CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews literature on transitions in education, transitional problems, suggested solutions and studies in South Africa and abroad. Motivation for studying transition in science education in particular is also given. The chapter ends with a discussion of the theoretical framework and a summary of the literature review.

2.2 INTERNATIONAL STUDIES

The words *transition* and *transfer* are key words in the discourse that follows. 'Transition' refers to the move from one year to another within the same school, while 'transfer' refers to the move from one stage of schooling and from one school to another (Demetriou, Goalen & Rudduck, 2000). I have noticed, however, that the two words may be used interchangeably in the literature on transition.

Transfer and transition are difficult issues to write about for an international audience, given the diversity of organisational structures in the education systems of different countries. In this study I note four major systemic transitions (or transfers), namely home to school, elementary (primary) to middle/junior high school, middle/junior high school to high school and high school to tertiary institutions or work. The fact that a learner has successfully negotiated one transition does not mean he or she will successfully negotiate the next one (Simmons & Blyth, 1987).

Learners must successfully negotiate the four major transitions mentioned if they are to be successful in the long run (Anderson, Jacobs, Schramm & Splittgerber, 2000). It is in the light of this observation that transition from the GET band (grades 0 to 9) to the FET band (grades 10 to 12) in South Africa will include a discussion of systemic transitions from elementary (primary) to middle/junior high school and from middle/junior high school to high school. The focus of the study is, however, on transition from grade 9 Natural Science to grade 10 Physical Science and progression through the FET phase.

2.2.1 Transition and transfer problems across the world

Transition between different institutions and phases of education is always important. It is important that, even though learners may move school, they do not experience discontinuity in the curriculum. This is particularly so between the last year of an institution or phase and the first year of the next institution or phase. A discussion of transition and/or transfer problems around the world follows.

The Kingdom of Swaziland

Swaziland is a small country situated between Mozambique and South Africa, with secondary school education divided into junior secondary and senior secondary (high school) phases. The junior secondary phase lasts three years and the senior secondary phase lasts two years. Each of these phases has a public examination in its final year. Learners sit for the Junior Certificate Examination (JC) in the third year of the junior secondary phase. The JC examination is administered by the Lesotho and Swaziland Examinations Council. At the end of the high school phase the learners sit for an examination known as the Ordinary level (O-level) administered by the University of Cambridge Local Examinations Syndicate (UCLES) (Manyatse, 1996).

Many stakeholders in the education system of Swaziland complained of a gap between the junior and senior secondary phases of schooling, particularly in the sciences. The public based its perception of the gap on external national examinations (JC and O-level examinations), while the teachers themselves based their perception on the basis of the teaching and learning processes in the classroom. The gap in science was not only perceived in Swaziland but also in Lesotho and Botswana, which also have a JC external examination (Manyatse, 1996).

An empirical study to identify the nature of the perceived gap was undertaken by Manyatse, (1996). Some of his findings were:

- There was no gap between the syllabuses and curriculum materials at the two levels (JC and O- level).

- There was a gap in terms of balance and testing of cognitive levels between the exams at the two levels.
- A conceptual teaching approach could improve the understanding of the particulate nature of matter.
- Detailed teaching materials might influence the teaching approach of teachers, that is, specially designed teaching materials that are more user-friendly than the textbooks can be produced to influence the teaching approaches of teachers.

The United Kingdom (UK)

Progression and continuity are cornerstones of the curriculum, according to Braund and Hames (2005). They noted that one of the most significant changes in the curriculum since the introduction of the National Curriculum in England and Wales in 1989 had been the rapid development of science in the primary school. The implications of such a development for continuity and progression throughout age 5 – 16 (Years 1 to 12) schooling in science and especially at the primary-secondary interface (Years 6 and 7) were recognised in a very influential government policy statement in the run up to the introduction of the National Curriculum (Braund & Hames, 2005):

> *The development of science in primary schools imposes an added responsibility on the schools to which the pupils transfer: they have to ensure, if the goal of making science from 5 to 16 a continuum is to be realised, that pupils' early start is neither ignored nor undervalued but rather reinforced and exploited in their subsequent work. Suitable arrangements for ensuring continuity and progression are therefore essential (Department of Education and Science/Welsh Office, 1985: 11, para 32).*

Braund and Hames (2005) noted that twenty years later and 15 years after the implementation of the National Curriculum, this goal had not been achieved. As many as forty-percent of the learners failed to make the progress in early secondary school predicted by their primary school performances. (Galton, Gray & Ruddock, 1999).

Some studies show that learners obtain lower scores when they are re-tested in secondary school using the same questions put to them previously in the primary school (Bunyan, 1998;

Nicholls & Gardner, 1999). Braund and Hames (2005) offer two kinds of explanations for this decline and for the fact that it is worse for science:

- A new, larger and more challenging environment, new friendship groupings, more teachers and new rules all make demands on incoming learners.
- The 'shock of the new' for learners after transfer, in terms of changes in pedagogy, may have a much more significant and long-term impact on learners' learning in science and on their attitude to the subject.

Literature on the transition over the primary-secondary interface suggest the following factors that are particularly important in relation to post-transfer regression and early decline in learners' attitudes to school science:

- Learners may repeat work done at primary school, often without sufficient increase in challenge, sometimes in the same context and using similar procedures (Galton et al., 1999; House of Commons Committee, 1995; Secondary Science Curriculum Review, 1987).
- Teaching environments, styles of teaching and teachers' language are often very different in secondary schools compared to primary schools. They represent a change in the culture of teaching and learning to which learners have difficulty adjusting (Hargreaves & Galton, 2002; Pointon, 2000).
- Teachers in secondary schools often fail to make use of or refer to learners' previous science learning experiences. Information supplied by primary schools on their learners' previous achievements is rarely used effectively to plan curriculum experiences in the secondary school (Braund, Crompton & Driver, 2003; Nicholls & Gardner, 1999; Schagen & Kerr, 1999; Doyle & Hetherington, 1998).
- Teachers in secondary schools do not trust the assessed levels of performance gained by learners in national examinations in science taken by learners at the end of primary school. Secondary school teachers often claim that these levels have been artificially inflated by intensive revision for these examinations (Schagen & Kerr, 1999; Bunyan, 1998). This may be used by secondary school teachers as justification for starting afresh when planning new learning (Nott & Wellington, 1999).

