The following is a discussion on the integrated science process skills that can be applied to the teaching of geography.

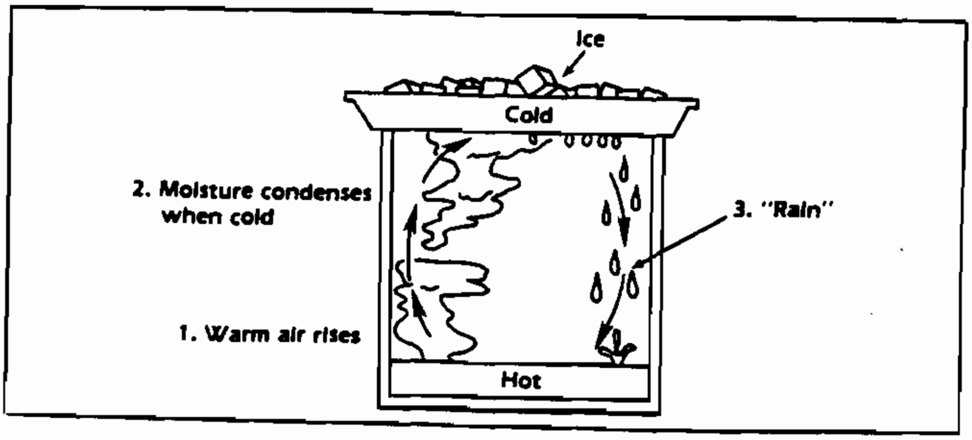
4.5.1 Defining Variables Operationally as a Process Skill Applied to the Teaching of Geography

According to Zeitler and Barufaldi (1988: 100) "*an operational definition is one designed by the investigator to clarify his/her meaning of terms, actions, conditions, or results within the scope of an investigation*". Operational definitions can be illustrated or verbalized (cf. 2.5.2.8). Aswegen et al. (1993: 17) maintain that learners should be able to differentiate between definitions that are operational and those that are not.

The development of this process skill could assist learners to communicate scientifically using terms that have definite operational meanings. Learners may also identify and explain what they regard as being the necessary condition for an experiment to be repeated successfully. The development of this skill also equips learners with the ability to construct operational definitions in problems that are new to them.

The skill of constructing operational definitions can also be developed through experiments. For instance, Friedl's (1991: 144) water cycle experiment allows learners to make operational definitions of evaporation, dew point temperature, humidity, rain, condensation, cloud, wind and the water cycle. Learners then, should also be capable of forming a theory on what causes rain. Figure 4.3 on the next page clearly indicates the major parts of the water cycle.

Figure 4.3 The water Cycle



(Friedl 1991: 144)

In the above experiment, the teacher sets up a small 'water cycle' in a jar. (S)he fills a large, wide-mouthed heat resistant glass, or plastic jar with 1 or 2 centimetres of hot water. (S)he covers the top of the jar with a metal pie plate filled with crushed ice. From time to time a small amount of smoke inside the container is added. When this is being done, learners should be able to identify and observe miniature forms of clouds, air movement, and rain. They should also be able to compare the conditions inside the jar with the conditions in the atmosphere. Learners' observation of this experiment may enable them to *define operationally* evaporation, dew point temperature, humidity, rain, condensation, cloud, wind and the water cycle as shown in Table 4.3. The table is as follows:

TABLE 4.3 Operational Definitions

TERM	DEFINITION
Evaporation	*Evaporation is the process whereby water changes from a liquid to water vapour and rises into the air.*
Wind	*Wind is moving air.*
Dew point temperature	*Dew point temperature is the point at which the rising warm air is saturated.*
Humidity	*Humidity is the amount of moisture in the atmosphere.*
Condensation in the atmosphere	*condensation is the process whereby rising warm moisture, cools and condenses to form clouds.*
Clouds	*Clouds are forms of condensation resulting from the rising and cooling of air.*
Rain	*Rain is precipitation in the form of water droplets that fall to the earth from clouds.*
The water cycle	*The water cycle is the process whereby water evaporates from the oceans and is transported by wind, in the form of water vapour and clouds, to the land, where it falls again as rain.*

Examples in Table 4.3 imply that the process of constructing operational definitions is a demonstrable task. The outcome of this task is that learners should be able to *observe* the experiment and give the meanings of scientific terminology. Furthermore, this experiment may also influence learners to *hypothesize* on what causes rain, hence learners may be able to form a theory on what causes rain. Learners are engaged in an integrated science process of *constructing hypotheses* on what causes rain and the hypotheses provides guidance on what data to collect to answer the question, *What causes rainfall*? This example also reveals that for an operational definition to be constructed, the teacher and learners should design an investigation and analyse it. Learners may also hypothesise the definitions of phenomena until they arrive at the best definition for those specific phenomena.

4.5.2 Hypothesizing as a Process Skill Applied to the Teaching of Geography

Hypothesizing is the activity of making an 'imaginative leap' beyond the data to try to account for observed features (Millar 1989: 56). A hypothesis is subject to empirical testing, validation, and possible rejection (Trowbridge and Bybee 1990: 49). It is a supposition stated in the form of a probable solution (Swanevelder et al. 1987: 7). Subsequently, a hypothesis is a tentative explanation or theorem of what the scientist thinks the outcome of his/her research will be (Van Aswegen et al. 1993: 17). It may also be a statement of the relationship that exists between two variables (Rezba et al. 1995: 219 and Zeitler and Barufaldi 1988: 100). Investigators who formulate hypotheses use their background knowledge, experience and information from other investigations (cf. 1.3.1 and 2.5.2.7).

Mhlongo (1996: 166) suggests that the hypothesizing skill may be developed from practical work rather than from teacher questions. Swanevelder et al. (1987: 41) maintain that geographers need scientific answers to a diverse of related problems. They require answers to:

- ☐ *relationships between physical phenomena;*

  For example, between distance from the sea and temperature, air pressure and wind, the amount of rainfall and percolation of water into the soil and so forth.

- ☐ *relationships between human phenomena;*

  For example, between distance from the markets and the pattern of production in crop farming, mechanisation and number of farm workers, agricultural raw material, transport costs, markets, and so forth.

- ☐ *relationship between physical phenomena and human phenomena,*

  For example, between water and type of settlement, steepness of slope and the location of a village, drought and depopulation *of a rural area; and so forth*

Learners should be capable of giving answers to the questions asked about these relations. Van Aswegen et al. (1993: 17) summarise the functions of the hypothesis as follows:

- *it serves to explain the relationship among variables;*
- *it brings order to an experiment by determining what is being tested and what is expected as a result; and*
- *it is of fundamental importance in giving direction to the research programme.*

The involvement of learners in hypothesis-testing activities is likely to empower them to derive useful and practical information from an hypothesis. It may also stimulate learners' interest in finding relationships between existing variables.

In the water cycle experiment (Figure 4.3), learners are likely to hypothesize that the water cycle is a source of rain. Furthermore, they may form a theory that for rain to occur, water should evaporate from water sources, then water vapour should rise, condensation should take place, cloud formation should occur, and precipitation in the form of water droplets should fall to the earth from clouds.

This process could contribute to the development of a critical outcome in which learners should be able to *collect, analyse, organise and critically evaluate information*. This is because learners need to *conduct and analyse investigations* and do research by means of experiments in order to test their hypotheses on what causes rain.

Data analysis depends on the complexicity of the collected data. Simple data does not require complex analysis whilst a complex data may require quantitative science process skills such as tables of data (cf. 2.5.2.2) and graphs (cf. 2.5.2.3). Learners analyse the collected data with the guidance of the teacher. Learners use the hypotheses listed as investigative guides. It is important for learners to be objective while analysing the collected data. They should emotionally detach themselves from the collected information.

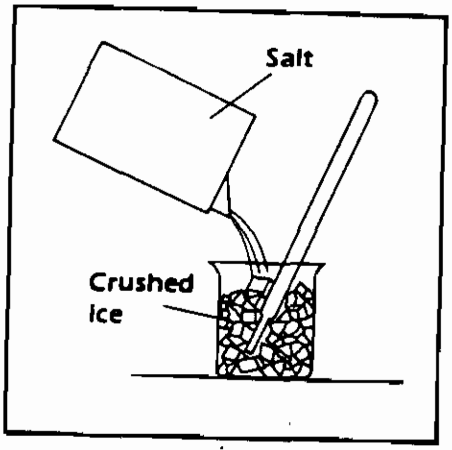
Another important point is that there is no hypothesis which should be viewed as correct or incorrect because all hypotheses are likely to lead to fruitful investigations. A hypothesis that is not supported by the collected data is rejected but it is not wrong. The investigator is supposed to redefine the problem, formulate new hypotheses and collect new data that will support the new hypotheses (cf. Figure 2.7).

4.5.3 Manipulating and Controlling of Variables as a Process Skill Applied to the Teaching of Geography

Zeitler and Barufaldi (1988: 99) are of the opinion that manipulating and controlling of variables begins when the investigator selects a variable to be changed or observed (cf. 2.5.2.1 and 2.5.2.4). They recommend that one variable should be manipulated at a time. If more than one variable is manipulated, it may not be easy for the investigator to determine the variable that has produced the result. The investigator may also not be able to determine if a combination of variables has produced the result.

For instance, Figure 4.4 on the next page indicates Friedl's (1991: 33) *Melt Ice ... Below Its Freezing Point* experiment. In this experiment, learners observe how the manipulation and controlling of variables affect temperature. The variables in this experiment are crushed ice and salt.

Figure 4.4 When Salt is Poured on Crushed Ice, What Happens to the Temperature?



(Friedl1991: 33)

In Figure 4.4 experiment, the teacher fills a beaker with about one-third of crushed ice. (S)he pours 4 to 8 tablespoonfuls of salt onto the crushed ice. Then, another one-third beaker of crushed ice is added. The teacher prepares the ice-salt mixture before the teaching period so that learners are not aware that salt was used.

The teacher shows the beaker of the ice-salt mixture to the learners. (S)he points out that liquid is collecting at the bottom of the beaker. Then, the teacher asks the learners to indicate the temperature at which ice melts. Most learners are likely to answer that it melts at 0 degrees Celsius. The teacher requests learners to register the temperature of the melted liquid with a thermometer. Learners are likely to find that the temperature is well below freezing point. The teacher then asks learners the question - *"How it is possible for ice to melt below freezing point?"* (cf. 4.5.5).

As already mentioned, there are three general categories of a variable, namely, independent (manipulated) variable, dependent (responding) variable and controlled (fixed) variable (cf.

2.5.2.1). These variables can be described as follows:

- Independent (manipulated) variable

This variable is the treatment that is expected to produce an outcome. It may be deliberately changed, since it is under the control of the investigator. It does not depend on the dependent variable, that it is why it is known as the independent variable. In the experiment discussed above, salt is the independent variable as it is the treatment that is expected to produce an outcome. The outcome here is that the crushed ice melts but the temperature remains very cold. As such, learners are expected to find the reason for the cold.

- Dependent (responding) variable

The dependent variable depends on the treatment it receives and it changes in response to the dependent variable. It is the condition to be measured, since it represents the outcome (effect) in response to the treatment (cause). In the experiment discussed above, temperature is the dependent variable because it depends on the added salt. It is important to note that the temperature of the melting ice remains very cold (effect) as a result of the added salt (cause).

- Controlled (fixed) variables

These are conditions that may affect the results of an investigation. However, they do not, as they are deliberately held constant. In the experiment, fixed variables are the beaker and the thermometer as they are not changed and remain constant.

4.5.4 Acquiring and Processing Data as a Process Skill Applied to the Teaching of Geography

A problem is identified after the teacher has recognized a cause and effect or correlational relationship to be investigated. The teacher plans in advance a question or problem that relates to the relationship. For example, on the question, "What *causes soil erosion?"* The class will start discussing the causes such as moving air, moving water, moving ice, overgrazing and so on. The teacher could also spontaneously introduce more facts about the cause of soil erosion.

The teacher also plans the data collection procedure beforehand because this procedure should enable learners to answer the question or solve the problem. Learners may select their data gathering instruments which could be literature sources, questionnaires and interviews and actual observation of soil erosion (fieldwork).

When one looks at the data gathering instruments named above, one can deduce that an inquiry lesson is not a single period activity. The teacher must take the available time into consideration when planning an inquiry lesson. To alleviate the problem of time, the teacher should integrate investigation of the question with other activities. For example, the teacher may assign the problem as a research project. The learners thus can be asked to record their investigations and submit an assignment on the factors that cause soil erosion.

The data sources learners' use to gather information can be either primary or secondary. In primary data sources, learners observe original data such as the process of soil erosion and interview people such as farmers and conservationists. In secondary data sources, learners consult sources such as literature and other reference books like encyclopaedias. The information contained in these sources has been analysed and interpreted by other researchers. This is second hand material which has perceptions and potential bias of others. Consequently, learners may be encouraged to use primary sources because the use of primary sources may offer learners the opportunity to organize and analyse their own data. However, time and cost constraints may cause learners to use relevant secondary sources which discuss the possible causes of soil erosion.

4.5.5 Interpreting Data as a Process Skill Applied to the Teaching of Geography

In order to determine the validity of an hypothesis, learners should be taught to analyse the results of their investigations. The development of this skill may empower learners to organise their gathered data and to make generalisations which are supported by their findings. The results of their investigations or experiments may support their *predictions*, *inferences* and *hypotheses*. Data interpretations should provide insight and understanding of the problem.

As an example, the question, *"How is it possible for ice to melt below freezing point?"* entails learners to interpret data provided by the experiment. Zeitler and Barufaldi (1993: 99) observe that interpreting means asking the question - "*What do the data and information mean*"? In the experiment discussed in section 4.5.3, learners are likely to be engaged in the following processes while interpreting data:

- ☐ they will observe that the temperature of the liquid in the beaker is many degrees below freezing point. The act of *observing* is a basic science process skill;

- ☐ they might formulate an incorrect theory that the thermometer does not work and the temperature is actually at the melting point. The use of a thermometer relates to the critical outcome of *using science and technology effectively and critically*;

- they will *record and graph* the temperature at periodic intervals. This process contributes to the development of the basic science process skill of *measuring*. As the task has to be done periodically, this will contribute to the development of the critical outcome in which learners are able to *manage themselves and their activities responsibly and effectively*. Furthermore, this activity contributes to the development of integrated science process skills such as *constructing* a *table of data* and *plotting* a *graph*; and

- They may also form a correct theory that the beaker might contain something other than pure ice (salt in this case). This is an integrated science process skill of *hypothesising* what the beaker might contain. As such, learners may *infer* why the temperature is many degrees below freezing point.

This example shows that the development of one science process skill may contribute to the development of other skills. Furthermore, this example reveals that the interpretation of these data may not be possible without *experimenting*. The following section briefly explains experimenting as a process skill applied to the teaching of geography.

4.5.6 Experimenting as a Process Skill Applied to the Teaching of Geography

Experimenting is an operation that combines all the science process skills that have been discussed above (cf. 2.5.2.10). Scientists combine basic and integrated process skills when experimenting. Children who are given opportunities to experiment, learn to state problems, to test the hypothesis through manipulation and control of variables, and to interpret and present results in the form of reports (Van Aswegen et al. 1993: 18).

Mossom (1989) as quoted in Van Aswegen et al. (1993: 18) has listed the sequence of experimenting steps as follows:

- *stating the problem;*
- *formulating a testable hypothesis;*
- *identifying and controlling variables;*
- *making observations and measurements;*
- *interpreting data; and*
- *communicating procedure and tentative conclusions.*

Sections 4.5.1 to 4.5.6 clearly indicate that it is possible for geography teachers to apply experimenting as a process skill to the teaching of geography. Experimenting requires the integration of all the other science process skills as illustrated in this chapter. Carin (1997: 153 - 211) and Friedl (1991: 124 - 214) have devised various geographical experiments which geography teachers can adapt and demonstrate in their classrooms.

In addition, teachers should also apply basic science process skills to the teaching of mapwork techniques. In South Africa, Grade 12 geography learners complete two examination papers at the end of each year - one paper deals with climatology, geomorphology, ecology, settlement geography and regional geography and the second paper deals exclusively with topographical maps and their respective orthophotos. Thus, it is also important for geography teachers to be able to apply science process skills to the teaching of mapwork. The following paragraphs attempt to indicate in what way teachers can apply basic science process skills to the teaching of mapwork activities.

4.6 BASIC SCIENCE PROCESS SKILLS AND THE TEACHING OF MAPWORK

In South Africa, secondary school geography learners are expected to be fully familiar with all technical aspects of mapwork (cf. 2.7). As a result, it should be possible for geography teachers to teach basic science process skills while they are dealing with mapwork activities. Sections 4.6.1 to 4.6.6, attempt to highlight how this can be done. Basic science process skills which teachers can apply to the teaching of mapwork are observing, measuring, inferring, classifying, predicting and communicating. Learners may be able to use the information on a topographical map to perform these skills. As integrated science process skills are applicable mainly to experimental activities, it may not be possible to apply these skills to mapwork activities.

4.6.1 Observing as a Science Process Skill Applied to the Teaching of Mapwork

Geography learners are expected to observe the title of the topographical map and interpret its meaning (cf. 4.3.4.3). Furthermore, learners should be capable of observing aspects of the map such as the scale of the map, relief and map symbols. The scale of the map is the ratio between the distance between two points on the map and the actual distance between the same points on the ground. This implies that the scale of the map is the relationship between a distance shown on the map and the corresponding distance in reality. It is usually indicated below the map as a linear scale or as a ratio scale. Relief is the form of the physical landscape, including differences in altitude, mountains and valleys, slope, and the shape of the earth's surface.

Map symbols are symbols that are used to depict features of the landscape on the map. Learners are also expected to *observe* and study map symbols closely before they can analyse and interpret the 1: 50 000 topographical maps used in South Africa (cf. 2.5.1.3 and Appendix 14). This process enables learners to observe and read maps, a skill that is likely to empower learners to perform other process skills that may be developed through mapwork activities. Learners could also demonstrate their ability to observe by giving correct answers which are mostly found on the map and the corresponding orthophoto through *observation*. This implies that *observing* is a skill which can be demonstrated by the learners engaged in mapwork activities.

4.6.2 Measuring as a Science Process Skill Applied to the Teaching of Mapwork

In the study of geographical techniques, learners should also learn how to measure lengths, volumes, heights, angles and distances. In most South African topographical maps, two linear scales are drawn to show distances measured in metric units such as kilometres and metres. The teacher may supply exercises that require learners to measure straight line distances and curve line distances.

As indicated in Liebenberg (1986: 55) and Vilakati and McLeod (1994: 26-35), map scales are useful when distances on maps are measured. For instance, to calculate a distance that is linear or straight between two points on the map, the learner should hold a strip of paper against the line. Then, the learner transfers the distance between the two points to the paper and compares the distance with the line scale on the map.

Sometimes the learner may be asked to *measure* the length of a river or a winding road on the map. The learner can do so by using one of the following three techniques:

- The learner should take a piece of thread or string and carefully place it along the winding line on the map. (S)he should mark the starting point and the ending point of the measurement on the string. Then, the learner should pull the string straight and measure the distance between the two marks against the graphical scale on the map;

- The learner can also measure the length of curve lines on the map by breaking up each curve into straight line segments. Then, (s)he should transfer the measured lengths of all the segments, one by one, onto a piece of paper; and

- Lastly, the learner may measure the length of a curve line on a map by setting the point of a pair of dividers accurately at a distance of 0,5cm apart. Then, (s)he should 'step off' the entire length of the line, counting the "steps". If say, the learner counts 40 steps, the total line distance will be 20 cm which is then compared to the line scale on the map.

These activities show that *measuring* skill is a demonstrable outcome. Learners could be seen engaged in measuring activities while dealing with mapwork activities. Engagement in this skill may enable learners to *infer* and *predict* how long it may take them to move from one point to another.

4.6.3 Inferring as a Science Process Skill Applied to the Teaching of Mapwork

An inference is an explanation or interpretation of an observation (Rezba et al. 1995: 70). The process of interpreting and explaining symbols indicated on the map may develop and promote the skill of inferring. Learners are likely to develop other skills that are necessary to make proper inferences based on map observation. Suppose, for an example, learners *observe* a dense drainage pattern and several perennial rivers on the map. Learners may *infer* that the area depicted on the map is a high rainfall region. If they *observe* that the map has several dams, they are likely to *infer* that the area experiences inadequate rainfall. Thus why a need to store water exists. Furthermore, if learners *observe* furrows ploughed along a slope that follows the contours, they are likely to *infer* that furrows are ploughed along the slope in order to prevent erosion during the rainy season.

These examples indicate that inferring is a demonstrable science process skill because learners are able to interpret and explain features observed on the map. They are able to recognise patterns on the map and make proper inferences based on past observations.

Most mapwork activities compel learners to give meaning to what they observe on the map. Giving meaning to the observation may require learners to invoke what they already know from past experiences or previous knowledge. Suppose, for example the topographical map consists of many solid blue lines and orchards. If learners are asked to indicate if most of the streams and water courses are perennial or seasonal, learners are likely to *infer* that the streams and water courses are perennial.

As a result of past knowledge, learners would have indicated that solid blue lines instead of blue dotted lines, represent perennial rivers. Furthermore, orchard symbols on the map cause learners to infer that commercial farming is practised in that area. Consequently, learners are also likely to infer that commercial farming is valuable where an adequate irrigation water system exists.

4.6.4 Classifying as a Science Process Skill Applied to the Teaching of Mapwork Techniques

Mapwork activities that may develop and promote the skill of classifying may include the classification of:

- geographical phenomena depicted on a map into natural features and man-made features. On the map, natural features are brown in colour whilst man-made features are black;

- rivers and water courses into perennial rivers and non-perennial rivers. On the map, perennial rivers are indicated by solid blue lines whilst non-perennial rivers are shown by blue dotted lines;

- rivers' drainage patterns into dendritic, trellis, radial, rectangular and deranged patterns;

- slopes into gentle slopes, steep slopes, vertical slopes, stepped slopes, uneven slopes, uniform slopes, convex slopes and concave slopes.

- river density into low density (coarse texture), medium density (medium texture), high density (fine texture) and extremely high density (superfine texture);

- farming into subsistence farming or commercial farming. Commercial farming is again classified into crop farming, livestock farming, horticulture and forestry;

- settlements into rural or urban settlements;

- rural settlements into dispersed or nucleated settlements;

- rural settlements into an isolated farmstead, a hamlet or a village;

- urban settlements into a town, a city, a metropolis, a conurbation or a megalopolis;

In order to foster the development of the *classification* skill, teachers should request learners to *classify* what they observe on the map according to one or more of the above-mentioned classifications. The implication of this activity is that the ability to *classify* effectively is determined inter-alia by the appropriate application of the criteria. *Classification* is a demonstrable science process skill as learners could demonstrate their competence of mastery by *classifying* objects and events on the basis of *observable* characteristics. The following paragraphs discuss predicting as a skill applied to mapwork.

4.6.5 Predicting as a Science Process Skill Applied to the Teaching of Mapwork

Geography teachers may require learners to make *predictions* when dealing with topographical maps. This process involves learners to say what may happen in the future. This is possible if learners know the situation prevailing at the present time. As every topographical map attempts to show physical and man-made surface features which are found in that area, it is assumed that these features may exist until a new map is compiled. Hence learners should be able to scrutinize the map carefully in order to imagine what would happen in the future. Consider the following example adapted from Liebenberg (1986:154) based on a 3318CD Cape Town topographical map (Appendix 14).

> *Cape Town is notorious for a south-easterly wind which sometimes reaches gale force during the summer months. Hence it is sometimes referred to as the 'Black South Easter'. Where would most people settle in Cape Town if they had a choice and could not tolerate the wind?*

This question would require learners to use the map and existing knowledge about Cape Town. Cape Town's central business district, and the suburbs of Oranjezicht and Vredehoek are not protected from the South-Easter as they are saddled between Devil's Peak and Table Mountain which 'funnels' the wind over the city. Furthermore, the air forced upwards by Table Mountain descends over the city and its surrounding residential areas, and Camps Bay. This causes local turbulence which may discourage people from living in these areas. Actually, Sea Point is the only area which is really shielded from the South-Easter. Using these logical deductions, learners are likely to *predict* that, most people would prefer to settle at Sea Point if they have a choice.

Effective prediction can be taught through encouragement of learners to observe features which are depicted on the map. After the *observation*, learners should be able to explain what patterns they expect to observe in the future (*prediction*). This implies that prediction is also a demonstrable activity as it starts with observation and end with reasoned statements on occurrences that might happen in the future.

The application of the predicting skill to the teaching of mapwork is crucial as it encourages learners to make informed predictions rather than guess work. Prediction also implies that learners understand something as they are afforded opportunities of choosing between contradicting explanations. Learners are likely to choose between the contradicting explanations by testing their ideas through logical reasoning as shown in the example. After testing their ideas and arriving at predictions, learners are supposed to show that they have mastered this process by communicating their predictions and any other relevant information.

4.6.6 Communicating as a Science Process Skill Applied to the Teaching of Mapwork

Topographical maps allow learners to interpret physical and man-made surface features. This implies that learners should be capable of communicating geographical phenomena which they observe on maps. Learners should also be taught to communicate the information accurately using colours and shapes of geographical features depicted on the map (cf. Appendix 14). In mapwork activities, learners are taught to use the tools of communicating such as graphs, symbols, numbers, oral descriptions, written language, data tables, drawings and charts. Learning to use these communication tools enables learners to make good decisions about how to communicate observation and ideas (Rezba et al. 1995: 19). This implies that map work activities also contribute to the development of the critical outcome of *communicating effectively using visual, mathematical and language skills*.

A map is a symbolic representation of realty. Topographical maps have a title indicating the exact location of the map (cf. 4.3.4.3). Consider for example the following map code, 3318CD Cape Town. Learners should be able to interpret the title of this map by following the steps which were shown in section 4.3.4.3. Subsequently Cape Town region is located at grid reference 33°S and 18°E. Furthermore, the map is positioned in the large block C and the small block D .

Cartographers also communicate phenomena on the map through symbols (cf. 2.5.1.3). Learners should be able to indicate what each symbol represents by referring to the map's key. The map also has a scale which learners may use to calculate relative distances, gradients and areas. Geography teachers could also develop communication skills in learners by giving them opportunities to draw map sketches. After drawing map sketches, learners may also give map descriptions to someone in the class and have them locate and recognize the desired phenomena (Rezba et al. 1995: 21). If most learners can use the map and its descriptions to find and recognize required phenomena, it may imply that the role of the map in the development of communication skills is effective. This is a demonstrable outcome because learners who are engaged in mapwork activities may *communicate* the information depicted on the map to their peers or to their teacher.

4.7 CONCLUSION

Science process skills can be advantageously applied to the teaching of geography, however, science process skills should not be applied in isolation of knowledge. The discussion in this chapter has indicated the importance of knowledge as a foundation to the development and understanding of science process skills.

The application of these skills may continue to be clarified through practice, reflective thinking and research. In this regard, Chapter 4 suggests that teachers should consider Piaget's stages of intellectual development before asking questions in class that require learners to apply science process skills. Furthermore, teachers should also follow the same process before providing learners with science process tasks that they should perform. Consideration of Piaget's theory might enable teachers to design activities that might be suitable to the learners' particular stage of cognitive development.

In conclusion, this chapter focussed on two aspects, namely, Piaget's theory of learning and its role in the development of science process skills in the geography curriculum. The chapter also explored several examples and activities for teachers to apply to their everyday teaching. The following chapter reviews the data processing procedures and the description of the statistical techniques applied in this study.

CHAPTER 5

REVIEW OF THE DATA PROCESSING PROCEDURES AND THE DESCRIPTION OF STATISTICAL TECHNIQUES APPLIED

5.1 INTRODUCTION

The purpose of this chapter is to review the data processing procedures and the description of the statistical techniques applied in this study. The data collection techniques, the sample, and the research design are described, followed by a section on the data analysis procedure.

5.2 DATA COLLECTION TECHNIQUES

This section examines the techniques used to collect data in this study. Data were obtained through questionnaires and interviews according to quantitative and qualitative research methods. Questionnaires were used as research instruments (cf. 1.5.2.1 & 5.3) because of the large population (cf. 5.2.3.3). The questionnaires were mailed to the respondents. Qualitative research was used to supplement the open-ended questions in the questionnaires (cf. 1.5.2.2). Response to open-ended questions was poor, hence the researcher also interviewed a number of geography teachers and learners (cf. 5.5) to improve the validity of the study.

Interviews are vocal questionnaires although they differ from questionnaires because they involve direct interaction between individuals (McMillan and Schumacher 1997: 263). Fraenkel and Wallen (1996: 372) argue that a face to face interview is the most effective way of enlisting the cooperation of the participants in a survey because rapport can be established. Furthermore, the researcher is also able to clarify the meaning of some of the questions to the respondents and to follow up on unclear or incomplete answers to the questions (Fraenkel and Wallen 1996: 372; and McMillan and Schumacher 1997: 263). The interview allows greater depth of response which is not possible through other means (Koul 1996: 176).

