A SUPPORT PROGRAMME FOR FIRST-YEAR CHEMISTRY STUDENTS: A CAMPUS CASE STUDY

by

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DECLARATION

I declare that this mini-dissertation, hereby submitted by me for the M.A. (H.E.S.) degree at the University of the Free State is my own independent work and has not been previously submitted by me at any other university, faculty or department. Furthermore, I cede copyright of this mini-dissertation in favour of the University of the Free State.

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SIGNATURE **DATE**

(MR. RANTOOA G. MOJI)

DEDICATION

To God be the glory for giving me the strength and wisdom to see this project through!
To my dad, Ntate Ntsu Moji, for believing in me even when I did not.

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LIST OF ACRONYMS

CHE	Council on Higher Education
DHET	Department of Higher Education and Training
HSRC	Human Science Research Council
NATP	New Academic Tutorial Program
PAL	Peer Assisted Learning
PLTL	Peer-Led Team Learning
PBL	Problem Based Learning
RBL	Resource Based Learning
SI	Supplemental Learning
UFS	University of the Free State

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ABSTRACT

Key words: Support programme, academic performance, first-year Chemistry teaching and learning, assessment practices.

Chemistry is often regarded as a difficult subject, which is reflected in the high failure rates of university first-year students. These students are faced by diverse challenges such as the difficult and abstract nature of the subject, lack of interest in and motivation for this subject, irrelevant prior knowledge or misconceptions, large classes, and the application in the world of work. The success rate of first-year Chemistry students at the UFS (Qwaqwa campus) has also been unsatisfactory for some years and that adversely affected the through-put rates of the Faculty of Natural and Agricultural Sciences. This made it necessary to embark on a study to establish what could be the root causes of this problem and propose a possible way to remedy the situation. In order to address this problem, this study was designed to address the following main research question: What are first-year students' and lecturers' experiences of the teaching, learning and assessment employed in the Chemistry subject (i.e. CEM104) and how can possible shortcomings be addressed?

This study used an adapted explanatory mixed methods design to address the main research question, using qualitative findings (from focus groups and semi-structured interviews) to explain the quantitative findings from the self-constructed questionnaire. Hundred and thirteen first-year Chemistry students (UFS, QwaQwa campus) participated in the questionnaire survey, while two focus groups were conducted and two lecturers were interviewed. In essence, the data revealed that both first-year Chemistry students and lecturers at the UFS (QwaQwa campus) perceived learning, teaching and assessment deficiencies, but the determinant factors/reasons for these were diverse. The participants, however, recognised the need for a support programme as well as various additional facilities (e.g. computers, e-mail, internet, library services and textbooks, academic support and a departmental manual) to improve the academic performance of first-year Chemistry students.

CHAPTER 1
ORIENTATION

1.1 INTRODUCTION, BACKGROUND AND PROBLEM STATEMENT

Worldwide, including South African higher education, it has been recognized that the extended length of completion rates and the high percentage of students terminating their studies (especially with regard to first-year students) are a major concern (Pitkethly & Prosser 2001; Scott, Yeld & Hendry 2007; the Department of Higher Education and Training (DHET) 2010). Pitkethly and Prosser (2001:186) indicated that "in Australia, approximately one third of all students entering university fail to graduate, and approximately half of those who withdraw do so in their first-year". In the same way Scott, Yeld and Hendry (2007:2) noted that "there has long been awareness of unsatisfactory student performance patterns in the higher education sector, particularly in relation to first-year attrition." These authors stated that in South Africa a study of the 2000 cohort by the Department of Education found that at "the end of 2004 only 30% of the total first-time entering student intake into the sector had graduated. 56% of the intake had left their original institutions without graduating and 14% were still in the system" (Scott *et al.* 2007:12). The DHET (2010) in South Africa mentioned student success as a major challenge facing the university sector, with student under-preparedness, coupled with high dropout and poor completion rates, as a cause for concern. The following statements indicate the impact of student success on various stakeholders:

- "How long it takes to graduate and who leaves a university without completing a degree, are issues which matter to students and their families, to higher education institutions and to the government as the main funder of higher education." (CHE 2010:6).
- Davidowitz and Rollnick (2005) said that failure does not only frustrate students, but it also affects the income of the institution.

It is apparent, therefore, that addressing this problem of students not being academically successful is to the benefit of all concerned with the business of higher education.

The focus of this study was on student success in first-year Chemistry, which is seen internationally as being among those courses that students struggle with. The following statements by various researchers/authors from across the globe highlight this issue:

- "The department has concerns about a high failure rate for new entrant students enrolled in first-year Chemistry, deemed to be out of line with international trends" (Coll, Ali, Bonato & Rohindra 2006:366).
- "Chemistry is often regarded as a difficult subject an observation that sometimes repels learners from continuing with studies in Chemistry" (Sirhan 2007:3).
- "A low rate of student success is a widespread and persistent characteristic of college general Chemistry" (McFate & Olmsted 1999:562).
- "During the early 1990s the combined drop-out and failure rate in the Department of Chemistry at the University of Manchester was approximately 20% of its total first-year intake. This clearly indicated that first-year Chemistry was a 'high risk' course" (Coe, McDougall & McKeown 1999:72).

This problem of low pass rates in first-year Chemistry is also evident at the Qwaqwa campus of the University of the Free State (UFS). For example, the pass rate for CEM104 from 2007 to 2009 was between 30% and 40% (UFS Qwaqwa 2010). This is a more worrying factor given the limited choice of courses at such a small campus, with students registering for a course just to try to collect enough credits to complete their degrees. These statistics confirmed the existence of a problem, but fail to explain what is at the root of the problem.

In addition, first-year Chemistry serves as a prerequisite to a number of other courses. Thus failure of first-year Chemistry can have a significant impact on the academic progress of the student; for example, those students who depend on the National Students' Financial Aid Scheme (NSFAS) for financial support have to meet a certain level of academic achievement to qualify for continued support (they thus are under tremendous pressure to succeed). Success or failure in first-year Chemistry therefore might have a bearing on whether the students continue with their studies or not, which may have diverse implications for higher education institutions.

It is apparent that first-year Chemistry at UFS (Qwaqwa) needed to be addressed in a systematic and scientific manner. This study was initiated in order to provide a scientific explanation for the observed failure rate, and to suggest possible solutions based on proper research findings.

This chapter highlighted the research problem, followed by the subsidiary questions, the aims and objectives of the study. Then the study was demarcated, while main concepts were defined to prevent any possible misinterpretations. The research design and methodology were specified as well as a brief overview of the chapters that will constitute this study, was provided.

1.2 RESEARCH QUESTIONS

In order to solve the research problem, answers had to be found to the following main and subsidiary research questions.

1.2.1 Main research question

What is first-year students' and lecturers' experiences of the teaching, learning and assessment practices employed in the Chemistry subject (i.e. CEM104) and how can possible shortcomings be addressed?

1.2.2 Subsidiary questions

The following subsidiary questions were asked:

- Which teaching, learning and assessment problems are encountered by first-year Chemistry students?
- What are first-year student's perceptions about their problems in learning Chemistry?
- What are the lecturers' perceptions on the problems of students in learning Chemistry?
- How do first-year students experience the current teaching, learning and assessment practices in Chemistry?
- How do first-year Chemistry lecturers experience the current teaching, learning and assessment practices being employed?

1.3 AIM AND OBJECTIVES OF THE RESEARCH

The aim of this study was to study the perceptions of both the students and lecturers regarding barriers to success in the first-year Chemistry course(s) at the UFS (Qwaqwa campus), and to recommend a support programme to alleviate the problem of poor success rate(s) in first-year Chemistry. In order to achieve this aim, the following research objectives were formulated:

- To undertake a comprehensive literature review on the teaching, learning and assessment problems encountered by first-year Chemistry students;
- to investigate and critically analyse the dual perceptions of fist-year Chemistry students and lecturers (as measured against the guidelines from literature) by means of a questionnaire, focus group discussions and semi-structured interviews;
- to suggest a support programme to remedy first-year Chemistry students' teaching, learning and assessment problems at QwaQwa campus (UFS).

1.4 SIGNIFICANCE OF THE RESEARCH

The purpose of this section is captured by Creswell (2003:149) when he said that the "purpose of a significance section is to elaborate on the importance and implications of a study for researchers, practitioners, and policy makers". The transition from high school to university holds diverse changes, complexities and challenges for first-year students. In addition, first-year Chemistry is regarded as a difficult subject with high failure rates (see 1.1). The overarching purpose of this study is to alleviate the problem of poor success rates in first-year Chemistry at the UFS (Qwaqwa campus).To do this, the teaching, learning and assessment practices were investigated aimed at the improvement and expansion of the support and academic network for future UFS (QwaQwa campus) first-year Chemistry students, not only to provide a conducive learning environment, but also to tackle teaching-learning practices at the UFS in order to optimise student learning.

1.5 DERMACATION OF THE STUDY

Student success in higher education is no longer the concern of only the students (as key players and/or clients), but also of the higher education institutions. This study, which is in the field of higher education, is concerned with one of Tight's (2003:7) themes, namely, student experiences, with the focus on success and non-completion of first-year Chemistry students. The study was undertaken at the Qwaqwa campus of the UFS. All the students registered for CEM104 in 2010, and two lecturers (who were responsible for first-year courses between 2010 and 2012) were involved. The data were collected using a self-constructed questionnaire as well as focus group discussions for students and semi-structured interviews for lecturers.