Studies elsewhere have identified similar problems e.g. in the United States (Anderson et al., 2000) and Finland (Pietarinen, 2000).

The United States of America (USA)

In the USA, researchers explored the reasons why transitions were difficult, the kind of learners that had the greatest difficulty with transition and the process of disengagement from school that too often followed unsuccessful transition. They focussed on the systemic transition from elementary to middle/junior high school and middle/junior high school to high school. Systemic here meant "systematically built into the typical structure of public school systems" (Rice, 1997, p. 1)

School transitions interrupt the continuity of life (Anderson et al, 2000). As learners move from one school to another (e.g. from middle/junior high school to high school), they are confronted with:

- An increase in the physical size of the new institution and the number of learners (Roderick, 1993)
- Increased differentiation of the learner population in terms of racial, ethnic and class diversity (Roderick, 1993)
- A greater emphasis on relative ability and competition (Schumaker, 1998)
- A more detached relationship with teachers (Mizelle, 1995; Wells, 1996)

The negative impact of systemic transitions on self-esteem tends to be greater for girls than for boys (Crockett, Peterson, Graber, Schuleners & Ebata, 1989; Blyth, Simmons & Bush, 1978). This decline is exacerbated by other life changes, such as the onset of puberty and divorce of parents (Simmons & Blyth, 1987). Learners with behavioural problems in primary school tend to have more difficulty in making the transition to middle/junior high school (Anderson et al, 2000). This lack of academic preparedness is evidenced by low scores on tests (Roderick, 1993).

The failure to successfully negotiate systemic transitions may initiate the gradual disengagement process from school and promote conflict between the affected learners and the school (Roderick, 1993). This gradual disengagement process may even lead to dropping out of school as the final step (Finn, 1989).

Finland

A study conducted in Finland by Pietarinen (2000) sought to explore and explain the experiences of Finnish comprehensive school learners as they transferred from the primary to the secondary school and as they studied in the latter institution. These learners were asked to describe their experiences of grades 6, 7 and 9. This longitudinal research setting made it possible to collect data dealing with the experiences of the same learners at key moments in transfer, that is before the transfer, at the end of the first year at secondary school and at the final stages of comprehensive school (Pietarinen, 2000). Two-thirds of the learners studied experienced some disappointments, problems and fears, which were expressed individually in their daily schoolwork. Asked about her experiences, one grade 9 girl responded as follows:

> *"Teaching has been quite boring at secondary school, quite different from what it was at primary school. At primary school we had more possibilities to take part in action, here it's mainly the teachers who just teach. Fortunately there has been some variation in some subjects. My study habits have also changed at secondary school. When I was at primary school the homework was always to be done and it was really done at home. If I say that I do so nowadays, I am lying. No, nowadays studying is mainly that one finishes off the homework right before the class starts. Here at secondary school one is more responsible oneself for one's own study than at primary school. In primary school teaching, there wasn't probably much that has supported study at secondary school. It's so different to study here. Yet there haven't been too many problems concerning study at secondary school. The only thing may be that when there is a new teacher in practically every class it is so easy to skip classes, which I did a lot at one point. So my grades dropped ...It's my own fault of course; here I am, living my youth, the best time in one's life, there are so many other things that are more interesting than school."* (Pietarinen, 2000, p. 390).

A sign of a teacher's professionalism remains the ability to analyse these experiences and determine which of them have relevance for developing a comprehensive, unified system (Pietarinen, 2000).

New Zealand

In New Zealand, the traditional transition school for most pupils is the Intermediate School, which caters for Years 7 and 8, and features the typical classroom teaching of primary schools with some additional specialist teaching. In this way learners are offered the continuity of the familiar integrated curriculum delivery model, while introducing specialist teaching characteristic of secondary schools. The most significant change occurred when the Intermediate Schools were extended to include Years 9 and 10, thus becoming four-year middle schools and delaying the transition by two years (Ward, 2000).

A discussion on studies on transition from different perspectives follows.

2.2.2 Studies of transition in science from a curriculum perspective

The transition in science from a curriculum perspective was examined by Weston et al. (1994), who made a study of Advanced (A) level and GCSE chemistry syllabuses. The results of a questionnaire, sent out to a large number of schools and colleges in England and Wales, showed that although there was no apparent gap in the syllabuses there was a perception that the GCSE science course was an inferior form of preparation for A level. This study again points to the inescapable tension within a course that tries to serve two types of clients: those who wish to continue (the minority) and those who wish to terminate (the majority) (Rollnick, Manyatsi, Lubben & Bradly, 1998).

Conflicting aims to teaching science

Problems in transition are not encountered in the subject of science only. What then, could have made the study in science more interesting to me? The conflicting aims to teaching science, the very nature of science and the different epistemological beliefs as well as my own science background were the motivating factors.

There are two fundamental aims to teaching science that are in conflict with one another (Black, Harrison, Osborne & Duschl, 2004; Weston, Lazonby & Tomlins, 1994). Traditionally, the science curriculum has been a pre-professional method of preparing the next generation of scientists. The curriculum that serves this aim begins with the foundations of science that address the basic concepts in a piecemeal fashion and then build additional layers of knowledge upon them. Any sense of depth and coherence is only obtained after many years of formal study. In addition, the knowledge that forms the substance of such a curriculum is seen to be well established, unequivocal and indubitable. Consequently, there is a tendency for much of the subject to be taught in an authoritarian manner, leaving little space for discussion or exploration of what, after all, is a set of unnatural and difficult ideas. One of the unfortunate results of this approach is that learners are left with a particular epistemological standpoint, a strong impression that science produces certain and absolute knowledge of the real world. Little chance, if any, is given to explore the uncertainties and tentative nature of the knowledge produced by science. Such knowledge is important if learners are to understand the tremendous contributions of the scientific endeavour (Black et al., 2004).