Borg and Gall (1989: 380) and McMillan and Schumacher (1997: 263) maintain that the primary disadvantage of an interview is subjectivity. Furthermore, to conduct interviews is expensive and time consuming (McMillan and Schumacher 1997: 264). It is expensive as it may involve travelling long distances to reach the interviews. As a result, a researcher is compelled to sample fewer respondents than could be obtained with a questionnaire. Koul (1996: 176) notes that the interview has the following limitations:

- it is a time consuming technique;
- its effectiveness depends on the skill of the interviewer not ordinarily possessed by inexperienced researchers;
- there is a constant danger of subjectivity on the part of the interviewer; and
- it is most difficult to employ successfully as some interviewees may not respond freely, frankly and accurately.

The purpose of an interview is to find out what is on the mind of the interviewees, i.e. what do they think or how do they feel about something (Fraenkel and Wallen 1996: 447). Koul (1996: 176) further maintains that the interview enables an interviewer to get information concerning feelings, attitudes or emotions in relation to other questions.

In this study, interviews were conducted because 53 teachers (75%) and 315 learners (89%) did not respond to the open-ended questions of the questionnaires. McBurney (1994: 201) has also noted that the response rate is the main problem with written questionnaires. It is argued that the low response rate may invalidate data because of differences between those who responded and those who did not. Therefore, interviews were conducted to supplement the information gathered by the questionnaires.

Interviews collected data qualitatively from selected geography teachers and learners. They were carried out to explore problems geography teachers and learners experienced when they were engaged in inquiry teaching and inquiry learning respectively. Respondents were also requested to suggest solutions to the problems they had identified.

Furthermore, interviews were also conducted to establish problems geography teachers and learners experienced when science process skills were applied to the teaching of geography. Teachers and learners were also requested to suggest solutions to the problems they have identified. The following sections describe data collection procedure.

5.3 DATA COLLECTION PROCEDURE

This section reviews data collection procedures which include the pilot study, how the sample was selected, how the questionnaires were compiled and administered to the population and how interviews were conducted.

5.3.1 Permission to Conduct Research in the Free State Department of Education

Permission to administer the questionnaires and conduct interviews was sought from the Head of Education: Free State Education Department (Appendix 8). It was granted (Appendix 9) subject to the following conditions:

- ☐ the names of learners/educators must be provided by the principals;
- ☐ learning facilitators/Educators/Learners participate voluntarily in the project;
- ☐ the names of the schools and educators/learners involved remain confidential in all respects;
- ☐ completion of questionnaires by educators/learners must take place outside normal tuition time of the school;
- ☐ a copy of the letter granting permission must be shown to all participating persons;
- ☐ a copy of the thesis must be donated to the Free State Education Department; and
- ☐ the researcher had to accept the above-mentioned conditions in writing.

The researcher also wrote a letter to the principals of participating schools to ask for their permission and cooperation (Appendix 10). The researcher opted for mailed questionnaires due to time and financial constraints. The questionnaires together with stamped self-addressed envelopes were sent to the school principals who were requested to hand them to the relevant respondents.

5.3.2 Pilot Study

Before preparing the final format of the questionnaires, the items were tested by fifteen secondary school geography teachers and fifteen secondary school geography learners in a pilot study in Welkom Education District. Respondents were requested to comment in writing on the items contained in the questionnaires.

Some deficiencies were detected and additional items were suggested. For instances, twelve teachers requested that a question requiring their qualifications should be rephrased. They did not prefer to list their qualifications and they suggested that the item should ask if they have specialised in geography at tertiary level. Fourteen teachers also suggested that item 33 which requested them if they allowed learners to move freely while the lesson was in progress to be rephrased. It was changed to "*I allow learners to move freely in the classroom while they are engaged in group work activities.*" These changes were also applied to item 29 of the learners' questionnaire.

The questionnaires were also handed to six lecturers at Vista University - Welkom Campus (Sub-faculty of Education), for comments and improvement. Furthermore, the questionnaires were also handed to the Department of Statistics at the University of Pretoria, where the researcher was advised on suitable layouts of the questionnaires to make them compatible with the SAS statistical program that was used to analyse data. As a result of all these processes, the questionnaires were revised and modified, and the final drafts were prepared (Appendices 3 & 4) and mailed to the participants.

5.4 POPULATION AND RESEARCH SAMPLE

In 2000, the year in which the data for this study was gathered, there were 302 secondary schools in the Free State province offering the subject geography (Appendix 6) comprising the population of this study. It was not possible to post the questionnaires and interview all geography teachers and learners in these schools. This would have been an expensive exercise in terms of money and time. A number of schools were selected from which teachers and learners who participated in this research project were drawn. Borg (1981: 73) maintains that the size of the samples and the procedures used in selecting samples determine the degree of confidence with which the researcher can apply the research findings to the population. Charles (1995: 96-97) supports this idea by asserting that samples are a necessity, in research where findings are intended to be generalized to the population. Furthermore, selected samples should accurately reflect the distribution of trait variables within the population at large.

A sample is the portion of a population that provides the subjects of a research study (Langenbach, Vaughn and Aagaard 1994: 375; and McMillan and Schumacher 1993: 598). This implies that a sample is a group from which information for the study is acquired. Sampling is the process of selecting a number of individuals for a study in such a way that the individuals represent the larger group from which they were selected (Fraenkel and Wallen 1996: 91; Gay and Airasian 2000: 140; McMillan and Schumacher 1997: 165).

For the completion of the questionnaires, the researcher applied a simple random sample and a systematic random sample to select the sample for geography teachers and learners respectively. For interviews, the researcher applied purposive sampling which is a nonrandom sample selected, because prior knowledge suggests it is representative, or because those selected have the needed information (Gay and Airasian 2000: 138; Fraenkel and Wallen 1996: 101; and McMillan and Schumacher 1997: 397). The following sections describe how the samples for the respondents were selected.

5.4.1 Geography Teacher Sample

The Free State Department of Education could not provide the accurate number of secondary school geography teachers because they were uncertain how many secondary school geography teachers were teaching in the province. It was subsequently assumed that there could be one geography teacher per school which totalled to 302 practising secondary geography teachers in the province. Questionnaires were sent to only 150 practising secondary school geography teachers, which represented 50 percent of the assumed total number of practising teachers. The researcher also decided on this figure because of time and financial constraints. Therefore, a description of the respondents from this population should be given in sufficient detail, so that interested researchers can determine the applicability of this research to their own situation (Fraenkel and Wallen 1996: 93).

As already mentioned, simple random sampling was conducted to select the sample for geography teachers. In a random sample, each individual has an equal chance of being included (Borg 1981: 73; Borg and Gall 1989: 220; McBurney 1994: 204; McMillan and Schumacher 1993: 166; Charles 1995: 97 and Howell 1999: 21). Furthermore, in a random sample the characteristics of each of the sample may reflect the characteristics of the total population (Leedy 1993: 201). This process ensured that each and every school that offered geography had an equal and independent chance of being selected. This was done by using a table of uniform random numbers (Appendix 6) to select 150 secondary schools that were included in the sample out of 302 schools that offered geography in 2000. The first school was identified as school 0001, the second as school 0002 and school 299 as 0299 and so on. Using the Table of Uniform Random Numbers (Appendix 7) (Howell 1999: 450 - 451), the first two numbers did not form part of the sample because there were no 682 and 610 in the population. However, the third number in the column, 046 formed part of the sample as it was also in the population. Thus, school 0046 duly formed part of the sample. The fourth and fifth numbers were 320 and 281 respectively and school 0320 did not form part of the sample as it was not in the list of the schools provided by the Free State Department of Education but school 0281 formed part of the sample. This selection process went on until a total of 150 numbers each representing a school in the population were included in the sample. Of 150 teacher questionnaires mailed, 71 were returned which represented a return of 47 percent. This low rate of return might have led to research bias as it was not representative of the research population.

Purposive sampling was used to select geography teachers interviewed. As interviews were conducted in 2001, matriculation results of the year 2000 were used as a criterion for identifying schools from which the respondents to be interviewed where drawn.

McMillan and Schumacher (1997: 401) suggest that a purposeful sample size should range from one to forty or more participants. Twenty schools with between 70 -100 percent pass rates were identified and included in the sample. Twenty geography teachers in these schools were individually interviewed and their teaching experiences ranged from two to twenty-four years. A number of thirteen male teachers and seven female teachers were interviewed.

It was assumed that these teachers could be knowledgeable and informative about the application of science process skills to the teaching of geography. It is important to note that Gay and Airasian (2000: 138) argue that the shortcoming of purposive sampling is inaccuracy in the researcher's criteria and resulting sample selections. The interview schedule for geography teachers can be found in Appendix 11. The following section highlights how geography learners were selected for the sample.

5.4.2 Geography Learner Sample

The targeted geography learner population was all Grade 8 to Grade 12 geography learners in all education districts in the Free State. However, due to time and financial constraints, the accessed geography learners' population was only conducted at fourteen secondary schools. It was assumed that all the characteristics of the 302 schools could be found in the selected fourteen schools. A systematic sample was used to select this sample.

In a systematic sample, every *n*th individual in the population list is selected for inclusion in the sample (McMillan and Schumacher 1993: 167, and Fraenkel and Wallen 1996: 98). Systematic sampling implies the selection of certain items in a series according to a predetermined sequence (Leedy 1993: 211). The fourteen schools that were sent learner questionnaires were selected in the following manner.

The researcher started by determining the sampling interval, i.e. the distance in the list between each school selected for the sample. The following formula (Fraenkel and Wallen 1996: 99) was used to determine the selection of the schools:

Sampling Interval =

$$\frac{\textit{Population Size}}{\textit{Desired Sample Size}}$$

$$\frac{302}{14}$$

21,57

22

School 0022, school 0044, school 0066, school 0088 and so on were selected from Appendix 7 until a sample of fourteen schools was reached. This process indicated that the origin of the sampling sequence was controlled by chance. Fifty questionnaires were sent to each selected school with an instruction to the school principal (Appendix 10) that ten questionnaires should be given to the learners of each Grade. Of 700 questionnaires mailed, 355 were returned which represented a return of 51 percent. It should be noted that this return rate resulted to the problem of bias as it was not sufficiently representative of the population.

Geography learners who were interviewed were from ten of the twenty secondary schools with pass rates of between 70 and 100 percent which could have resulted in an extremely biassed sample. Only five Grade 12 learners per selected school were interviewed as a group, hence ten groups of Grade 12 geography learners were interviewed. The researcher interviewed only Grade 12 learners because it was assumed that they would be able to give adequate and accurate information on the problems they experienced in inquiring learning and science process skills. It was also assumed that Grade 12 learners would also be able to suggest quality solutions to the problems identified. The interview schedule for geography learners can be found in Appendix 12.

5.5 ARRANGEMENT FOR CONDUCTING INTERVIEWS

Approximately five months after receiving the last questionnaire, the researcher telephoned the school principals of the identified schools to arrange for interviews. Most principals referred the researcher to their geography teachers. The researcher requested the teachers for interviews not lasting more than fifteen minutes. The purpose of the interview was explained and the information sought was made clear. Teachers of the ten schools were requested to identify and prepare five Grade 12 geography learners who could be interviewed.

After the telephonic conversation, the researcher sent the interview schedule to the geography teachers and requested the teachers to suggest times at which the schools could be visited. Where there was a time conflict, the teachers concerned were phoned and alternative times that were available were suggested. Interviews in all schools were conducted during their forty-five minutes break time.

Two days before each interview, the researcher phoned the geography teacher concerned and reminded him/her of the interview. On the day of the interviews, the researcher tried to arrive in the schools twenty minutes before break. The researcher introduced himself to the school principals who took him to the geography teachers. The researcher introduced himself and stated briefly that he had come in accordance with previously made arrangements. Some small talk followed to make the interviewees as comfortable as possible. The interviews were conducted in a professional manner and the researcher kept to the questions sent to the teachers earlier. As the interview schedule consisted of only six questions, the researcher wrote down the answer to each question. After the interview, the teachers were thanked for their courtesy of giving their time and a word of appreciation was also expressed.

Then, the teachers selected the five learners to be interviewed. Learners were mostly seated in the school library or laboratory when the interviews took place. The researcher introduced himself to the learners and explained the purpose of his visit to them. He further explained the information he was seeking from them and why he was seeking it. He then started by explaining the meaning of inquiring teaching and inquiry learning. Thereafter, he explained what science process skills were by means of examples. The interviews were also conducted in a professional manner and the researcher kept to the questions sent to the schools earlier. After the interview, learners were thanked for their courtesy of giving their time. Each learner was given a bar of chocolate as a token gesture. Twenty-nine female learners and twenty-one male learners were interviewed. The interviewing process took twenty-five days to complete.

5.6 CONSTRUCTION OF QUESTIONNAIRES

A questionnaire is an instrument which attempts to obtain comparable data from all members of a population or sample because the same questions are asked of all research participants (Gay and Airasian 2000: 280). It is an instrument for gathering data beyond the physical reach of the researcher (Leedy 1993: 187). A researcher constructs a set of questions and requests the subjects to answer them, usually in a form that asks the respondents to check the response (McMillan and Schumacher 1997: 46). A questionnaire has some limitations. For instances Koul (1996: 150-151) maintains that:

- it can not be used with children and illiterates;
- the return rate is as low as 40 percent to 50 percent, hence the data obtained are of limited validity. The respondents who return the questionnaires may not be representative of the entire population. It will make a sample a biassed one

thus nullify the findings;

- sometimes respondents do not like to respond in writing to the questions of intimate nature and confidential nature or to the questions involving certain controversial issues;

- sometimes it is difficult to formulate and phrase questions on certain complex, delicate and intricate problems;

- there is no check on a respondent who may misinterprets a question or gives incomplete or indefinite responses; and

- sometimes the respondent may modify his earlier original responses to the questions when he finds that his responses to latter questions are contracting the previous ones.

Questionnaires were used to obtain data on the application of science process skills to the teaching of secondary school geography in the Free State Province. This section describes the constructions of the geography teachers' questionnaire (Appendix 3), and the geography learners' questionnaire (Appendix 4).

Gay and Airasian (2000: 282) maintain that a questionnaire should be attractive, brief and easy to complete. A researcher should carefully plan, its content and format. A sloppy, crowded, misspelled, and a lengthy questionnaire could put respondents off causing the research to yield too few responses. The researcher should include items and questions that have been properly thought and that directly relate to the topic and objectives of the study (Gay and

Airasian 2000: 282; McMillan and Schumacher 1997: 253).

The geography teachers' questionnaire consisted of five sections whilst the learners' questionnaire consisted of four sections. The teachers' questionnaire was constructed to look into the application of science process skills to the teaching of geography. The learners' questionnaire was designed to determine if learners concur with their teachers' perception of their application of science process skills to the teaching of geography.

- Part one of the teachers' questionnaire was designed to obtain personal information of the surveyed population. Respondents were requested to state their gender. This information was needed for statistical purposes and for the application of analysis of variance (ANOVA) (cf 6.3). Teachers were also requested to indicate if they took geography as a school subject up to matric standard, and if they had specialised in geography at tertiary level. This information was used to determine if geography teachers were qualified to teach the subject.

- Part two was designed to obtain data regarding geography teachers' experience in the teaching of geography. Teachers were requested to state their teaching experiences in years. This information was requested to determine the experience of the teachers teaching the subject. Teachers were also requested to indicate if on appointment to their present school they were interested in teaching geography and whether they found geography easy to teach. This information was used to find out if geography teachers were enthusiastic about their subject.

- Part three was designed to obtain school details of the respondents. Teachers were requested to indicate if their schools were in rural or urban area. This information was needed for statistical purposes only. They were also asked to indicate if their schools were public, independent, farm, missionary or mine schools for use in ANOVA.

- Part one of the learners' questionnaire was also designed to obtain personal information of the surveyed population. Learners were requested to indicate their gender and age in completed years as well as to indicate their present Grade at school. They were also requested to indicate if they found geography easy to learn. Gender and Grade information was used in the application of ANOVA (cf. 6.3)

- Part two was designed to gather data on the schools learners were attending. Learners were requested to indicate if their schools were in rural or urban area. They were also requested to classify their schools as public, independent, farm, missionary or mine schools. These items were included in the questionnaire for the application ANOVA.

Parts four and five of the teachers' questionnaire and Parts three and four of the learners' questionnaire, were drawn from the theory in the literature review chapters hence, the following paragraphs highlight content validation of the questionnaires.

5.6.1 The Content Validation of the Questionnaires

- Part four of the teachers' questionnaire and Part three of the learners' questionnaire were designed to establish if geography teachers were inquiry teachers (cf. 5.3 and 6.2.2). In items 15 to 42, teachers were requested to indicate the frequency to which they did as described in the statements. This was done with the aid of the numeric or Likert-type scales. This is a self-reporting instrument in which the respondent replies to a series of statements by indicating the extent of agreement (Fraenkel and Wallen 1996: 584; and Gay and Airasian 2000: 625). Each choice was given a numerical value and the following categories were used to categorise each item:

Never	1	Sometimes	2	Often	3	Always	4

In items 11 to 38, learners were requested to indicate the degree to which they agreed or disagreed as described in the statements. This was also done according to the numeric or Likert-type scales and the following categories were used to categorise each item:

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

Items 43 to 46 in the teachers' questionnaire and items 39 to 42 in the learners' questionnaire were designed to establish the difficulties which teachers and learners experienced while they were engaged in inquiry teaching and inquiry learning respectively (cf. 6.4.2.1 and 6.4.2.3). Respondents were also requested to suggest how the identified difficulties could be alleviated (cf. 6.4.2.2 and 6.4.2.4). Questionnaire items which measured inquiry teaching methods applied to the teaching of geography were taken from sections 2.2, 2.3 and 2.4 of this study. Thirty-two items in both teacher and learner questionnaires established the extent of inquiry teaching.

- Part five of the teachers' questionnaire and Part four of the learners' questionnaire were designed to gather data on the application of science process skills to the teaching of geography. This section was divided into two sections, namely, Section A which dealt with the application of basic science process skills whilst Section B dealt with the application of advanced science process skills. Teachers were requested to indicate the degree to which they did as described in the statements whilst learners were requested to indicate the degree to which they agreed or disagreed as described in the statements according to the numeric or Likert-type scales as explained in the previous paragraph.

Section A in both questionnaires dealt with basic science process skills applied to the teaching of geography. Items 47 to 54 and items 59 to 63 in the teachers' questionnaire, and items 43 to 55 in the learners' questionnaire were designed to establish basic science process skills that geography teachers applied to the teaching of geography (cf. 6.2.3.2). These items were constructed to elicit information on whether teachers devised exercises and activities that enabled learners to practice and develop the following skills, which is to:

- ***identify** and **observe** geographical problems and to **observe** geographic phenomena* (items 47, 52 and 60 of the teachers' questionnaire and items 43, 48 and 52 of the learners' questionnaire).

  These items were included in the questionnaires to find out if learners are engaged in activities that enable them to look for patterns through their senses (observation). The items measured the application of *observation* skill to the teaching of geography. This is the skill on which all other science process skills are based.

- ***classify** geographical features and **order** them according to their structures.* (items 48 and 63 in teachers' questionnaire and items 44 and 55 in learners' questionnaire).

These items were constructed to find out if learners are able to look for similarities and differences in phenomena. The items measured the application of *classifying* skill to the teaching of geography.

- ***communicate** information through drawing maps, charts, symbols, graphs and diagrams*; (items 49, 50, 59, 61 and 62 in teachers' questionnaire and items 45, 46, 51, 53 and 54 in learners' questionnaire).

  Maps, charts, symbols, graphs and diagrams are communication tools which are used in geography. These items were included in the questionnaires to find out if learners are given activities that allow them to communicate orally or in writing what they know or are able to do. The items measured the application of the *communicating* skill to the teaching of geography.

- ***observe** and **measure** geographical phenomena and to compare objects using standardized units of measure and suitable measuring instruments.* (items 51 and 52 in teachers' questionnaire and items 47 and 48 in learners' questionnaire).

  These items were structured to find out if learners are engaged in exercises in which they measure geographical objects and events through instruments and equipment. For instance, the use of rulers to measure distances and the use of climatological instruments to measure the elements of weather. The use of instruments enables learners to quantify descriptions of objects and events.

These items of the questionnaire assessed the application of the *measuring* skill to the teaching of geography.

- *use observations to* ***predict*** *future geographical events.* (item 53 in teachers' questionnaire and item 49 in learners' questionnaire).

  This item was included to find out if learners are encouraged to predict possible events before they are actually observed. The item evaluated the application of the *predicting* skill to the teaching of geography

- *use various forms of data to determine the* ***correctness of geographical theory***. (item 54 in teachers' questionnaire and item 50 in learners' questionnaire).

  This item was structured to find out if learners are given opportunities to use data to infer their explanations of theories and to change their explanations as new information becomes available. The item assessed the application of the *inferring* skill to the teaching of geography.

Questionnaire items which measured basic science process skills applied to the teaching of geography were taken from sections 2.5.1, 4.4 and 4.6 of this study. Theoretical discussions of these sections revealed that geography teachers should provide learners with opportunities to be engaged in basic science process skills' exercises and activities.

Section B in both questionnaires dealt with the application of advanced science process skills to the teaching of geography. Items 64 to 72 in the teachers' questionnaire, and items 56 to 58 and items 63 to 68 in the learners' questionnaire were designed to elicit information from the respondents on whether teachers devised exercises and activities that enabled learners to practice and develop the following integrated science process skills, which are to:

- ***identify variables*** *that affect geographical phenomena, for example, how variables such as air temperature, air pressure, humidity, and cloud cover influence the occurrence of rainfall.* (item 64 in teachers' questionnaire and item 56 in learners questionnaire.

  This item was structured to find out if learners are encouraged to identify variables that affect a geography phenomenon such as rainfall. The item assessed the application of the skill of *identifying variables* to the teaching of geography.

- ***construct table of data*** (item 65 in teachers' questionnaire and item 57 in learners' questionnaire).

  This is a skill that is needed to record the results of an investigation, hence the construction of this item in the questionnaire. Organizing data into tables helps to see pattern of the results (Rezba et al. 1995: 133).

  The item was used to measure the application of the skill of *constructing tables of data* to the teaching of geography.

- *use the tables of data to* ***construct and interpret graphs*** (items 66 and 72 in teachers' questionnaire and items 58 and 68 in learners' questionnaire).

  Items' 58 and 66 were designed to find out if learners are given exercises in which they communicate information through graphs instead of using a spoken or written message. These items assessed the application of the skill of *constructing a graph* to the teaching of geography.

  Items' 68 and 72 were formulated to find out learners are given exercises in which they interpret the graphs by describing the relationship between variables on the graphs.

  These items evaluated the application of the skill of *describing relationships between variables* to the teaching of geography.

- ***design and conduct investigations***. (items 67 and 71 in teachers' questionnaire and items 63 and 67 in learners' questionnaire)

  These items were formulated to find out if learners are given opportunities to design and conduct investigations to test hypotheses.

  These items were used to measure the application of the skill of *designing and conducting investigations* to the teaching of geography.

- ***identify the variables under study*** (item 68 in teachers' questionnaire and item 64 in learners' questionnaire).

The item was included in the questionnaire to find out if learners are given exercises in which they identify the manipulated and responding variables. This may enable them to recognize the parts of a typical investigation (Rezba et al. 1995: 205). Identification of the variables under study is done when analysing investigations hence this item measured the application of the skill of *analysing investigations* to the teaching of geography.

- ***construct hypotheses*** (item 69 in teachers' questionnaire and items 65 in learners' questionnaire).

  The item was included in the questionnaire to establish if learners are given opportunities to state hypotheses when solving problems as hypotheses provide guidance on what data to collect.

  The item evaluated the application of the skill of *constructing hypotheses* to the teaching of geography.

- **defining operationally** (item 70 in teachers' questionnaire and 66 in learners' questionnaire).

  The item was included in the questionnaire to establish if learners are encouraged to define geographical phenomena by using the observable characteristics of the phenomena.

  The item assessed the application of the skill of *defining operationally* to the teaching of geography.

Items in this section of the questionnaires were formulated from sections 2.5.2 and 4.5 of this study. Theory in these sections indicated that integrated science process skills are applicable to the teaching of geography. This implies that geography learners should be provided with opportunities to acquire and master these skills in order to participate in social life as critical and active citizens.

- Furthermore, in Part five of the teachers' questionnaire, question 73 requested the respondents to state problems which they experienced when applying science process skills to the teaching of geography. Item 74 requested teachers to suggest how the problems they have identified could be alleviated.

  In Part four of the learners' questionnaire question 69 requested the respondents to state problems which they experienced when science process skills were applied to the teaching and learning of geography. Item 70 requested them to suggest how the problems they have identified could be alleviated.

  These questions were included in the questionnaires because it was assumed that teachers and learners were bound to meet some problems when science process skills were applied to the teaching of geography.

In conclusion twenty- four items that dealt with the application of science process skills to the teaching of geography were formulated. After the questionnaires were constructed and finalised, they were administered to their respective respondents

5.6.2 Instructions for the Completing of the Questionnaire

The purpose for the instructions was to clarify what was expected from to the respondents and how they should complete the questionnaire. Instructions were clear and concise and the information that was given in the questionnaires was as follows:

- respondents were told that the study attempted to describe and explain the application of science process skills to the teaching of geography;

- respondents were also informed that the study was likely to provide useful information which could be of supportive nature to geography teachers in general and outcomes-based education in particular;

- respondents were told that the study also attempted to gain information on inquiry teaching methods applied to geography teaching and learning. They were also informed that the adoption of inquiry teaching and inquiry learning was likely to lead to the application of science process skills to the teaching of geography. It was also assumed that acquisition of science process skills might develop critical understanding of issues and the ability to solve problems;

- respondents were informed that the survey was approved by the Free State Education Department;

- the researcher indicated that he was grateful for the responses and ensured them that their responses would remain completely confidential and anonymous;

- in closed-form statements, the respondents were requested to answer by making a cross (X) over the appropriate number in the shaded area whilst in open-ended questions, the respondents were requested to write their answers in the shaded block provided;

- respondents were requested to send the questionnaire by the due date after completing it; and

- respondents were thanked in advance for their co-operation.

5.7 PROCEDURES FOR ANALYSING QUESTIONNAIRE DATA

A research study usually produces a mass of collected data that should be correctly scored and efficiently organised to facilitate data analysis. Descriptive and inferential statistics were used to analyse data.

5.7.1 Descriptive Statistics

Descriptive statistics enables the researcher to describe data with numerical indices or in graphic form (Fraenkel and Wallen 1996: 629). It is also concerned with describing or summarising data from the sample (Gay and Airasian 2000: 437 and Rowntree 1981: 21). Analysis procedure in descriptive statistics involves calculating and interpreting statistics. The major types of descriptive statistics are measures of central tendency, measures of variability, measures of relative position, and measures of relationships (Fraenkel and Wallen 1996:437; and Gay and Airasian 2000: 437). Measures of a central tendency are used to determine the average score of a group of scores (Fraenkel and Wallen 1996: 437). These measures are the mode, the median and the arithmetic mean. Measures of variability show how spread out a group of scores is (Fraenkel and Wallen 1996: 437). The range, standard deviation and variance are the most commonly used in educational research. Measures of relative position describe a respondent's performance compared to the performance of all other respondents. Measures of relationship indicate the degree to which two sets of scores are related (correlation)(Fraenkel and Wallen 1996: 437).

The SAS statistical program was used to compute the collected data. The statisticians who assisted in the research applied the FACTOR procedure to the collected data. The FACTOR procedure performs a variety of common factors and component analyses and rotations (SAS User's Guide: Statistics, Version 5: 1985: 336). The FACTOR procedure also performs factor analysis (cf. 6.4.1) where a number of factors are established which have something in common with some of the variables which are used in the research (Mulder 1986: 113). In this study, the items of the questionnaire were not grouped when response data were loaded onto the computer. Hence the researcher conducted an investigative factor analysis.

5.7.1.1 Factor Analysis

Factor analysis involves a search for 'clusters' of variables, all of whom are correlated with each other (Fraenkel and Wallen 1996: 314; and Gay and Airasian 2000: 336). Therefore, each cluster represents a factor. This implies that factor analysis reduces a set of variables to a small number of factors. It is used to determine whether certain items in the inventory have something in common (Motseke 1998: 153). The method of extraction used was the principal component analysis (Table 6.7). The method for rotation applied was the varimax (Table 6.7). Its purpose was to obtain as many high positive and zero loadings as possible. The varimax method of rotation's output included means, standard deviations , eigenvalues and a scree plot (6.2.3).