1.6 CLARIFICATION OF CONCEPTS

The following concepts, in alphabetical order, need clarification because of their particular interpretation in the context of this study.

1.6.1 Outcomes-based assessment

"Outcomes-based assessment" is defined "as the identification, collection and interpretation of a student's performance measured against the outcomes of the specific qualification" (UFS 2006:2). Student success will thus imply that "appropriate assessment instruments" have been applied, which concurrently can be applied for "lifelong learning" encouragement (UFS 2006:2). (See more details in 2.3.2.5.)

1.6.2 First-year Chemistry student

In the study this refers to all students registered for first-year level courses in the Chemistry Department at the UFS (Qwaqwa campus), irrespective of whether they are repeating the course or not.

1.6.3 Support programme

Support programme refers to an "educational programme intended to improve the academic performance of students and to provide early academic assistance to students who actually are at risk of not succeeding" (Garfield 2010:491).

1.6.4 Teaching and learning

Many different descriptions for the concept "teaching and learning" exist. For the purpose of this study the UFS Teaching and Learning Policy (2008) will be the basis for the interpretation of this concept from a constructivist paradigm (see Chapter 2). In this study it has a bearing on "all staff and students in the undergraduate" (UFS 2008:1) first-year Chemistry programme, in which "a learning-centred and knowledge-based teaching-learning environment is promoted" (UFS 2008:3). In addition, "quality teaching to induce effective learning is characterised not only by an active involvement, but also by a self-directed and self-regulated approach to learning. Effective learning presupposes a learning process that allows students to become active participants, directing their own learning. Efforts to attain such active involvement should be contextualised and included at programme, curriculum and module level." (UFS 2008:5).

1.7 RESEARCH DESIGN AND METHODOLOGY

This study applied a case study research design. Bromley (in Maree 2007:75) defined a case study "... as a systematic inquiry into an event or a set of related events, which aims to describe and explain the phenomenon of interest". Therefore, this study examines the teaching, learning and assessment practices to explain the problem of student failure in first-year Chemistry.

The aim of this study (see 1.3) was achieved by using both quantitative and qualitative approaches. For the quantitative research approach a self-constructed questionnaire (see Appendix A) was used for data gathering, while for the qualitative approach focus group discussions with first-year Chemistry students (see Appendix B) and semi-structured interviews with first-year Chemistry lecturers (see Appendix C) at the UFS (QwaQwa campus) were employed. Therefore, this is classified as an adapted sequential explanatory mixed-method approach (see 3.2.2), since the focus group and interview findings (qualitative) helped to clarify questionnaire (quantitative) results (Maree 2007).

1.7.1 Paradigmatic perspective

A paradigm is defined as "a set of assumptions or beliefs about fundamental aspects of reality which gives rise to a particular world-view" (Maree 2007:47). Schwartz and Ogilvy (as quoted by Maree 2007:48) added that "paradigms enable us to tell a coherent story by depicting a world that is meaningful and functional, but culturally subjective". In this study the literature review was based on Constructivist paradigm principles (see Chapter 2), while this study's empirical investigation followed an interpretivist and post-positivist paradigm due to the combined quantitative and qualitative approaches (Maree 2007:21; 65-66).

The interpretive paradigm is based on the assumption that "individuals develop subjective meanings of their experiences in their attempt to understand the world in which they live" (Creswell 2003:8). This author further pointed out that those meanings are varied; thus, the goal of research in this paradigm is to rely on the participants' views of the situation being studied rather than confining meaning to a few categories. Gephart (1999:4) expanded on Creswell's views when he said "interpretivists assume that knowledge and meaning are acts of interpretation hence there is no objective knowledge which is independent of thinking, reasoning humans". The researcher's interpretive intention in this study is to understand the perceptions of first-year Chemistry students and lecturers with regard to teaching and learning (including assessment) and the influence of teaching and learning on the academic performance within the context of a particular institution, in this case the UFS, QwaQwa campus (*cf.* Plano Clark & Creswell 2008:365-368; Maree 2007:65). These views were gathered through questionnaires, focus group discussions and semi-structured interviews with participants (see 1.7.3).

Parts of the post-positivistic components were also present due to qualitative approaches (i.e. open-ended questions of questionnaire, focus groups and semi-structured interviews), where human behaviour (i.e. thinking, feeling) is still important although not observable, as stressed by literature (Maree 2007:65; Mertens 2010:11). Maree (2007:65; 263) further states that, for the mixed methods, pragmatism is the best philosophical foundation that justifies using the combined qualitative and quantitative methods in this study.

1.7.2 Mode of research

In this study a combined quantitative and qualitative mode of research was employed, as it is the most suitable approach to produce "more in-depth understanding" of first-year Chemistry students' experiences at the UFS (QwaQwa campus) (*cf.* Maree 2007:261).

1.7.3 Data collection techniques

Three data collection techniques were used in this study (see 3.2.4), namely a self-constructed questionnaire (mainly quantitative, complemented by qualitative elements), followed by qualitative focus groups to close the gaps emanating from the questionnaire analysis, while semi-structured interviews were conducted with the lecturing staff as they were regarded as having expert insight into the problem.

1.7.4 Data analysis and reporting

Data analysis is defined as 'those procedures which enable you to organise and make sense of the data in order to produce findings and an overall understanding of the case" (Simons 2009:117). In mixed methods "analysis occurs both within the quantitative and the qualitative approaches, and often between the approaches" (Creswell 2003:220). In this study (see 3.2.5; 3.2.6), the quantitative data from the questionnaires were analysed using the mean percentage of each response category in table format. Meanwhile, the qualitative data from the focus groups and semi-structured interviews were collated through thematic analysis and then reported (see 4.3; 4.4) - thus "… not imposed by the researcher" (Dawson 2009:119). The data collected through the interviews were also used for data triangulation (see 3.2.7; 4.6).

1.7.5 The sample of the study

The population for this study consisted of all enrolled first-year Chemistry students (i.e. CEM104 (2010) about 120 and CHE142 (2011) about 130 students) at the UFS (Qwaqwa campus). The CEM104 course was discontinued in 2011 and was replaced by CHE142, hence the use of students registered for CHE142 in 2011. As well as all the first-year Chemistry lecturers involved in first-year teaching in 2011. Questionnaires were completed during class. Although all these students were invited to the focus groups, only a limited number of students participated in the focus group discussions due to the examination and the nature of the focus group.

1.7.6 Ethical considerations

The study adhered to the following ethical principles, amongst others (Creswell 2003):

- The identification of a problem that will benefit the participants.
- Informed and voluntary participation in the study.
- Guaranteed anonymity for participants.
- Request for permission from persons in authority.

The researcher obtained formal written consent from the Departmental Head before proceeding with the research (see Appendix D). Then the participants were informed about the purpose and intentions of the study (as well as that their identity would be protected; thus anonymous participation). In order to ensure this, the identity of the participants was kept strictly confidential by coding personal identification information of the questionnaire and by obtaining voluntary permission for recording the semi-structured interviews strictly for research purposes.

1.7.7 Role of the researcher

The researcher in this study is also involved in lecturing first-year Chemistry courses. Thus this study can be regarded as “backyard” research (*cf.* Creswell 2003:184) with the researcher considered as an insider (Dwyer & Buckle 2009). Like any type of research this research has its advantages and its disadvantages; the steps taken to address the trustworthiness of this study (see 1.9, 3.2.7) will militate against the disadvantages inherent in this type of research.

1.7.8 Limitations of the research

The study was limited to the Qwaqwa campus of the UFS, because of ease of access (since the researcher was a member of the Chemistry department on this campus). The fact that students at the main campus of the UFS did not do the same Chemistry courses at first-year level also contributed to this limitation and therefore their exclusion. The results of the study cannot be transferable, because they are related only to the case that had been studied. Another limitation was that most of the first-year Chemistry students were pre-occupied with the examination and thus were not keen to participate in the focus groups (see 3.2.4.2; 4.4; 4.7).

1.7.9 Trustworthiness of the research

Lincoln and Guba (as quoted by Maree 2007:97) maintain that trustworthiness refers to the way in which the inquirer is able to persuade the audience that the findings in the study are worth paying attention to and that the research is of high quality. The researcher undertook steps to ensure the following are addressed in order to enhance the trustworthiness of the study, namely validity, reliability, objectivity, and transferability. These aspects are expanded on in 3.2.7.

1.8 LAYOUT OF CHAPTERS

This first chapter of this study introduced and outlined the research rationale; the methodology used in investigating the research problem, and clarified the terminology used. The study is then divided into two sections, namely the literature review and the empirical study:

Chapter two reviews the literature on selected aspects related to teaching, learning and assessment practices with regard to support programmes for first-year Chemistry students.

Chapter three provides a detailed description of the research design, methodology and procedures employed for obtaining, processing, analysing and interpreting the data.

Chapter four brings the reader the findings of the study and the interpretation thereof.