On the other hand, there are those who argue that science should be compulsory for all, the major rationale for this being the view that the pervasiveness of science within society requires all learners to be educated about it until age 16 (Black et al., 2004). However, this aim is, best served by a fundamentally different curriculum and approach, that is one that gives much less importance to content and places more emphasis on teaching *about* science. From this perspective, the major explanatory themes should be presented in a contemporary context that offers improved relevance and an opportunity to explore and appreciate both the intellectual achievement of science and its cultural importance. This approach would allow the exploration of the ways decisions about science and technology affect society, the nature of risk and its assessment, the mechanisms by which scientific ideas are judged and evaluated and the role of models in science (Black et al., 2004). It is my view that the Natural Science curriculum of the GET phase under Curriculum 2005 was meant to serve this aim.

The essential tension is that the school science curriculum has to develop an adequate knowledge base for those who wish to pursue the study of science beyond the GET band, while also attempting to develop an understanding about science necessary for society. In other words, the compulsory science curriculum is battling with the competing demands of the requirement that science education should provide training for the next generation of scientists on the one hand, and the needs of the majority for a broader scientific education on the other. These aims are often in conflict with one another and undermine the effectiveness of the science curriculum in achieving either aim (Black et al., 2004). This tension between teaching science for the sake of society, or for the sake of scientists, is the essence of the transitional problems between the GET and FET in the current study.

The nature of science

Understanding the nature of science has been regarded as one of the basic requirements for scientific literacy. In Science for all Americans (American Association for the Advancement of Science, 1989), the meaning and importance of the nature of science is extensively described. Duschl (1990) argued that educators' view of scientific theory is likely to be related to their method for selecting content and instructional strategy. This relationship has been further confirmed by Brickhouse (1990), Gallagher (1991) and Lederman and Zeidler (1987).

What science educators teach depends firstly on their scientific understandings and skills, on what they are able and willing to teach and on what they believe they are required to teach (Rens & Dekkers, 2001). Curriculum reform depends largely on the educators. Although it is not the aim of the current study, it is important to find out whether their understanding of the nature of science is in accordance with what they are required to teach (Dekkers & Mnisi, 2003). This will help determine the readiness and competence of the educators to deal with transition problems of learners in the field of natural sciences.

The relationship between student science learning and their understanding of the nature of science has caught the attention of science educators. It was found that students' views of science are significantly related to their knowledge integration and learning orientation methods (Songer & Linn, 1991; Tsai, 1998). Regarding my study, learner's knowledge integration and learning orientation may be related to their strategies and approaches for negotiating the transition, shedding light on research question 3.

The DoE (2002(b)) contends that one of the underlying differences between modern science and technology on the one hand and traditional and indigenous knowledge systems on the other hand, is the existence of different worldviews, with empiricism as the basis of the prevailing worldview of science. Empiricism claims that if something can be observed and measured in some way, it is real and can be used to explain how events happen in nature

(DoE, 2002(b)). Another worldview is that people are not separate from the earth and its living things, and that they believe all things have come from God or a creative being, and therefore have spiritual meaning. Traditional and indigenous knowledge systems and technologies have developed within this system of thought (DoE, 2002(b)). However, there is yet another worldview, that of post-positivism, which posits that human knowledge is not based on unchallengeable, rock-solid foundations, but rather is conjectural. Although there are firm grounds for asserting the beliefs that one may hold as a scientist, these grounds are not unquestionable, it may change in the light of further investigation (Phillips & Burbules, 2000). In fact, the Nature of Science includes the tentativeness of knowledge, also called the developmental nature of science (Klee, 1997).

2.2.3 Studies of transition from a learner's point of view

Murphy and Beggs (2001) suggest that the lack of experimental work and intensive preparation for national tests in Britain may contribute to learners' loss of interest in science. The loss of interest in science amongst girls may contribute to the well known phenomenon of girls' lower participation rate in Physical Science (Gerard & See, 2009).

In Australia, Speering and Rennie (1996) found that during transition there was a considerable change in the organisation of the school, the curriculum and the teacher-student relationship. They found that students in their study, especially girls, were generally unhappy with the teaching strategies used in their secondary science classrooms, and that they regretted the loss of the close teacher-student relationship of their primary school years. Their perceptions were that science in secondary school was not what they had expected, and this experience might have long term implications for subject and career choices (Speering & Rennie, 1996).

Again in Australia, White, Gunstone, Elterman, MacDonald, McKittrick, Mills and Mulhall (1995) reported that first year university Physics students found difficulty in adjusting to the teaching approaches at university and were frequently not certain about the functions of the various teaching situations. First-year undergraduates moved from a system where they were closer and had ready access to their educators, whose personalities and methods they knew and who in turn knew them well, and also where they were likely to be questioned and have their understandings monitored, to a system of detachment. There the educators would rarely recognise a student outside the lecture hall as a member of their class, let alone know a name or anything personal about him or her. In addition, interchanges between educator and individual students would be rare and the educators might test and judge students' progress from time-to-time but show students little concern over any lack of progress (White et al., 1995).

Vlaardingerbroek and Ros (1990) studied transition rates of learners in five developing countries where access is controlled between junior and senior secondary school. The movement of learners from one level in the school system to another was defined as the educational transition rate and expressed as the percentage of the cohort at the lower level that had reached the higher level. They set out to present one methodological approach that seemed useful for probing the relationship, if any, between developing countries' educational policies as reflected by transition rates at certain specific points in the school system and the academic quality of students entering senior secondary institutions. Data for testing the approach were obtained by:

- developing a test of basic mathematical ability that was considered a valid criterion for measuring the academic quality of learners entering upper secondary institution
- conducting a comparative study using transition rates and measures of academic quality obtained from five developing countries, namely, Liberia, Kenya, Papua New Guinea, Solomon Islands and Tanzania
- conducting a longitudinal study using transition rates and measures of academic quality obtained across a ten-year period in Papua New Guinea.