The first step in factor analysis was the construction of an intercorrelation matrix (cf. Table 6.7). The factors to be singled out were determined with the aid of the eigenvalues of the intercorrelation matrix (cf. Figure 6.1 and Table 6.7).

After the initial factor analysis, the factors were subjected to a Scree-test (cf. Figure 6.1) which is an analytical technique adopted from factor analysis (Race and Planek 1992: 173). Cattell (1966) as cited in Race and Planek (1992: 173) describes a scree test as a graph of eigenvalues plotted along the ordinated (y-axis) and factors plotted along the abscissa (x-axis). Its first roots show a 'cliff' of important factors and the other roots denote the 'rubble' (unimportant factors). All eigenvalues of greater than one are considered priority items (cf. 6.4.1) whilst eigenvalues which are less than one are discarded (SAS User's Guide: Statistics, Version 5: 1985: 339).

Principal component analysis is a multivariate technique for examining relationships among several quantitative variables (SAS User's Guide: Statistics, Version 5: 1985: 621). Plots of principal components are valuable tools in exploratory data analysis. Its output is all eigenvalues of greater than 1 (SAS User's Guide: Statistics, Version 5: 1985: 339). Data were also subjected to frequency distribution.

5.7.1.2 Frequency Tabulation

Frequency distribution which showed all the scores in each item of the questionnaires was used to tabulate data. Frequency data was converted to percentage indicating the number of the respondents who marked a particular item in relation to the total number of respondents.

Frequency tables were used to indicate biographical data (cf. Tables 6.1 and 6.2) of the respondents and to tabulate data for inquiry teaching method (cf. Tables 6.3 and 6.5). Frequency tables were also used to indicate responses to basic and integrated science process skills' items respectively (cf. 6.2.3). Data were also subjected to the measure of a central tendency of arithmetic mean.

5.7.1.3 Measures of Central Tendency

The means procedure, one of the indices of measures of a central tendency was used to establish if geography teachers used inquiry methods (Tables 6.4 and 6.6). It was also used to establish if geography teachers applied basic science process skills (Tables 6.10 and 6.12) and integrated science process skills to their teaching (Tables 6.13 and 6.15).

The arithmetic mean is the most important and frequently used measure of central tendency (Fraenkel and Wallen 1996: 589; Gay and Airasian 2000: 43; Mulder 1986: 17). It is calculated by adding up all the scores and dividing the total by the number of scores. The arithmetic mean is expressed by the following formula:

$$\bar{x} = \frac{\sum X}{N}$$

Where $\bar{x}$ = the arithmetic mean;

$\sum$ = the symbol for "the sum of";

x = any raw score value

N = the total number of scores

This formula indicates that the mean is computed by dividing the sum of all the scores in the distribution by the total number of scores in the distribution. Data were also subjected to index of variability of standard deviation.

The standard deviation is the most frequently used index of variability (Gay 1987: 349 and Mulder 1986: 25) and it is a measure of the spread (variation) around the mean (Gay 1987: 349). The first step in calculating the standard deviation entails discovering how far each score is from the mean. This process involves squaring each difference, adding all the squares, and dividing by the number of scores. This measure of variability is called variance. The higher the deviation (variance), the more variation is the data around the mean (Gay 1987: 349). This implies that the scores are spread out. If the variance is small, it implies that the scores are close together. The square root of the variance is called the standard deviation. If the standard deviation is small, the scores are closer together whilst if the standard deviation is large, the scores are spread out.

If the distribution of the scores is normal, then the mean plus 3 standard deviations and the mean minus 3 standard deviations encompass about all the scores, over 99 percent of them (cf. 6.3.1, 6.3.2, 6.4.1.1 and 6.4.1.2). The following is the formula for calculating the standard deviation:

$$SD = \frac{1}{N} \sqrt{N\Sigma X^2 - (\Sigma X)^2}$$

where SD = standard deviation

N = number of scores

X^2 = each score squared

$(X)^2$ = the sum of all the scores squares

After descriptive statistics, inferences were made to predict about the similarity of the sample to the geography teacher and learner population from which the sample was drawn. Hence, the following discussion on inferential statistics.

5.7.2 Inferential Statistics

Inferential statistics are certain types of techniques that allow researchers to make inferences and generalize about a population based on findings from a sample (Borg and Gall 1989: 350; Gay and Airasian 2000: 469; Fraenkel and Wallen 1996: 205; Langebach et al. 1994: 240).

Simple, or one-way analysis of variance (ANOVA) is used to determine whether there is a significant difference between two or more means at a selected probability level (Gay and Airasian 2000: 491). Therefore, the researcher used teachers' responses to conduct a series of one-way analysis of variance (ANOVAs) to determine if there were any statistically significant differences among the independent variables (*Gender, Teachers with or without matriculation geography, Grade and Location of the school*) with respect to the dependent variables (*Inquiry teaching methods, Basic science process skills and Integrated science process skills*).

Learners' responses were also used to conduct a series of one-way ANOVAs to determine if there were any statistically significant differences among the independent variables (*Gender, Grade and Type of the school*) with respect to the dependent variables (*Inquiry teaching methods, Basic science process skills and Integrated science process skills*).

Selaledi (1996: 64) points out that findings of no difference support a decision to combine the participants into one sample, regardless of membership in any education district. In this study the districts were combined because some districts had very few respondents. The results of one-way ANOVAs are presented in section 6.3.

5.8 CONCLUSION

Chapter 5 has reviewed the data processing procedures followed in this study. It initially supplied a rationale for a detailed description of the procedure employed in the development of the science process skills' questionnaire. Finally, the chapter concluded with a description of the statistical techniques applied to the data analysis. Chapter 6 presents the results of this study.

CHAPTER 6

RESULTS OF THE EMPIRICAL INVESTIGATION

6.1 INTRODUCTION

The previous chapter reviewed the data processing procedures and described the statistical techniques applied. This chapter provides the data analyses on the application of science process skills to the teaching of geography in secondary schools in the Free State province.

The chapter is divided into three sections. The first section, **descriptive statistics**, describes teachers' and learners' perception of the application of an inquiry approach to geography teaching. It also describes their perception of the application of basic science process skills and integrated science process skills to the teaching of geography.

The second section, **inferential statistics**, reports the results of the one-way ANOVAs computed to determine if there were significant differences among the various education districts that could hinder the districts being treated as a single main sample.

The third and final section deals with the interpretation of the results of the **interviews**. Problems encountered by teachers and learners, and identified during the interviews, are presented. Lastly, results are presented regarding the solutions suggested by the teachers and learners during the interviews.

6.2 DESCRIPTIVE STATISTICS

This section provides a demographic profile of the samples used in the study - namely the teachers, learners and schools. It also provides statistical descriptions which arise from responses to items which measured inquiry teaching methods, basic science process skills and integrated science process skills applied to the teaching of geography.

6.2.1 Biographical Data Analysis

Geography teacher questionnaires were mailed to 150 teachers whilst learner questionnaires were mailed to 700 learners (cf. 5.2.3.3). Seventy-one teachers and 355 learners returned the questionnaire. Following is the personal information for the teachers and learners who responded to the questionnaires.

6.2.1.1 Biographical Data for Geography Teachers

The questionnaire can be found in Appendix 3. On the basis of the 71 returns, the following generalisations can be made about secondary school geography teachers in the Free State Education Department (Table 6.1).

In secondary schools which offer geography, 52 percent of the teachers were males and 48 percent were females. The majority of teachers (69%) took geography as a subject to matric and 77 percent of the teachers specialised in geography at tertiary level. The teachers have an average of 15 years of teaching experience. Furthermore, most geography teachers (65%)

in the department have 5 or more years of geography teaching experience and 62 percent of these teachers teach up to and including Grade 12.

It is also interesting to note that only 10 percent of the respondent teachers were not interested in teaching geography when appointed at their schools. However, it is comforting to note that 89 percent of the teachers find geography easy to teach.

More than half of the teachers (52%) teach in urban schools and 94 percent of these schools are public schools. In general, geography teachers are reasonably experienced and have specialised in geography at tertiary level. Following is Table 6.1 which gives a summary of biographical data for geography teachers

Table 6.1 Summary of Teacher Personal Data, Experience in the Teaching of Geography and School Details Expressed as Percentage Scores

N=71

PERSONAL ITEMS	% RESPONDENTS ACCORDING TO CATEGORY	%TOTAL
1. Gender	Male (37) 52% Female (34) 48%	100
2. Matriculation Geography	Yes (49) 69% No (22) 31%	100
3. Tertiary Geography Education	Yes (55) 77% No (16) 23%	100
4. Average Teaching Experience in Years	15	
5. Highest Teaching Level	Grade 8 = (3) 4% 9 = (6) 8% 10 = (10) 14% 11 = (5) 7% 12 = (44) 62% Other = (3) 5%	100
6. Geography Teaching Experience in Years	Less than 5 (25) 35% More than 5 (46) 65%	100
7. Interested in Teaching Geography?	Yes (64) 90% No (7) 10%	100
8. Is Geography Easy to Teach?	Yes (63) 89% No (8) 11%	100
9. Location of the Schools	Rural (34) 48% Urban (37) 52%	100
10. School's Classification	Public (67) 94% Independent (2) 3% Mine (2) 3%	100

6.2.1.2 Biographical Data for Geography Learners

Geography learners' questionnaire can be found in Appendix 4. On the basis of the 355 returns the following generalisations can be made about secondary school geography learners in the Free State Education Department (Table 6.2). Secondary school geography is learned mainly by female learners (67,6%). The personal data and school details of the learners were as follows:

Table 6.2 Summary of Learner Personal Data and School Details Expressed as Percentage Scores (continues)

N=355

PERSONAL ITEMS	% RESPONDENTS ACCORDING TO CATEGORY	% TOTAL
1. Gender	Male: (114) 32, 1% Female: (241) 67, 8%	100
2. Age in Years	Less than 13: (9) 3% 13 to 18: (332) 88% More than 18: (14) 9%	100
3. Grade	8 = (86) 24,2% 9 = (90) 24,3% 10 = (95) 26,8% 11 = (51) 14,4% 12 = (33) 9,3%	100
4. Do You Find Geography Easy to Learn?	Yes: (237) 66, 8% No: (118) 32, 2%	100

Continues...

Table 6.2 Summary of Learner Personal Data and School Details Expressed as Percentage Scores

N=355

5. Location of the School	Rural (21) 5,9 %	Urban (334) 94,1%	100
6. School's Classification	Public (244) 68, 7%	Independent (111) 31%	100

Table 6.2 indicates that most schools did not adhere to the request that ten questionnaires should be given to the learners of each Grade (Appendix 10). It seems as if questionnaires were given mainly to Grades 8, 9 and 10 learners. Only 14,4 percent and 9,3 percent of the respondents were Grades 11 and 12 learners respectively. One of the reasons for this pattern could be the fact that Grade 12 learners write public examinations. Schools did not want to burden Grade 12 learners with work which was not related to their preparation for the examinations. Despite this minor setback, it is interesting to note that 67 percent of the learners found geography easy to learn.

94,1 percent of the learners who responded to the questionnaire attended schools which were in urban areas and most of these schools (68,7%) were public schools. This could be due to the fact that most schools in the rural Free State are privately owned farm schools which do not have secondary school grades. Hence most rural learners are forced to go to a nearby town or city for secondary school education.

6.2.2 Data Analysis for Inquiry Teaching Methods

Part Three of the learners' questionnaire and Part Four of the teachers' questionnaire dealt with inquiry teaching methods. The following section presents teachers' and learners' responses. Teachers' responses are dealt with first because teachers are the ones who are supposed to apply inquiry methods to the teaching of geography. Learners' responses are used to check teachers' responses to each item of the questionnaire.

6.2.2.1 Geography Teachers' Perception of their Application of Inquiry Methods to the Teaching of Geography

As it has already been mentioned, Part Four of the teachers' questionnaire was designed to establish geography teachers' perception of their application of inquiry teaching methods to the teaching of geography (**objective 1**). It is assumed that the application of inquiry teaching methods could lead to the application of science process skills.

Table 6.3 below indicates teacher responses in percentage to each statement. Items in the table start at 15 because items 1 to 14 in the teachers' questionnaire dealt with statistical information of the respondents. As such, the items in the table are numbered the way they were numbered in the teachers' questionnaire.

Table 6.3 Geography Teachers' Perception of their Application of Inquiry Teaching Methods Expressed as Percentage Scores

N = 71

Inquiry Teaching Method	Never	Sometimes	Often	Always
15. I focus on lessons involving exploration of important problems that can be investigated at many levels of difficulty.	7, 0	49, 3	33,8	9, 9
16. I Use learning materials that stimulate learners' interest.	2, 8	25, 4	60, 6	11, 2
17. I make available many different learning resources for learners' use.	7, 0	45, 1	39, 4	8, 5
18. My lessons present some problems that develop learners' thinking skills.	4, 2	35, 2	46, 5	14, 1
19. When I teach, the learners talk more than I do.	22, 5	56, 3	17, 0	4, 2
20. Learners are free to discuss their ideas in class.	5, 6	38, 0	34, 0	22, 4
21. When I talk, I "question", I do not "tell".	-	25, 4	38, 0	36, 6
22. I consciously use ideas my learners' have raised in class.	5, 6	35, 2	48, 0	11, 2
23. I redirect learners' questions in such a way that learners are encouraged to arrive at their own answers.	1, 4	28, 1	53, 5	17, 0
24. I consciously base my questions on learners' ideas in class.	8, 4	42, 2	39, 4	10, 0
25. Learners are free to interchange their ideas in class.	1, 4	49, 3	26, 8	22, 5
26. I encourage the learners to evaluate if their arguments are relevant to the ideas being discussed.	7, 0	36, 6	42, 3	14, 1
27. My learners gain understanding in science process skills.	8, 5	49, 3	32, 3	9, 9
28. I encourage learners to investigate geographical problems.	-	18, 3	49, 3	32, 4
29. I emphasise learning, rather than classroom discipline when learners are engaged in groupwork activities.	7, 0	39, 4	36, 6	17, 0
30. Class discussions are conducted in an orderly fashion that emphasizes courtesy and willingness to listen to each person's ideas.	2, 8	25, 3	40, 9	31, 0
31. My learners gain practice in scientific process of acquiring knowledge.	12, 7	40, 9	35, 2	11, 2

Continues...

Table 6.3 Geography Teachers' Perception of their Application of Inquiry Teaching Methods Expressed as Percentage Scores

N = 71

Inquiry Teaching Method	Never	Sometimes	Often	Always
32. I reward the free exchange of ideas in class.	12, 7	35, 2	36, 6	15, 5
33. I allow learners to move freely in the classroom while they are engaged in group work activities.	38, 0	40, 9	15, 5	5, 6
34. I encourage the testing of ideas in class.	7, 1	38, 0	33, 8	21, 1
35. I avoid criticising ideas offered by learners in class.	8, 5	23, 9	32, 4	35, 2
36. Each learner's contribution is considered important in class.	-	1, 4	31, 0	67, 6
37. I evaluate learners on growth in many aspects of the learning experience, rather than simply on the basis of facts required.	8, 5	28, 1	43, 7	19, 7
38. All geographical topics are critically examined, not "taught" as closed issues with a single "correct" solution.	4, 2	39, 5	35, 2	21, 1
39. Use of unfounded, emotionally charged language is minimized in guided didactic conversations.	7, 0	15, 5	31, 0	46, 5
40. I emphasize that values are permissible areas of discussion.	4, 2	18, 3	40, 9	36, 6
41. I allow for maximum learner use of learning materials.	2, 8	19, 7	45, 1	32, 4
42. I play low-key role in directing the learning experience of my learners.	11, 3	59, 1	26, 8	2, 8

Teacher responses to items 15 to 42 of the questionnaire enabled the researcher to apply *The Means Procedure* to establish if geography teachers perceived that they were inquiry teachers (cf. 5.3.1.3). Table 6.4 shows *The Means Procedure* for teachers' perception of their application of inquiry methods to the teaching of geography.

Table 6.4 The Means Procedure for Teachers' Perception of their Application of Inquiry Teaching Methods

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV20V47	71	2.7	0.4	1.8	3.9

Table 6.4 indicates the mean value which is the average or arithmetic mean of the data for the inquiry teaching methods variable. The Standard Deviation is a measure of the spread (variation) around the mean. The higher the Standard Deviation, the more variation is the data around the mean. The mean for teachers' perception of their application of inquiry methods to the teaching of geography is 2.7. *This mean implies that teachers are of the opinion that they "often" apply inquiry methods to the teaching of geography.* As the application of inquiry methods is likely to lead to the application of science process skills, *Table 6.4 also implies that teachers are likely to apply science process skills to the teaching of geography.*

6.2.2.2 Teacher Application of the Inquiry Teaching Methods according to Geography Learners' Responses

Items 11 to 38 in Part three were to establish learners' perception of their teachers' application of inquiry methods to the teaching of geography. Table 6.5 indicates learners' perception of their teachers' application of inquiry methods. The items start at 11 because items 1 to 10 in the learners' questionnaire dealt with personal data and school details of the respondents. Therefore, the items are numbered the way they were numbered in the learners' questionnaire.

Table 6.5 Teacher Application of Inquiry Teaching Methods According to Geography Learners' Responses Expressed as Percentage Scores

N = 355

Inquiry Teaching Method	Strongly Disagree	Disagree	Agree	Strongly Agree
11. My geography teacher focuses on lessons involving exploration of important problems that can be investigated at many levels of difficulty.	8,1	14,7	58,3	18,9
12. My geography teacher uses learning materials that stimulate my interest.	7,9	22,0	49,9	20,2
13. My geography teacher makes available many different learning resources for my use.	6,2	26,8	53,0	14.0
14. My geography teacher's lessons present some problems that develop my thinking skills.	7,9	24,5	52,1	15,5
15. When the lesson is in progress, I talk more than my geography teacher.	36,9	39,4	17,8	5,9
16. I am free to discuss my ideas with other learners in the class.	7,0	28,5	42,3	22,2
17. When my geography teacher talks, (s)he "question", (s)he does not "tell".	15,2	42,8	34,4	7,6
18. My geography teacher consciously uses ideas I have raised in class.	13,2	38,0	40,6	8,2
19. My geography teacher redirects my questions in such a way that I am encouraged to arrive at my own answers.	8,2	29,0	48,7	14,1
20. My geography teacher consciously bases his/her questions on my ideas in class.	11,8	55,5	29,0	3,7
21. I am free to interchange my ideas with other learners in class.	10,7	28,7	46,8	13,8
22. My geography teacher encourages us to evaluate if our arguments are relevant to the ideas being discussed.	7,9	29,0	49,9	13,2
23. I gain understanding in the usage of science process skills.	10,7	25,6	47,6	16,1
24. My geography teacher encourages us to investigate geographical phenomena.	10,4	20,3	53,8	15,5
25. My geography teacher emphasizes learning, rather than classroom discipline when we are engaged in groupwork activities.	10,7	30,4	43,7	15,2
26. Class discussions are conducted in an orderly fashion that emphasizes courtesy and willingness to listen to each person's ideas.	7,9	18,6	45,9	27,6
27. I gain practice in scientific process of acquiring knowledge.	9,3	25,6	50,2	14,9

Continues...

Table 6.5 Teacher Application of Inquiry Teaching Methods According to Geography Learners' Responses Expressed as Percentage Scores

N = 355

Inquiry Teaching Method	Strongly Disagree	Disagree	Agree	Strongly Agree
28. My geography teacher rewards free exchange of ideas in class.	8,2	32,3	48,5	11,0
29. My geography teacher allows us to move freely in the classroom while we are engaged in group work activities.	52,4	38,3	7,6	1,7
30. My geography teacher encourages the testing of ideas in class.	7,3	27,6	49,3	15,8
31. My geography teacher avoids criticising ideas offered by us in class.	12,1	18,0	44,3	25,6
32. Our contributions in discussions are considered important in class.	5,4	15,5	58,0	21,1
33. My geography teacher evaluates us on growth in many aspects of the learning experience, rather than simply on the basis of facts required.	8,7	24,5	49,0	17,8
34. All geographical topics are critically examined, not "taught" as closed issues with a single "correct" solution.	9,0	29,6	44,2	17,2
35. Use of unfounded, emotionally charged language is minimized in guided didactic conversations.	12,4	27,6	48,7	11,3
36. My geography teacher emphasizes that values are permissible areas of discussion.	10,1	30,4	52,7	6,8
37. My geography teacher allows for my maximum use of learning materials.	5,4	22,5	55,2	16,9
38. My geography teacher plays a low-key role in directing my learning experience.	25,3	45,4	24,8	4,5

Responses to items 11 to 38 also enabled the researcher to apply *The Means Procedure* to establish if learners perceived that their teachers applied inquiry methods to the teaching of geography. Table 6.6 indicates The Means Procedure for teacher application of inquiry teaching methods according to learners' responses.

Table 6.6 The Means Procedure for Teacher Application of Inquiring Teaching Methods According to the Learners' Responses

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV11V38	355	2.6	0.3	1.4	3.7

In Table 6.6 the arithmetic mean for teacher application of inquiring teaching methods according to learners' responses is 2,6. This arithmetic mean is almost identical to the mean in Table 6.4. *This arithmetic mean implies that learners "agree" that teachers apply inquiry teaching methods to the teaching of geography.*

Therefore, analyses of both teacher and learner responses to items 15 to 42 and 11 to 38 of their respective questionnaires indicate that *secondary school geography teachers and their learners are in agreement with regard to the application of inquiring methods to the teaching of secondary school geography.* As such, *the researcher concludes that respondents perceive that geography teachers use inquiry teaching methods in their classrooms* **(objective 1)**.

Therefore, *teacher and learner responses justify the researcher's assumption that the application of inquiry teaching methods could lead to the application of science process skills to the teaching of geography.* The following section presents teachers' and learners' perception of science process skills applied to the teaching of geography.

6.2.3 Data Analysis for the Application of Science Process Skills to the Teaching of Geography

Items 43 to 55 in the learners' questionnaire and items 47 to 54 & 59 to 63 in the teachers' questionnaire dealt with basic science process skills applied to the teaching of geography. Furthermore, items 56 to 58 & 63 to 68 in the learners' questionnaire and items 64 to 72 in the teachers' questionnaire dealt with integrated science process skills applied to the teaching of geography. Factor analysis and item analysis were used to establish the science process skills applied to the teaching of secondary school geography.

6.2.3.1 Factor Analysis

Items that dealt with the application of science process skills in the teachers' questionnaire were subjected to factor analysis (cf. 5.7.1.1). Factor analysis is used to determine if certain items in the questionnaire have something in common with some of the variables which are used in the research (Black 1999: 220; Boniface 1995: 131 and Mulder 1989: 132). With the aid of the eigenvalues of the intercorrelation matrix the principal components to be singled out were determined. The principal components were sorted out by the descending order of the eigenvalues. Table 6.7 shows the eigenvalues of the correlation matrix for science process skills. Items in this table are numbered according to the numbering system used in the teachers' questionnaire.

Table 6.7 Eigenvalues of the Correlation Matrix for Science Process Skills

Eigenvalues of the Correlation Matrix: Total = 22 Average = 1

N = 71

Questionnaire Items on Science Process Skills	Eigenvalue	Difference	Proportion	Cumulative
47. I give my learners many opportunities to **identify** geographical important problems.	11,5	9,7	0,5	0,5
48. I organize classroom activities in which learners **classify** the observed geographical features.	1,9	0,6	0,1	0,6
49. I encourage learners to use any means to **communicate** learned information, i.e. to draw maps, charts, symbols, graphs and diagrams to **communicate** the information.	1,2	0,3	0,1	0,7
50. I link the work in geography on **diagrams** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	1,0	0,2	0,1	0,7
51. I organize activities in which my learners **compare** objects using standardize units of measure and suitable measuring instruments.	0,9	0,4	0,0	0,7
52. I organize my learners to **observe** geographical phenomena such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.	0,7	0,0	0,0	0,8
53. I encourage my learners to **predict** future geographical events based upon their observations.	0,7	0,0	0,0	0,8
54. I encourage learners to use various forms of data to determine the **correctness of geographical theory**.	0,6	0,1	0,0	0,8
59. I encourage learners to **describe** a geographical feature's position in relation to other geographical features.	0,5	0,0	0,0	0,9
60. I give my learners many opportunities to **observe** geographical important problems.	0,5	0,0	0,0	0,8
61. I encourage learners to use any means to **communicate** investigated information.	0,4	0,0	0,0	0,9
62. I link the work in geography on **graphs** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	0,4	0,0	0,0	0,9
63. I organize activities in which my learners arrange geographical features in logical **order** according to their structures.	0,3	0,0	0,0	0,9

Continues..

Table 6.7 Eigenvalues of the Correlation Matrix for Science Process Skills

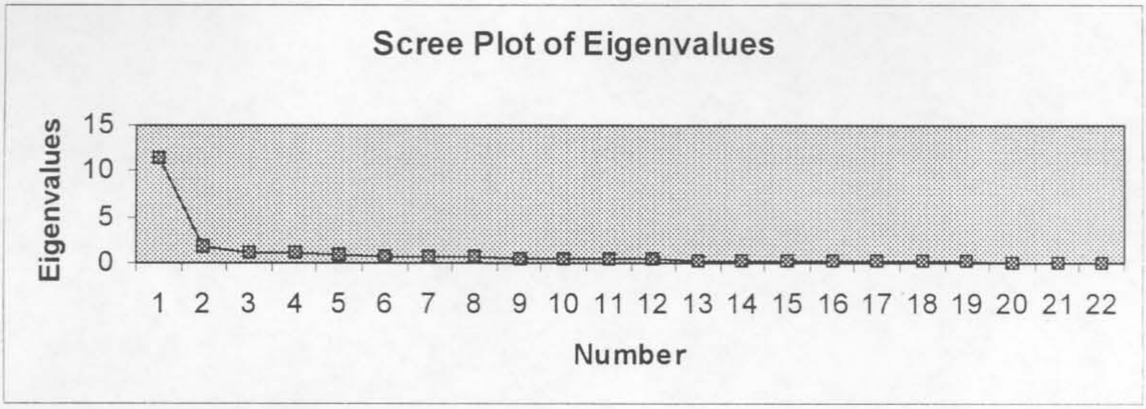
Eigenvalues of the Correlation Matrix: Total = 22 Average = 1

N = 71

Questionnaire Items on Science Process Skills	Eigenvalue	Difference	Proportion	Cumulative
64. I encourage learners to **identify variables** that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity, and cloud cover influence the occurrence of rainfall.	0,3	0,1	0,0	0,9
65. I devise exercises in which my learners have to **construct tables of data**.	0,2	0,0	0,0	1,0
66. I devise exercises in which learners have to **construct graphs.**	0,2	0,0	0,0	1,0
67 I devise exercises in which my learners **conduct investigations**.	0,2	0,0	0,0	1,0
68. I devise exercises in which my learners **identify the variables** understudy.	0,2	0,0	0,0	1,0
69. I give my learners geographical problems in which they are encouraged to **construct hypotheses.**	0,1	0,2	0,0	1,0
70. I give exercises in which my learners **define** geographical features by using observable characteristics of the features.	0,1	0,0	0,0	1,0
71. I give my learners hypotheses and request them to **design investigations** to test the given hypotheses.	0,1	0,0	0,0	1,0
72. I devise exercises in which learners have to **describe the relationship between variables** on a graph.	0,1	0,0	0,0	1,0

An inspection of the factor loadings in Table 6.7 reveals that two factors are retained by the NFACTOR criterion. The first principal component has 11.5 eigenvalues whilst the second principal component has 1.9 eigenvalues. The fact that factorial analysis could distinguish between two factors that could be identified as basic and integrated science process skills confirms that the respondents distinguished mentally between the two constructs. It also confirms that the respondents have come to terms with the fact that these two factors include skills that could be applied to the teaching of geography. The intention of the factor analysis was to determine whether certain factors could be isolated and after this was done, the factors were identified and labelled as basic and integrated science process skills. Following is a graphical representation (scree curve) of the percentage of variance explained by each consecutive factor.

Figure 6.1 Scree Plot of Eigenvalues



The varimax method of rotation was also used as an analytical approach to obtain an orthogonal rotation of factors. Its purpose was to obtain as many high positive and near zero loadings as possible. This application of the varimax rotation method also revealed that there were two categories of science process skills. Table 6.8 on the next page shows this rotated factor pattern. The homogenous clustering of items with high internal consistencies (correlations) implies that respondents were comfortable with the assumption, according to them, that the science process skills could be grouped into two main clusters. It therefore confirms a high construct validity of the questionnaires.