Chapter five provides a summary of the findings of the research study. In this section, the conclusions and limitations of the study are also raised. This chapter concludes with a proposed support programme for first-year Chemistry teaching and learning (including assessment) at the UFS (Qwaqwa campus).

1.9 CONLUSION

This chapter provided a brief theoretical background to the study and continued to define the problem. The research questions (main and subsidiary), and the aim and objectives of the study were explicitly stated. Then the chapter also demarcated the study, briefly provided information on the research design and methodology and concluded by outlining the rest of the report in chapters.

The next chapter describes the literature review of support programmes for first-year Chemistry students.

CHAPTER 2

THE TEACHING, LEARNING AND ASSESSMENT OF FIRST-YEAR CHEMISTRY

"Teaching and learning are not synonymous; we can teach, and teach well, without having students learn" (Bodner 1986:873)

2.1 INTRODUCTION

Student success within the higher education context is paramount as already stipulated (see 1.1). This study is concerned with identifying learning and teaching problems that may lead to the high failure and/or dropout rate(s) of first-year Chemistry students. Based on the literature review reported on in this chapter and the empirical study (see Chapter 4) this study aimed to propose a support programme to assist UFS (QwaQwa campus) first-year Chemistry students to counter the adverse effects of identified problems (see Chapter 5).

This chapter, which is a report on the literature review, focuses on conceptualising learning, teaching and assessing first-year Chemistry based on Constructivism (as seen by the researcher as the starting point of this chapter). This was followed by factors that adversely affect learning in a first-year Chemistry course (with special reference to teaching and assessment practices). Finally, support programme(s) that could enhance learning of first-year Chemistry, and alternatively that may mitigate the effects of these identified factors, are discussed.

2.2 CONSTRUCTIVISM

As already stipulated this study followed the Constructivist approach (see 1.7.1). This approach is based on the philosophy of Edmund Husserl's phenomenology and Wihelm Dilthey's and other German philosophers' study of interpretive understanding called

Hermeneutics (i.e. study of interpretive understanding or meaning)" (Eichelberger 1989; Mertens 2010). According to Bodner (1986:873), a constructivist model/theory can be summarized in one sentence: "*Knowledge is constructed in the mind of the learner.*" In addition, Constructivism's fundamental basis is evident in the following principles:

- Knowledge is not passively received, but actively built up by the cognizing subject, and
- the function of cognition is adaptive and serves organisation of the experiential world, not the discovery of ontological reality (Wheatly as quoted by Coll & Taylor 2001).

These principles affirm the assertion by von Glaserfeld as quoted by Bodner (1986:874) that "... learners construct understanding and do not simply mirror and reflect what they are told or what they read. Therefore, learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information." This linked with Daniel, Jenaro, Antonio, Antonio, De Carvalho, Torregrosa, Salinas, Pablo, Eduardo, Anna, Andree, Hugo and Romulo (2002) who viewed a constructivist approach in science education as a proposal that contemplates active participation of students in the knowledge construction and not a simple personal reconstruction of previously elaborated knowledge provided by the teacher or textbook. It is apparent from the above-mentioned statements that the constructivists view the student as an active role player in the learning process and not just a mere passive receiver of information. Therefore Constructivism puts the student and not the lecturer at the centre of the learning process and it hopes to bring back the learning into the teaching.

Additionally in Constructivism a learner's role is best explained by the metaphor that views the learner as a novice researcher rather than a scientist, where a novice researcher catches up with the standard level of the team not through verbal transmission, but rather through the treatment of problems in fields where his/her more experienced colleagues are experts (Daniel *et al.* 2002). These authors further assert that the proposal to organise student learning as a knowledge construction resembles an oriented research in fields very well known to the research director or teacher, where partial embryonic results obtained by students can be reinforced, completed or even questioned by those obtained by the scientific community. The constructivists attempt to foster active learning, guiding learners to create their own understanding by using a process of peer and teacher facilitated learning, as opposed to traditional teachers who prefer the transmission method (Coll & Taylor 2001).

Finally, constructivism, according to Bodner (1986:874), is an instrumentalist view of knowledge, namely knowledge is good if and when it works, if and when it allows us to achieve our goals. It is imperative to note what Solomon (quoted by Coll & Taylor 2001) highlights when saying that no paradigm is or can be considered incontrovertibly right and that no single perspective is ever likely to provide a final description of science education. The researcher does not, therefore, claim that constructivism is the only paradigm that can be used in teaching and learning Chemistry; however, for the purpose of this study, it was the frame of reference.

2.3 LEARNING CHEMISTRY

This study was aimed at developing a support programme for first-year Chemistry students to help them overcome some of the factors that adversely affect their learning. In this section attention will be paid to the type of learning that is envisaged for learners, and the factors that militate against such a type of learning.

2.3.1 Student learning

Students' learning can be classified as either rote learning or meaningful learning. McGuire (2006:7) defines rote learning as "verbatim memorization of information, which is not necessarily accompanied by any understanding of the material". While the same author views meaningful learning as "learning that is tied to previous knowledge where students understand the material well enough to manipulate, paraphrase and apply it to novel situations". Thus, from the above-mentioned definition, rote learning can be associated with a surface approach to learning, while meaningful learning can be associated with a deep approach to learning. It is also apparent from the above-mentioned definitions that students would benefit more from the learning process if they adopted a meaningful learning approach. In addition, Farrell, Moog and Spencer (1999), noted that recent development in cognitive learning theory and classroom research results suggests that students generally experience improved learning when they are actively engaged in the classroom and when they construct their own knowledge. Therefore, it is important for this study's proposed support programme to encourage active student participation and the adoption of a deep rather than a surface learning approach.

Those factors which have been identified as having a significant effect on the learning process will now be discussed.

2.3.2 Factors that affect the learning process

Ben-Zvi and Hofstein (as quoted by Coll *et al.* 2006) argue that no single aspect can account adequately for the whole spectrum of learning difficulties and their underlying causes. These authors also suggested that students' difficulties arise from a mismatch of their abilities in information processing, deficiencies in knowledge structure, information overload and inappropriate use of analogy or confusion of scientific terminology. These factors were regarded by the researcher as the most relevant for Chemistry departments in general, and first-year lecturers in particular.

2.3.2.1 Student preparedness

Zeegers, Flinters and Smith (as quoted by Matoti 2010) cited student preparedness as one of the problems associated with transition from school to university. Under prepared students are seen as those students who “enter higher education institutions with a lack of writing, reading and mathematical skills and an inadequate English proficiency” (Matoti 2010:137). This lack of academic proficiency could lead to low student success rates which adversely affect the country, institution as well as the students financially (Scholtz & Allen-Ile 2007).

Lea and Street (as quoted by Scholtz & Allen-Ile 2007:923) viewed learning in higher education as characterized by adapting to new ways of knowing, such as new ways of understanding, interpreting and organizing knowledge. In this regard Matoti (2010:136) suggested the following as some of the factors that contribute positively to students adjusting to this new situation, namely the attitudes of the university lecturers, their preparedness to understand the students’ problems and their willingness to provide the relevant academic support.

It is imperative for “strategies that assess the level of preparedness of students to be used to enable the lecturer to comprehend the level of understanding of the students in the programme, exercise some patience and help them succeed” (Matoti 2010:152). Academic literacy tests (e.g. Benchmark tests) are proposed as one strategy that could provide insight into the academic readiness of the students and thus inform the nature of academic intervention and curriculum responsiveness (Scholtz & Allen-Ile 2007).

2.3.2.2 Student motivation

According to Fry, Ketteridge and Marshall (2009) student motivation depends on the extent to which they want to succeed, thus not a simple aspect to explore nor support. The following observations made by different researchers capture the importance of student motivation for learning. For example, Zusho, Pintrich and Coppola (2003) observed that investigators have proffered numerous explanations on what are the determinants of student success, but have ignored the crucial aspect of motivation. This view is supported by Ward and Bodner (1993) when they say motivation to learn is an important factor controlling the success of learning. Jurisevic, Glazar, Pucko and Devetak (2008) also maintain that learning is a complex mental phenomenon in which motivation is one of the key variables.

Motivation can be defined as "an orientation toward a goal which provides a source of energy that is responsible for why learners decide to make an effort, how long they are willing to sustain an activity, how hard they are going to pursue it, and how connected they feel to the activity" (Rost 2006:1). This definition is supported by Zusho *et al.* (2003:1083) in the four components of motivation they mention, namely:

- "Self-efficacy which is the students' judgments of their capabilities, students with more confidence in their ability to perform better academically and engage in behaviours that promote learning.
- The students' beliefs about the usefulness and importance of a course (task value): There is a positive correlation between the task value beliefs and deeper levels of cognitive processing and performance.
- Goal orientation, which is individuals' purposes when approaching, engaging in, and responding to achievement situations, mastery rather than performance goals is positively related to various learning and motivation indices.
- Affect, which can be looked at in terms of interest (general liking of subject matter) which has been linked to deeper cognitive processing as well as higher levels of achievement and anxiety (negative emotions about doing well in class) which has been found to have negative effects on both cognition and performance."