They showed that the less rigorous the selection at this point, the poorer the performance in basic mathematics.

2.2.4 Studies of transition from the teacher's point of view

In Great Britain, Dawson and Shipstone (1991) pointed to the positive role played by liaison teachers at the primary/secondary school interface. Some primary schools were engaged in science liaison with secondary schools. Schools could be engaged in science liaison in different ways, for example meetings, staff visits and exchanges, equipment borrowing, inter-school science clubs and joint in-service training (INSET). Both groups of educators (primary and secondary) gave the need for knowing each other's science courses as the most important reason for starting liaison. Primary educators were in particular conscious of having little knowledge of what science was being taught in secondary schools and therefore of being unable to make any accurate assessment of what science they should undertake to help children after transition. Both groups, who also saw liaison as offering mutual support, gave the need for curriculum consistency as an important reason and one leading to involvement of the wider community in the science the children were undertaking. Secondary educators, though, to a much greater extent than the primary educators, saw liaison as offering them the opportunity to improve their understanding of the cognitive needs and development of the children (Dawson & Shipstone, 1991).

Overton and Reiss (1990) highlighted the concern of teachers about a gap at the GCSE/ A-level interface. The General Certificate of Secondary Education (GCSE), a public examination open to students in England and Wales, is usually taken at age 16. It replaced GCE O-level and CSE examinations. Many educators referred to the existence of a 'quantum leap' between GCSE and A-level, some feeling that GCSE was simply an insufficient preparation for A-level Biology. Other educators felt it was time that A-level courses changed in the light of the gap at the GCSE/A-level interface. These educators argued that A-levels should place greater emphasis on process skills, with at least 20-percent practical assessment and a reduced theoretical content. Finally, a third group of educators felt that the leap required to go from GCSE to A-level had been much exaggerated. These educators argued that GCSE students might start A-levels knowing fewer biological facts, but would be better at data handling and more motivated. It is noteworthy that after this study on process skills, there was a decrease in the amount of content to be covered and a shift towards modularisation. These changes were likely to help students who had taken GCSE (Overton & Reiss, 1990).

2.2.5 Suggested solutions to transition problems

The following recommendations for facilitating successful systemic transitions have been made:

Preparedness

Preparedness as a multidimensional concept includes:

Academic preparedness – learners must have the knowledge and skills to succeed at the next level (Simmons & Blyth, 1987).

Independence – learners should be independent and should neither require direct teacher intervention nor direct supervision (Ward, Mergendoller, Tikunoff, Rounds, Mitman & Dadey, 1982).

Conformity to adult standards - learners should conform to adult standards of behaviour (Simmons & Blyth, 1987).

Coping mechanisms – when learners are skilled at using effective mechanisms for coping, they are likely to make successful systemic transitions (Snow, Gilchrist, Schilling, Schinke & Kelso, 1986).

Support

Kurita and Janzen (1996) have identified four types of support, namely:

Informational support – by merely providing learners with information about the transition can help them through it.

Tangible support – providing resources or services to learners can help them through transition.

Emotional support – Emotional support from parents and teachers can help learners through transition.

Social support – having friends at the same school can ease transitional difficulties.

Bridging the gap

Pietarinen (2000) suggests that the starting point for bridging the gap between primary and secondary school and forming a wider, undivided comprehensive school is to locate areas of shared interests. She suggests that these should not be limited to a particular school level but should seek to unite class teachers (from primary school) and subject teachers (from secondary school).

Improving continuity and progression

Studies of transitions from primary to secondary education have been conducted in England by Maurice Galton and his team based at the University of Cambridge. Galton et al. (1999) identified five areas of improvement:

- Bureaucratic: e.g. meetings between staff from primary and secondary schools.
- Social and personal: e.g. induction days, open evenings and the use of learners and parents as guides for new entrants to the secondary school.
- Curriculum: e.g. joint projects and training days for teachers, lessons taught by secondary school teachers in primary schools.
- Pedagogic: e.g. teacher exchanges, joint programmes to develop specific teaching and learning approaches.
- Management of learning: e.g. extended induction programmes in the secondary school that focus on aspects of learning skills, learners' self-assessment, and that recognize how learning in secondary school progresses from that in primary school.

Galton's team carried out a survey of 215 secondary schools in England that revealed that schools invested most effort in the bureaucratic and social or personal areas of action and that a few schools took actions relating to the establishment of curriculum or pedagogic bridges to improve continuity and progression in teaching and learning (Galton et al., 1999).

Bridging work

According to Braund and Hames (2005), a number of strategies are used by schools to address curricular and pedagogical discontinuities. These include:

- Co-observation of teaching.
- Improving teachers' knowledge of content taught each side of transfer (e.g. grade 9 Natural Science and grade 10 Physical Science).
- Shared assessment of learners' work.
- Jointly planned teaching.

It is in the last strategy that much recent attention and effort has been focused. The strategy would be to plan work that learners start at the end of primary school and continue and complete when they arrive at the secondary school (Braund & Hames, 2005). These schemes are described differently as transition units (Qualifications and Curriculum Authority, 2002), link projects (Davies & McMahon, 2004) and bridging units (Braund, 2002). There has been criticism of bridging work, however.

Criticism of bridging work

Galton's main criticism of bridging work can be summarised as follows (Galton, 2002):

- The breakdown of 'pyramids' where well-defined groups of primary schools transfer learners to just one secondary school meant that not all learners entering secondary school science classes would have covered the primary part of the bridging unit.
- Primary school teachers and their learners not being very keen about the use of bridging course material after the stresses of national examinations carried out in the last term of primary school and the revision period that preceded them.
- Primary school teachers not willing or not having time to mark work at the depth that would be helpful in allowing secondary teachers to develop and progress the topic.
- Some learners claiming that they rarely saw the work that had been transferred or that primary work was only referred to superficially and then the secondary teacher returned to the normal work.
- Learners entering secondary school expecting and looking forward to doing new things and leaving behind their primary school experience.