Table 6.8 Orthogonal Transformation Matrix

Prerotation Method: Varimax

	Basic Science Process Skills	Integrated Science Process Skills
Basic Science Process Skills	0.73931	0.67336
Integrated Science Process Skill	-0.67336	0.73931

N = 71

Questionnaire Items on Science Process Skills	Factor 1 Basic Science Process Skills	Factor 2 Integrated Science Process Skills
47. I give my learners many opportunities to **identify** geographical important problems.	0,7	0,2
48. I organize classroom activities in which learners **classify** the observed geographical features.	0,6	0,4
49. I encourage learners to use any means to **communicate** learned information, i.e. to draw maps, charts, symbols, graphs and diagrams to **communicate** the information.	0,5	0,4
50. I link the work in geography on **diagrams** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	0,5	0,5
51. I organize activities in which my learners **compare** objects using standardize units of measure and suitable measuring instruments.	0,7	0,3
52. I organize my learners to **observe** geographical phenomena such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.	0,6	0,3
53. I encourage my learners to **predict** future geographical events based upon their observations.	0,8	0,2
54. I encourage learners to use various forms of data to determine the **correctness of geographical theory**.	0,9	0,2
59. I encourage learners to **describe** a geographical feature's position in relation to other geographical features.	0,7	0,3
60. I give my learners many opportunities to **observe** geographical important problems.	0,7	0,3
61. I encourage learners to use any means to **communicate** investigated information.	0,6	0,5
62. I link the work in geography on **graphs** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	0,6	0,5
63. I organize activities in which my learners arrange geographical features in logical **order** according to their structures.	0,6	0,4
64. I encourage learners to **identify variables** that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity, and cloud cover influence the occurrence of rainfall.	0,7	0,4

Continues...

Table 6.8 Orthogonal Transformation Matrix

N = 71

Questionnaire Items on Science Process Skills	Factor 1 Basic Science Process Skills	Factor 2 Integrated Science Process Skills
65. I devise exercises in which my learners have to **construct tables of data**.	0,0	0,8
66. I devise exercises in which learners have to **construct graphs**.	0,3	0,8
67. I devise exercises in which my learners **conduct investigations**.	0,3	0,8
68. I devise exercises in which my learners **identify the variables** under study.	0,3	0,8
69. I give my learners geographical problems in which they are encouraged to **construct hypotheses**.	0,4	0,7
70. I give exercises in which my learners **define** geographical features by using observable characteristics of the features.	0,5	0,6
71. I give my learners hypotheses and request them to **design investigations** to test the given hypotheses.	0,4	0,6
72. I devise exercises in which learners have to **describe the relationship between variables** on a graph.	0,4	0,7

Variance Explained by Each Factor

Factor 1 = Basic Science Process Skills	Factor 2 = Integrated Science Process Skills
7.1382852	6.2380386

Table 6.8 indicates that in Factor 1, values which are above 0.5 form one category of science process skills and values which are below 0.5 form another category. Analysis of Factor 2, also reveals the same pattern. Values which are less than 0.5 also form one category of science process skills and values which are more than 0.5 form another category. As such, in Factor 1, values above 0.5 can be classified as basic science process skills whilst values below 0.5 can be classified as integrated science process skills. In Factor 2, values less than

0.5 may be classified as basic science process skills whilst values more than 0.5 may be classified as integrated science process skills.

As a result of the factor analysis, data will be analysed under the identified 2 principal components. Item analysis is used to investigate basic science process skills (Tables 6.9 to 6.12) and integrated science process skills (Tables 6.13 to 6.16) applied to the teaching of geography in secondary schools in the Free State.

6.2.3.2 Basic Science Process Skills

Table 6.9 to 6.12 show teacher and learner perceptions of the application of basic science process skills to the teaching of geography. Teacher and learner responses to items in their respective questionnaires attempted to measure the application of science process skills to the teaching of geography as follows:

Table 6.9 Geography Teachers' Perception of their Application of Basic Science Skills Expressed as Percentage Scores

N = 71

Questionnaire Items on Basic Science Process Skills	Never	Sometimes	Often	Always
47. I give my learners many opportunities to **identify** geographical important problems.	4, 2	32, 4	43. 7	19. 7
48. I organize classroom activities in which learners **classify** the observed geographical features.	5, 6	42, 3	40, 9	11. 2
49. I encourage learners to use any means to **communicate** learned information, i.e. to draw maps, charts, symbols, graphs and diagrams to **communicate** the information.	4, 2	29, 6	29, 6	36, 6
50. I link the work in geography on **diagrams** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	2, 8	35,2	31. 0	31. 0
51. I organize activities in which my learners **compare** objects using standardize units of measure and suitable measuring instruments.	21, 1	38, 0	31, 0	9, 9
52. I organize my learners to **observe** geographical phenomena such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.	14, 0	26, 8	32, 4	26. 8
53. I encourage my learners to **predict** future geographical events based upon their observations.	12, 7	29, 6	35, 2	22, 5
54. I encourage learners to use various forms of data to determine the **correctness of geographical theory**.	9, 9	39, 4	32, 4	18, 3
59. I encourage learners to **describe** a geographical feature's position in relation to other geographical features.	7, 0	43, 7	39, 4	9, 9
60. I give my learners many opportunities to **observe** geographical important problems.	9, 9	35, 2	38. 0	16, 9
61. I encourage learners to use any means to **communicate** investigated information.	11, 3	31, 0	39, 4	18, 3
62. I link the work in geography on **graphs** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.	5, 6	38, 1	32, 4	23, 9
63. I organize activities in which my learners arrange geographical features in logical **order** according to their structures.	18, 3	38, 0	35, 2	8, 5

Teacher responses to items 47 to 63 of the questionnaire enabled the researcher to apply *the*

Means Procedure to establish the extent to which teachers perceive their application of basic science process skills to the teaching of geography. Following is Table 6.10 which shows the means procedure for the application of basic science process skills according to teachers' responses.

Table 6.10 The Means Procedure for Teachers' Perception of their Application of Basic Science Process Skills

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV68V84	71	2.6	0.7	1.4	4.0

Analysis of Table 6.10 indicates that the arithmetic mean is 2,6. *As such, teachers' responses to basic science process skills' questionnaire items reveal that they perceive that they "often" apply basic science process skills to the teaching of geography. This implies that there could be a good foundation for the application of integrated science process skills in geography classrooms.*

Items 43 to 55 in Part four of the learners' questionnaire were used to establish learners' perception of their teachers' application of basic science process to the teaching of geography. Table 6.12 indicates learners' perception of teacher application of basic science process to the teaching of geography and the items start at 43 because the items are numbered the way they were numbered in the questionnaire.

Table 6.11 Geography Teacher Application of Basic Science Skills According to Learners' Responses Expressed as Percentage Scores

N = 355

Questionnaire Items on Basic Science Process Skills	Strongly Disagree	Disagree	Agree	Strongly Agree
43. My geography teacher gives us many opportunities to **identify** geographical important problems.	9, 9	17, 8	49, 0	23, 3
44. My geography teacher organizes classroom activities in which we **classify** the observed geographical features.	15, 5	30, 7	39, 4	14, 4
45. My geography teacher encourages us to use any means to communicate learned information, i.e. to draw maps, charts, symbols, graphs and diagrams to **communicate** the information.	5, 4	12, 7	39, 1	42, 8
46. My geography teacher links the work in geography on **diagrams** to our everyday life, i.e. getting us to bring examples from newspapers and magazines for discussion in class.	12, 1	42, 3	29, 3	16, 3
47. My geography teacher organizes activities in which we **compare** objects using standardize units of measure and suitable measuring instruments.	12, 7	38, 3	38, 3	10, 7
48. My geography teacher organizes us to **observe** geographical phenomena such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.	10, 7	22, 8	40, 3	26, 2
49. My geography teacher encourages us to **predict** future geographical events based upon our observations.	11, 6	36, 6	41, 4	10, 4
50. My geography teacher encourages us to use various forms of data to determine the **correctness of geographical theory**.	7, 9	27, 9	47, 3	16, 9
51. My geography teacher encourages us to **describe** a geographical feature's position in relation to other geographical features.	8, 5	25, 6	49, 9	16, 0
52. My geography teacher gives us many opportunities to **observe** geographical important problems.	5, 9	25, 9	52, 1	16, 1
53. My geography teacher encourages us to use any means to **communicate** investigated information.	7, 9	32, 4	46, 5	13, 2
54. My geography teacher links the work in geography on **graphs** to our everyday life, i.e. getting us to bring examples from newspapers and magazines for discussion in class.	12, 7	43, 1	31, 0	13, 2
55. My geography teacher organizes activities in which we arrange geographical features in logical **order** according to their structures.	9, 9	40, 9	41, 7	7, 5

Learners' responses to items 43 to 55 also enabled the researcher to apply *The Means Procedure* to establish the extent to which they perceive their teachers' application of basic science process skills to the teaching of geography Table 6.12 indicates the means procedure for the application of basic science skills according to learners' responses.

Table 6.12 The Means Procedure for Teacher Application of Basic Science Process Skills According to Learners' Responses

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV59V71	355	2.7	0.5	1.0	4.0

Table 6.12 reveals that the arithmetic mean is 2.7. *This mean implies that learners "agree" that teachers apply basic science process skills to the teaching of geography.* Basic science process skills form the foundation for integrated science process skills. The following section presents data analysis on the perceived application of integrated science process skills to the teaching of geography.

6.2.3.3 Integrated Science Process Skills

Items 56 to 58 and 63 to 68 in Part Four of the learners' questionnaire, and items 64 to 72 of teachers' questionnaires were designed to establish teacher and learner perceptions of the application of integrated science process skills to the teaching of geography. Table 6.13 indicates teachers' perception of their application of integrated science process skills to the teaching of geography.

Table 6.13 Geography Teachers' Perception of their Application of Integrated Science Skills Expressed as Percentage Scores

N = 71

Questionnaire Items on Integrated Science Process Skills	Never	Sometimes	Often	Always
64. I encourage learners to **identify variables** that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity, and cloud cover influence the occurrence of rainfall.	2, 8	25, 4	45, 0	26. 8
65. I devise exercises in which my learners have to **construct tables of data.**	22, 5	46, 5	22, 5	8, 5
66. I devise exercises in which learners have to **construct graphs**.	12, 7	59, 1	19, 7	8, 5
67. I devise exercises in which my learners **conduct investigations**.	14, 1	54, 9	23. 9	7. 1
68. I devise exercises in which my learners **identify the variables** understudy.	19, 7	42, 3	28, 0	10, 0
69. I give my learners geographical problems in which they are encouraged to **construct hypotheses**.	19, 7	43, 7	29, 6	7, 0
70. I give exercises in which my learners **define** geographical features by using observable characteristics of the features.	16, 9	25,4	45, 0	12, 7
71. I give my learners hypotheses and request them to **design investigations** to test the given hypotheses.	25, 4	42, 2	25, 4	7, 0
72. I devise exercises in which learners have to **describe the relationship between variables** on a graph.	14, 0	46, 5	31, 1	8. 5

Teacher responses to items 64 to 72 of the questionnaire enabled the researcher to apply *the Means Procedure* to establish the extent to which they perceived their application of integrated science process skills to the teaching of geography. Following is Table 6.14 which shows the means procedure for the application of integrated science process skills.

Table 6.14 The Means Procedure for the Application of Integrated Science Process Skills According to Teacher Responses

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV85V93	71	2.3	0.7	1.1	4.0

Data in Table 6.14 indicate that the arithmetic mean is 2,3. *This mean implies that teachers perceive that they sometimes apply integrated science process skills to the teaching of geography.*

Items 56 to 68 in Part four of the learners' questionnaire were to establish learners' perception of their teachers' application of integrated science process skills to the teaching of geography. Following is Table 6.15 which indicates learners' perception.

Table 6.15 Geography Teacher Application of Integrated Science Skills According Learners' Responses Expressed as Percentage Scores

N = 355

Questionnaire Items on Integrated Science Process Skills	Never	Sometimes	Often	Always
56. My geography teacher encourages us to **identify variables** that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity, and cloud cover influence the occurrence of rainfall.	7, 0	18, 0	50,2	24, 8
57. My geography teacher devises exercises in which we have to **construct tables of data**.	14, 1	30, 1	41, 7	14, 1
58. My geography teacher devises exercises in which we have to **construct graphs**.	9, 6	34, 1	44, 2	12, 1
63. My geography teacher devises exercises in which we **conduct investigations**.	9, 9	38, 5	46, 8	4, 8
64. My geography teacher devises exercises in which we **identify the variables** understudy.	8, 4	31,0	52, 7	7, 9
65. My geography teacher gives geographical problems in which we are encouraged to **construct hypotheses**.	13, 5	31, 6	45, 4	9, 6
66. My geography teacher gives us exercises in which we are encouraged to **define** geographical features by using observable characteristics of the features.	11, 3	24, 8	47, 6	16, 3
67. My geography teacher gives us hypotheses and request us to **design investigations** to test the given hypotheses.	13, 5	49,9	29, 9	6, 7
68. My geography teacher devises exercises in which we have to **describe the relationship between variables** on a graph.	7, 6	37, 8	42, 2	12, 4

The Means Procedure derived from learners' responses could also be used to establish the degree to which learners perceived their teachers' application of integrated science process skills to the teaching of geography. Table 6.16 shows the means procedure for the application of integrated science process skills.

Table 6.16 The Means Procedure for Teacher Application of Integrated Science Process Skills according to Learners' Responses

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SV72V84	355	2.6	0.5	1.1	4.0

A review of Table 6.16 indicates that the arithmetic mean is 2,6. *This implies that learners "agree" that their teachers apply integrated science process skills to the teaching of geography*

The results of descriptive statistics in Tables 6.10 and 6.12 indicate that geography teachers and learners are in agreement with regard to the application of basic science process skills to the teaching of geography. The results in these tables reveal that teachers and learners perceive that basic science process skills are applied to the teaching of geography.

Further examinations of the results of descriptive statistics divulge interesting information regarding the application of integrated science process skill to the teaching of geography. *Table 6.14 show that teachers are of the opinion that they "sometimes" apply integrated science process skills to the teaching of geography whilst Table 6.16 that learners "agree" that their teachers apply integrated science process skills to the teaching of geography.*

The differences of teacher and learner perceptions of the application of integrated science process skills to the teaching of geography could be attributed to the respondents' misunderstanding of questionnaires' items. This assertion is confirmed by the researcher's experience who had to explain during interviews to both teachers and learners the meaning of science process skills (cf. 6.4.2.5 and 6.4.2.6). The following paragraphs present inferential statistics results.

6.3 INFERENTIAL STATISTICS

This section deals with inferences made from the sample of this study to the geography teacher and learner population in the Free State province. The results of the one-way ANOVAs were computed to determine if there were statistically significant differences among the sampled members of the twelve education districts.

The education districts were combined into three districts as individual districts had few respondents. Districts 1, 2, 3 and 4 were combined to form *Education District 1*; districts 5, 6, 7 and 8 were combined to form *Education District 2*; and districts 9,10,11 and 12 were combined to form *Education District 3.*

6.3.1 Sample Mean Differences

ANOVAs were conducted to determine if there were any mean differences among the sampled members of the education districts. Three ANOVAs were computed on the three factors, namely, *inquiry teaching methods*, *basic science process skills* and *integrated science process skills.* The researcher, maintained an overall significance level of 0,05 and set the excedance probability at 0.05 ÷ 3. The probability level was 0.0167.

6.3.1.1 One-way ANOVA for Inquiry Teaching Methods

❑ *Teacher Responses*

A series of one-way ANOVAs were conducted on teachers' responses and statistically significant differences were found among *Gender, Teachers with(out) Matriculation Geography, Grade and Location of the school* as independent variables with respect to *inquiry teaching methods* as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.72, 2 = 72 and 2.72 and 3 = 2.73 (The names of the combined education districts are deliberately withheld in compliance with the terms of agreement on confidentiality). The F ratio using p < 0,0167 was 0.0396

The *F-value* for *gender* was 6.12 and Pr > F was 0.158. This indicates that a significant difference exists between males and female teachers with respect to their perceived inquiry methods they apply to the teaching of geography. A comparison of the means of male and female teachers indicates that male teachers (mean = 2.82) perceive that they apply inquiry methods to the teaching of geography more than female teachers (mean = 2.60).

The *F-value* for *teachers with or without matriculation geography* was 3.48 and Pr > F was 0.0663. This indicates that a significant difference exists between *teachers with or without matriculation geography* with respect to their perceived inquiry methods they apply to the teaching of geography. A further review of the ANOVA reveal that teachers who took geography as a subject to matric perceive that they have a higher application of inquiry methods to the teaching of geography (mean = 2.78) than those teachers who did not take geography as a subject to matric (mean = 2.60).

The *F-value* for *Grade* was 2.35 and Pr > F was 0.0807. This indicates that a significant difference exists between *teachers who teach different Grades* with respect to their perceived inquiry methods they apply to the teaching of geography. A comparison of the means of Grades 9, 10, 11 and 12 teachers indicates that Grade 10 teachers (mean = 2.94) perceive that they apply inquiry methods to the teaching of geography more than other teachers. Grade 10 teachers are followed by Grade 12 teachers (mean = 2.75), Grade 9 teachers (mean = 2.57 and lastly, by Grade 11 teachers (mean = 2.50).

The *F-value* for *the Location of the school* was 0.96 and Pr > F was 0.3312. This indicates that a significant difference exists between *teachers who teach at rural schools and those who teach at urban schools* with respect to their perceived inquiry methods they apply to the teaching of geography. Quite interestingly, teachers in urban schools (mean 2.80) show a higher perception of their application of inquiry methods than teachers in rural schools (mean = 2.50).

- *Learner Responses*

A series of one-way ANOVAs were conducted on learners' responses and statistically significant differences were found among *Gender, Grade and Type of the school* as independent variables with respect to *inquiry teaching methods* as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.60; 2 = 2.60 and 3= 2.60 (The names of the combined education districts are also deliberately with held in compliance with the terms of agreement on confidentiality). The F ratio using p < 0,0167 was 0,1127.

The *F-value* for *gender* was 1.19 and Pr > F was 0.2768. This indicates that a significant difference exists between males and female learners. An analysis of the means reveals that female learners have a higher score of perception (mean = 2.61) of their teachers' application of inquiry methods to the teaching of geography than male learners (mean = 2.58).

The *F-value* for *Grade* was 9.26 and Pr > F was 0.001. This indicates that a significant difference exists between learners of different Grades. Further examination of the results, divulges interesting information according to Grades regarding the application of inquiry methods to the teaching of geography. Although it is important to note that learners in all Grades agree (all means are 2.5 or above) that their teachers apply inquiry methods, Grade 11 learners indicate a higher score of perception (mean = 2.82) followed by Grade 9 learners (mean = 2.64); Grade 12 (mean = 2.59); Grade 10 learners (mean = 2.57) and lastly, Grade 8 learners (mean = 2.50).

The *F-value* for *Type of the school* was 3.52 and Pr > F was 0.0613. This indicates that a significant difference exists between learners at public schools and independent schools. A further review of the results show that learners at independent schools have a higher score (mean = 2.65) on their teachers' application of inquiry methods to the teaching of geography than learners at public schools (mean = 2.58).

6.3.1.2 One-way ANOVA for Basic Science Process Skills

- *Teacher Responses*

A series of one-way ANOVAs were conducted on teachers' responses and statistically significant differences were found among *Gender, Teachers with(out) Matriculation Geography, Grade and Location of the school* as independent variables with respect to *Basic Science Process Skills* as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.65; 2 = 2.68 and 3 = 2.65. The F ratio using $p < 0,0167$ was 0,0221.

The *F-value* for *gender* was 5.46 and Pr > F was 0.0224. This indicates that a significant difference exists between males and female teachers with respect to their perceived basic science process skills they apply to the teaching of geography. A comparison of the means of male and female teachers indicates that male teachers (mean = 2.82) have a higher perception of their application of basic science process skills to the teaching of geography than female teachers (mean = 2. 46).

The *F-value* for *teachers with or without matriculation geography* was 8.98 and Pr > F was 0.0038. This indicates that a significant difference exists between *teachers with or without matriculation geography* with respect to their perceived basic science process skills they apply to the teaching of geography. Further analysis shows that teachers who took geography as a school subject to matric (mean = 2.80) perceive that they apply basic science process skills to the teaching of geography more than teachers without matriculation geography (mean = 2.31).

The *F-value* for *Grade* was 2.90 and Pr > F was 0.0414. This indicates that a significant difference exists between *teachers who teach different Grades* with respect to their perceived basic science process skills they apply to the teaching of geography. It is also interesting to note that Grade 10 teachers (mean = 2.89) perceive that they apply basic science process skills to the teaching of geography more than teachers who teach other Grades. The means for other teachers are as follows: Grade 12 (mean = 2.77), Grade 11 (mean = 2.29) and Grade 9 (mean = 2.23).

The *F-value* for *the Location of the school* was 4.38 and Pr > F was 0.0400. This indicates that a significant difference exists between *teachers who teach at rural schools and those who teach at urban schools* with respect to their perceived basic science process skills they apply to the teaching of geography. Further analysis reveals that teachers in urban schools (mean = 2.80) have a higher perception of their application of basic science process skills to the teaching of geography than teachers in rural schools (mean 2 = 2.48).

- *Learner Responses*

A series of one-way ANOVAs were conducted on learners' responses and statistically significant differences were found among *Gender, Grade and Type of the school* as independent variables with respect to *Basic Science Process Skills* as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.70; 2 = 2.70 and 3 = 2.70. The F ratio using p < 0,0167 was 0,0258.

The *F-value* for *gender* was 1.22 and Pr > F was 0.2705. This indicates that a significant difference exists between males and female learners. The results of the analyses indicate that female learners have a higher perception score (mean = 2.69) on their teachers' application of basic science process skills to the teaching of geography than male learners (mean = 2.62).

The *F-value* for *Grade* was 9.27 and Pr > F was 0.001. This indicates that a significant difference exists between learners of different Grades. Further examination of the results, divulge interesting information regarding learners in different Grades with respect to their teachers' application of basic science process skills to the teaching of geography. Grade 11 learners have a higher perception score (2.97), followed by Grade 9 learners (2.70), Grade 12 learners (2.64), Grade 10 learners (2.58) and Grade 8 learners (2.56).

The *F-value* for *Type of the school* was 3.14and Pr > F was 0.0770. This indicates that a significant difference exists between learners at public schools and independent schools. Learners in independent schools have a higher perception score (2.74) than learners in public schools (2.64) with respect to their teachers' application of basic science process skills to the teaching of geography.

6.3.1.3 One-way ANOVA for Integrated Science Process Skills

- *Teacher Responses*

A series of one-way ANOVAs were conducted on teachers' responses and statistically significant differences were found among *Gender, Teachers with (out) Matriculation Geography, Grade and Location of the school* as independent variables with respect to

Integrated Science Process Skills as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.35; 2 = 2.35 and 3 = 2.38. The F ratio using $p < 0{,}0167$ was 0,0743.

The *F-value* for *gender* was 5.95 and Pr > F was 0.0173. This indicates that a significant difference exists between males and female teachers with respect to their perceived integrated science process skills they apply to the teaching of geography. The results of the ANOVA reveal that male teachers (mean = 2.53) perceive that they apply integrated science process skills to the teaching of geography more than female teachers (mean = 2.15).

The *F-value* for *teachers with or without matriculation geography* was 6.12 and Pr > F was 0.0158. This indicates that a significant difference exists between *teachers with or without matriculation geography* with respect to their perceived integrated science process skills they apply to the teaching of geography. Teachers who took geography as a school subject to matric (mean = 2.48) perceive that they apply integrated science process skills to the teaching of geography more than those teachers who did not study geography to matric (mean = 2.07).

The *F-value* for *Grade* was 2.35 and Pr > F was 0.0807. This indicates that a significant difference exists between *teachers who teach different Grades* with respect to their perceived integrated science process skills they apply to the teaching of geography. Further examination of the results indicates that Grade 10 teachers (mean = 2.62) perceive that they apply integrated science process skills to the teaching of geography more than other teachers. The mean for Grade 12 teachers, is 2.41; for Grade 11 teachers, the mean is 2.26 whilst for Grade 9 teachers the mean is 1.99.

The *F-value* for *the Location of the school* was 0.73 and Pr > F was 0.3943. This indicates that a significant difference exists between *teachers who teach at rural schools and those who teach at urban schools* with respect to their perceived integrated science process skills they apply to the teaching of geography. Furthermore, the results indicate that teachers in urban schools (mean = 2.41) perceive that they apply integrated science process skills more than teachers in rural schools (mean = 2.28).

☐ *Learner Responses*

A series of one-way ANOVAs were conducted on learners' responses and statistically significant differences were found among *Gender, Grade and Type of the school* as independent variables with respect to *Integrated Science Process Skills* as a dependent variable. The mean statistics for each group of combined education districts were: 1 = 2.58; 2 = 2.58 and 3 = 2.58. The F ratio using p < 0,0167 was 0,1982.

The *F-value* for *gender* was 2.68 and Pr > F was 0.1024. This indicates that a significant statistical difference exists between males and female learners. The results of the analyses indicate that female learners have a higher perception score (mean = 2.61) than male learners (mean = 2.51) with regard to their teachers' application of integrated science process skills to the teaching of geography.

The *F-value* for *Grade* was 5.41 and Pr > F was 0.0003. This indicates that a significant statistical difference exists between learners of different Grades. Further review of the results, reveal that Grade 9 learners have a higher perception score (2.73) than learners at other

Grades with respect to their teachers' application of integrated science process skills to the teaching of geography. Means for learners at other Grades are as follows: Grade 11 = 2.64; Grade 10 = 2.57; Grade 8 = 2.48 and Grade 12 = 2.33.

The *F-value* for *Type of the school* was 0.47and Pr > F was 0.4918. This indicates that a significant statistical difference exists between learners at public schools and learners at independent schools. Further examination of the results divulges interesting information regarding learners at independent and learners at public schools with regard to their teachers' application of integrated science process skills to the teaching of geography. Learners at public secondary school have a higher perception score (2.59) than learners at independent schools (mean = 2.55). The following paragraphs present data gathered through interviews.

6.4 INTERVIEWS

As indicated earlier, (cf. 5.2) the interviews allowed the researcher to explore problems geography teachers and learners experienced when they were engaged in inquiry teaching and inquiry learning respectively. Interviews also allowed the researcher to establish problems geography teachers and learners experienced when science process skills were applied to the teaching of geography. Furthermore, interviews revealed possible solutions to the identified problems.

6.4.1 Interview Data Analyses

The researcher reviewed the entire set of interviews once initially. Then, the researcher reviewed the data again and induced categories of responses for each research question. Finally, interpretative summaries for each question were noted. The researcher validated the interpretations, inferences and categories by discussing the analyses with five colleagues. Following are the results of the interview.

6.4.2 Interview Results

This section presents the results and conclusions about the interviews. The results are likely to serve as valuable guides to further study in other areas of research such as inquiry learning and learner application of science process skills to the learning of geography.

6.4.2.1 Difficulties Geography Teachers Experience When Developing Inquiry Teaching

The following questions were asked to elicit information on problems teachers experience when they develop inquiry teaching (**objective 2**).

Teacher Question: *What difficulties do you experience when developing inquiry teaching?*

Learner Question: *What problems does your geography teacher experience when (s)he develops inquiry teaching?*

Eight teachers and three groups of learners who were interviewed responded that there was a lack of learner involvement as small numbers of learners were willing to participate in inquiry. It was mentioned that learners who attempted to participate were scorned by their peers if their ideas or questions were irrelevant to the problems or issues under investigation. Hence.

learners were discouraged from participating in discussions.

One teacher mentioned that *"very few students participate in inquiry tasks. They do not want to speak in class because other students laugh at them if the make language mistakes."*

According to one group of learners *"Some learners laugh at us if we make mistakes."*

This implies that learners' command of English as a medium of instruction was inadequate and as a result, they were not willing to speak in class because their peers laughed at their English.

It was further indicated by thirteen teachers that learners lacked independent thinking as they were used to teacher domination in the classroom. This problem was also aggravated by a shortage of library facilities. Furthermore, learners did not read widely as some of the schools did not have functioning libraries. It was difficult to develop inquiry teaching if learners were not exposed to a wide variety of reading material. Hence, learners could not be frequently engaged in individual or group inquiry as there were no learning materials.

This is further illustrated by a teacher who stated the following:

"They are lazy to think, they do not exercise their thinking skills. They always want me to do everything for them"

Another teacher says, *"I cannot engage my students in inquiry because our library does not have any other geography textbook except the textbook we use."*

Two teachers indicated that Grade 12 geography syllabus was too lengthy to finish on schedule and teachers resorted to survival teaching methods which enabled them to finish the syllabus as quickly as possible. For instance, according to one teacher, "*it is difficult to use inquiry teaching methods because Grade 12 syllabus is very long. I teach in such a way that I finish it as quickly as possible.*"

6.4.2.2 Suggested Solutions to Difficulties Geography Teachers' Experience When Developing Inquiry Teaching

The following question was formulated to examine how the problems identified above could be alleviated (**objective 4**).