Motivation can be either intrinsic (i.e. wanting to learn for learning's sake) or extrinsic (i.e. studying for external rewards). Intrinsic motivation is said to be "the true drive in human nature, driving us to search for the new, to face challenges, to test the boundaries of our abilities, and to learn from our birth onwards, even when there are no external rewards to be won" (Harter as quoted by Jurisevic, Glazar, Pucko & Devetak 2008:88; Fry *et al.* 2009). Furthermore, Jurisevic *et al.* (2008:89) noted that "intrinsic motivation in educational psychology literature is described in terms of the following three interconnected elements such as an inclination to tackle more demanding tasks, learning triggered off by special interest and development of competence and a mastering of learning tasks in which learning is seen as a value in itself". The sustenance and development of the intrinsic motivation of students should therefore be central to the learning process.

It has been observed, however, that students seem to have both weak motivation and minimal self-discipline, and thus are becoming more dependent on lecturers to "make them learn" (Huddle 2000:1154). While Dalgety, Coll and Jones (as quoted by Coll *et al*. 2006:365) noted that students, "who do Chemistry just to meet requirements generally, have low self-efficacy towards studying Chemistry".

Davis (2004) noted that the classroom environment can either enhance or destroy whatever motivation students bring to the class. Davis (2004) also mentions a number of factors that affect students' motivation to work and to learn, namely the interest in the subject matter, perception of its usefulness, as well as a general desire to achieve self-confidence and self-esteem. Finally, he made the following suggestions for the instructors to assist students to become self-motivated, independent learners (Davis 2004:4):

- "Give frequent, early, positive feedback that supports students' beliefs that they can do well and ask students' feedback on the course to demonstrate your interest in their learning.
- Ensure opportunities for students' success by assigning tasks that are neither too easy nor too difficult.
- Help students find personal meaning and value in material.
- Create a positive and open atmosphere.

- Help students feel that they are valued members of a learning community."

The above-mentioned could go a long way to create a motivating environment as part of an instructor's guidelines for lecturers.

2.3.2.3 Existing conceptions

The constructivist view of learning emphasises the importance of prior knowledge or existing conceptions in the construction of new knowledge (see 2.2). This is supported by literature, for example:

- Bodner (as quoted by Burcin & Leman 2008) indicates that the most important factor that affects learning is the student's existing conceptions.
- Hunt and Minstrell (as quoted by Mohammed 2007) assert that students' difficulties in science happen because students' conceptions before teaching are not taken into account, and, as a result, effectual communication between teachers and students does not take place.

The significance of existing conceptions is further confirmed by Bretz (2001:1109), when suggesting the following as conditions necessary for meaningful learning:

- A student must have some relevant prior knowledge, to which the new information can be related in a non-arbitrary manner;
- material to be learned must contain important concepts and propositions relatable to existing knowledge; and
- a student must consciously choose to non-arbitrarily incorporate this meaningful material into his/her existing knowledge.

In all the above-mentioned conditions existing knowledge is highly prominent. Therefore, the importance of prior or existing knowledge for subsequent learning cannot be overemphasised, especially given the abstract nature of Chemistry. It is imperative for the latter that new information is linked to information already stored in the long-term memory for effective learning to occur, otherwise the new information will either not be stored or it will be stored as a single entity (Gabel 1999). Furthermore, it is vital that the envisaged support programme will enable both the lecturer and students to establish the students' existing knowledge and any misconceptions that may be present.

The existing conceptions may be contrary to the held scientific understanding in which case they may be referred to as misconceptions or alternative conceptions, and, as noted by Mulford and Robinson (2002), they play a larger role in learning Chemistry than simply producing inadequate explanations to questions. Nakhleh (1992) also identified the following problems with learning Chemistry: profound misconceptions, failure of most of the students to spontaneously visualize chemical events as dynamic interactions, and learning is more difficult if the students must master different definitions for the same phenomenon. The observed misconceptions, according to Gabel (1999), may be due to the high density of chemical concepts. The amount of information a first-year Chemistry student has to assimilate, Rowe (1983) maintains, is between 6000 and 6750 units of information - more new language than one finds in the first year of foreign language study – bearing in mind that in Chemistry both meanings and the words are new. Tsaparlis, quoted by Mohammed (2007), observed that students' inability to employ formal operations, a lack of prior knowledge, and a lack of related concepts in long-term memory are other fundamental causes for misconceptions in science.

Students having formed their conceptions are seen by Coll *et al.* (2006) to be reluctant to change them even in the face of incontrovertible evidence. This was supported by Cakir (2008) when noting that research consistently showed that misconceptions are deeply seated and likely to remain after instruction in the student's cognitive structure. It is given therefore, that a conscious and informed effort must be taken to help students overcome or change any misconception that may exist. For this to happen, Bodner (1986) noted, students should first acknowledge the existence of a problem with their conception before they can accept an explanation. The latter author is of the opinion that the only way to replace a misconception is by constructing a new concept that more appropriately explains our experience. In addition, Bilgin (2006) confirmed that conceptual change is one of the most significant methods to eliminate or prevent student misconceptions in order to promote meaningful learning. Conceptual change may be seen in terms of recognizing, evaluating and reconstructing. An individual decides whether or not to evaluate the utility or worth of these conceptions, and the individual also decides whether or not to reconstruct these conceptions (Cakir 2008). The following conditions for conceptual change are discussed in literature:

- Posner, as quoted by Bilgin (2006), states that there first must be dissatisfaction with the existing conception and that the new conception must be intelligible, plausible and fruitful.
- Hewson and Thorley (as quoted by Cakir 2008) suggest that the conception must be meaningful, truthful and useful to the student.
- White and Gunstone (as quoted by Cakir 2008) argue that a new conception should do more than the prior conception for the person, but it must do so without sacrificing any of the benefits of the prior conception.

In addition, Bilgin (2006) states that students' conceptual change is promoted by instructional strategies based on cognitive conflict and that group discussions (see 2.4) in which students are motivated to talk about their tasks and to share ideas help them to understand conceptual meaning.

Finally Cakir (2008) highlights that a critical point is that it is only when the learner rather than the teacher decides (implicitly or explicitly) that the conditions have been met that conceptual change occurs. In this individual transformation process, the learner actively constructed his/her own knowledge, which are based on Constructivism (see 2.2). The research into student learning, however, has not made the task of the academic any easier, because there is no single answer yet for questions such as the following:

- How do students learn?
- How can we, as lecturers, bring about learning?

Fry *et al.* (2009:8) confirmed this when they indicated that unfortunately academics' knowledge about the "relationship between student learning (see 2.3.1) and teaching (see 2.3.2.4) is incomplete" as well as that both academic and students' "attitudes and actions" play a crucial role in the end result. However, within the higher education context there is enough evidence to make statements about what actions are necessary for enabling learning, but for the purpose of this study the focus will only be on learning and teaching Chemistry.

2.3.2.4 Teaching

Currently teaching and learning in the experimental sciences (such as Chemistry) are complex due to the diversity within the institutional context as well as legislative demands and pressures (Thomas 2000; Hall & Kidman 2004; Glenn, Patel, Kutieleh, Robbins, Smigiel & Wison 2012). One of the additional critical issues, surrounding the context within which teaching and learning are delivered, to be taken into account is the extent of freedom for curriculum development and delivery (Hughes and Overton as quoted in Fry *et al.* 2009:226-229).

There appears to be differences within the various disciplines whether the curricula (including teaching, learning and assessment methods including minimum requirements for practical work and accreditation) be determined by professional bodies and/or employers (e.g. engineering), while other professional bodies/employers simply indicate the focus of the discipline involved without making judgements about content and standards (Stefani quoted by Fry *et al*. 2009). Thus, be it as a result of involvement of professional bodies, future employers or current higher education legislation, the individual lecturer/academic no longer is in control of the "what and why of teaching". In addition, lecturers/academics in experimental sciences (such as Chemistry) are faced with the rapid expansion of discipline knowledge and overload in undergraduate curriculum (Fry *et al.* 2009). Listed below are some of the factors that impact on what is contained in the curriculum, and how it is taught, as well as recruitment strategies and how to address increased access:

- Employer involvement in course specification and delivery

According to literature (Teichler 1999; Fry *et al*. 2009) the world of work (i.e. employer) plays an increasing role in the design and delivery of courses and the development of work/problem-based learning (see 2.4.2; 2.4.3.3). Therefore, the impetus has been on improvement of student employability, and higher education, with special reference to the lecturer/academic, has to produce graduates with various skills and competencies which will have an immediate impact on work.

- Recruitment imperatives

Experimental sciences (such as Chemistry) have been seen as a difficult subject (see 1.1) and are also becoming "unfashionable alongside the plethora of new disciplines" (Fry *et al.* 2009). The increase in student numbers in higher education has not been matched by a proportionate rise of numbers in experimental sciences. This gives rise to the need for higher education institutions to "fill available places; inevitably, that implies that entry grades are decreasing and students are less prepared" (Fry *et al.* 2009:228; Huddle 2000). This resulted in serious implications for curriculum design, teaching and learning strategies, as well as support and retention systems.