Criticism of the middle school concept

The following objections were voiced against the middle school concept (grades 7 to 10) where transition was delayed by two years in New Zealand included (Ward, 2000):

- Learners who enter secondary school at about age 13 (Year 9) embarked on a four or five year longitudinal program in each subject. As a consequence late entry into the programme (Year 11) interrupted the continuity of the programme's content and skills progression.
- In Year 11, learners sit for the first national examination, the New Zealand School Certificate. Learners who entered secondary school in Year 11 already had sufficient challenges in adapting to a new school environment.

- Learners from middle schools would be inadequately prepared for secondary programmes because middle schools did not have the qualified specialist subject teachers and laboratory resources of the secondary school.
- Middle school learners entering secondary school in Year 11 would find difficulty in being included socially and being part of a substantially different culture.

2.2.6 Attitude towards studies - another perspective on transition

Educational objectives in the affective domain, dealing with attitudes, interests and values, are of great importance and this is almost universally acknowledged (Choppin & Frankel, 1976). According to Schibeci (1984), science-related attitudes are subdivided into two major categories, namely, *attitudes to science* (e.g. interest in/enjoyment of science lessons), and *scientific attitudes* (dispositions such as tolerance of the views of others which scientists are presumed to display in their scientific work).

Researchers use *attitude to science* as a broad category that includes attitudes to science careers, science instruction, specific science issues and scientific processes (Schibeci, 1984). Many studies have reported a decline in attitudes with increasing grade level, including those of Ayers and Price (1975), Bohardt (1975), Johnson (1981), Sullivan (1979) and Yager (1983). Johnson (1981) noted that the decline in attitudes in the USA was more rapid among white students than amongst black ones. However, Aiken (1979) and Hobbs and Erikson (1980) have reported that attitudes did not decline with increasing grade level.

Studies in the USA and Australia show that positive attitudes towards science decrease throughout the school years, with the most dramatic change occurring during the transition from primary phase to the secondary phase (Schoon, Ross & Martin, 2007; Linn & Hyde, 1989). At the end of their primary school years, learners have a great deal of enthusiasm for science and its activities (Baird, Gunstone, Penna, Fensham & White, 1990), but fewer learners express the same enthusiasm for secondary science (Rosier & Banks, 1990). The decline in motivation towards science in secondary school is particularly disturbing as it is likely to have negative effects on the learners' career choices.

2.2.7 Determining transitional success and failure

Researchers have used several indicators, one being student grades, which may be low (Ward et al., 1982), or declining (Roderick, 1993). Ward et al. (1982) identified other indicators, namely the appropriateness of the student's post-transitional classroom behaviour, given the rules and norms operating in the classroom. A third indicator is the student's post-transitional social relationships with peers. A fourth indicator is the student's academic orientation in the post-transition classroom, which can be defined as correctness of oral responses to teacher questions and completion of assignments.

The first and fourth indicators are of most importance in the current study.

2.3 SOUTH AFRICAN STUDIES

Two relevant studies on C2005 are discussed below. In trying to solve problems arising out of the implementation of the C2005 in South Africa, Rogan and Grayson (2003) proposed a theory on the implementation of the learning area Natural Science. The Department of Education (DoE) also commissioned a report on the reasons for the low pass rate in grade 10 in 2003 (Reddy, Dlamini, and Ntshingila-Khosa, 2004).

2.3.1 The implementation of the Natural Science learning area of Curriculum 2005: an emerging theory

South Africa has developed a new curriculum, something not peculiar to the country but a common event across the world. These curricula are mostly well designed and the aims they are intended to achieve are often laudable. However, the attention and energies of policymakers and politicians are focused on the 'what' of desired educational change, neglecting the 'how' (Rogan & Grayson, 2003).

In trying to rescue the implementation problems faced by schools, Rogan and Grayson (2003) proposed a theory based on three constructs, namely, the profile of implementation, capacity to support innovation and support from outside agencies. These constructs share three characteristics:

- They can be measured by means of indicators.
- They are broad enough to encompass a number of related factors.
- They are narrow enough to include one main idea.

The nature of these constructs is given below. The theory is based on the learning environment as unit of analysis, i.e. learners, educators, curriculum and educational resources were considered for the theory. Their focus is based on what happened in the classroom. Classroom observation in the current study on transition was conducted against this background. A brief overview of constructs is given below.

Profile of implementation

This construct attempts to understand and express the extent to which the ideals set out in the curriculum proposal are being put into practice. However, it does assume that new criteria of excellence will emerge from the nature and values of the curriculum. For example, based on the old syllabus in South Africa, excellence of schools was judged primarily on one criterion only, the percentage pass rate on the external matriculation examination. Excellence, as seen from the perspective of C2005, will need to be determined by criteria that are in line with its values and expected outcomes, such as what learners are actually able to do at various points in their schooling (Rogan & Grayson, 2003).

Capacity to support innovation

The construct 'capacity to support innovation' is an attempt to understand and elaborate on the factors that are able to support, or hinder, the implementation of new ideas and practices in a system such as a school (Rogan & Grayson, 2003).

Support from outside agencies

Outside agencies are defined as organisations, including the DoE, that interact with a school in order to implement some kind of change (Rogan & Grayson, 2003). The emergent theory of Rogan and Grayson (2003) is put forward by means of a series of propositions, mostly based on the hypothesized inter-relationships between the three constructs. Outside Support should be organized in a way that ultimately improves the quality of the learning experience for learners. Capacity to innovate should be focused on the extent to which various factors can be considered for providing an enriched and more effective learning experience for learners. If, for example, teachers attend workshops on learner-centred teaching approaches but do not implement them, then the learning experience will not be provided to the learners. In the Profile of Implementation, assessment and use of resources should all be viewed in terms of how well they enrich the learning experience (Rogan & Grayson, 2003).

Since the current study on transition is taking place in a situation where OBE was being implemented, this theory will help put it in context.