Teacher and Learner Question: *How can one solve these difficulties?*

Four teachers and five groups of learners interviewed indicated that teachers should involve learners by giving them individual or group tasks which encourage inquiry learning. At the end of each task, all learners should be requested to present reports on the investigated issue or problem. Teachers should encourage learners to present their reports orally as well as in writing. Teachers noted that this process was likely to improve learners' communication skills.

Three groups of learners also suggested that teachers should discourage learners from scorning their peers when they give ideas or ask questions that are irrelevant. Teachers should also help learners who ask senseless questions or give irrelevant ideas by prompting them to formulate questions correctly. They should point out to the learners what is wrong with their questions. Hence, this could help learners to formulate questions or ideas properly.

Eleven teachers were of the opinion that because outcomes-based education requires teachers to be creative and design learning materials, it could alleviate the problem of the shortage of learning materials at their schools if it is implemented properly. Teacher invention of learning materials could also alleviate the lack of these in the library. However, the teachers also indicated that they were not trained in OBE, hence once they were equipped with OBE's teaching skills they might be able to design and create learning materials for their learners.

6.4.2.3 Difficulties Learners Experience When They are Involved in Inquiry Learning

The following questions were formulated to establish difficulties that learners experienced when they were involved in inquiry learning (**objective 3**).

Teacher Question: *What difficulties do your learners experience when they are involved in inquiring learning?*

Learner Question: *What problems do you experience when you are involved in inquiry learning?*

Six groups of learners indicated that they found it difficult to generate their own questions. One group said, *"We cannot ask our own questions. We wait for the teacher to ask us questions or to teach us. The teacher always tells us what to do in class."*. They mentioned that this was intensified by the fact that the resources, content and problems were still selected by their geography teachers. Learners were expected to use these to interpret and evaluate an issue or a problem because they failed to understand the processes and techniques involved in geographical inquiry.

Furthermore, seven teachers and one group of learners indicated that most learners were unable to identify an issue or a problem that they might use to generate questions that would guide their inquiry individually or in groups. Learners also indicated that their teachers failed to provide them with guidance about the methods and sequence of inquiry which made it difficult to collect and analyse data related to a problem on their own. For instance, a group of learners mentioned that, *"the teacher gives us a project and expects us to do it without his guidance. If we ask him a question he says "I do not know, go and look for the information on your own. Do you want me to do the project for you?"*

Four groups of learners further indicated that their teachers did not indicate to them suitable sources of information which they might use when involved in inquiry learning. Hence learners sometimes collected and analysed inaccurate data which did not relate to the investigated issue or problem.

Five teachers indicated that some learners failed to select appropriate methods for presenting, analysing and interpreting the data they have gathered. Hence they lacked the ability to give logical reasoned solutions and to justify their recommendations.

6.4.2.4 Suggested Solutions to Difficulties Learners Experience When They are Involved in Inquiry Learning

The following question was formulated to examine how the problems identified above could be alleviated (**objective 5**).

Teacher and Learner Question: *How can one solve these problems?*

Four groups of learners indicated that their geography teachers should teach them how to think. They argued that the teacher as a provider of structured learning experience should plan learning activities that stimulate their curiosity and make them ask questions.

Furthermore, ten teachers indicated that they should always ask learners to give reasons why certain geographical phenomena do or do not happen, i.e. ask probing questions. Two teachers further indicated that they should ask learners to construct ways of finding out answers to the questions. They assumed that these processes were likely to stimulate and motivate their learners.

Three teachers also indicated that they would encourage their learners to identify and state problems. A teacher even suggested one question which may invoke inquiry in their learners. He argued that inquiry might be developed by asking learners the following question:

- *What could be the cause of the problem?*

Three teachers felt that they should encourage learners to investigate the problem under their guidance and also suggested that learners should be assisted to finding suitable data from sources in and out of school. Teachers and learners should discuss methods of analysis and interpretation of data hand in hand. Learners should also be encouraged to present their findings and to speculate about the reasons for their findings.

If the solutions given above are implemented, it could promote the use of science process skills to the teaching of geography. Learners are likely to be engaged in activities that improve knowledge and understanding of the environment through research.

The following section analyses responses to questions that attempted to establish problems and solutions associated with science process skills applied to the teaching of geography.

6.4.2.5 Problems That Learners Experience When Science Process Skills are Applied to the Teaching of Geography

The following question was formulated to examine problems that learners experienced when science process skills are applied to the teaching of geography (**objective 7**).

Learner Question: *What problems do you experience when science process skills are applied to the teaching of geography?*

All groups of learners (100%) interviewed, indicated that they did not know the meaning of the term science process skills. The researcher explained to them that science process skills were activities that geographers do when they investigated a problem, an issue or a phenomenon. Examples of basic science process skills such as *observing, communicating, measuring, prediction and inferring* were listed as well as examples of integrated science process skills such as *experimenting, designing investigations, conducting investigations and identifying variables*.

Learners indicated that difficulties were found in mapwork activities. Three groups of learners indicated that mapwork activities were not taught in their schools at all. These learners indicated that it seemed as if their teachers were not comfortable with this section of the syllabus. Those learners whose teachers taught this section of the syllabus, indicated that they found it difficult to measure and calculate distances between points on the map. They mentioned that it was difficult to measure the distance with a ruler in centimetres or millimetres and convert the measurement to metres or kilometres.

All groups of learners indicated that they were taught abstract concepts which were difficult to understand. Concepts such as atmospheric pressure, temperature, humidity and atmospheric air circulation, and they have never handled equipment which is used to observe these meteorological elements which are essential in weather forecasting . Instruments such as a wet and dry bulb thermometer, wind vanes, anemometer and a rain gauge are used to make surface observations of these elements. Hence they felt that this problem did not expose them to the process skills of making quantitative observations, recording data and interpreting data.

Four groups of learners indicated that their teachers had never demonstrated simple geographical experiments in their lessons. Hence integrated science process skills such as *experimenting, formulating hypotheses, identifying variables, defining variables operationally, designing investigations, analysing investigations and describing relationships between variables* were not easily developed in their geography classrooms.

Learners also indicated that they were unable to observe phenomena and interpret what they have observed. They reported that making sense (*inferring*) of what they have observed was not easy because they were taught to reproduce facts rather than to show insight and understanding in their answers. They also indicated that they found it difficult to make accurate *predictions* or to give reasoned statements based on what they have observed.

6.4.2.6 Suggested Solutions to Problems That Learners Experience When Science Process Skills are Applied to The Teaching of Geography

The following question was formulated to examine how the problems identified above could be alleviated (**objective 8**).

Learner Question: *How can one solve these problems?*

All groups of learners suggested that geography learning facilitators (subject advisors) or geography teachers from other schools should be incorporated in assisting them. Three groups suggested that learning facilitators should organize and conduct mapwork workshops annually, especially at the beginning of the year. These groups also suggested that geography learning facilitators should also visit schools under their guidance and present mapwork lessons a few weeks before final examination commence.

Seven groups of learners further suggested that Free State Department of Education should supply every secondary school which offered geography with meteorological instruments such as a barometer, a wet and dry bulb thermometer, a hygrometer, the Stephenson screen, a thermometer, a wind vane and a rain gauge. They believed that this equipment would enable them to participate in the recording of the information obtained from the instruments and observations which could enable them to apply science process skills to the learning of geography.

6.4.2.7 Problems That Teachers Experience When Applying Science Process Skills to The Teaching of Geography

The following question was formulated to examine difficulties that teachers experienced when they applied science process skills to the teaching of geography (**objective 9**).

Teacher Question: *What problems do you experience when you apply science process skills to the teaching of geography?*

Eighteen teachers indicated that they did not know the meaning of the term science process skills. The researcher explained what science process skills were and listed examples as indicated in section 6.4.2.5. All twenty teachers indicated that they did not specifically teach science process skills as a theme or topic in their lessons. They further indicated that most of the basic sciences process skills are developed when they teach other themes or topics of the syllabus.

Furthermore, they added that the skills were not examined in Grade 12 examinations and were regarded as a waste of time to teach because the geography syllabus was very long. They were expected to finish it by the end of June each year. Eight teachers also noted that examination questions sometimes did not test higher-order thinking skills of the learners.

Nineteen teachers also indicated that they would like to conduct some geographical experiments in their classrooms but they did not have the facilities and equipment to do so. They argued that experiments were likely to bring reality into the classroom which could enable learners to understand abstract concepts such as the water cycle, porosity, permeability, air pressure, evaporation, water vapour, convection currents, weathering, erosion and so on.

6.4.2.8 Suggested Solutions to Problems That Teachers Experience When Applying Science Process Skills to The Teaching of Geography

The following question was formulated to examine how the problems teachers experience when they applied science process skills to the teaching of geography could be alleviated (**objective 10**).

Teacher Question: *How can one solve these problems?*

Teachers answered this question, by suggesting some of the solutions given by their learners in section 6.4.2.6. Seven teachers further indicated that they would consider devoting much time to the teaching of the process skills of science if Grade 12 geography examiners could also include questions on the scientific method. They indicated that the scientific method formed part of the syllabus but it was never examined, which influenced them to ignore this section of the syllabus. They indicated that they concentrated on sections which were important for the examination purposes. For instance, one teacher said, *"if science process are included in the exam then I will be forced to teach them."* He further went on, "*The syllabus has a section on the scientific method but examiners ignore this section."*

Five teachers also indicated that to compensate for time they might spend teaching the scientific method, other parts of the syllabus would have to be removed or the contents should be reduced. In short the syllabus was too extensive and it needed to be revised and reduced. One teacher indicated that the emphasis of the syllabus should also be shifted away from the content and concentrate on teaching skills which were useful in the modern economy.

It is interesting to note that all teachers were of the opinion that it was the duty of the Free State Department of Education to provide schools with facilities and equipment which would enable them to design and conduct experiments. One teacher sensed he was not trained to be creative, hence it was difficult for him to introduce programs that would make it possible for him to teach abstract geographical concepts effectively. Four teachers suggested that Free State Department of Education should organise workshops or short courses in which teachers would be trained to teach science process skills. Furthermore, these teachers also suggested that the Free State Department of Education should encourage them to improve their qualifications by linking teacher qualifications with salaries. They claimed that they were not keen on furthering their studies because a once-off merit payment is effected by the department when they have improved their qualifications.

6.5 CONCLUSION

This chapter presented teacher and learner perceptions of the application of science process skills to the teaching of geography. Finally, a synthesis of the views expressed by teachers and learners during interviews was furnished. Chapter seven elaborates on the findings stated in Chapter six by way of discussion, conclusion and recommendations.

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.

Bibliography

Adey P.S. and Halen W. 1986. A Piagetian Analysis of Process Skill Test Items. *Journal of Research in Science Education*, 25(8): 707-726.

Ary D.; Jacobs L.C. and Razavieh A. 1990. *Introduction to Research in Education*. Fort Worth: Harcourt Brace College.

ASCD Update 1994. Outcomes-Based Education Comes Under Attack. *ASCD Update.* 36(3): 1-8.

Bailey P. 1987. What are Geographer's Contributions? Geography in the Curriculum from 9 to 19. In Bailey P. Binns J. A. (eds). *A case for Geography.* Geographical Association: Sheffield.

Bale J. 1983. Welfare Approaches to Geography. In Huckle J. (ed). *Geographical Education: Reflection and Action*. Oxford: Oxford University Press.

Ballantyne R.R. 1986. Change in Secondary School Geography Education: Teacher Attitude and Practices. Unpublished PhD Thesis. Cape Town: University of Cape Town.

Ballantyne R.R. 1987/1988. Graves' Typology and Geography in South African Secondary Schools. *South African Geographer*, 15(1 / 2): 109-115.

Ballantyne R.R. 1989/1990. Cultural Background and the Nature of Geography Education in South Africa. *South African Geographer*, 17 (1 \ 2): 124-128.

Bamber C. and Ranger G. 1990. Values Enquiry in Practice: Investigating a Local Controversial Issue. *Teaching Geography*, 15(2): 60-62.

Baron M. A. and Boschee F. 1994. OBE: Some Answers for the Uninitiated. *The Clearing House*, 67(4): 193-196.

Bartlett L. 1982. Systems in Teaching Geography. *Teaching Geography*, 8(2): 65-69.

Bateman W.L. 1990. *Open to Question: The Art of Teaching and Learning by Inquiry.* San Francisco: Jossey-Bass.

Battersby J. 1992. Differentiation in teaching and Learning Geography. in Tilbury D. and Williams. (eds). *Teaching and Learning Geography.* London: Routledge.

Biehler R. F. and Snowman J. 1993. *Psychology Applied to Teaching.* Boston: Houghton Mifflin Company.

Black T. R. 1999. *Doing Qualitative Research in the Social Sciences: An Integrated Approach to Research Design, Measurement and Statistics.* London: Sage.

Blackbeard A.D 1992. *Mapwork Made Easy: A Handbook for Geography Students Standards 8 to 10*. Pietermaritzburg: Heinemann-centaur.

Bloom B.S. 1984. The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. *Educational Leadership*, 4-17.

Boniface D.R. 1995. *Experimental Design and Statistical Methods for Behavioural and Social Research*. London: Chapman and Hall.

Bonville W. 1996. Outcome- Based Education: A White Knight to the Rescue or A Disaster in the Making. *CSD Internet*, www.new-jerusalem.com/education/whatisOBE.html,1-9.

Borg W. R. 1981. *Applying Educational Research: A Practical Guide for Teachers*. New York: Longman

Borg W.R. and Gall M.D. 1989. *Educational Research: An Introduction*. New York: Longman.

Boqwana E.P. 1991. Fieldwork as A Compensatory Teaching Strategy for Rural Black Senior Secondary Schools. Unpublished M Ed Dissertation. Grahamstown: Rhodes University.

Brandt R. 1994. Overview: Is Outcome-based Education Dead? *Educational Leadership*, 51(6): 1.

Brotherton P.N. and Preece P.F.W. 1995. Science Process Skills: their Nature and Interrelationships. *Research in Science and Technological Education*. 13(1): 5 - 11.

Burron A. 1994. Traditionalist Christians and OBE: What is the Problem? *Educational Leadership*, 51(6): 73-75.

Campbell R.L. and Okey J.R. 1977. Influencing the Planning of Teachers with Instruction in Science Process Skills. *Journal of Research in Science Teaching*, 14(3): 231-234.

Carin A. A. 1997. *Guided Discovery Activities for Elementary School Science*. Upper Saddle River: Prentice-Hall.

Carin A.A. and Sund R.B. 1989. *Teaching Modern Science*. Columbus: Merril.

Carstens A 1991. *Geographical Concepts*. Department of Geographical Sciences. Pretoria: Vista University.

Chapman J.D. 1966. The Status of Geography. *Canadian Geographer*, 10(3): 133-144.

Christie P. and Collins C. 1984. Bantu Education: Apartheid Ideology and Labour Reproduction. In Kallaway P. (ed). *Apartheid Ideology and Education: The Education of Black South Africans*. Johannesburg: Ravan.

Constitution of the Republic of South Africa. 1996. Pretoria: Government Printer.

Cox B. 1984. Making Inquiries Work in the Geography Classroom. In Fien J.; Gerber R. and Wilson P. (eds). *The Geography Teacher's Guide to the Classroom.* South Melbourne: MacMillan.

Davies D.H. 1987/1988. School Geography: A University Perspective. *South African Geographer,* 15(1 / 2): 116-126.

De Souza A. R. 1992. and Munroe S. 1994. Implementation of Geography Standards: Potential Strategies and Initiatives. *Journal of Geography,* 93(1): 46-49.

Dembo M. H. 1991. *Applying Educational Psychology in the Classroom.* New York: Longman.

Department of Education. 1997a. *Lifelong Learning for the 21st Century.* Pretoria: Government Printer.

Department of Education 1997b. *Outcomes-based Education in South Africa: Background Information for Educators.* Pretoria: Government Printer.

Department of Education. 1997c. *Curriculum 2005: Specific Outcomes, Assessment Criteria, Range Statements. Grades 1 to 9.* Pretoria: Government Printer.

Department of Education. 2001a. *Draft Revised National Curriculum Statement for Grades R-9 (Schools): Overview.* Pretoria: Government Printer.

Department of Education. 2001b. *Draft Revised National Curriculum Statement for Grades R-9 (Schools): Natural Sciences*. Pretoria: Government Printer.

Donald D.; Lazarus S. and Lolwana P. 1997. *Educational Psychology in Social Context: Challenges of Development, Social Issues, & Special Need in Southern Africa*. Cape Town: Oxford University Press.

Dreckmeyr M.; Maarschalk J. and McFarlane L. R. 1994. *Successful Physical Science Teaching*. Pretoria: Kagiso Tertiary.

Education and Training Act. 1995. Pretoria: Department of Education.

Eggen P.D. and Kauchak D.P. 1988. *Strategies for Teachers: Teaching Content and Thinking Skills*. Englewood Cliffs: Prentice Hall.

Eggen P. and Kauchak D. 1997. *Educational Psychology: Windows on Classrooms*. New Jersey: Merrill.

Esler W.K. and Esler M. K. 1981. *Teaching Elementary Science*. Belmont: Wadsworth.

Farrant J.S. 1988. *Principles and Practice of Education*. Singapore: Longman.

Feibleman J.K. 1972. *Scientific Method: The Hypothetic-Experimental Laboratory Procedure of the Physical Sciences*. The Hague: Martinus Nijhoff.

Fien J 1983. Humanistic Geography. In Huckle J. (ed). *Geographical Education: Reflection and Action*. London: Oxford University Press.

Fien J., Gerber R. and Wilson P. 1984. (eds). *The Geography Teacher's Guide to the Classroom*. South Melbourne: Macmillan.

Fraenkel J.R. and Wallen N. E. 1993. *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Fraenkel J.R. and Wallen N. E. 1996. *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Fraser W.J. 1999. *The Foundations of Continuous Assessment: Its Link to Performance-Based, Authentic, Competence-Based and Outcome-Based Assessment*. Facullty of Education. Pretoria: University of Pretoria.

Friedl A. E. 1991. *Teaching Science to Children: An Integrated Approach*. New York: McGraw-Hill.

Funk H.J.; Fiel R.L.; Okey J.R.; Jaus H.H. and Sprague C.S. 1979. *Learning Science Process Skills*. Iowa: Kendall/Hunt.

Gay L.R. 1987. *Educational Research: Competencies for Analysis and Application*. Columbus: Merrill.

Gay L.R. 1992. *Educational Research: Competencies for Analysis* and *Application*. Columbus: Merrill.

Gay L.R. and Airasian P. 2000. *Educational Research: Competencies for Analysis and Application*. Upper Saddle River: Merrill.

Good T.L. and Brophy J. 1995. *Contemporary Educational Psychology*. New York: Longman.

Graves N. 1992. Geographical Education in the 1990s. in Tilbury D. and Williams. (eds). *Teaching and Learning Geography*. London: Routledge.

Graves N. and Moore T. 1972. The Nature of Geographical Knowledge. in Graves N. (ed). *New Movements in the Study and Teaching of Geography*. London: Temple Smith.

Greasely B.; Ranger G.; Winter C. and Williamson E. 1992. *Enquiry Geography: Teacher's Resource Pack* 2. Kent: St Edmundsburg.

Guideline Document and Interim Syllabus for Geography Grades 10 to 12. 1996. Bloemfontein. Department of Education and Culture, Free State.

Harber C. 1989. *Politics in African Education*. London: Macmillan. HarperCollins.

Hartshorne K. 1989. The State, Democracy and the Education of Black South Africans. in *Politics and Education*. Human Science Research Council. Pretoria: Human Science Research Council. Education Report. Programme № 16.

Hartshorne K. 1992. *Crisis and challenge: Black Education in 1910 - 1990*. Cape Town: Oxford University Press.

Hassard J. 1992. *Minds on Science: Middle and Secondary School Methods*. New York: HarperCollins.

Hawley D. 1992. Cross-curricular Concerns in Geography: Earth Science and Physical Geography. in Tilbury D. and Williams. (eds). *Teaching and Learning Geography*. London: Routledge.

Hill A.D. 1994. Geography Instructional Materials for Standards-Based Education. *Journal of Geography*, 93(1): 14-20.

Hofmeyr J. and Buckland P. 1992. Education System in South Africa. in McGregor Robin and Anne. (eds). *McGregor's Education Alternatives*. Kenwyn: Juta.

Howell D.C. 1999. *Fundamental Statistics for the Behavioural Sciences*. Pacific Grove: Duxbury.

Hurry L.B.; Hart G.H.T. and de Montille S. 1991. *Exploring Geography Standard 9*. Hatfield: Via Afrika.

Inhelder B. and Piaget J. 1958. *The Growth of Logical Thinking from Childhood to Adolescence: An Essay on The Construction of Formal Operational Structure*. New York: Basic Books.

Inhelder B. and Piaget J. 1964. *The Early Growth of Logic in The Child: Classification and Seriation*. London: Routledge and Kegan Paul.

Inhelder B. ; Sinclair H. and Bovet M. 1974. *Learning and The Development of Cognition*. London: Routledge and Kagan Paul.

International Charter on Geographical Education. 1992. *Commission on Geographical Education*. International Geographical Union.

James P.E. 1969.The Significance of Geography in American Education. *The Journal of Geography*, 54: 473-480.

Jansen J.D. 1997. *Why OBE will Fail.* Faculty of Education. Durban: University of Durban Westville.

Jaus H.H. The Effects of Integrated Science Process Skills Instruction on Changing Teacher Achievement and Planning Practices. *Journal of Research in Science Teaching*, 12:(4): 423-447.

Jenkins E.W. 1989. Processes in Science Education: An Historical Perspective. in Wellington J. (ed). *Skills and Processes in Science Education: A Critical Analysis*. London: Routledge.

Joyce B. and Weil M. 1986. *Models of Teaching*. Englewood Cliffs: Prentice-Hall.

Kallaway P. 1984. *Apartheid Ideology and Education: The Education of Black South African*. Johannesburg: Ravan.

Kidder L.H. and Judd C.M. 1991. *Research Methods in Social Relations*. New York: Holt, Rinehart and Wiston.

Killen R. 1998. *An Australian Perspective on Outcome-Based Education. A Paper Presented at the OBE Conference*. Pretoria: Vista University.

Killen R. 1999. *Outcomes-Based Education in South African: Some Guidelines for Programming*. Unpublished Manuscript. University of Newcastle, Australia.

King J.E. and Evans K.M. 1991. Can We Achieve Outcome-Based Education? *Educational Leadership*, 49(2): 67-72.

Kohn C.F. 1982. Looking Back; Working Ahead. *Journal of Geography*, 81(2): 44-46.

Kok A. and Woolnough B.E. 1994. Science Process Skills: Are They Generalisable? *Research in Science and Technological Education*, 12(1): 31 - 42.

Koul L. 1977. *Methodology of Educational Research*. New Delhi: Vikas.

Lambert D. and Balderstone D. 2000. *Learning to Teach Geography in the Secondary School: A Companion to School Experience*. New York: RoutledgeFalmer.

Langenbach M.; Vaughn C. and Aagaard L. 1994. *An Introduction to Educational Research*. Boston: Allyn and Bacon.

Laws K. 1984. Teaching the Gifted Student in Geography. In Fien J.; Gerber R. and Wilson P. (eds). *The Geography Teachers Guide to the Classroom*. South Melbourne: Macmillan.

Ledger R.H. 1978. The 'New' Geography in South African High School Teaching. Unpublished M. A. Dissertation. Cape Town: University of Cape Town.

Leedy P. D. 1993. *Practical Research: Planning and Design*. New York: Macmillan.

Levy B.H. 1984. Geographical Teaching in South Africa for Whites (1800-1980). Unpublished M Ed Dissertation. Johannesburg: University of Witwatersrand.

Liebenberg E.C. 1986. *Techniques for Geographers: Book 1*. Durban: Butterworths.

Magi L. M. 1990. *Geography and Society: The Site of Struggle*. KwaDlangezwa: University of Zululand Press.

Magi L.M. 1981. Black University Geography Students' Perception of School Geography and the Geography Teacher. *South African Geographer*, 9(2): 145 - 153.

Mahlangu D.M.D. 1987. *Educational Research Methodology*. Pretoria: De Jager - Haum.

Malan B. 1997. *Excellence through Outcomes*. Pretoria: Kagiso.

Manno B. V. 1995. The New School Wars: Battles Over Outcome-Based Education. *Phi Delta Kappan*, 76(9): 720-726.

Maree L. 1984. The Hearts and Mind of the People. In Kallaway P. (ed). *Apartheid Ideology and Education: The Education of Black South Africans*. Johannesburg: Ravan.

Marran J.F. 1994. Discovering Innovative Curricular Models for School Geography. *Journal for Geography*, 93(1): 7-10.

Martin R.E.; Sexton C.; Wagner K. and Gerlovich J. 1994. *Teaching Science for All Children*. Boston: Allyn and Bacon.

Mattheis F.E., Spooner W.E., Coble C.R., Takemura S., Matsumoto S., Matsumoto K. and Yoshida A. 1992. A Study of the Logical Thinking and Integrated Process Skills of Junior High School Students in North Carolina and Japan. *Science Education*, 76(2): 211-222.

McBurney D.H. 1994. *Research Methods*. Pacific Grove: Brooks/Cole.

McCown R.; Driscoll M. and Roop P. G. 1996. *Educational Psychology: A Learning - Centred Approach to Classroom Practice*. Boston: Allyn and Bacon.

McGhan B. 1994. The Possible Outcomes of Outcome-Based Education. *Educational Leadership*. 5(6): 70-72.

McGregor Robin and Anne. (eds). 1992. *McGregor's Education Alternatives*. Kenwyn: Juta.

McMillan J.H. and Schumacher S. 1993. *Research in Education: A Conceptual Introduction*. New York: HarperCollins.

McMillan J.H. and Schumacher S. 1997. *Research in Education: A Conceptual Introduction*. New York: HarperCollins.

Mhlongo R. 1996. The Development of Observational and Allied Skills in the Teaching - Learning of Natural Sciences. Unpublished D Ed Thesis. Pretoria: University of South Africa.

Millar R. 1989. What is `Scientific Method' and can it be Taught? in Wellington J. (ed). *Skills and Processes in Science Education: A Critical Analysis*. London: Routledge.

Millar R. 1991. A Means to an End: The Role of Processes in Science Education. in Woolnough B. *Practical Science: The Role and Reality of Practical Work in School Science*. Buckingham: Open University Press.

Millar R. and Driver R. 1987. Beyond Processes. *Studies in Science Education*, 14: 33-62.

Motseke M.J. 1998. Factors Contributing to Teacher Stress in Township Secondary Schools. Unpublished M Ed Dissertation. Pretoria: University of South Africa.

Mphaphuli S.E. 1992. A Search for Educational Relevance: An Investigation into the Teaching of the Rural Settlement Component of the Secondary School Syllabus with Special Reference to Venda. Unpublished M Ed Dissertation. Grahamstown: Rhodes University.

Mulder J.C. 1986. *Statistical Techniques in Education*. Pretoria: Kagiso Tertiary.

Mwamwenda T.S.1995. *Educational Psychology: An African Perspective*. Durban: Butterworths.

Naicker S.G. 1999. *Curriculum 2005: A Space for All: An Introduction to Inclusive Education*. Cape Town: Renaissance.

Naish M. 1997. The Scope of School Geography: A Medium for Education. In Tilbury D. and Williams M. (eds). *Teaching and Learning Geography*. London: Routledge.

Nakayama S. 1995/1996. The New Era of Geography Education in Japan. *International Journal of Social Education*, 10(2): 22-26.

Nicol I.G. 1979. The Evaluation of High School Geography. *South African Geographer*, 7(1): 70-79.

O' Neil J. 1994. Aiming for New Outcomes: The Promise and the Reality. *Educational Leadership*, 5(6): 6-10.

Padia M.J., Okey J.R. and Garrard K. 1984. The Effects of Instruction on Integrated Science Process Skill Achievement. *Journal of Research in Science Teaching*, 21(3): 227 - 287.

Parkison J. 1994. *The Effective Teaching of Secondary Science*. London: New York.

Piaget J. 1929. *The Child Conception of The World*. London: Granada.

Piaget J. 1952. *The Origin of Intelligence in Children*. New York: International Universities Press.

Piaget J. 1964. *Six Psychological Studies*. Brighton: The Harvester Press.

Piaget J. 1972. *Psychology and Epistemology: Towards a Theory of Knowledge*. Hamondsworth: Penguin Books.

Piaget J. 1980. *Language Learning: The Debate between Jean Piaget and Noan Chomsky*. Cambridge: Harvard University Press.

Piaget J. 1981. *Intelligence and Affectivity: Their Relationship during Child Development*. Palo Alto: Annual Review Monographs.