- Widening participation, aspirations and differentiated learning

Increased student numbers in higher education have been accompanied by diversification in student aspirations, motivation (see 3.2.2.2) and ability. This brought with it an increased focus on the development of generic/transferable skills that has implications for employability outside the original discipline of study. In addition, the decline in mathematical ability and English proficiency (Fry *et al.* 2009:228-229) complicated the role of the academic and institution, because they also have "moral and contractual obligations" towards the paying students/clients to put multiple support mechanisms in place for struggling students (also the focus of the proposed support programme in this study).

Planning teaching and learning is the foundation of any academic's role (e.g. in this study of teaching Chemistry). However, this teaching function is not taking place in a vacuum, but in accordance with the nature of the institution (e.g. currently most higher education's mission statements give a sense of institutional objectives and graduate attributes). The UFS mission statement (UFS n.d.), namely "Setting the highest standards for undergraduate and postgraduate education and advancing excellence in the scholarship of research, teaching and public service" emphasises the necessity of this study. The details of the most relevant teaching and learning strategies and methods used at the UFS, in accordance with effective teaching-learning approaches, as specified in the UFS's Teaching and Learning policy (2008:3-7), which are particularly important for Chemistry, are heavily content driven and are specified and discussed later (see 2.4).

Biggs and Tang (2007:19) suggested three levels of teaching with the third level having its focus as "what the student does and how that relates to teaching." This level of teaching resonates with the constructivist view of learning (see 2.2) in that it is concerned with what students do instead of what teachers do. Teachers should therefore be developed to realise this level in their teaching so that the envisaged learning can be facilitated. The issue of teaching ethics also is becoming more prominent, implying that academics should take into account both "ethical and sustainability issues when making decisions and choices", but also must ensure that their students are acquainted with constructing "arguments based on ethical principles such as autonomy, beneficence, non-maleficence, fairness" etc. (Fry *et al*. 2009:239).

2.3.2.5 Assessment

- Defining assessment

Due to the diverse conceptualisations and applications of assessment, this study viewed the outcomes-based assessment approach (as stipulated in 1.6.1) as the preferred one for learning and teaching Chemistry. The reasons for this are because this approach is a learner-centred, result-orientated educational approach where students have the capability of realising their potential (also emphasising the core of the Constructivism model (see 2.2). Additional implications of this approach for practitioners are clearly defined learning outcomes, improvement of students' skills and competencies, existence of diverse teaching and learning strategies (see 2.3.2.4) and assessment instruments, as well as fair and transparent student opportunities and support (UFS 2006:2). This approach does not only support the development of students; but also ensures effective learning within context; improvement of teaching practices; and grading of student performance (UFS 2006:2).

- Role of assessment

Bennett (2004:52) aptly captures the role of assessment when he says that "assessment is a (if not the) major driver for students in higher education". This sentiment, which emphasises the crucial role played by assessment in the learning process, is echoed by several authors, for example, Maclellan (2001), declares that the quality of student learning is as high or low as the cognitive demand level of the assessment task, while Troskie–de Bruin and Otto (2004), maintain that assessment plays an important role in determining the quality of student learning and that if students are not challenged by assessment to take a deep approach to learning, the better quality students lose interest and consequently under-perform. Assessment could thus (if properly implemented) be used to achieve the primary goal of teaching, which is student learning.

- Time spent on assessment

Hughes (2006) purports that even with modules with similar credit-bearings, diverse variations exist in the amount of time that academics spend on assessment, students spend on being assessed, and the time involved in providing and receiving feedback. Although higher education has attempted to standardise these assessments across modules or disciplines, variations will remain, because assessment should be linked to learning outcomes and teaching methods (i.e. constructive alignment). Thus a dire need exists for both the lecturers and students to change how they view the role of assessment in the learning environment. Student success in introductory Chemistry courses, for example, is usually judged by the ability to solve numerical problems

(Nurrenbern 1987; Swarey 1990), which is not the same as conceptual understanding. Agung and Schwartz (2007) reported that faculty (lecturers) identified conceptual understanding as one of the most important learning outcomes for students, giving rise to the need for assessment that embodies conceptual structure.

- Assessment tools

A variety of assessment tools are available, of which the main ones for experimental sciences (with the focus on Chemistry) appeared to be unseen written examinations, written assignments/essays, multiple choice questions and other forms of objective testing, laboratory/practical/field trip reports, project reports and software developed for the purpose, portfolios and personal development plans, and poster and oral presentations. The most prevalent assessment method in experimental sciences, however, remains the written examination or summative assessment (Hughes & Overton as quoted by Fry *et al.* 2009:241). Bennett (2004:55) noted the following shortcomings of examinations: a mismatch of stated outcomes and outcomes tested, some outcomes tested several times and some omitted; in the worst cases, students achieve a pass grade with less than 20% of outcomes fully achieved. Beall and Prescott (1994:112) propose that examination questions with word answers are one of the possible ways of reinforcing and testing conceptual knowledge and should be included in Chemistry courses, while Bennett (2004:57), suggested that examinations should be subjected to a simple learning outcomes test to remedy some of their observed shortcomings.

- Assessment feedback

Assessment of student learning cannot be discussed meaningfully without considering assessment feedback. As part of formative assessment, feedback has, according to Hyland (as quoted by Higgins, Hartley and Skelton 2002:54) “the capacity to turn each item of assessed work into an instrument for the further development of each student’s learning.” Higgins *et al.* (2002:58) found that students wanted feedback because they “feel they deserve it and because they recognise its potential to be formative”. The same authors maintained that the feedback should be timely and it should clarify misconceptions and propose improvements for future work. Sadler (as quoted by Nicol &

Macfarlane-Dick 2006:204) identified the following conditions necessary for students to benefit from feedback in academic tasks:

- Students should know what good performance implies.
- Students should be informed about how current performance relates to good performance.
- Students should be guided in how to act to close the gap between current and good performance.

Nicol and Macfarlane-Dick (2006:205), having done a synthesis of research literature proposed the following seven principles of good feedback practice. Good feedback:

- Helps to clarify what good performance is;
- facilitates the development of self-assessment in learning;
- brings high quality information about learning to students;
- encourages teacher and peer dialogue around learning;
- encourages positive motivational beliefs and self-esteem;
- provides opportunities to close the gap between current and desired performance; and
- provides information to teachers that can be used to help shape teaching.

The UFS (2006:5) summarised this responsibility of recording progress and performance as crucial and "in the case of professional degrees … forms part of the student's portfolio". This policy (UFS 2006:5) views feedback not only as "an integral part of the teaching, learning and assessment" process, but also regards "effective communication of the students' performance as a pre-condition for quality education". Therefore the feedback process should:

- Keep students informed regarding their progress in the teaching and learning process;
- be an accurate reflection of the students' progress and performance; and

- encourage motivation through a constructive approach.

Taking the above-mentioned into consideration, assessment plays a crucial role in and has a significant impact on student learning. Therefore the following assessment practice guidelines, as stipulated by the UFS (2006:3), summarise what is required from an UFS academic (which should also be reflected in this study's proposed support programme), and should be included in study guides and applied:

- The purpose of assessment must be communicated clearly.
- Assessment must be holistic and criterion referenced (whereby student performance is judged against pre-specified criteria or standards), rather than norm referenced (whereby student performance is compared with that of peers in the same class or cohort).
- Assessment must be authentic and balanced.
- Assessment must be integrated with the teaching and learning process.
- Assessment must be transparent, valid, reliable and just.
- Assessment can assume various forms, gather information from various contexts and use various methods depending on what is being assessed and the needs of the student and the lecturer.
- Assessment must be impartial, sensitive towards race, gender, cultural background and knowledge level of students.
- The feedback regarding assessment results must be clear, accurate, timely and meaningful.
- Progress must be linked to the demonstration of the achievement of outcomes within context.
- Results of assessment opportunities must be used to support students.
- The process and volume of assessment must be realistic and manageable for both students and lecturers.
- Security must be maintained through the introduction of the necessary procedures to prevent, detect and handle dishonesty as far as possible.

2.3.2.6 Library and information services

The library of any higher education institution plays a significant role in the realization of the primary functions of the institution, that is, teaching and learning, research and community/service learning. This view is supported by the following statements:

- Kuh and Gonyea (2003:267) assert that “libraries play an important role in helping the institution achieve its academic mission”.
- Kelly, quoted by Mezick (2007:562), argues that “libraries are an integral part of the college experience and identified academic libraries and librarians as playing a pivotal role in the education and retention of students.”

In addition, it is argued that frequent use of the library by students has a positive correlation with academic performance, as proclaimed in literature:

- Hiscock (quoted by Mezick 2007:562) reported that frequent use of the library catalogue by students resulted in better academic performance.
- Kuh and Gonyea (2003:267) alleged that “those students who more frequently use the library reflect a studious work ethic and engage in academically challenging tasks that require higher-order thinking”.

Despite the library’s significance, students, if left to their own devices, will not voluntarily choose to use the library unless the institution sets high standards that are academically challenging to students - then students will be impelled to use the library (Kuh & Gonyea 2003). For the library to remain relevant and maintain its central role in the institution, it must adapt to the changes around it. According to Arko-Cobbah (2004:268) the library and/or librarian must do the following to maintain its status:

- Help establish teaching models that are not teacher and classroom-centred and that are accessible at all times.