2.3.2 Previous studies on transition in science education in South Africa

The DoE (2002(a)) admitted as early as 2002 that there were discontinuities between the curriculum followed by learners in the GET band and grade 10 (the first year of the FET band). Figure 2.1 shows that the highest repetition rate has been in grade 10 from 2001 to 2004. From 1997, OBE was implemented in the GET band but the content based curriculum was followed in the FET band. It was not until 2006 that Curriculum 2005 was replaced by the NCS and introduced in the FET band.

The Department of Education in South Africa commissioned a study on the reasons for the low pass rate in grade 10 in 2003. Reddy et al. (2004) undertook the study and published an extensive list of key findings regarding the period of transition between C2005 and the NCS.

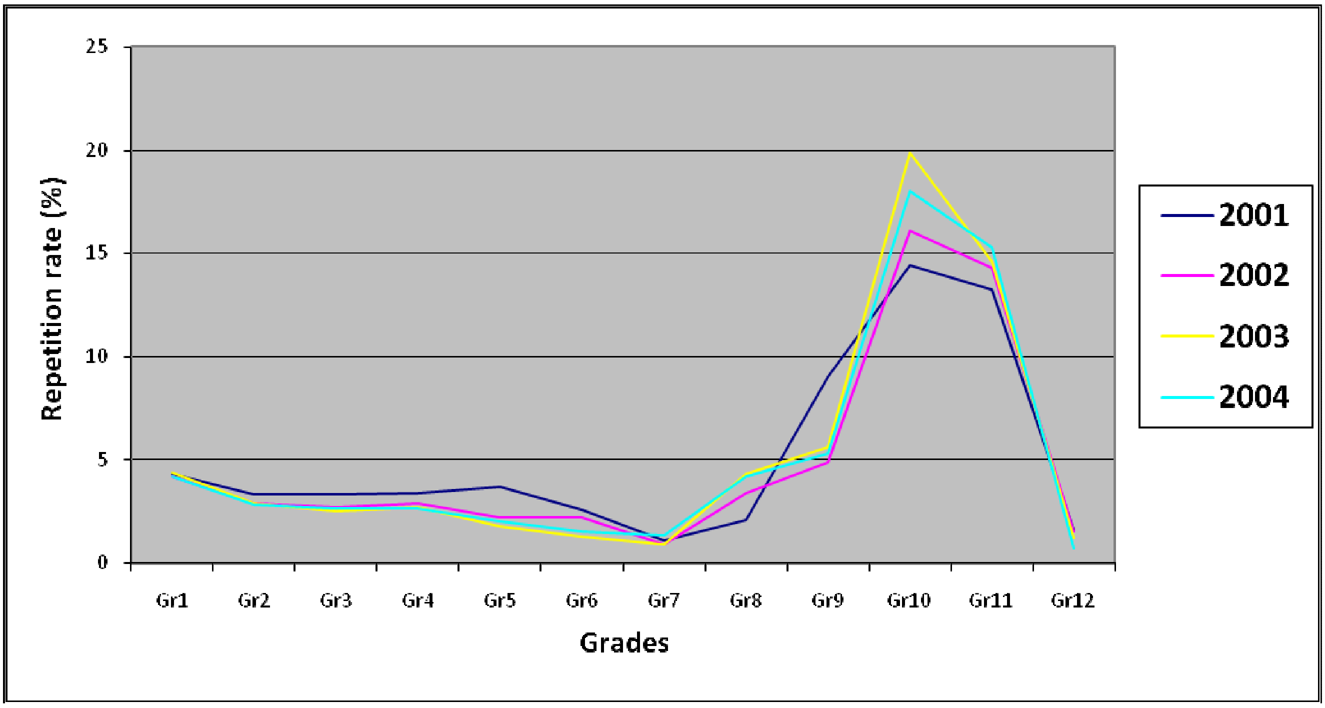

Figure 2.1 The repetition rate from 2001 to 2004. Data source: GDE (Annual Report 2004/2005)

Key Findings

- **Philosophy of the transition phase**

1. There seemed to have been two objectives for the 'transition phase'
   - to infuse the principles of OBE into the FET band and
   - to assist teachers to fill knowledge gaps as a result of moving from an OBE system to a content based system (Résumé of Instructional Programmes in Public Ordinary School, commonly known as NATED 550 (Department of National Education, 1989)).

   They found this to have been over-ambitious and maintained that it would have been less confusing to keep to one aim, viz. filling the knowledge gaps.

2. There seemed to be a tension between the responsibilities of the national DoE and provincial Departments of Education. The DoE gave tight deadlines for the transition and provincial departments felt there was not enough support. Provinces

also felt that the implementation of OBE in Grade 10 was an additional responsibility to their other functions.

3. There was not a strong basis in the educational system of how to manage curriculum change. They noted that South Africa had had many curriculum change processes but did not seem to have a strong body of knowledge of how the process worked.

- **Structures and responsibilities**

4. They found that structural issues between the DoE and provincial departments and within the provinces did not facilitate easy coordination, communication or monitoring. This was evident by, for example, GET and FET directorates not communicating with each other to coordinate the transition process, which involved both directorates. It was sad to note that this pattern existed from the DoE to the classroom level where the grade 9 educator did not communicate with the grade 10 educator in terms of teaching and learning issues. Evidence collected showed that there was no handover of the grade 10 learner by the grade 9 educator in almost all provinces.

- **Enrolments, pass rates and throughputs**

5. Analysis of enrolment rates showed an increase of around 130 000 learners from 2001 to 2003. This was a great expansion of the system and if there had not been a concomitant increase in resources and support, then quality was bound to have decreased.

- **Curriculum**

6. The central hypothesis for the grade 10 results dropping had been the role of OBE. However, the research team’s analysis indicated that the learner only experienced 3 years of OBE in his/her schooling career. This seemed to suggest that the reasons for the drop might have been located in the broader issues of educational quality and that required a deeper investigation.

7. There were gaps between the GET OBE curriculum and the FET NATED curriculum and that was to be expected given the difference of the two approaches. There was a great deal of pressure on the grade 10 teacher to fill those gaps, to teach extra 'content' in the same timeframe, and to infuse OBE principles.

8. There was uncertainty about how the grade 12 examination would look in 2005, whether similar to the traditional matriculation examination or based on OBE principles.