Piaget J. and Inhelder B. 1969. *The Psychology of The Child*. London: Routledge and Kegan Paul.

Pick W. and Renwick 1984. Teaching the Less Able Student in Geography. In Fien J.; Gerber R.: and Wilson P. *The Geography Teachers Guide to the Classroom*. South Melbourne: Macmillan.

Pressley M. and McCormick C. B. 1995. *Cognition, Teaching, and Assessment*. New York:

Pretorius F.P. 1998. The System of Education and Training. In Pretorius F. and Lemmer E. M. (eds). *South African Education and Training: Transition in a Democratic Era*. Johannesburg: Hodder & Stoughton.

Proctor N. 1987. Concepts or Skills? - A Question of Focus. *Teaching Geography*, 12 (5): 224-225.

Race K. E. H. and Planek T. W. 1992. Modified Scree Test: Further Considerations on Its Application to Delphi Study Data. *Evaluation Review*, 16(2): 171-183.

Radford D.L. 1988. *Integrating Process Skills Instruction into the Traditional Science Curriculum*. Paper Presented at the annual meeting of the National Association for Research in Science Teaching.

Rakow S.J. 1985. Prediction of the Science Inquiry Skill of Seventeen-year-olds: A Test of the Model of Educational Productivity. *Journal of Research in Science Teaching*, 289-302.

Rambuda A.M. 1994. Geography Teachers' Attitude and Practice in Secondary Schools in Venda. Unpublished M Ed Dissertation. Cape Town: University of Cape Town.

Ranby P. 1994. *New Ventures in Geography Standard 6.* Manzini: Macmillan Boleswa

Rawling E.M. 1992. The Making of a National Curriculum. *Geography*, 77(4): 292-309.

Rezba R.J.; Sprague C.; Fiel R.L.; Funk H.J.; Okey J.R. and Jaus H.H. 1995. *Learning and Assessing Science Process Skills*. Dubuque: Kendall/Hunt.

Riley J.P. 1979. The Influence of Hand-on Science Process Training on Preservice Teachers' Acquisition of Process Skills and Attitude toward Science Teaching. *Journal of Research in Science Teaching*, 16(5): 373-384.

Roberts M. 1992. Curriculum Planning and Course Development:: A matter of Professional Judgement. in Tilbury D. and Williams. (eds). *Teaching and Learning Geography.* London: Routledge.

Rowntree D. 1981. *Statistics without Tears: A Primer for Non-Mathematicians*. Harmondsworth: Penguin Books.

Salter K. and Rigg-Salter C. 1993. Yet Another Perspective on Educational Reform: Ten Verities. *Journal of Geography*, 92: 154-155.

SAS User's Guide: Statistics, Version 5 Edition. 1985. Cary: SAS Institute Inc.

Sauvain P. 1989. *Skills for Geography.* Leckhampton: Stanley Thomas.

Schlafly P. 1993. *What is Wrong with Outcome-Based Education?* The Phyllis Schlafly Report, www.eagleforum.org/psr/1993/psrmay93.html, 1-8.

Scott D. 1996. Methods and Data in Educational Research. In Scott D. and Usher R. (eds). *Understanding Educational Research.* London: Routledge.

Selaledi D.K. 1997. Teachers' Sense of Efficacy in Schools in the Major Urban Centres of the Free State Province after May 10, 1994. Unpublished PhD Thesis. Pretoria: Vista University.

Shortle D. 1975. Geography as a Discipline of Knowledge: Some Curriculum Implication. *Geographical Education*, 2: 281-303.

Slavin R. E. 1997. *Educational Psychology: Theory and Practice.* Boston: Allyn and Bacon.

Smit M.J. and van der Merwe A.J. 1992/1993. A Short Communication: The International Charter on Geographical Education. *South African Geographer.* 20(1 / 2): 148-151.

Spady W.G. 1988. Organizing for Results: The Basis of Authentic Restructuring and Reform. *Educational Leadership*, 46(2): 4-8.

Spady W.G. 1994a. Choosing Outcomes of Significance. *Educational Leadership*, 51(6): 18-22.

Spady W.G. 1994b. *Outcomes-Based Education: Critical Issues and Answers*. American Association of School Administrators.

Spady W. and Schlebusch A. 1999. *Curriculum 2005: A Guide for Parents*. Cape Town: Renaissance.

Stenhouse L. 1975. *An Introduction to Curriculum Research and Development*. London: Heinemann.

Strawitz B.M. 1989. The Effects of Testing on Science Process Skills Achievement. *Journal of Research in Science Teaching*, 26(8): 659-664.

Swain J.R.L. 1989. Innovations and Developments: The Development of a Framework for the Assessment of Process Skills in a Graded Assessments in Science Projects. *International Journal of Science Education*, 11(3): 251-259.

Swanevelder C.J.; van Huyssteen M.K.R. and Kotze J.C. 1987. *Senior Geography Standard 10*. Cape Town: Nassou.

Swanevelder C.J.; Kotze J.C. and Roos T.J. 1986. *Senior Geography Standard 9*. Cape Town: Nassou.

Swanevelder C.J.; van Huyssteen M.K.R. and Kotze J.C. 1987. *Senior Geography Standard 10.* Cape Town: Nassou.

Swanevelder C.J.; van Kradenburg L.P. and Hatting L.L. 1985a. *Senior Geography Standard 8.* Cape Town: Nassou.

Swanevelder C.J.; Kotze J.C. and Myburgh D.W. 1985b. *Junior Geography Standard 7.* Cape Town: Nassou.

Swanevelder C.J.; Kotze J.C. and van Kradenburg L.P. 1985c. *Junior Geography Standard 6.* Cape Town: Nassou.

Teaching Geography. 1995. International Charter on Geographical Education. *Teaching Geography*, 20(2): 95-99.

Trowbridge L.W. and Bybee R.W. 1990. *Becoming a Secondary School Science Teacher.* New York: Macmillan.

Trüper M. and Hustedde M. 1990. Geography Education in West German High School: Do Fours Make a Difference? *Journal of Geography*, 84(3): 109-112.

Unwin T. 1992. *The Place of Geography.* London: Longman.

Vakalisa N.C.G. 1996. Participative Teaching. In Jacobs M. and Gawe N. (eds). *Teaching - Learning Dynamics: A Participative Approach*. Johannesburg: Heinemann.

Van Aswegen S.; Fraser W.; Nortje T.; Slabbert J. and Kaske C. 1993. *Biology Teaching: An Information and Study Manual for Students and Teachers*. Pretoria: Acacia.

Van Dalen D.B. 1979. *Understanding Educational Research: An Introduction*. New York: McGraw-Hill.

Van der Horst H. and McDonald R. 1997. *Outcomes-based Education: A Teachers Manual*. Pretoria: Kagiso.

Verma G. K. and Mallick K. 1999. *Researching Education: Perspectives and Techniques*. London: Falmer Press.

Vilakati S.S. and McLeod G. 1994. *Practical skills and Model Answers in Geography*. Manzini: Macmillan.

Waugh D. 1990. *Geography: an Integrated Approach*. Surrey: Nelson.

Wellington J. 1989. Skills and Process in Science Education: An Introduction. in Wellington J. (ed). *Skills and Processes in Science Education: A Critical Analysis*. London: Routledge.

Wessels M. and Van der Berg R. 1998. *Practical Guide to Facilitating Language Learning: Methods, Activities, and Techniques for OBE*. Johannesburg: International Thomson Publishing.

Wiegand P. and Galbraith I. 1988. *Landforms: An Introduction to Geomorphology*. Oxford: Oxford University Press.

Winter K. 1992. Inquiry Learning in Geography Education. *South African Geographer*, 19(1/2): 141 - 145.

Wolfinger D. M. 1984. *Teaching Science in the Elementary School: Content, Process, and Attitude*. Boston: Little, Brown and Company.

Zeitler W.R. 1981. The Influence of the Type of Practice in Acquiring Process Skills. *Journal of Research in Science Teaching*, 18(3): 189-197.

Zeitler W. R. and Barufaldi J. P. 1988. *Elementary School Science: a Perspective for Teachers*. New York: Longman.

Zitterkopf R. 1994. A Fundamentalist's Defence of OBE. *Educational Leadership*, 51(6): 76-78.

APPENDIX 1

GUIDELINE DOCUMENT AND INTERIM SYLLABUS FOR GEOGRAPHY FOR GRADES 10, 11 AND 12

DEPARTMENT OF EDUCATION AND CULTURE

FREE STATE

GUIDELINE DOCUMENT

AND

INTERIM SYLLABUS

FOR

GEOGRAPHY

GRADES 10 TO 12

IMPLEMENTATION DATE
1996
GRADES 10 TO 12

GEOGRAPHY

GRADES 10 TO 12

1 PRINCIPLES ON WHICH THE SYLLABUS IS BASED

1.1 Nature of Geography

Geography as a subject has many areas of overlap with other subjects, in both the natural and the social fields of study. This syllabus takes into account the essential nature of Geography. It ensures that:

1.1.1 The four major traditions in geography are upheld. These are:

- human-land relationships;
- the spatial perspective;
- the regional viewpoint;
- the earth-science component;

1.1.2 a balance is maintained between Physical Geography and Human Geography;

1.1.3 provision is made for both the theoretical and the practical aspects of the subject;

1.1.4 sufficient flexibility exists to allow for the changing nature of the subject.

1.2 General education of the pupil

Education is concerned with the development of the "whole being", and not merely with imparting knowledge.

1.2.1 The most important aims, in the long term, are for pupils to:

- acquire and develop intellectual skills and abilities which will promote on-going education;
- adjust to a society that is undergoing rapid and far-reaching social, economic

and political changes;

- enter the world-of-work that is becoming increasingly more technologically orientated;

- develop their moral and emotional (affective) attributes.

1.2.2 The teaching of Geography should be neither specifically vocationally orientated nor entirely university orientated. The syllabus should provide for two groups of pupils:

- those who will receive no further instruction in the subject; and

- those who will continue with the study of Geography at a tertiary level.

1.2.3 Although the syllabus is divided into a Junior Secondary Phase and a Senior Secondary Phase, the two phases must be related and must allow for the progressive development of geographical knowledge, skills and attitudes.

2 OBJECTIVES

- In lesson preparation teachers should bear in mind the higher abilities of comprehension, analysis, application, synthesis and evaluation.

- This subject should be taught in such a way that pupils develop an eagerness for further study and individual inquiry.

- Teachers should we aware of the contribution Geography is making to the general education of the pupil. It is this awareness that gives direction to day-to-day teaching.

- Objectives should be meaningful to pupils and teachers alike, and must constitute both realistic and achievable targets.

- The type and number of short-term objectives in Geography are numerous: those selected for a lesson should be closely correlated with the nature of the subject matter and the resources available to the teacher.

Objectives can be classified into four main categories:

2.1 Knowledge

2.1.1 Pupils should acquire a fundamental body of knowledge which is meaningful and useful to them and which can be applied and reproduced in whatever form is required.

2.1.2 Pupils should recognise the unity of knowledge through the links that Geography has with other subjects.

2.2 Skills

2.2.1 No list of skills can be complete. The following should, however, be kept in mind:

- The importance attached to different skills should be related to the abilities and maturity of the pupils.
- The development of skills should enable pupils to deal with knowledge in an organised manner.
- Pupils should gain proficiency in the use of skills through repetition and the application of these skills to new situations.

2.2.2 Geography can make particular contribution to the following skills:

- Oracy and literacy : thinking logically, writing concisely, speaking with assurance and accuracy;
- Numeracy: introduce with simple statistical methods, graphs and tables;
- Graphicacy: the ability to draw, read and interpret;
- Interpretation : of pictures, photographs, statistics and maps;
- Fieldwork techniques : using either the traditional (survey) or the scientific approach.

2.3 PERCEPTION

The way in which the environment is "perceived" in reaction to the "actual" environment influences the pupil's concept of space (spatital conceptualization).

2.3.1 In order to heighten the pupils' perception of their environment, it is necessary for them to :

- recognise the relationships that exist between people and their environment;
- identify spatial patterns, spatial relationships and interaction. (This is closely linked with an understanding of location, distance and accessibility);
- be aware of the underlying processes which act upon spatial patterns and relationships and which bring about change;
- be aware of the world's place-to-place variety; to recognise the uniqueness of place.

2.3.2 Many studies require pupils to examine the spatial aspects of social and economic problems. Such studies provide opportunities for pupils to respond to problem solving and decision-making situations through critical divergent and creative thinking.

2.4 APPRAISAL

2.4.1 Studies in Geography should promote the formation and reinforcement of positive attitudes and values.

- This is an affective objective, because without appealing to the emotions and without sufficient motivation, learning seldom takes place.

2.4.2 Pupils need to develop a social awareness. This means that they are expected to:

- recognise the interdependence of people;
- acquire a tolerant attitudes towards others with different social, economic and political circumstances.

2.4.3 Pupils need to develop an environmental awareness. They need to feel a commitment towards the environment by development a "caring attitude". This means they are expected to :

- recognise the need for conservation;
- understand that the balance of nature is largely dependent on peoples' wise management of their environment.

They should be aware of how people use/abuse their environment, particularly the resources available to them; the options and constraints that are placed on their actions.

- Realise that quality of life is influenced by the aesthetic aspects of peoples' environment as well as by an appreciation of the grandeur and wonder of creation.

3 TEACHING GUIDELINES

3.1 Teaching approaches

Teachers should make every effort to create effective learning experiences for their pupils. Whatever teaching approach is used, it is essential to develop a sense of reality in the teaching situation.

3.1.1 The holistic of global approach

- It is particularly important that the components of the syllabus are viewed as parts of a whole and not as isolated compartments of knowledge.
- The divisions of the syllabus should merely be regarded as a convenient means of grouping the characteristics of the individual components.
- Wherever possible, the relationship and interaction between components should be stressed.

3.1.2 The descriptive versus the problem-solving approach

- Although there is still room for some of the descriptive techniques of traditional Geography, emphasis should be given to a more problem-orientated skills-based approach.

- Pupils should gain insight into the process of decision-making by participating in exercises such as simulation and games.

3.1.3 The systems approach

- It is recommended that teachers introduce the concept of systems into their teaching.
- Pupils should be aware that Geography encompasses the study of a very complex human-environmental ecosystem. This complex system is broken down into a number of sub-systems to facilitate its study.
- Several components of the syllabus could be taught as sub-systems such as those associated with weather, drainage and urban sub-systems.

3.1.4 The inter-disciplinary approach

- Concepts studies in Geography may overlap with those of other subjects such as Biology, Science and Economics.
- Interdisciplinary studies should form part of the broad teaching strategy. This will enhance the value of both the learning content and the learning objectives.

3.1.5 The scientific approach

- Pupils should be trained in the scientific method of inquiry (statement of hypothesis, followed by the collection and classification of information, and finally the testing of the hypothesis).

3.2 Teaching techniques

It is recommended that, where appropriate, teachers should:

3.2.1 Integrate the reading and analysis of photographs, statistics and maps with the relevant sections of the syllabus. This includes:

- photographs : vertical, oblique and horizontal (i.e. aerial and ordinary);

- statistics: appropriate statistical geographical data;

- maps : such as wall, atlas, topographic maps of Southern Africa (particularly the 1:50 000 SA series) and municipal maps of the local area.

3.2.2 Ensure the pupils become competent in the use of various measuring instruments and other apparatus.

3.2.3 Make use of diagrammatic representation of statistics. For example, climatic figures, economic data and population characteristics can be illustrated by means of line graphs, columns, rectangles, circle segments, dots, colour, pictorial diagrams and isolines.

3.2.4 Introduce quantitative techniques such as means, deviations (range), simple correlations, scattergrams, regression lines and probabilities. Emphasis should be on understanding what the different techniques reflect. Complicated calculations and constructions are not required.

3.2.5 Refer to models. These include:

- Theoretical models (such as urban and economic models) which need to be tested against the real world. These enable Geography to be studies by means of a more problem-orientated approach.

- Physical models (such as globes, tellurions, papermaché and sand-tray models) which provide effective representations of the real world.

3.2.6 Undertake well-planned and meaningful fieldwork:

- This includes observation and measurement in the filed and the recording and processing of data; the interpretation of written and graphic information.

3.2.7 Encourage individual and group research techniques:

- Pupil involvement, independent activity, initiative, creativity and independence should constantly be extended.

- Pupils should learn to rely on personal observation in the field (primary source) and to make use of secondary sources such as reference books, maps, photographs and diagrams, films, tapes and slides, as well as television, the ratio and the press.

- Pupils need to develop worthwhile, attitudes towards learning such as respect for evidence, a critical appraisal of reporting, a suspicion of simplistic explanations and a willingness to engage in rational discussion.

- Pupils need to distinguish between central issues of importance and peripheral issues.

NOTE : Pupils should undertake short, independent study topics throughout the year on work related to the requirements of the syllabus.

3.3 Differentiation

3.3.1 Teachers should not expect the same amount and quality of work from all pupils. Differences in ability must be taken into account. However,

- Layout of paper for the Higher Grade and the Standard Grade:

  SECTION A : PHYSICAL GEOGRAPHY

  TWO questions set, at least ONE must be answered.

  SECTION B : SETTLEMENT GEOGRAPHY

  TWO questions set, at least ONE must be answered.

  SECTION C : REGIONAL GEOGRAPHY

  THREE questions set, at least ONE must be answered

- COMBINED questions may be set in each section; for example, a question in Section A may comprise the Geomorphology, Ecology and Climatology components.

- HIGHER GRADE questions may either be SYSTEMATIC or of the COMPOSITE variety. A composite question in one section (e.g. Section A) may 'include aspects from one of both the other two sections (B and/or C), provided the marks allocated to aspects from other sections do not exceed

25 % of the total marks for the question.

- STANDARD GRADE emphasis should be on the SYSTEMATIC type of questions

4.4 Differentiation between Higher Grade and Standard Grade, for both internal and external papers, should be achieved through the type of questions set and on their mark allocation.

APPENDIX 2

GRADE 12 GEOGRAPHY LEARNERS' PERFORMANCE IN 1998 AND 1999 EXAMINATIONS IN THE FREE STATE PROVINCE

FREE STATE PROVINCIAL GOVERNMENT

Education

PO Box 521 • Bloemfontein • 9300 • South Africa
Examinations Subdirectorate • 50 Elizabeth Street • Bloemfontein
Tel. : +27 (0) 51 - 404 8000 • Fax : +27 (0) 51 – 4048262

Enquiries : Mrs E van Heerden
Reference no. :

Tel. : (051) 4048252
E-mail :

Mr AM Rambuda
PO Box 1881
Welkom
9460

LEARNERS' PERFORMANCE IN GEOGRAPHY

1. This office regrets to inform you that the only statistics we are able to supply you with are those for 1998 and 1999. If this office obtains earlier information, it will be provided to you.

YEAR	1998	1998	1999	1999
GRADE	HG	SG	HG	SG
% FAIL	49.64	48.7	70.91	55.38
% PASS	50.36	51.3	29.09	44.62

2. Hoping that you will find the information in order

Yours sincerely

HEAD: EDUCATION
DATE 2000.03.29

APPENDIX 3

GEOGRAPHY TEACHER QUESTIONNAIRE

University of Pretoria

RESEARCH ON THE APPLICATION OF SCIENCE PROCESS SKILLS

Dear geography teacher

I am a PhD research student enrolled at the University of Pretoria. I am involved in a project which is attempting to describe and explain the application of Science Process Skills to the teaching of geography at secondary schools in the Free State Province. Science Process Skills are activities that scientists like geographers do when they study and investigate problems. As such, the project will provide useful information which could be of a supportive nature to geography teachers in general and outcomes-based education in particular.

Attached is a questionnaire which attempts to gain information on inquiry teaching methods applied to geography teaching and learning. Inquiry teaching methods are teaching processes which contribute to learning processes involving the investigation of a question, a problem or an issue, in which the interrelationship between people and their environment is studied. This study assumes that the adoption of inquiry teaching and inquiry learning is likely to lead to the application of Science Process Skills to the teaching of geography. These skills may develop critical understanding of issues and the ability to solve problems.

The survey has the approval of Free State Education Department. The researcher will be grateful for your response and wishes to ensure that your response will remain completely confidential and anonymous.

Kindly answer by circling the appropriate number in the shaded area or write your answer in the shaded block provided.

For Example: 1 What is your gender?

Male	1
Female	2

After completing the questionnaire use the provided envelope to return it to me not later than 23 March 2000.

Thank you for your co-operation.

Mr Awelani Rambuda
Student

Prof WJ Fraser
Promoter

GEOGRAPHY TEACHER QUESTIONNAIRE

FOR OFFFICIAL USE ONLY

1 Questionnaire Type

2 Respondent Number

3 Card Number 1

4 Education District

FOR OFFICE USE ONLY

V1 [1] 1

V11 [| |] 2-4

V3 [1] 5

V4 [|] 6-7

PART ONE: PERSONAL DATA

5 What is your gender?

Male	1
Female	2

V5 [ ] 8

6 Did you take geography as a school subject to matric?

Yes	1
No	2

V6 [ ] 9

7 Did you specialise in geography at tertiary level?

Yes	1
No	2

V7 [ ] 10

PART TWO: EXPERIENCE IN THE TEACHING OF GEOGRAPHY

8 How many years of teaching experience do you have?

[ ]

V8 [|] 11-12

9 What is the highest grade do you teach geography?
[Mark ONE category only].

Grade 8	1
Grade 9	2
Grade 10	3
Grade 11	4
Grade 12	5
Other (Please Specify)	

V9 [ ] 13
V10 [ ] 14
V11 [ ] 15
V12 [ ] 16
V13 [ ] 17
V14 [|] 18-19

10 How long have you been teaching geography at school level?

Less than 5 years	1
5 years and over	2

V15 ☐ 20

11 Were you interested in teaching geography, on appointment at your present school?

Yes	1
No	2

V16 ☐ 21

12 Do you find geography easy to teach?

Yes	1
No	2

V17 ☐ 22

PART THREE: SCHOOL DETAILS

13 What is the location of your school? (Choose one only)

Rural	1
Urban	2

V18 ☐ 23

14 Which one of the following would classify your school?

Public	1
Independent	2
Farm	3
Church/Missionary	4
Mine	5
Other (Please Specify)	

V19 ☐☐ 24

PART FOUR: INQUIRY TEACHING METHOD

In the shaded areas below indicate the **degree** to which you **do** as described in the statement. Please respond by making a cross (X) over the number in the appropriate shaded block.

15 I focus on lessons involving exploration of important problems that can be investigated at many levels of difficulty.

Never	1	Sometimes	2	Often	3	Always	4

V20 ☐ 25

16 I use learning materials that stimulate learners' interest.

Never	1	Sometimes	2	Often	3	Always	4

V21 ☐ 26

17 I make available many different learning resources for learners' use.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V22 ☐ 27

18 My lessons present some problems that develop learners' thinking skills.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V23 ☐ 28

19 When I teach, the learners talk more than I do.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V24 ☐ 29

20 Learners are free to discuss their ideas in class.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V25 ☐ 30

21 When I talk, I "question, I do not "tell".

Never 1 | Sometimes 2 | Often 3 | Always 4 — V26 ☐ 31

22 I consciously use the ideas my learners' have raised in class.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V27 ☐ 32

23 I redirect learners' questions in such a way that learners are encouraged to arrive at their own answers.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V28 ☐ 33

24 I consciously base my questions on learners' ideas in class.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V29 ☐ 34

25 Learners are free to interchange their ideas in class.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V30 ☐ 35

26 I encourage the learners to evaluate if their arguments are relevant to the ideas being discussed.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V31 ☐ 36

27 My learners gain understanding in science process skills.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V32 ☐ 37

28 I encourage learners to investigate geographical problems.

Never 1	Sometimes 2	Often 3	Always 4	V33 ☐ 38

29 I emphasize learning, rather than classroom discipline when learners are engaged in groupwork activities.

Never 1	Sometimes 2	Often 3	Always 4	V34 ☐ 39

30 Class discussions are conducted in an orderly fashion that emphasizes courtesy and willingness to listen to each person's ideas.

Never 1	Sometimes 2	Often 3	Always 4	V35 ☐ 40

31 My learners gain practice in scientific process of acquiring knowledge

Never 1	Sometimes 2	Often 3	Always 4	V36 ☐ 41

32 I reward the free exchange of ideas in class.

Never 1	Sometimes 2	Often 3	Always 4	V37 ☐ 42

33 I allow learners to move freely in the classroom while they are engaged in groupwork activities.

Never 1	Sometimes 2	Often 3	Always 4	V38 ☐ 43

34 I encourage the testing of ideas in class.

Never 1	Sometimes 2	Often 3	Always 4	V39 ☐ 44

35 I avoid criticising ideas offered by learners in class.

Never 1	Sometimes 2	Often 3	Always 4	V40 ☐ 45

36 Each learner's contribution is considered important in class.

Never 1	Sometimes 2	Often 3	Always 4	V41 ☐ 46

37 I evaluate learners on growth in many aspects of the learning experience, rather than simply on the basis of facts required.

Never 1	Sometimes 2	Often 3	Always 4	V42 ☐ 47

38 All geographical topics are critically examined, not " taught" as closed issues with a single "correct" solution.

Never 1	Sometimes 2	Often 3	Always 4	V43 ☐ 48

39 Use of unfounded, emotionally charged language is minimized in guided didactic conversations.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V44 [ ] 49

40 I emphasize that values are permissable areas for discussion.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V45 [ ] 50

41 I allow for maximum learner use of learning materials.

Never 1 | Sometimes 2 | Often 3 | Always 4 — V46 [ ] 51

42 I play a low-key role in directing the learning experience of my learners

Never 1 | Sometimes 2 | Often 3 | Always 4 — V47 [ ] 52

43 What difficulties do you experience when developing inquiry teaching?

	V48	53
	V49	54
	V50	55
	V51	56
	V52	57

44 State how these difficulties can be solved.

	V53	58
	V54	59
	V55	60
	V56	61
	V57	62

45 What difficulties do your learners experience when they are involved in inquiry learning?

	V58	63
	V59	64
	V60	65
	V61	66
	V62	67

46 State how these difficulties can be solved.

	V63 ☐ 68
	V64 ☐ 69
	V65 ☐ 70
	V66 ☐ 71
	V67 ☐ 72

PART FIVE: SCIENCE PROCESS SKILLS

A: Basic Science Process Skills applied to the teaching of geography. Please respond to the following statements by making a cross (X) over the number in the appropriate shaded block.

47 I give my learners many opportunities to **identify** geographical important problems.

Never 1	Sometimes 2	Often 3	Always 4	V68 ☐ 73

48 I organize classroom activities in which learners **classify** the observed geographical features.

Never 1	Sometimes 2	Often 3	Always 4	V69 ☐ 74

49 I encourage learners to use any means to **communicate** learned information, i.e. to draw maps, charts, symbols, graphs and diagrams to **communicate** the information.

Never 1	Sometimes 2	Often 3	Always 4	V70 ☐ 75

50 I link the work in geography on **diagrams** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.

Never 1	Sometimes 2	Often 3	Always 4	V71 ☐ 76

51 I organize activities in which my learners **compare** objects using standardized units of measure and suitable measuring instruments.

Never 1	Sometimes 2	Often 3	Always 4	V72 ☐ 77

52 I organize my learners to **observe** geographical phenomena, such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.

Never 1	Sometimes 2	Often 3	Always 4	V73 ☐ 78

53 I encourage my learners to **predict** future geographical events based upon their observations.

Never 1	Sometimes 2	Often 3	Always 4	V74 [ ] 79

54 I encourage learners to use various forms of data to determine the **correctness of geographical theory**.

Never 1	Sometimes 2	Often 3	Always 4	V75 [ ] 80

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FOR OFFICE USE ONLY

55 Questionnaire Type	V76 [1] 1
56 Respondent Number	V77 [ ][ ][ ] 2-4
57 Card Number 2	V78 [2] 5
58 Education District	V79 [ ][ ] 6-7

59 I encourage my learners to **describe** a geographical feature's position in relation to other geographical features.

Never 1	Sometimes 2	Often 3	Always 4	V80 [ ] 11

60 I give my learners many opportunities to **observe** geographical important problems.

Never 1	Sometimes 2	Often 3	Always 4	V81 [ ] 9

61 I encourage learners to use any means to **communicate** investigated information.

Never 1	Sometimes 2	Often 3	Always 4	V82 [ ] 10

62 I link the work in geography on **graphs** to the everyday life of the learners, i.e. getting learners to bring examples from newspapers and magazines for discussion in class.

Never	1	Sometimes	2	Often	3	Always	4	V83	☐	11

63 I organize activities in which my learners arrange geographical features in logical **order** according to their structures.

Never	1	Sometimes	2	Often	3	Always	4	V84	☐	12

B: Integrated Science Process Skills applied to the teaching of geography. Please respond to the following statements by making a cross (X) over the number in the appropriate shaded block.