- Place course lectures, graphics, other media, and bibliographies on the Web, where students can access them from wherever they may be at any time.
- Provide professional help in creating home pages for academic staff.
- Be responsible for making the necessary information resources available and ensure that they can be accessed to aid the learning process.
- Provide information literacy programmes for students. These programmes will assist students to know when they need information, and to identify, evaluate, organize and use the information effectively in addressing problems (Williams & Zald, quoted by Arko-Cobbah 2004).

According to Kuh and Gonyea (2003:257), one strategy to achieve the above-mentioned entails “that the librarians move out of the library into classrooms where they team-teach courses with faculty colleagues from various disciplines”. Kuh and Gonyea (2003) see the library as the physical manifestation of the core values and activities of academic life that supports and nurtures academic success in collaboration with peers.

To this end, Mezick (2007:565) noted that “despite the availability of continuous electronic access to information resources, students continue to demand increased library hours to avail themselves of quiet study spaces, facilities for group study, and social space for meeting with fellow students between classes”.

In conclusion, Mezick (2007:562) is of the opinion that the attainment of information competency/literacy is essential to the learning process, while Kuh and Gonyea (2003:268) maintain that “institutions that are serious about graduating information-literate students should require activities that give students practice and require them to demonstrate their competence in evaluating the quality of the information they use”.

2.4 STRATEGIES THAT SUPPORT STUDENT LEARNING

Literature provides information on a variety of strategies that may be employed to support student learning. One of the strategies that have been proven by research to be successful entails that students should be actively involved in the learning process. Farrell *et al.* (1999:573) assert that students who are active and involved in a classroom setting find it difficult not to learn something. Bodner (1986:873) made the observation that anyone who had studied Chemistry, or tried to teach it to others, knew that active students learn more than passive students. An example of an active teaching-learning strategy which is widely propagated and commonly used is group work.

Group work is regarded as an active teaching method, which supports effective student learning. This was confirmed by Burcin and Leman (2008) when they noted that students commonly liked working in groups and enjoyed learning. Mahalingam, Schaefer and Morlino (2008) noted that students generally liked working in groups to solve problems. Thus, students stand to benefit from group discussions, because giving explanations is positively correlated with achievement, while receiving explanations may not result in improvement (Webb, quoted by *Cooper*, Cox, Nammouz, Case & Stevens 2008). Group work has also been found to decrease existing misconceptions in students by listening to and watching their peers' discussions, and participating in such discussions (Lyon & Lagowski 2008; Mahalingam *et al.* 2008). Group work also helps them to master more material, to feel more confident, be motivated to learn, have more competence in critical thinking and, therefore, to exhibit higher achievement and acquire more positive attitudes toward subjects studied (Johnson & Johnson, quoted by Mahalingam *et al.* 2008). Mahalingam *et al.* (2008) further found that peer interaction and instruction during group discussions helped students learn that Chemistry problems were solved through logical thinking, and that simply reading a chapter or memorizing its contents did not result in problem solving ability. In addition, *Cooper et al.* (2008) asserts that even informal collaborative groups are a valuable tool in a teacher's arsenal that can lead to measurable improvements in student problem-solving ability in a relatively short time. Herreid (1998:554) and *Cooper et al.* (2008:871) state that team work is not an alien concept to scientists; they know that groups often produce better results than individuals, but they rarely consider the impact that group interactions can have on education.

Despite the advantages of active teaching-learning methods, the lecture method still is the dominant teaching method in many higher education institutions, because it is easy to control; as it is the traditional method lecturers were exposed to themselves, many lecturers are most comfortable with it (Timberlake 2010). Though this method is effective for teaching simple factual material (Coll & Taylor 2001), it has the following disadvantages:

- It does not allow for active student engagement (Cakir 2008).
- The information flow in lectures is faster than the time needed by students to properly process and store it (Rowe 1983).

This is in contrast with the constructivist view of teaching and learning that advocates for student-centred strategies, which necessitates a shift from teaching to learning facilitation (Bodner 1986). The literature review revealed the following teaching-learning strategies which are student-centred and more effective in the teaching and learning of Chemistry:

2.4.1 Cooperative or collaborative learning

Collaborative or cooperative learning (the terms will be used interchangeably) is defined as an instructional technique whereby students work together in small fixed groups on a structured task (Cooper 1995). According to Millis and Cottell (quoted by Shibley & Zimmaro 2002), using well-structured assignments helps guide such a group of students toward achieving a particular learning outcome. The benefits of collaborative learning are summarised by the following statements:

- Burcin and Leman (2008) assert that co-operative learning as an active application does not only provide improvement in learning achievement, that is, maximises the learner's own learning as well as that of others (Johnson *et al.* quoted by Herreid 1998), but also fosters development of social abilities.
- Mahalingam *et al.* (2008) state that collaborative learning has been proven to have a positive impact on students' attitude toward Chemistry and that healthy exchange of ideas within small groups not only increases interest among participants, but also promotes critical thinking.
- *Cooper et al.* (2008) noted that student problem solving can be improved by having students work in collaborative groups, where students were forced to be more thoughtful about their actions.
- According to Jacobs's (2000) study, students reported enhanced self-confidence, deeper conceptual understanding, greater interest in Chemistry, and improved problem-solving skills when enrolled in courses where cooperative learning was used compared to the traditional teaching and learning methods.
- Towns (1998) reported that research had shown that cooperative learning led to better achievement, increased positive attitudes toward the subject area studied, higher self-esteem, greater acceptance of differences among peers, and enhanced conceptual development.

Johnson, Johnson and Smith (quoted by Bowen 2000) proposed the following five essential components of cooperative learning that activities should possess:

- Positive interdependence
- Face-to-face-interaction
- Individual accountability
- Interpersonal skills
- Group processing.

These components confirmed what Herreid (1998) regarded as the value of cooperative learning, namely that learning is enhanced when people explain their ideas to one another. Additionally, literature (Cooper 1995; Shibley & Zimmaro 2002) noted the positive influences of collaborative learning such as more effective group functioning and cohesiveness, more independence, increased student retention, students take responsibility for their own learning and become actively involved, and students develop higher-order thinking skills, as well as the ability to address the issue of 'free loaders' - group members must evaluate each other and those evaluations must contribute to the final grade.

Literature thus has proven the advantages of collaborative learning, and to encourage the use of this strategy to improve student learning, Srinivas (2010) advocated the use of the following collaborative learning strategies:

- Think-pair-share: Students attempt to find an answer to a question individually and then share their responses with a partner.
- Three-step interview: In pairs (dyads), students interview each other and the initial dyad then links with a second dyad; the four-member team then discusses information gathered from the semi-structured interviews.
- Simple jigsaw: The instructor divides a topic into four sub-topics, and a student from the group chooses one sub-topic to work on with students from other groups; then the student comes back to his/her group to present that part of the topic.
- Numbered heads together: Group members are assigned numbers after they have discussed the posed question; the instructor calls any number and the group member allocated that number responds as group spokesperson.

2.4.2 Problem-based learning (PBL)

Yu (2004:28) defined problem-based learning (PBL) as learning that is driven by a real-life problem (that has no quick and easy solution), not by an abstract concept. Other researchers (Banta *et al*., quoted by Bilgin, Senocak and Sozbilir 2009; Chin and Chia, quoted by Bilgin *et al.* 2009) described PBL as a method of instruction, which uses ill-structured problems as a context for students to acquire problem-solving skills and basic knowledge. This view is supported by Belt (2009) in whose opinion all PBL problems cannot simply be solved by application of a series of known algorithms or by reference to a previous or related example. According to Overton (2007), PBL differs from other forms of learning in that the students work in teams throughout and move towards a solution to the problem together by gathering and sharing information. Because the problem is encountered before all the relevant learning has taken place, the problem acts as the driver for new learning.

Yuzhi (2003) regards PBL as a curriculum design, a teaching/learning strategy and/or a learning environment that embodies most of the principles on which learning improvement is based, namely:

- Students are active and cooperative learners;
- feedback is prompt; and
- student empowerment and accountability are promoted.

Bilgin *et al.* (2009) view PBL as a way of learning which encourages a deeper understanding of the material, rather than superficial coverage, and because it is a problem-oriented approach through which students do not merely receive basic knowledge while learning, but also experience how to use (apply) their knowledge to solve real-world problems. According to Belt (2009), PBL is underpinned by the philosophy that students advance their knowledge and understanding of a topic by tackling problems related to it. This philosophy demands PBL problems always to be placed in an applied context to provide relevance and it requires of students to work as part of a team towards a common goal.

Ram (1999:1122) proposes the following stages for the PBL process:

- Introduction: Students are presented with a succinct problem statement.
- Inquiry: The facilitator guides students to look for additional information from materials provided, to select learning issues and commit to a hypothesis.
- Self- directed study: Students obtain information from different sources.
- Revisiting the hypotheses: Students evaluate the resources they have used, share information with their colleagues, and reconsider their hypotheses with the benefit of the new information they have gathered.
- Self-evaluation: Students are asked to evaluate their efforts as problem solvers, self-directed learners and as members of a group and to discuss these evaluations with their group.