- **Cascade model of training**

9. The DoE used a cascade model to implement the decisions for an OBE model in grade 10. This model was found not to be working well. It raised issues of the chain of responsibility and the viability of the cascade model in implementing curriculum change.

10. The cascade model was hastily prepared and not implemented correctly.

11. The research team found no evidence of the DoE consulting provincial departments in terms of the logistical requirements of, and the capacity required to coordinate and monitor the process. This resulted in poor coordination in provinces, lack of proper communication to all levels within the system and no monitoring of the process right from the DoE to the classroom. There was also very little communication to empower the senior management teams ready for the cascade process. This resulted in some principals refusing to release teachers to attend training.

12. The training consisted of a higher amount of generic than specific training and therefore did not give guidance on how teachers could cope in the classroom.

13. They noted that lots of work was done in planning something new, but the same energy did not seem to be involved in seeing through implementation. They argued

that ultimately even the best policies would have succeeded or failed depending on the attention given to the implementation strategies.

14. There seemed to be a single package designed for different situations. For example, in KwaZulu Natal (KZN), the rural dynamic meant a different model of training ought to have been planned.

In the light of the above findings, the research team made recommendations, some of which are listed below (Reddy et al., 2004):

Recommendations

1. It is important that there is an alignment between the grades 9 and 10 assessment systems so as to not disadvantage the learners.

2. Teachers in the FET phase should concentrate more on filling the knowledge gaps than infusing the principles of OBE in the curriculum.

3. Since 1994, South Africa has been involved in curriculum changes to Curriculum 2005, followed by the RNCS and NCS. For the transitions between curricula, the cascade model of training has, however, been problematic. This was further compounded in the rushed and under-resourced manner in which the training was done. The issues of managing curriculum change in a large system are very complex and complicated and require much planning and many resources. There should be greater thought, planning and resources given to the implementation phase.

4. As the country moved towards the process of implementation of the NCS in 2006 for the FET system, the lessons of the implementation models used for the transition phase (and possibly the RNCS) should be examined and a more thorough model developed.

5. Ensure that the training packages are differentiated to meet the different contextual realities. A “one size fits all” model does not work.

6. In training for the future FET curriculum, ensure that the training consists more of what would be relevant to teachers in the classroom than broad, generic principles.

7. There should be monitoring in the schools to see what happens in schools.

8. The issues of implementation are key to the success in effecting curriculum change. Therefore there must be many more resources for this aspect of the curriculum change process.

2.3.3 Transition within transition

The following unique set-up in education in South Africa must also be taken note of when studying transitions:

There are different types of institutions. These are pre-primary, primary, intermediate/middle, secondary and university. With the introduction of the new curriculum (OBE), the following phases were also introduced:

- Early Childhood Development (from birth to grade 0)
- Foundation phase: grade 1 – grade 3
- Intermediate phase: grade 4 – grade 6
- Senior phase: grade 7 – grade 9
- FET phase: grade 10 – grade 12

Table 2.1 shows the number of schools in Gauteng offering particular ranges of grades. Some of the phases overlap into different types of institutions. For example, most primary schools offer tuition up to grade 7, which is the first year of the senior phase (refer to Table 2.1). When a learner proceeds to grade 8 to continue with the senior phase, s/he has to go to a different school with a different culture of teaching and learning. This exposes the learner to the dangers that Braund and Hames (2005) referred to, namely:

> *A new, larger and more challenging environment, new friendship groupings, new teachers and new rules that will make demands on the learner as well as the fear of the unknown after transfer to a new school.*

Table 2.1 Schools in the Gauteng province according to lowest and highest grade (2006)

	Public ordinary schooling – schools according to lowest and highest grade												
	Foundation Phase			Intermediate Phase			Senior Phase			Further Education and Training phase			
	Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Gr 9	Gr 10	Gr 11	Gr 12	Total
Gr 1			8	62	5	66	1024	41	24	1		33	1264
Gr 2								3					3
Gr 3							1						1
Gr 4						1	5		1				7
Gr 5							43	1	1				45
Gr 6													1
Gr 7									25				28
Gr 8									9	4	2	440	455
Gr 9													4
Gr10													20
Total			8	62	5	67	1073	45	60	5	2	501	1828

Note: The grades (Gr) in the left-hand column indicate lowest grade available in each school, and the grades (Gr) along the top row indicate the highest grade. Adapted from the Annual Survey of Schools (2006) in the Annual Performance Plan 2007/08 to 2009/10 (GDE, 2008). It must be noted, however, that by some mistake, the numbers under the grade 12 column in Table 2.1 do not add up to 501 – and this is so from the source.

The importance of Table 2.1 is that it helps with the understanding of the breakdown of grades within phases across the schools of Gauteng. From the table it can be seen that the majority (1073 out of 1828) of schools in the Gauteng province offer tuition up to grade 7, the first year of the senior phase, and that only 51 schools out of 1 828 offer the full complement of grades in the senior phase (grades 7 – 9). Most learners, therefore, have to be transferred from one school to another within the senior phase.

Throughout the senior phase, learners were taught according to C2005, where content was left almost entirely to the discretion of the teacher and the school while the grade 10 – 12 curriculum was content based. Up to 2005, the old content based curriculum taken over from the previous dispensation was still in place in the FET. When the NCS was introduced in the FET in 2006, content was again specified, this time by the Assessment Standards in Physical Science which gave an indication of content. Learning Area statements specified content that needed to be included and outcomes encouraged local applications of content. Consequently learners who graduated from the outcomes based grade 9 in 2005 had to enrol for grade 10 Physical Science, in which content that had to be included was specified. The senior phase learner in South Africa was therefore faced with double transition problems: those within the senior phase and those across the senior phase/FET interface. He or she had to cross the border from grade 7 at primary school to grade 8 at a new secondary school where s/he was to complete the senior phase and then proceed to a new phase, namely FET, in grade 10.