64 I encourage learners to **identify** variables that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity and cloud cover influence the occurrence of rainfall.

Never	1	Sometimes	2	Often	3	Always	4	V85	☐	13

65 I devise exercises in which my learners have to **construct tables of data**.

Never	1	Sometimes	2	Often	3	Always	4	V86	☐	14

66 I devise exercises in which learners have to **construct graphs**.

Never	1	Sometimes	2	Often	3	Always	4	V87	☐	15

67 I devise exercises in which my learners **conduct investigations**.

Never	1	Sometimes	2	Often	3	Always	4	V88	☐	16

68 I devise exercises in which my learners **identify the variables** under study.

Never	1	Sometimes	2	Often	3	Always	4	V89	☐	17

69 I give my learners geographical problems in which they are encouraged to **construct hypotheses.** *(A hypothesis is a tentative answer to a problem).*

Never	1	Sometimes	2	Often	3	Always	4	V90	☐	18

70 I give exercises in which my learners **define** geographical features by using observable characteristics of the features.

Never 1	Sometimes 2	Often 3	Always 4	V91 ☐ 19

71 I give my learners hypotheses and request them to **design investigations** to test the given hypotheses.

Never 1	Sometimes 2	Often 3	Always 4	V92 ☐ 20

72 I devise exercises in which learners have to **describe the relationship between variables** on a graph.

Never 1	Sometimes 2	Often 3	Always 4	V93 ☐ 21

73 State problems which you experience when **applying Science Process Skills** to the teaching of geography.

	V94 ☐ 22
	V95 ☐ 23
	V96 ☐ 24
	V97 ☐ 25
	V98 ☐ 26

74 State how these problems can be solved.

	V99 ☐ 27
	V100 ☐ 28
	V101 ☐ 29
	V102 ☐ 30
	V103 ☐ 31

THANK YOU FOR YOUR CO-OPERATION

If you have any queries regarding this study, please contact the researcher:

Mr Awelani Rambuda
P.O. Box 1881
WELKOM
9460

(057) 396 4112 X267 (W)

082 491 8014

e-mail address: RMBDA-AM@weasel.vista.ac.za

APPENDIX 4

GEOGRAPHY LEARNER QUESTIONNAIRE

University of Pretoria

RESEARCH ON THE APPLICATION OF SCIENCE PROCESS SKILLS

Dear geography learner

I am a PhD research student enrolled at the University of Pretoria. I am involved in a project which is attempting to describe and explain the application of Science Process Skills to the teaching of geography at secondary schools in the Free State Province. Science Process Skills are activities that scientists like geographers do when they study and investigate problems. As such, the project will provide useful information which could be of a supportive nature to geography teachers in general and outcomes-based education in particular.

Attached is a questionnaire which attempts to gain information on inquiry teaching methods applied to geography teaching and learning. Inquiry teaching methods are teaching processes which contribute to learning processes involving the investigation of a question, a problem or an issue, in which the interrelationship between people and their environment is studied. This study assumes that the adoption of inquiry teaching and inquiry learning is likely to lead to the application of Science Process Skills to the teaching of geography. These skills may develop critical understanding of issues and the ability to solve problems.

The survey has the approval of Free State Education Department. The researcher will be grateful for your response and wishes to ensure that your response will remain completely confidential and anonymous.

Kindly answer by circling the appropriate number in the shaded area or write your answer in the shaded block provided.

For Example: 1 What is your gender?

Male	1
Female	2

After completing the questionnaire hand it to your geography teacher who will then return it to me by 23 March 2000.

Thank you for your co-operation.

Mr Awelani Rambuda
Student

Prof WJ Fraser
Promoter

GEOGRAPHY LEARNER QUESTIONNAIRE

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		FOR OFFICE USE ONLY
1	Questionnaire Type	V1 [2] 1
2	Respondent Number	V2 [ ] 2-5
3	Card Number	V3 [1] 6
4	Education District	V4 [ ] 7-8

PART ONE: PERSONAL DATA

5 What is your gender?

Male	1
Female	2

V5 [ ] 9

6 What is your age in completed years?

[ ]

V6 [ ] 10-11

7 Indicate your present grade. (Choose ONE category only)

Grade 8	1
Grade 9	2
Grade 10	3
Grade 11	4
Grade 12	5

V7 [ ] 12

8 Do you find geography easy to learn?

Yes	1
No	2

V8 [ ] 13

PART TWO: SCHOOL DETAILS

9 What is the location of your school? (Choose ONE category only)

Rural	1
Urban	2

V9 [ ] 14

10 Which one of the following would classify your school best?

Public	1
Independent	2
Farm	3
Church/Missionary	4
Mine	5
Other (Please Specify)	

V10 [ ][ ] 15-16

PART THREE: INQUIRY TEACHING METHOD

In the shaded areas below indicate the degree to which you **agree** or **disagree** with the statement. Please respond by making a cross (X) over the number in the appropriate shaded block.

11 My geography teacher focuses on lessons involving the exploration of important problems that can be investigated at many levels of difficulty.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V11 [ ] 17

12 My geography teacher uses learning materials that stimulate my interest.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V12 [ ] 18

13 My geography teacher makes available many different learning resources for my use.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V13 [ ] 19

14 My geography teacher's lessons present some problems that develop my thinking skills.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V14 [ ] 20

15 When the lesson is in progress, I talk more than my geography teacher.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V15 [ ] 21

16 I am free to discuss my ideas with other learners in class.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V16 ☐ 22

17 When my geography teacher talks, (s)he "questions", (s)he does not "tell".

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V17 ☐ 23

18 My geography teacher consciously uses ideas I have raised in class.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V18 ☐ 24

19 My geography teacher redirects my questions in such a way that I am encouraged to arrive at my own answers.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V19 ☐ 25

20 My geography teacher consciously bases his/her questions on my ideas in class.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V20 ☐ 26

21 I am free to interchange my ideas with other learners in class.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V21 ☐ 27

22 My geography teacher encourages us to evaluate if our arguments are relevant to the ideas being discussed.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V22 ☐ 28

23 I gain understanding in the usage of science process skills.

Strongly Disagree 1 | Disagree 2 | Agree 3 | Strongly Agree 4

V23 ☐ 29

24 My geography teacher encourages us to investigate geographical phenomena.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V24 [ ] 30

25 My geography teacher emphasizes learning, rather than classroom discipline when we are engaged in groupwork activities.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V25 [ ] 31

26 Class discussions are conducted in an orderly fashion that emphasizes courtesy and willingness to listen to each person's ideas.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V26 [ ] 32

27 I gain practice in scientific processes of acquiring knowledge.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V27 [ ] 33

28 My geography teacher rewards free exchange of ideas in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V28 [ ] 34

29 My geography teacher allows us to move freely in the classroom while we are engaged in groupwork activities.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V29 [ ] 35

30 My geography teacher encourages the testing of ideas in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V30 [ ] 36

31 My geography teacher avoids criticising ideas offered by us in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V31 [ ] 37

32 Our contributions in discussions are considered important in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V32 ☐ 38

33 My geography teacher evaluates us on growth in many aspects of the learning experience, rather than simply on the basis of facts required.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V33 ☐ 39

34 All geographical topics are critically examined, not "taught as closed issues with a single "correct" solution.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V34 ☐ 40

35 Use of unfounded, emotionally charged language is minimized in guided didactic conversations.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V35 ☐ 41

36 My geography teacher emphasizes that values are permissable areas for discussion.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V36 ☐ 42

37 My geography teacher allows for my maximum use of learning materials.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V37 ☐ 43

38 My geography teacher plays a low-key role in directing my learning experience.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V38 ☐ 44

39 What problems does your geography teacher experience when (s)he develops inquiry teaching?

V39 [ ] 45
V40 [ ] 46
V41 [ ] 47
V42 [ ] 48
V43 [ ] 49

40 State how these difficulties can be solved.

V44 [ ] 50
V45 [ ] 51
V46 [ ] 52
V47 [ ] 53
V48 [ ] 54

41 What problems do you experience when you are involved in inquiry learning?

V49 [ ] 55
V50 [ ] 56
V51 [ ] 57
V52 [ ] 58
V53 [ ] 59

42 State how these problems can be solved.

V54 [ ] 60
V55 [ ] 61
V56 [ ] 62
V57 [ ] 63
V58 [ ] 64

PART FOUR: SCIENCE PROCESS SKILLS

A: **Basic Science Process Skills applied to the teaching of geography. Please respond to the following statements by making a cross (X) over the number in the appropriate shaded block.**

43 My geography teacher gives us many opportunities to **identify** geographical important problems.

Strongly Disagree	1	Disagree	2	Agree	3	Strongly Agree	4

V59 [ ] 65

44 My geography teacher organizes classroom activities in which we **classify** the observed geographical features.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V60 ☐ 66

45 My geography teacher encourages us to use any means to **communicate** learned information, i.e. to draw maps, charts, symbols, graphs, and diagrams to **communicate** the information.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V61 ☐ 67

46 My geography teacher links the work in geography on **diagrams** to our everyday life, i.e. getting us to bring examples from newspapers and magazines for discussion in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V62 ☐ 68

47 My geography teacher organizes activities in which we **compare** objects using standardized units of measure and suitable measuring instruments.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V63 ☐ 69

48 My geography teacher organizes us to **observe** geographical phenomena such as the maximum and minimum air temperatures, wind direction and speed, atmospheric pressure, relative humidity, amount and type of rainfall.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V64 ☐ 70

49 My geography teacher encourages us to **predict** future geographical events based upon our observations.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V65 ☐ 71

50 My geography teacher encourages us to use various forms of information to determine the **correctness of a geographical theory.**

Strongly Agree 1	Agree 2	Disagree 3	Strongly Disagree 4	V66 ☐ 72

51 My geography teacher encourages us to **describe** a geographical feature's position in relation to other geographical features.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V67 ☐ 73

52 My geography teacher gives us many opportunities to **observe** geographical important problems.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V68 ☐ 74

53 My geography teacher encourages us to use any means to **communicate** investigated information.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V69 ☐ 75

54 My geography teacher links the work in geography on **graphs** to our everyday life, i.e. getting us to bring examples from newspapers and magazines for discussion in class.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V70 ☐ 76

55 My geography teacher organizes activities in which we arrange geographical features in logical **order** according to their structures.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V71 ☐ 77

B: Integrated Science Process Skills applied to the teaching of geography. Please respond to the following statements by making a cross (X) the number in the appropriate shaded block.

56 My geography teacher encourages us to **identify** variables that affect geographical phenomena, e.g. how variables such as air temperature, air pressure, humidity and cloud cover influence the occurance of rainfall.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V72 ☐ 78

57 My geography teacher devises exercises in which we have to **construct tables of data** (tables of information).

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V73 ☐ 79

58 My geography teacher devises exercises in which we have to **construct graphs.**

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V74 ☐ 80

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FOR OFFICE USE ONLY

59 Questionnaire Type	V75	2 1
60 Respondent Number	V76	2-5
61 Card Number	V77	2 6
62 Education District	V78	7-8

63 My geography teacher devises exercises in which we **conduct investigations.**

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V79 ☐ 9

64 My geography teacher devises exercises in which we **identify the variables** under study.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V80 ☐ 10

65 My geography teacher gives us geographical problems in which we are encouraged to **construct hypotheses**. *(A hypothesis is a tentative answer to a problem).*

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V81 ☐ 11

66 My geography teacher gives us exercises in which we are encouraged to **define** geographical features by using observable characteristics of the features.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V82 ☐ 12

67 My geography teacher gives us hypotheses and request us to **design investigations** to test the given hypotheses.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V83 ☐ 13

68 My geography teacher devises exercises in which we have to **describe the relationship between variables** on a graph.

Strongly Disagree 1	Disagree 2	Agree 3	Strongly Agree 4	V84 ☐ 14

69 State problems which you experience when **Science Process Skills** are applied to the teaching of geography.

V85 ☐ 15
V86 ☐ 16
V87 ☐ 17
V88 ☐ 18
V89 ☐ 19

70 State how these problems can be solved.

V90 ☐ 20
V91 ☐ 21
V92 ☐ 22
V93 ☐ 23
V94 ☐ 24

THANK YOU FOR YOUR CO-OPERATION

If you have any queries regarding this study, please contact the researcher.

Mr Awelani Rambuda (057) 396 4112 OR 082 491 8014
P.O. Box 1881
WELKOM e-mail address: RMBDA-AM @weasel.vista.ac.za
9460

APPENDIX 5

A LETTER FROM THE HUMAN SCIENCES RESEARCH COUNCIL WITH REGARD TO RESEARCH ON TEACHERS' APPLICATION OF SCIENCE PROCESS SKILLS TO THE TEACHING OF GEOGRAPHY IN SECONDARY SCHOOLS

Human Sciences Research Council
Lekgotla la Dinyakisišo tša Semahlale tša Setho
Raad vir Geesteswetenskaplike Navorsing
Umkhandlu Wezokucwaninga Ngesayensi Yesintu

Centre for Science Development
Lefapha la Tlhabollo ya Thutamahlale
Sentrum vir Wetenskapontwikkeling
Wokuthuthukiswa Kwesayensi

HSRC
RGN

1999·03

Tel: (012) 302-2731
Fax: (012) 302-2892

Dear Mr A. M. Rambuda

RESEARCH INFORMATION

Your request for a computer print-out refers.

According to the records of the **Database of Current and Completed Research in the Human Sciences**, no previous research has been done on this topic.

Yours sincerely

H.J. Terblanche

NEXUS DATABASE SYSTEM

134 Pretorius Street Pretoria Private Bag X270 Pretoria South Africa 0001 Tel (012) 302 2999 Fax (012) 302 2892
Pretoriusstraat 134 Pretoria Privaatsak X270 Pretoria Suid-Afrika 0001 Tel (012) 302 2999 Faks (012) 302 2892

APPENDIX 6

A LIST OF SCHOOLS THAT OFFERED GEOGRAPHY IN THE FREE STATE EDUCATION DEPARTMENT IN 1999

FREE STATE PROVINCIAL GOVERNMENT

Education

Private Bag X20565 • Bloemfontein • 9300 • South Africa
55 Elizabeth Street • CR Swart Building • Bloemfontein
Tel. : +27 (0) 51 - 4074911 • Fax : +27 (0) 51 – 4074036

Enquiries :Dr FJ Wilkinson
Reference no. :

Tel. : (051) 4048414
Fax. : (051) 4048094
E-mail : fredw@majuba.ofs.gov.za

Mr A Rambuda
Vista University
PO Box 1881
WELKOM
9460

Dear Mr Rambuda

ENQUIRES ABOUT GEOGRAPHY

Enclosed please find some statistics with regard to Geography as a school subject. Please accept my apologies for not responding at an earlier stage. We are experiencing a severe manpower problem and enquiries such as yours must be addressed in between our other commitments. Unfortunately I do not information about teachers teacher geography as a subject.

Please contact Mr Motsau at the Examination Section Tel. 051-4048250

HEAD: EDUCATION
2000-02-28

EDUC_DISTRICT:		School_Name:	Gr10	Gr11	G12	Tot
BETHLEHEM	0001	BEACON S/S	41	48	12	101
	0002	BETHLEHEM C/S	33	0	0	33
	0003	CLARENS C/S	33	49	81	163
	0004	DEO GLORIA CHRISTIAN CI/S	1	0	0	1
	0005	DINARE S/S	136	94	65	295
	0006	ED-U-COLLEGE	0	0	5	5
	0007	GLENASH CF/S	119	82	89	290
	0008	IPOKELLENG S/S	64	58	42	164
	0009	ITHABISENG S/S	48	25	7	80
	0010	KOALI S/S	237	142	177	556
	0011	LEKGULO S/S	107	119	89	315
	0012	MAKGABANE S/S	94	72	28	194
	0013	MOHATO S/S	244	88	94	426
	0014	NKARABENG S/S	35	0	0	35
	0015	NTHABISENG S/S	43	102	42	187
	0016	PAUL ERASMUS S/S	23	17	9	49
	0017	REHOTSE S/S	61	0	18	79
	0018	REKGOTSOFETSE S/S	80	76	70	226
	0019	SEANAKWENA S/S	155	233	36	424
	0020	THABO-THOKOZA S/S	155	69	73	297
	0021	TIISETSANG S/S	249	314	235	798
	0022	TSEKI S/S	93	95	51	239
	0023	VOORTREKKER S/S	30	56	49	135
	0024	WITTEBERG S/S 2'	40	70	38	148

Summary for 'EDUC_DISTRICT:' = BETHLEHEM (36 detail records)

			Gr10	Gr11	G12	Tot
			2121	**1809**	**1310**	**5240**
BFN EAST	0025	CHRISTIAAN DE WET C/S	28	16	0	44
	0026	KGORATHUTO S/S	106	97	61	264
	0027	LEFIKENG S/S	68	48	25	141
	0028	LOUW WEPENER C/S	21	38	28	87
	0029	METSIMAPHODI S/S	89	93	52	234
	0030	MPATLENG S/S	79	86	92	257
	0031	NTEMOSENG S/S	137	140	66	343
	0032	NTUMEDISENG S/S	170	151	70	391
	0033	POPANO S/S	109	58	35	202
	0034	QIBING S/S	210	117	45	372
	0035	REAMOHETSE S/S	105	102	23	230
	0036	SEEMAHALE S/S	209	214	109	532
	0037	SENAKANGWEDI S/S	198	0	0	198
	0038	SETJHABA-SE-MAKETSE C/S	31	15	23	69
	0039	THAPELONG S/S 15	33	23	13	69

Summary for 'EDUC_DISTRICT:' = BFN EAST (26 detail records)

			Gr10	Gr11	G12	Tot
			1593	**1198**	**642**	**3433**
BFN SOUTH	0040	ALBERTINA SISULU S/S	12	34	35	81
	0041	BEANG TSE MOLEMO S/S	60	18	17	95
	0042	CALCULUS S/S	32	71	81	184

EDUC_DISTRICT:		School_Name:		Gr11	G12	Tot
BFN SOUTH	0043	DR VILJOEN C/S	55	39	28	122
	0044	EDENBURG (REITZ-STEYNSTR)	30	24	22	76
	0045	FICHARDTPARK S/S	67	76	79	222
	0046	HENDRIK POTGIETER A/S	0	1	20	21
	0047	IKAELELO S/S	40	43	11	94
	0048	JIM FOUCHé S/S	48	45	42	135
	0049	KAGISHO CS/S	41	40	36	117
	0050	LERE LA THUTO S/S	121	191	76	388
	0051	LEREKO S/S	109	77	34	220
	0052	PELLISSIER C/S	13	11	7	31
	0053	RELEBOHILE SIBULELE C/S	49	49	13	111
	0054	ROUXVILLE S/S	106	41	34	181
	0055	SAND DU PLESSIS S/S	61	67	82	210
	0056	SPRINGFONTEIN S/S	88	63	31	182
	0057	ST BERNARDS S/S	30	36	29	95
	0058	THABO-VUYO S/S	32	22	18	72
	0059	TROMPSBURG S/S	0	0	4	4
	0060	UITKOMS CF/S	8	0	0	8
	0061	WONGALETHU S/S	60	63	0	123
	0062	ZASTRON C/S	15	18	12	45
Summary for 'EDUC_DISTRICT:' = BFN SOUTH (39 detail records)						
			1077	1029	711	2817
BFN WEST	0063	AKADEMIA S/S	69	43	34	146
	0064	ARAMELA C/S	140	140	20	300
	0065	BFN CHRISTIAN (ACE) C/S	0	1	0	1
	0066	BLOEMFONTEIN S/S	100	77	49	226
	0067	BOARAMELO C/S	38	35	34	107
	0068	BOSHOF C/S	26	29	7	62
	0069	BREBNER S/S	81	66	53	200
	0070	C&N H/MEISIESKOOL ORANJE	21	40	41	102
	0071	CHRISTIAN BROTHERS COLLE	15	11	13	39
	0072	DR. BLOK S/S	95	28	10	133
	0073	EUNICE S/S	60	33	32	130
	0074	FAME COLLEGE	13	25	50	88
	0075	GREY-KOLLEGE S/S	45	84	77	206
	0076	HEADSTART HIGH	97	100	87	284
	0077	HEATHERDALE CS/S	58	78	45	181
	0078	IKANYEGENG C/S	25	25	15	65
	0079	INOSENG C/S	76	55	38	169
	0080	KAELANG S/S	145	151	112	408
	0081	KAGISANO C/S	32	28	13	73
	0082	KGHOLOLOSEGO S/S	8	13	7	28
	0083	KOFFIEFONTEIN C/S	11	11	4	26
	0084	LEKHULONG S/S	294	187	128	609
	0085	LUCKHOFF I/S	59	42	0	101
	0086	MATSHEDISO S/S	79	121	69	269
	0087	MOEMEDI S/S	118	103	56	277
	0088	OLIEN S/S	85	46	5	136

EDUC_DISTRICT:		School_Name:	Gr10	Gr11	G12	Tot
BFN WEST	0089 *	OPPERMANS C/S	35	0	0	35
	0090	PANORAMA SECONDARY C/S	22	13	9	44
	0091	PETUNIA S/S	102	70	42	214
	0092	PRESIDENT STEYN C/S	37	19	26	82
	0093	REFIHLETSE C/S	41	27	13	81
	0094	REIKAELETSE S/S	32	31	16	79
	0095	SEHUNELO S/S	103	100	55	258
	0096	SENTRAAL S/S	58	81	56	195
	0097	SENZILE C/S	0	0	23	23
	0098	ST ANDREW'S C/S	21	33	29	83
	0099	ST MICHAEL'S C/S	10	12	13	35
	0100	STAATSPRES. SWART C/S	20	28	14	62
	0101	TATELLO	2	1	0	3
	0102	VULAMASANGO S/S	123	143	90	356
Summary for 'EDUC_DISTRICT:' = BFN WEST (62 detail records)						
			2396	**2135**	**1385**	**5916**
HARRISMITH	0103	ABERFELDY CF/S	50	32	26	108
	0104	DIRKIE UYS C/S	15	12	6	33
	0105	EERAM CF/S	61	39	34	134
	0106	HARRISMITH HOëRSKOOL S/S	22	32	10	64
	0107 *	HARRISMITH S/S	210	144	120	474
	0108	HLAJOANE S/S	88	72	76	236
	0109	INTABAZWE S/S	97	73	67	237
	0110	IPHONDLE S/S	186	144	62	392
	0111	LERATO THANDI CS/S	99	88	52	239
	0112	MAANANKOE S/S	94	104	74	272
	0113	MAKWANE I/S	26	0	0	26
	0114	MANTHATISI S/S	69	65	42	176
	0115	MAPEKA I/S	105	0	0	105
	0116	MASOPHA S/S	53	39	46	138
	0117	METSI-MATSHO S/S	131	154	86	371
	0118	MMATHABO S/S	87	192	108	387
	0119	MOLAPO S/S	200	183	217	600
	0120	MOOKODI S/S	75	59	58	192
	0121	NEW HORIZON COLLEGE S/S	40	51	46	137
	0122	PHOFUNG S/S	262	98	73	438
	0123	RANTSANE S/S	68	100	60	228
	0124	SASAMALA S/S	115	111	77	303
	0125	SEROALI S/S	109	45	32	186
	0126	SHAKHANE S/S	185	90	70	345
	0127	SIBONAKALISO CF/S	0	10	18	28
	0128	TSHIRELA S/S	59	66	77	202
	0129	TSHOLO S/S	114	166	89	369
Summary for 'EDUC_DISTRICT:' = HARRISMITH (44 detail records)						
			2620	**2169**	**1631**	**6420**
KROONSTAD	0130	AFRIKAANSE H/SKOOL KROO	25	26	29	80
	0131	BODIBENG S/S	84	145	130	359
	0132	BOTHAVILLE S/S	38	0	0	38

EDUC_DISTRICT:		School_Name:		Gr11	G12	Tot
KROONSTAD	0133	BRENTPARK C/S	53	71	25	149
	0134	CALCULUS KOLLEGE C/S	17	21	6	44
	0135	CVO SKOOL VIERFONTEIN	6	2	0	8
	0136	DIPHETOHO S/S	60	26	44	130
	0137	DR ML MAILE S/S	171	113	27	311
	0138	DR REGINALD CINGO CS/S	45	55	20	120
	0139	EDENVILLE C/S	19	41	25	85
	0140	HARRY LEBONA S/S	46	0	0	46
	0141	JSM SETILOANE S/S	0	37	12	49
	0142	KANANELO S/S	429	213	37	679
	0143	KGABARENG T/S	27	17	8	52
	0144	KGOLAGANO S/S	140	114	110	364
	0145	KROONSTAD CS/S	20	25	17	62
	0146	MAMELLANG-THUTO S/S	76	51	17	144
	0147	MATSERIPE S/S	107	105	56	268
	0148	MOPHATE S/S	65	48	36	149
	0149	MOTSWELA S/S	93	115	72	280
	0150	NGWATHE S/S	32	44	46	122
	0151	NIEKERKSRUS AS/S	14	16	23	53
	0152	OZIEL SELELE CS/S	69	75	48	192
	0153	PHEPHETSO S/S	114	83	65	262
	0154	REHAUHETSWE AS/S	0	0	13	13
	0155	SALOMON SENEKAL C/S	31	19	12	62
	0156	THABANG S/S	51	132	0	183
	0157	THAKAMESO CS/S	50	74	19	143
	0158	ZENITH C/S	6	8	14	28
Summary for 'EDUC_DISTRICT:' = KROONSTAD (49 detail records)						
			1888	1676	911	4475
LADYBRAND	0159	ALBERT MOROKA S/S	86	141	135	362
	0160	BOITUMELO S/S	29	34	29	92
	0161	CHRISTIAN LIPHOKO I/S	102	35	0	137
	0162	FICKSBURG CS/S	19	28	26	73
	0163	GORONYANE S/S	55	109	84	248
	0164	IKAELELO I/S	15	0	0	15
	0165	ITOKISETSENG BOKAMOSO S/	37	0	0	37
	0166	JEVINGTON CF/S	27	0	0	27
	0167	KEIKELAME I/S	12	0	0	12
	0168	KING'S CHRISTIAN I/S	3	1	0	4
	0169	LADYBRAND S/S	42	32	30	104
	0170	LE RENG S/S	26	62	23	111
	0171	MARALLANENG S/S	0	0	69	69
	0172	MODDERPOORT IF/S	31	35	20	86
	0173	MOROKA S/S	165	172	144	481
	0174	PHETOGANE S/S	106	93	57	256
	0175	REUTLWAHETSE S/S	96	55	40	191
	0176	RT MOKGOPA S/S	195	202	165	562
	0177	SEHLABENG S/S	171	72	29	272
	0178	STRYDOM I/S	107	78	0	185

EDUC_DISTRICT:	No.	School_Name:	[illegible]	Gr11	G12	Tot
LADYBRAND	0179	TAUNG S/S	101	73	30	204
	0180	TLOKOLA S/S	56	55	187	298
	0181	TLOTLANANG C/S	10	27	40	77
	0182	TLOTLISONG No1 S/S	80	67	26	173
	0183	TSHEPANG S/S	139	71	115	325
Summary for 'EDUC_DISTRICT:' = LADYBRAND (37 detail records)						
			1710	**1442**	**1249**	**4401**
ODENDAALSRUS	0184	BULTFONTEIN C/S	31	34	16	81
	0185	CONCORDIA S/S	64	59	36	159
	0186	ELDORET S/S	0	0	12	12
	0187	HANOVER CF/S	21	30	30	81
	0188	HOERSKOOL WESSELS MARE	23	18	10	51
	0189	HOOPSTAD C/S	17	11	12	40
	0190	IPHATELENG S/S	30	0	0	30
	0191	IPOPENG S/S	130	0	0	130
	0192	ITHABELENG S/S	194	288	106	588
	0193	ITOKISETSENG CF/S	43	19	11	73
	0194	JC MOTUMI S/S	171	72	0	243
	0195	KUTLOANONG S/S	120	141	49	310
	0196	LA WESI S/S	120	147	71	338
	0197	MONYAKENG S/S	125	237	282	644
	0198	MOOKODI S/S	97	157	194	448
	0199	MOSALA S/S	81	43	38	162
	0200	NALEDI-YA-BOTJABELA S/S	82	123	164	374
	0201	PHEHELLO S/S	69	29	71	169
	0202	REARABETSWE S/S	198	191	98	487
	0203	REPHOLOSITSWE S/S	42	53	103	198
	0204	SANDVELD C/S	15	10	4	29
	0205	SEKGWENG IF/S	20	0	0	20
	0206	SELLO IF/S	5	0	0	5
	0207	SEQHOBONG S/S	76	110	61	247
	0208	SIYASIFUNELA S/S	54	0	0	54
	0209	TAIWE S/S	37	64	46	147
	0210	TIKWANE CS/S	39	86	40	165
	0211	WINBURG C/S	23	25	5	53
Summary for 'EDUC_DISTRICT:' = ODENDAALSRUS (44 detail records)						
			1927	**1952**	**1459**	**5338**
PHUTHADITJHABA	0222	BLUEGUMBOSCH S/S	94	67	25	186
	0223	CLUBVIEW S/S	56	64	54	174
	0224	DIKWENA S/S	192	173	100	465
	0225	KGOLATHUTO S/S	0	0	70	70
	0226	LETSIE S/S	120	87	17	224
	0227	MAMPOI S/S	125	221	128	474
	0228	MOTEKA S/S	54	53	27	134
	0229	NKHOBISO S/S	95	39	69	203
	0230	REAHOLA S/S	69	76	21	166
	0231	SELELEKELA S/S	121	63	13	197
	0232	THAHAMESO S/S	183	110	154	447