There are a number of benefits associated with the implementation of PBL; Yuzhi (2003:28) highlighted the following:

- PBL offers students an obvious answer to the questions: ‘Why do we need to learn this?’ and ‘What does what I am doing in class have to do with anything in the real world?’
- PBL promotes meta-cognition and self-regulated learning by asking students to generate their own strategies for problem definition, information gathering, data analysis, hypothesis building and testing, comparing these strategies against, and sharing them with other students’ and mentors’ strategies.
- PBL engages students in learning information in ways that are similar to the ways in which it will be recalled and employed in future situations.
- PBL assesses learning in ways which demonstrate understanding and not mere acquisition.

Boud and Felleti (quoted by Yu 2004) mention the following as advantages of a PBL approach:

- PBL results in more motivated students with a deeper subject understanding;
- it encourages independent and collaborative learning; and

- it develops higher-order cognitive skills, as well as a range of transferable skills including problem-solving, group work, critical analysis, lifelong learning and communication skills.

The role of teacher in PBL, as seen by Bilgin *et al.* (2009) is to select the problem and present it to students, provide direction for student research and inquiry, and to be a facilitator responsible for guiding students to identify key issues. PBL makes it possible for the teacher to grade students not only on what they remember, but also on what they can do (Kuwana quoted by Yu 2004).

2.4.3 Peer-assisted learning (PAL)

Capstick (2003:3) defines peer-assisted learning (PAL) as a scheme for learning support and enhancement that enables students to work co-operatively under the guidance of students. This author further characterizes PAL sessions as those that offer a safe, friendly place to help students adjust quickly to university life, improve their study habits, acquire a clear view of course direction and expectations and enhance their understanding of the subject matter of their course through group discussions. With the main purposes of PAL being, according to him, to aid retention of first-year students, support the first-year student experience, enhance the learning experience of PAL leaders and provide a further mechanism of communication to teaching staff and students. The following strategies conform to this definition and will now be discussed.

2.4.3.1 Supplemental Instruction (SI)

Lundenberg (1990:153) describes supplemental instruction (SI) as a peer-led cooperative learning programme that encourages students to develop conceptual understanding by articulating both understanding and misconceptions in a think-aloud fashion, while Arendale (1994) sees SI as a student academic assistance programme that increases academic performance and retention through its use of collaborative learning strategies. Both these definitions stress the collaboration part, in concurrence with McGuire (2006) who maintains that students in SI sessions work collaboratively to understand the course concepts, brainstorm ideas and engage in discussions of how concepts relate to each other. The latter author, however, fails to highlight the issue of peer leadership. McGuire (2006) also notes that in such an engaging, inviting environment most students shift their learning paradigm from simply memorising information to perform well on a test to learning material for conceptual understanding. SI avoids the remedial stigma attached to traditional academic assistance programmes, since it does not identify high-risk students, but high-risk classes and participation is voluntary (Arendale 1994). These SI sessions are offered as additional to the normal lectures (hence *supplemental* instruction).

Arendale (1994:13) viewed the following personnel as key to the SI programme:

- The SI leader who is a student who has successfully completed the targeted course;
- the SI supervisor who is an on-site professional staff member who implements the SI programme and supervises the SI leader; and
- the academic who teaches the course in which SI is offered.

Lundenberg (1990) describes the role of the SI leader as being to model the thinking involved in learning the subject concerned, to ask relevant questions and to encourage students to work cooperatively in solving subject specific problems. McGuire (2006) maintains that SI leaders, being students themselves, develop leadership skills, learn how to influence group dynamics and learn strategies for motivating others to excel. Meetings with SI leaders provide information on student understanding, problems and potential trouble spots and this allows academic staff to be more in touch with their students' needs.

2.4.3.2 Peer-Led Team Learning (PLTL)

According to Tien, Roth and Kampmeier (2002) the peer-led team learning (PLTL) instructional model preserves the lecture and introduces a new structure, the PLTL Workshop, that requires active engagement of the students with specially constructed material and with each other. This forms an integrated and fundamental part of the course structure, constructed by the course instructor for all the students in the course. These authors note that the PLTL Workshop provides an active and collaborative learning environment for students to discuss, debate, build, and present their understanding and hear the perspectives of their peers. Gafney (quoted by Tien *et al.* 2002) highlights the following as critical components of PLTL, namely organizational arrangements, peer leadership and training, materials that are challenging at an appropriate level, and integration with the overall course.

2.4.3.3 Workshop Chemistry

Workshop Chemistry is a peer-led team learning model of instruction that provides an active learning experience for students, creates new leadership roles for those who have done well, and involves faculty in the process of reform (Gosser, Roth, Gafney, Kampmeier, Strozak, Varma-Nelson, Radel & Weiner 1996). These authors confirmed that Workshop Chemistry is intended to achieve the following goals:

- Improve student attitudes toward Chemistry and the scientific enterprise in general
- Increase students' mastery of Chemistry concepts and problem solving skills
- Increase students' ability to express scientific ideas and to work as a team, skills that are required in the workplace.

Workshop leaders are undergraduate students who have just completed the course and need not be experts but be a facilitator of the group discussion and a mentor and role model for the other students in the group.

2.4.3.4 Guided Inquiry

Farrell *et al.* (1999) revealed that in guided inquiry, no lectures are given, groups use Guided inquiry activities that follow the learning cycle paradigm to develop and learn concepts. Students are assigned different roles within a group to help them develop skills needed for each of the roles, and these roles include manager, recorder, technician, reflector and presenter. These authors additionally stated that guided inquiry worksheets consist of three parts:

- Model, Data and/or Information, this is designed to define or develop some chemical concept (Exploration phase of learning cycle).
- Critical Thinking Questions (CTQs) are crafted to lead students to make inferences and conclusions about fundamental relationships or concepts inherent in the model (Concept Invention Phase).
- Applications are exercises designed to give students practice in problem solving using chemical concepts discovered through the model and CTQs (Final phase).

This strategy can help address the dilemma experienced in the practical sessions, highlighted by Mohrig (2004:1083), namely “the majority of chemistry laboratories in universities are based on cookbook verification experiments which produce little meaningful learning”. Montes, Lai and Sanabria (2003:447) support this view, stating that “this approach provides students with the opportunity to conduct experiments aimed at solving a specific problem, analyzing the results, and reaching their own conclusions based on empirical data”.

The guided-inquiry experiments (where students are provided with tested experimental procedures but no specified outcome) have the following advantages (Gaddis & Schoffstall 2007):

- Guided Inquiry Experiments combine the pedagogical benefits of open-inquiry with the practical benefits of verification experiments;

- provide students with higher cognitive achievement;
- add an element of mystery for students and thus increase students' interest in the activity; and
- can be readily adapted to large laboratory classes.

2.4.4 Concept maps

Zeitz and Anderson-Inman (quoted by Markow and Lonning 1998:1016) describe concept mapping as a form of two-dimensional diagramming which emphasises the relationships between and among important concepts. Sisovic and Bojovic (1999:136), in turn, define a concept map as a teaching aid by which connections and relations, as well as the hierarchy of concepts, are presented in an obvious way. These authors assert that concepts are the most important of all forms of knowledge, acting as mental tools of thinking that enable one to understand both the physical and the social worlds, and communicate intelligibly. Since concepts are the main tools of thinking, their organisation in cognitive structures is of great importance. Cakir (2008:204) proposes concept mapping as one of the techniques that can be used to support students' organisational processes. This is supported by Sisovic and Bojovic (1999) as they assert that concept maps help students to understand how concepts are linked, how one concept develops out of another, all of which enable students to deepen their knowledge of the subject of study.

Regis, Albertazzi and Roletto (1996) assume that concept maps could reveal the concepts already present in the students' minds, the conceptual linkages between the concepts, as well as the evolution that takes place as a result of teaching/learning activities. According to Markow and Lonning (1998) pre-instruction concept maps help students to record their pre-conceptions, eliciting from them questions about the material to be learned, while post-instruction maps help the teacher to see the progress made by individual students in assimilating and accommodating new knowledge into their existing cognitive structures. Cakir (2008) purports that by comparing the concept maps that students produce during the course of instruction the teacher can trace development in students' conceptual networks.

To conclude this discussion of teaching-learning strategies, it is fitting to relate the information from literature to the UFS Teaching and Learning policy (2008), which creates the context in which the support programme that is proposed will have to be implemented.

In brief, the above-mentioned student learning strategies are reflected in and supported by the UFS Teaching and Learning policy (2008:4), in which it is stated that "effective learning entails the engagement of students as active participants in the learning process, while acknowledging that all learning must involve a complex interplay of active and receptive processes, the constructing of meaning by the student, and learning with and from others". Therefore, these Constructivist principles are reinforced by "an engaged learning approach that involves interactive, reflective, cooperative, experiential, creative or constructive learning, as well as conceptual learning". This policy (2008:4) further specifies two important aspects which also impact on student learning, namely an effective teaching-learning environment and the premises that support effective teaching-learning at the UFS.