2.4 THEORETICAL FRAMEWORK

The theoretical framework that was used to understand the issues in this study was adapted from the model developed by Rollnick et al. (1998) that provides a basis for investigating gaps in education.

There are studies that link transition problems to gaps between consecutive phases in education. For example, the transition from high school to university may appear so severe that a substantial proportion of students fail to cope with their first-year chemistry courses (Bradley, Brand & Langley, 1985). This has been attributed to a gap between high school and university chemistry (Cantrell, Kouwenhoven, Mokoena & Thijs, (eds), 1993). Grayson (1996) states that it is common to speak of a gap between high school and university and that this gap exists for all students coming largely from the highly authoritarian and disciplinarian type of schooling. It is therefore necessary to build into the theoretical framework the conceptualisation of the gap in the levels of education.

Crowther et al. (1995, p. 486) define a gap as “an opening or a break in something or between two things or a lack of something that is needed”. Grayson (1996) refers to the gap between high school and university as “a discontinuity between the attitudes to learning, amount of work, intellectual environment and other factors encountered” (Grayson, 1996, p. 993). Rollnick et al. (1998) developed a model providing a basis for investigating gaps holistically. The current study used the word ‘gap’ as conceptualised in the adapted model by Rollnick et al. (1998), as shown in Figure 2.2.

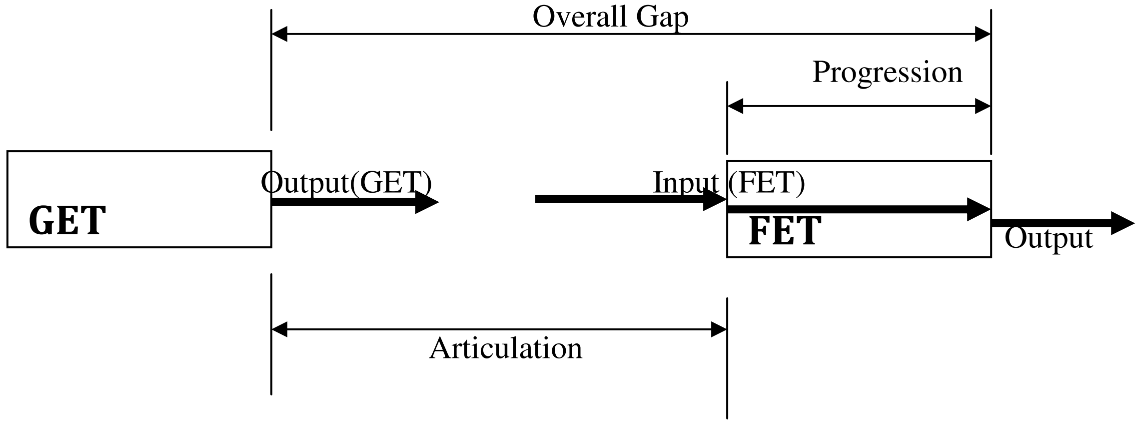

Fig. 2.2 Aspects of a gap adapted from Rollnick et al., 1998

The gap is being identified on the basis of a mismatch between the output of one level and the input of the next level in the education system, namely, GET and FET as shown in Fig.2.2. This is, however, blurred by two possible contributing aspects that may exist, namely, a momentary and a longitudinal aspect. A gap can be characterised by what happens at the interface between the two levels: between the end of one stage (grade 9) and the beginning of the next stage (grade 10). This is referred to as the *articulation*. A gap may also be characterised by what happens within the latter educational stage (FET), referred to as the *progression* or lack thereof during the stage. The two aspects, articulation and progression combined, will be referred to as the *overall* gap. The presumed gap will therefore be explored by the extent to which grade 9 is aligned with grade 10, and then by the nature of the throughput during the FET phase.

The first research question aimed to describe the characteristics of the transition in an objective way. At the articulation of the gap, I investigated whether the knowledge output of the GET phase matches the knowledge input required for the FET phase. Furthermore, I investigated differences in the GET and FET curricula, assessment practices and teaching strategies that could perpetuate throughout the progression of the FET.

The second research question aimed to explore the transitional experiences from the learners' perspective. Changing interest in science at the articulation as well as during the progression of the gap were investigated, while performance, conceptual understanding and relationships with teachers were explored throughout the progression of the gap to capture a rich, detailed image of learner's experiences of the transition.

The third research question explored learners' strategies to deal with the transition throughout the progression of the gap. Performance, epistemological orientation, problem solving skills and career choices were explored as indicators of learners' coping.

It is within this framework of a gap that I explored the transition from Natural Science in the GET phase to Physical Science in the FET phase at the time of a changing curriculum. Important, the existence of the overall gap was presumed. I did not try to prove the existence of the gap, but rather to describe the characteristics of the gap, the learners' experiences of the gap and their strategies to cope with the demands of the gap. The theoretical framework provided a structure against which I explored how the characteristics of the transition at the articulation and progression throughout the gap contributed to the learners' experiences and how they managed these experiences throughout the progression of the gap.

2.5 WAY FORWARD

The focus of this study is learner experiences in the transition from the General Education and Training band to the Further Education and Training band in the sciences. So a longitudinal study was conducted from the learners' perspective. In trying to understand the learner experiences, it was important not only to include their perspective, but also their learning environment. Therefore, documentation and classroom observation were used to provide the background to understand learners' experiences. To explore learners' experiences, various instruments were employed to assess performance, conceptual understanding, knowledge of the Nature of Science, and interest in science.

2.6 CHAPTER SUMMARY

This chapter reviewed literature on transitions in education, transitional problems and suggested solutions. International studies on transition in science were discussed from the perspective of the curriculum, the teachers, the learners and attitudes towards studies. A number of recommendations from previous studies were discussed and a critique of some of them was given. Motivation for studying transition in science education was given, that is conflicting aims to teaching science, the nature of science and different epistemological beliefs. I also discussed an emerging theory on the implementation of the Natural Science learning area of Curriculum 2005 and a study on the high grade 10 failure rate. Finally, a model on gaps in education developed by Rollnick et al. (1998) was discussed to provide a theoretical framework for the study.