EDUC_DISTRICT:		School_Name:		Gr11	G12	Tot
PHUTHADITJHABA	0233	THOKOANA MAKAOTA S/S	154	241	139	534
	0234	TLHORONG S/S	301	121	114	536
	0235	TSEBO S/S	127	238	109	474
	0236	TSHIBOLLO S/S	94	178	57	329
Summary for 'EDUC_DISTRICT:' = PHUTHADITJHABA (25 detail records)						
			1785	1731	1097	4613
REITZ	0237	BONGANE-LEBOHANG S/S	83	69	34	186
	0238	ESIZIBENI S/S	203	124	102	429
	0239	ETEMBENI IF/S	20	0	0	20
	0240	EVUNGWINI S/S	45	124	157	326
	0241	FALESIZWE S/S	80	208	93	381
	0242	IKAHENG ZAKHENI S/S	42	42	40	124
	0243	INTUTHUKO-KATLEHO S/S	57	112	0	169
	0244	KGOTSO-UXOLO S/S	29	16	20	65
	0245	LEIFO IZIKO S/S	0	88	108	196
	0246	LERATSWANA S/S	85	59	38	182
	0247	LINDLEY S/S	19	10	10	39
	0248	MATLWANGTLWANG S/S	78	70	65	213
	0249	PHUKALLA S/S	61	23	34	118
	0250	REFENG THABO S/S	45	38	31	114
	0251	REITZ C/S	21	18	7	46
	0252	RETSHEDISITSWE S/S	68	112	40	220
	0253	STEYNSRUS C/S	16	19	4	39
	0254	TWEELING C/S	6	1	4	11
	0255	VILLIERS C/S	15	20	11	46
	0256	WILGERIVIER C/S	14	19	14	47
Summary for 'EDUC_DISTRICT:' = REITZ (34 detail records)						
			987	1172	812	2971
SASOLBURG	0257	AFRIKAANSE H/SKOOL SASOL	51	44	46	141
	0258	BARNARD MOLOKOANE S/S	182	88	76	346
	0259	BOIPHIHLELO S/S	40	64	77	181
	0260	BOITLAMO S/S	29	16	14	59
	0261	CEDAR S/S	40	31	0	71
	0262	HEILBRON C/S	19	17	31	67
	0263	KWAKWATSI S/S	80	58	32	170
	0264	LE NOTSI S/S	104	88	20	212
	0265	NKGOPOLENG S/S	44	44	42	130
	0266	NOMSA S/S	40	35	22	97
	0267	PARYS SKOOL S/S	56	46	41	143
	0268	PELE-YA-PELE S/S	41	30	36	107
	0269	PHEHELLANG S/S	65	55	79	199
	0270	PHIRITONA S/S	156	139	81	376
	0271	REBATLA THUTO S/S	94	84	39	217
	0272	SANDERSVILLE C/S	15	0	0	15
	0273	SAREL CILLIERS C/S	17	12	0	29
	0274	SASOLBURG S/S	63	70	69	202
	0275	SCHOOL OF DESTINY	1	1	0	2
	0276	SEDIBA-THUTO S/S	77	53	46	176

EDUC_DISTRICT:		School_Name:			Gr11	G12	Tot
SASOLBURG	0277	VAAL CHRISTIAN C/S		0	6	3	9
	0278	VAALPARK S/S		33	37	18	88
	0279x	WEIVELD AS/S		21	9	4	34
	0280	YAKHISISWE S/S	24	21	53	49	123
Summary for 'EDUC_DISTRICT:' = SASOLBURG (44 detail records)							
				1289	**1080**	**825**	**3194**
WELKOM	0281	BAHALE S/S		0	0	97	97
	0282	ED-U-COLLEGE		12	13	22	47
	0283	GOUDVELD S/S		55	57	49	161
	0284	HARMONIE S/S		72	50	42	164
	0285	HENNENMAN S/S		36	51	41	128
	0286	HENTIE CILLIERS H/S		55	49	22	126
	0287	KHELENG S/S		201	80	58	339
	0288	LEBOGANG S/S		130	167	105	402
	0289	LEPHOLA CS/S		92	77	65	234
	0290	LETSETE S/S		168	132	98	398
	0291	MAREMATLOU S/S		95	0	0	95
	0292	NANABOLELA 1 S/S		152	207	76	435
	0293	REATLEHILE S/S		137	190	120	447
	0294	RIEBEECKSTAD S/S		46	60	62	168
	0295	SANDVLIET I/S		14	0	0	14
	0296	ST DOMINIC'S COLLEGE S/S		10	12	15	37
	0297	TETO S/S		89	97	57	243
	0298	THOTAGAUTA S/S		139	77	121	337
	0299	UNITAS CS/S		24	39	17	80
	0300	WELKOM HIGH S/S		19	30	28	77
	0301	WELKOM S/S		93	95	42	230
	0302	WELKOM-GIMNASIUM S/S	22	17	32	8	57
Summary for 'EDUC_DISTRICT:' = WELKOM (40 detail records)							
				1656	**1515**	**1145**	**4316**
Grand Total		**480**		**21049**	**18908**	**13177**	**53134**

APPENDIX 7

A TABLE OF UNIFORM RANDOM NUMBERS

Table of Uniform Random Numbers

68204	38787	73304	44886	92836	43877	61049	49249	66105
61010	78345	75444	91680	33003	24128	97817	77562	62045
04604	93468	78459	27541	19672	14220	25102	42021	19252
36021	25507	64060	72923	58848	10374	63102	41534	92884
28129	43470	94097	16753	56425	75299	93688	75569	52067
09406	06584	46324	13981	06449	42604	13372	69040	95955
86423	81835	64226	20398	65772	91052	73496	14451	95967
13249	58525	81893	32894	68627	75644	45848	61511	90232
75454	17352	56548	39618	86705	50783	48388	82047	14660
06260	46176	99237	69874	84180	32005	66130	18055	99748
38507	92795	80672	00102	22980	69115	95653	05231	94996
03917	26795	59832	19014	96206	45413	76624	71219	65855
17927	32368	08177	31236	45401	26731	92256	99530	43998
26811	88937	37187	39762	29942	40091	65731	95955	23368
18480	28160	81908	30456	22462	15677	55642	67383	86884
37589	91842	76351	90585	45588	42858	37806	67969	50621
79903	34187	26952	75820	96335	90281	04269	85202	94965
46155	30200	75000	28570	47516	06744	72193	01258	85047
60916	73212	15853	28398	04721	69363	47071	65568	88519
34419	82840	88235	61966	86517	23966	45764	42177	17269
08692	26667	12941	14813	30815	26633	68184	80721	80505
92851	44185	90848	18341	77915	00177	64014	35490	02937
97909	07280	72167	10002	27374	92880	60055	94168	30742
28437	22027	07739	30905	33151	73567	82960	50104	67005
48165	28174	17909	11230	00929	54604	32435	54120	85199
99891	30913	06315	30201	72073	39589	62868	66339	15850
98022	13010	67970	99203	12536	88149	44387	20250	50798
91292	54688	47029	38970	77880	77295	11887	17628	93802
89081	34643	12988	12971	87742	57720	24438	64088	49496
32527	74239	20056	46668	94561	70111	92537	83562	11306
01870	21584	48574	09871	74453	24812	45770	95667	52377
84011	87542	96564	64256	64653	90025	61613	94168	83254
01568	29682	67489	62984	51901	30716	24513	46678	67991
40360	19206	40321	16004	64481	16130	03904	15811	19369
09392	39926	79590	23991	82492	13032	67337	54322	06058
77323	20500	52466	33008	84211	26357	79006	41178	35169
47590	01007	65376	18189	84040	39476	25383	45398	64917
29321	65783	71403	32894	32627	39067	47985	51485	27415
09530	05358	58722	31912	73356	65884	12883	36242	29646
65612	06843	72233	73352	66600	23237	71759	76881	19652
40355	85067	40788	40148	46099	48056	27858	58365	30202
24963	49571	82377	08687	73448	95484	15155	41780	71951
87273	44050	71961	48464	84084	65225	62846	11634	04853
31643	44756	12493	09024	74204	69949	67842	36141	08477
58326	55342	31419	80776	64028	59957	52969	71997	71477
02327	00460	39178	09511	92688	88585	99257	98752	39623
19377	49122	60591	79773	66289	89650	49298	13499	53623
95046	30203	47493	74395	45213	66739	45097	91670	62152
65013	71958	48360	70885	60313	44241	18740	05705	07488
86032	89018	97117	35656	20401	86438	87250	04717	67726
11799	15777	11548	45918	45706	88554	75315	70233	72575
17843	64809	00390	11980	66129	07197	36712	55062	61191
42770	65397	45010	06463	86242	06361	14293	36343	97628
02410	96933	57864	93197	88227	57139	66382	95768	60660
70939	20457	62468	68698	74875	61111	59083	09152	93625
85616	15100	26242	28677	74655	05679	56676	67224	75318
85515	33174	05496	78789	81297	73985	82120	94070	20529

Continued

73466	06254	88113	98367	22018	99372	70171	52705	61202
72255	50729	05681	37216	09363	02385	93098	09502	92589
08121	48330	86725	52922	90349	81934	14849	68005	06791
94005	85164	22994	58921	85943	67506	79730	85382	61568
09108	52299	25991	00940	22493	60987	93573	79469	97147
85687	31723	67907	55306	71748	85048	17690	04784	98470
26190	02164	95889	89712	89795	73001	82210	39357	23867
34208	07539	60907	60693	01965	43492	46688	28891	23410
13032	78798	21733	35703	71707	11931	93513	78339	74754
16801	05582	47975	25046	59220	08275	67901	94954	36662
88735	91500	41654	97225	61188	24527	35220	99794	56097
82127	17594	94217	55324	06134	25207	26758	08687	06929
29284	42271	45833	19481	56972	99042	45304	39832	40188
56300	60964	13751	72385	91180	42371	55924	95783	33096
33132	33229	39955	16779	99286	23392	24255	90856	60004
65296	94444	32091	90681	95823	73091	92912	85979	30232
11069	52931	26381	71830	50467	47783	25223	81796	97745
06720	69637	99670	58392	57943	75965	14740	74814	75598
62719	14295	16605	13146	36992	50560	50121	90278	98283
95556	36672	87202	92730	81961	38894	61358	44519	71529
12490	12304	28804	42772	27104	35518	67361	84159	52442
29865	28847	70904	96638	54226	44701	67589	27352	81078
74486	63507	92193	65022	09583	43615	59910	05301	69347
01878	56351	68618	84432	30948	65180	75446	95963	75619
65405	25720	09364	51333	03752	65756	51967	92469	47296
31711	35173	45290	49326	50368	63829	05640	26675	27367
41028	50367	01904	68068	02324	58723	96333	77032	47878
76916	55336	48767	76915	79711	05182	70489	10244	45078
16404	93068	91519	85895	34872	24701	60932	91141	33252
06776	51133	76482	14812	19777	19614	51100	52943	04068
76818	05839	26058	80972	43337	24203	72345	37967	88138
16916	64028	38968	02783	63049	12261	89587	88988	88834
33696	41621	16648	11837	08094	38217	32919	16625	91567
00143	56431	90537	95332	29879	29363	48055	86410	10594
15932	59628	00086	74633	81208	05470	56385	23601	70545
86111	14530	39958	36155	60613	73849	74842	31030	30448
46218	36313	62063	59326	93522	48983	50335	30178	42755
84153	32199	77166	63912	07984	55369	56520	14633	00252
81439	35471	29742	57110	13710	21351	29816	32783	69004
92339	82043	80136	97269	28858	03036	01304	51363	40412
78421	33809	92792	96106	95191	43514	08320	25690	76117
44265	86707	80637	44879	81457	06781	11411	88804	62551
89430	51314	76126	62672	31815	12947	76533	19761	93373
36462	19901	02919	29311	31275	83593	34933	95758	63944
55996	59605	51680	27755	06077	12797	67082	12536	64069
69338	43838	06320	63988	16549	27931	27270	94711	47834
40276	17751	72508	23027	70257	42812	87319	09160	02913
67834	93014	07816	93085	14552	10115	87740	44125	51227

APPENDIX 8

A LETTER FOR APPLICATION TO UNDERTAKE RESEARCH AT SECONDARY SCHOOLS IN THE FREE STATE

P.O. Box 1881
Welkom
9460

09 December 1999

The Head: Free State Department of Education & Culture
P.O. Box 20565
BLOEMFONTEIN
9300

Dear Mr van Rooyen

Re: Request for Conducting Research within the Free State Department of Education

I, the undersigned and lecturer at Vista University: Welkom campus, hereby request for permission to conduct research studies at some of the schools under your jurisdiction.

1 Personal Demographics

Title: Mr Awelani M Rambuda

Address: P.O. Box 1881
Welkom
9460

Tel: (057) 396 4112 X 267

Institution: University of Pretoria

Degree: PhD

Promoter: Prof WJ Fraser

Title of Thesis: *A Study of the Application of Science Process Skills to the Teaching of Geography in Secondary Schools in the Free State Province*

2 The Research Project

2.1 Rationale

The South African education system is currently undergoing a major transformation process from Christian National Education (CNE) which focuses on a product approach to Outcomes-based Education (OBE) which is a process approach as it focuses on what learners understand and can do. This is a paradigm shift from an education system which encourages rote and passive learning of facts and concepts to an education system which encourages an interactive teaching-learning process through which learners uncover facts and concepts. Research indicates that in secondary school subjects such as geography, learners are taught geographical facts and concepts with minimal understanding. Outcomes-based education has been phased-in with an aim of alleviating the problems mentioned above.

Outcomes-based education has been phased-in with effect from 1998. Before it was phased-

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Outcomes-based education has been phased-in with effect from 1998. Before it was phased-in, the Department of National Education released a White Paper on education which envisaged an education system which encourages independent and critical thought. Furthermore, the Act also maintains that learners should *"...develop the capacity to question, enquire, reason, weigh evidence and form judgements, achieve understanding, recognise the provisional and incomplete nature of most human knowledge, and communicate clearly"*.

This implies that teachers should teach processes through which knowledge develops. Furthermore, it implies that learners should be able to investigate and discover knowledge through observation, measuring, inferring, manipulating variables and so forth. These activities are science process skills which both teachers and learners have to acquire and master in order to develop the principles of outcomes-based education.

The introduction of science process skills is likely to enable learners to learn geographical phenomena with insight and understanding. Hence, it will not be easy for geography learners to forget the information they have investigated, discovered and `felt'. Geography education at secondary schools is regarded as a burden to the memory because learners are expected to memorise too many facts. The application of science process skills is likely to reduce problems such as these as science process skills encourage learning by doing. Learning by doing is something which outcomes-based education encourages and develops.

The paradigm shift has to be supplemented by innovative teaching and learning processes as outcomes-based education provides opportunities for logical, rational and critical thinking to learners. It is imperative that innovative teaching and learning strategies include process skills of science which demand more than mere memorization.

The analysis of geography's core syllabus preamble and guidelines indicates that science process skills are supposed to be applied to geography teaching and learning. This is also supported by the critical outcomes of outcomes-based education which have the elements of science process skills. However, the review of literature on geography teaching and the researcher's observation of classroom practice suggest that knowledge transmission by teachers dominates the teaching-learning process in South Africa.

2.2 Aims and Objectives

The purpose of this study is to examine the application of science process skills to the teaching of geography in secondary schools in the Free State Province. It is assumed that the application of science process skills is likely to develop inquiring minds and critical ability. It also assumed that this is likely only if geography teachers develop inquiry teaching and inquiry learning in the learners.

Objectives of the study are:

- ☐ to establish if geography teachers are inquiry teachers;
- ☐ to examine problems which geography teachers encounter when they develop inquiry learning in their learners;
- ☐ to establish difficulties which geography learners experience when engaged in inquiry learning;
- ☐ to examine how the problems geography teachers and learners experience

when engaged in inquiry teaching and learning can be alleviated;

- to establish the nature of science process skills applied by geography teachers;
- to examine problems that geography teachers experience when they apply science process skills to the teaching of geography; and
- to examine how the problems geography teachers experience when applying science process skills to the teaching of geography can be alleviated.

2.3 Questions to be Investigated

- Are geography teachers inquiry teachers?
- What problems do geography teachers encounter when they develop inquiry teaching?
- How can the problems geography teachers experience when developing inquiry teaching be alleviated?
- What are the science process skills applied to the teaching of geography in secondary schools?
- What difficulties do geography teachers experience when applying science process skills to the teaching of geography in secondary schools?
- How can the problems which restrict the application of science process skills to the teaching of geography in secondary schools be alleviated?

2.4 Significance of the Study

The recommendations of this study are likely to motivate and encourage geography teachers in the Free State to integrate process skill's instruction in their practice. Furthermore, the application of science process skills to the teaching of geography is likely to contribute to the realization of the principles of outcomes-based education in South Africa in general and in Free state in particular.

2.5 Population

The population targeted for study is a sample of secondary schools practising geography teachers, geography learners and geography subject advisors in the Free State in all 12 Education District. I will appreciate if you could allocate me a sample which consists of +1 000 geography teachers, +1 000 geography learners and 12 geography subject advisors. I am willing to come to your office to discuss my empirical research requirements with you. Please provide me with address lists for secondary schools and the number of secondary school geography teachers and learners per grade in the Free State Education Department.

2.3 Research Instruments

The research has two phases. Phase one entails gathering information through questionnaires and interviews. Before the questionnaires are despatched and interviews are conducted, permission to undertake the study will be sought first from district managers and school principals. Questionnaires for geography teachers and learners will be sent to the school principals. Questionnaires for subject advisors will be sent to district managers. The respondents will fill the questionnaires anonymously and questions about qualifications have not been asked. This will be a take home one week exercise. There will be no encroachment on school activities. It is projected that phase one will commence on 1March 2000 and end on 28 April 2000

Phase two is important for this study. It attempts to check interpretation of respondents' answers through lessons' observation. Analysis of the questionnaires may say something about what teachers and learners are saying but little of what may actually be happening. In order to close the rhetoric-reality gap, I request that I should be allowed to observe ± 30 geography lessons in secondary schools in Kroonstad, Welkom and Odendaalsrus districts. If my presence in the classrooms is going to disturb facilitation of the lessons, I propose that I should be allowed to give a small tape recorder to the teachers who will then record the lessons on my behalf. The name of the teachers and schools involved will not be recorded, only the lessons' content will be recorded. It is projected that this phase will commence and end in the third school term in 2000.

Please enclosed find the questionnaires for both geography teachers, learners and subject advisers as approved by my promoter. A copy of the thesis and the summary findings of this study will be sent to the Free State Education Department as soon as the study is completed.

Thanking you in anticipation.

Yours sincerely

....
Mr AM Rambuda
Student

....
Prof WJ Fraser
Promoter

APPENDIX 10

A LETTER TO THE PRINCIPALS REQUESTING PERMISSION TO UNDERTAKE RESEARCH AT THEIR SCHOOLS

P.O.Box 1881
Welkom
9460

1 March 2000

The Principal

Dear Sir\Madam

Re: Permission to Undertake Research in Your School

I am a PhD research student enrolled at the University of Pretoria. I am involved in a project which is attempting to describe and explain the application of science process skills to the teaching of geography in secondary schools in the Free State. As such, the project is likely to provide interesting and useful information which could be of a supportive nature to geography teachers in general and Outcomes-based Education in particular.

I have received permission to undertake the study from the Free State Education Department. Your school has been selected to participate in this study because it is one of the best schools in the province. I will be grateful if you could be of assistance with the research by giving the enclosed questionnaires to geography teachers and 10 learners per Grade.

Completion of the questionnaires should be a take-home one-day exercise. I will be grateful if you could encourage the respondents not to leave any question unanswered. The name of your school, teachers and learners involved will remain completely anonymous. I would greatly appreciate it if you could then return the survey to me in the enclosed self-addressed envelope by 23 March 2000.

Obviously the success of the research will largely be dependent on the number of surveys that are returned. Your assistance in this regard will be greatly appreciated.

Yours sincerely

....
Mr AM Rambuda

APPENDIX 11

INTERVIEW SCHEDULE FOR GEOGRAPHY TEACHERS

INTERVIEW SCHEDULE FOR GEOGRAPHY TEACHERS

1 What problems do you experience when you develop inquiry teaching?

2 How can one solve these difficulties?

3 What difficulties do your learners experience when they are involved in inquiry learning?

4 How can one solve these problems?

5 What problems do you experience when you apply *Science Process Skills* to the teaching of geography.

6 How can one solve these problems?

APPENDIX 12

INTERVIEW SCHEDULE FOR GEOGRAPHY LEARNERS

INTERVIEW SCHEDULE FOR GEOGRAPHY LEARNERS

1. What problems does your geography teacher experience when (s)he develops inquiry teaching?

2. How can one solve these difficulties?

3. What problems do you experience when you are involved in inquiry learning?

4. How can one solve these problems?

5. What problems do you experience when *Science Process Skills* are applied to the teaching of geography?

6. How can one solve these problems?

APPENDIX 13

SYNOPTIC WEATHER CHART

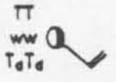
MAJOR CHANGES T ATHER BULLETIN

As from 1 September 1992 the format of the Daily Weather Bulletin has changed. The isobars are drawn at MSL, over the ocean AS WELL AS OVER THE CONTINENT. in 4 hPa intervals. In some places, where necessary, isobars are drawn in 2 hPa intervals.

HOOFVERANDERINGS AAN DIE DAAGLIKSE WEERBULLETIN

Vanaf 1 September 1992 het die formaat van die Daaglikse Weerbulletin verander. Die isobare word op seevlak, oor die oseaan SOWEL AS OOR DIE KONTINENT. in 4 hPa intervalle getrek. Op sommige plekke, waar nodig, word die isobare in 2 hPa intervalle getrek.

KEY / SLEUTEL



AIR TEMPERATURE — TT — LUGTEMPERATUUR

DEW POINT — T_dT_d — DOUPUNT

The arrow flies with the wind
Each feather represents 10 knots

Die pyltjie beweeg met die wind
Elke veer stel 10 knope voor

CLOUD AMOUNT — ⊙ 1/8 — ◔ 1/4 — ◑ 1/2 — ◕ 3/4 — ● overcast / betrokke — WOLKBEDEKKING

ww - PRESENT WEATHER / HUIDIGE WEER

- Lightning visible / Weerlig sigbaar
- Precipitation within sight / Neerslag op 'n afstand
- Thunderstorm without precipitation at time of observation / Donderstorm sonder neerslag tydens waarneming
- Duststorm / Stofstorm
- Fog / Mis
- Drizzle / Motreën
- Rain / Reën
- Snow / Sneeu
- Showers / Buie
- Thunderstorm / Donderstorm

ww] - WEATHER AT THE STATION DURING THE PRECEDING HOUR BUT NOT AT THE TIME OF OBSERVATION / WEER BY DIE STASIE GEDURENDE DIE VOORAFGAANDE UUR MAAR NIE TYDENS DIE WAARNEMING NIE

- Drizzle / Motreën
- Rain / Reën
- Snow Sneeu
- Rain and snow / Reën en sneeu
- Freezing drizzle or freezing rain / Vriesmotreën of vriesreën
- Showers of rain / Reënbuie
- Showers of snow / Sneeubuie
- Showers of hail / Haelbuie
- Fog / Mis
- Thunderstorm / Donderstorm

AUTOMATIC WEATHER STATION — △ — OUTOMATIESE WEERSTASIE

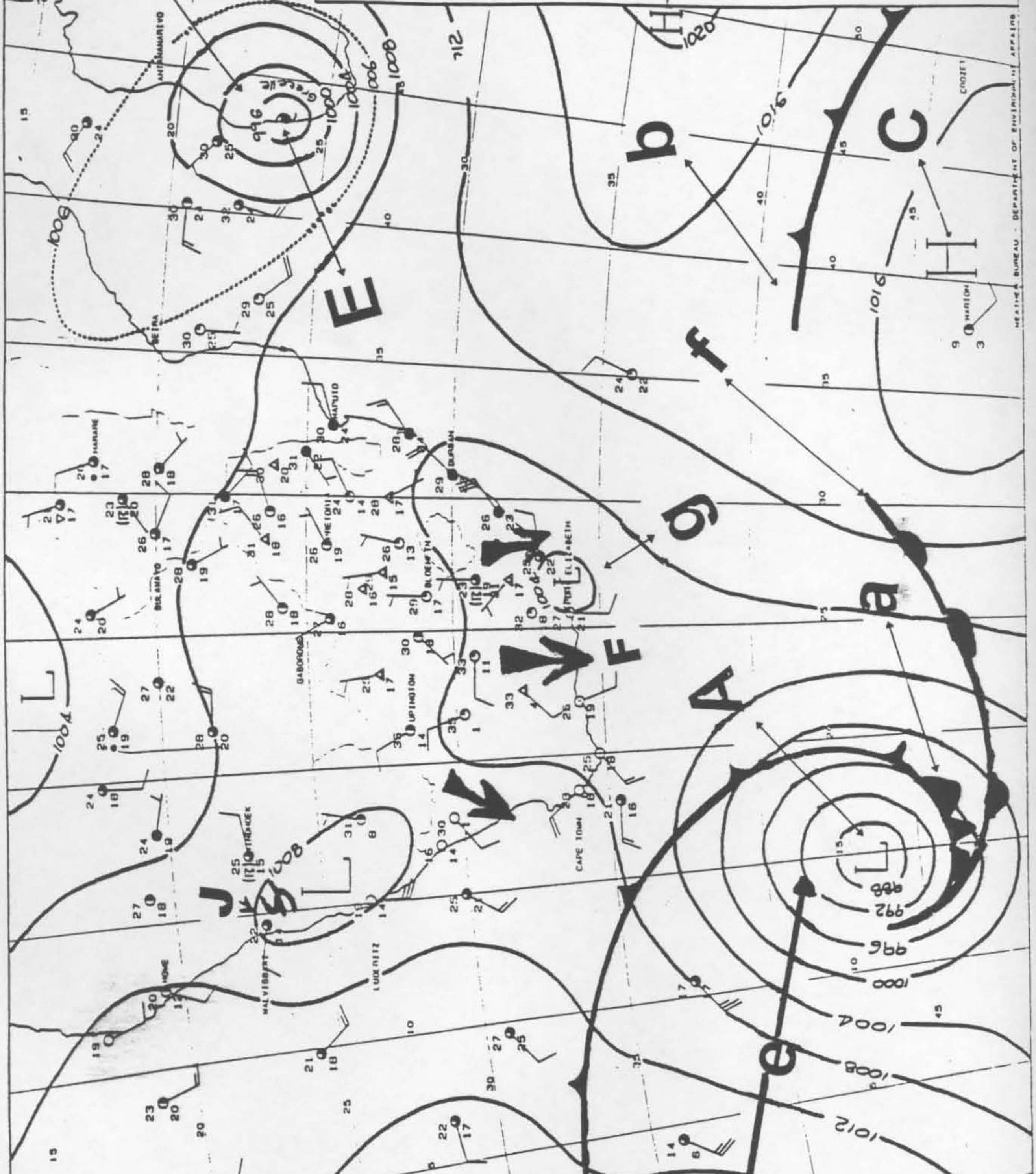
Isobars at MSL in 4 hPa intervals ———————— Isobare op seevlak in 4 hPa intervalle
Isobars at MSL in 2 hPa intervals - - - - - - - - - - - - Isobare op seevlak in 2 hPa intervalle

APPENDIX 13

SYNOPTIC WEATHER CHART

SYNOPTIC WEATHER MAP
SINOPTIESE WEERKAART

12:00 UT - 14:00 SAST -: 970125



BESPREKING: Verspreide donderbuie het oor die sentrale binneland voorgekom, oos van die oppervlaktrog, terwyl vogtige, maritieme lug bewolkte weer oor die noordoostelike deel van die land veroorsaak het, met ligte reën.

DISCUSSION: Scattered thundershowers occurred over the central interior, east of the surface trough, while moist, maritime air caused cloudy weather over the north-eastern part of the country, with light rain.