In the UFS Teaching and Learning policy (2008:4) these impacting aspects are elucidated as follows:

"**An effective teaching-learning environment,** which is created by:

1. Exposure of students to high-level challenges that will raise the standard of expected performance.
2. Encouraging students' active involvement and engagement in the learning process by moving away from one-way content delivery to increasing interaction.
3. Ensuring clarity of focus through clearly articulated outcomes as well as short-term and long-term aims at every stage of the teaching-learning process.

4. Nurturing students’ independence and interdependence, self-direction and self-regulation.
5. Providing flexible and expanded opportunities for all students to achieve success.
6. Enriching the learning environment through diversity.”

In addition, “**effective teaching-learning approaches** are supported by:

1. Well-designed and active learning tasks or opportunities to encourage a deep rather than a surface approach to learning.
2. Content integration that entails the construction, contextualisation and application of knowledge, principles and theories rather than the memorisation and reproduction of information.
3. Learning that involves students building knowledge by constructing meaning for themselves.
4. The ability to apply what has been learnt in one context to another context or problem.
5. Knowledge acquisition at a higher level that requires self-insight, self-regulation and self-evaluation during the learning process.
6. Collaborative learning in which students work together to reach a shared goal and contribute to one another’s learning.
7. Community service learning that leads to collaborative and mutual acquisition of competencies in order to ensure cross-cultural interaction and societal development.
8. Provision of resources such as information technology and library facilities of a high quality to support an engaged and blended teaching-learning approach.
9. A commitment to give effect to parallel-medium teaching-learning in innovative ways.
10. Establishing a culture of learning as an overarching and cohesive factor within institutional diversity.
11. Teaching and learning that reflect the reality of diversity.

12. Taking multi-culturality into account in a responsible manner that seeks to foster an appreciation of diversity, build mutual respect and promote cross-cultural learning experiences that encourage students to display insight into and appreciation of differences".

2.5 CONCLUSION

The literature review confirmed the teaching, learning and assessment issues concerning first-year Chemistry. Literature on student learning and the factors that may impact on effective learning in the first-year Chemistry course (i.e. student- and course-related factors) were scrutinised carefully. Strategies that may be employed, from the constructivist view, to make sure that the student is firmly in the centre of teaching/learning endeavours, have been discussed at length. The pivot around which the information in the chapter revolved was ways in which student learning as well as teaching and assessment practices could be supported for those students struggling to pass Chemistry.

In the next chapter the research design and methods that were employed in the study to achieve its aim, will be discussed.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The previous chapter reviewed the relevant literature on what influences the learning of first-year Chemistry and the possible ways available to support student learning in this course. First-year Chemistry is seen as one of the most difficult courses in higher education institutions (see 1.1) and appears to have poor success rates (see 1.1). These concerns were addressed in the first two chapters, which explained the nature and complexity of learning first-year Chemistry. This formed the basis of this study's empirical investigation, namely collecting data for designing a support programme for first-year Chemistry at the QwaQwa campus of the UFS (see Chapter 4).

This chapter provides a more detailed account of the research design and methods that were succinctly discussed in Chapter 1, and provides a rationale for the case study design (see 1.7) employed to gain insight into first-year Chemistry learning at the Qwaqwa campus of the UFS. The choice of methods, sampling, data collection, data analysis and interpretation, trustworthiness and ethical considerations utilised to accomplish the research objectives (see 1.3) are discussed.

3.2 RESEARCH DESIGN AND METHODOLOGY

In this study the researcher employed the case study (see 1.7) as the preferred research design and coupled that with the mixed methods methodology to achieve the objectives of the study (see 1.3). The following two sections will be dedicated to looking at the chosen design and methodology in detail.

3.2.1 Case study design

"The function of a research design is to ensure that the evidence obtained enables us to answer the initial question as unambiguously as possible" (De Vaus 2001:9). The case study design is adopted in this study to serve that function (see 1.7). Case study is defined by Bromley (quoted by Maree 2007:75) as "*a systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest"*. Simons (2009:21) expands on this definition of a case study by saying that "*a case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy or programme in a 'real life' context".* This author further mentioned the following as the primary purposes of a case study:

- Generation of knowledge.
- Generation of in-depth understanding of a specific topic, policy etc.
- To inform policy development, professional practice and community action (Simons 2009:21).

For this study it was envisaged that the research would serve mainly the third purpose of informing professional practice within the Chemistry Department. The type of case study employed in this study is the situational analysis where a specific event (i.e. student learning in first-year Chemistry) is studied from different perspectives (McMillan 2000:267), that is, both first-year students' and lecturers' perspectives. The choice of this design was further supported by the strengths inherent in the case study design, namely:

- Flexibility, in that it is neither time-dependent nor constrained by method. This means that the case study design is not exclusively related to certain methods and that it can be performed for as long as it is necessary (no time restrictions).

- The potential to engage participants in the research process and also provide an opportunity for researchers to take a self-reflexive approach to understand the case and themselves (Simons 2009:23).

It is important to note that this design does not imply any particular form of data collection, nor method. Therefore, the researcher employed the mixed methods approach as the most suitable for the study (see 1.7; 1.7.2).

3.2.2 Mixed methods methodology

Mixed methods is defined as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts and/or language in a single study (Johnson & Onwuegbuzie 2004:17). This definition is enriched by Creswell (quoted by Maree 2007:261) who highlights two crucial issues as far as mixed methods are concerned. The first issue is the fact that the "mixing" can happen at different stages of the study, and secondly, that the mixing is done so as to understand a research problem more completely. The latter is supported by Johnson and Onwuegbuzie (2004), stating that the important thing is that the research question(s) and method(s) should help the researcher to answer the question effectively.

The above-mentioned allows researchers to classify the mixed methods approach (see 1.7.2). In this study the sequential explanatory approach was adopted (*cf.* Creswell 2003). The study started with the implementation of the self-constructed questionnaire which contained both closed and open-ended questions, followed up with focus group discussions with students and semi-structured interviews with lecturers to help clarify the results of the questionnaire (see Figure 3.1). The figure has been adapted for this study. The focus group discussions were used to clarify some of the findings from the questionnaire that needed further elucidation, and the semi-structured interviews with lecturers gave an "expert" view on the questionnaire findings (see 1.7; 1.7.3; 3.2.4).

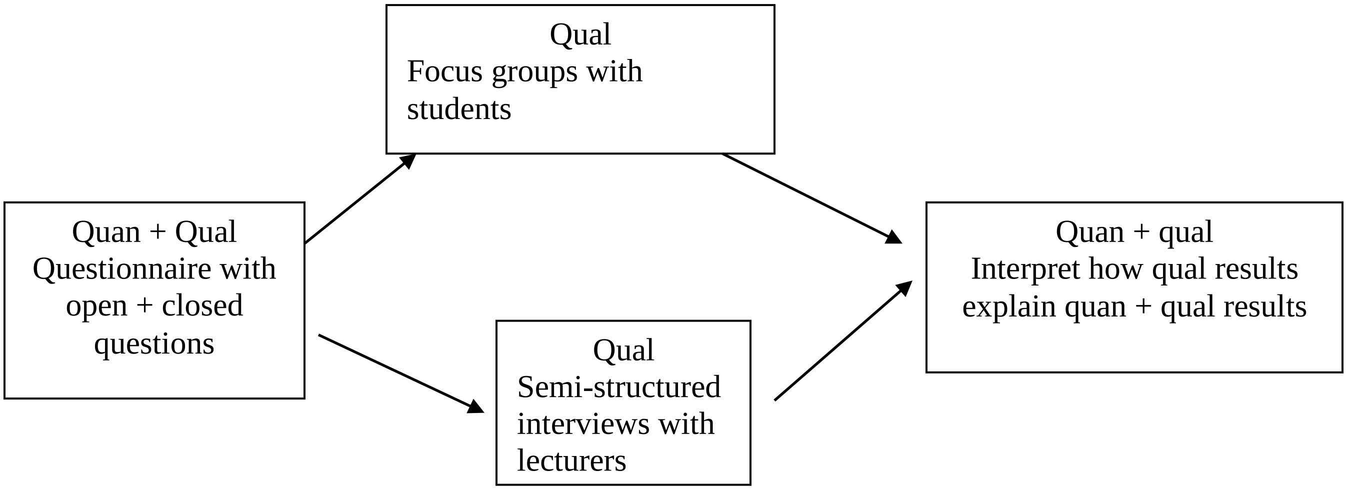

Figure 3.1: Adapted sequential explanatory mixed methods design

3.2.3 Sampling

The sample of this study consisted of all involved first-year Chemistry students at the UFS Qwaqwa campus in 2010 (CEM104), as well as lecturers involved in first-year Chemistry teaching between 2010 and 2012. The non-probability sampling techniques such as convenience sampling and purposive sampling were employed for this study (Cohen, Manion & Morrison 2007), for the following reasons:

- Convenience sampling was used because the respondents for the questionnaire and participants of the focus groups were readily available (*cf.* McMillan 2000), since the researcher is involved in the teaching of the participants. When it comes to the participants of the semi-structured interviews purposive sampling was used, because the members of the lecturing staff were regarded as being the most suitable people from whom to collect the required information, as McMillan (2000:108) puts is, they would “be particularly informative about the topic”.

3.2.4 Data collection

A mixed methods research approach (see 1.7; 1.7.2; 3.2.2) was applied, using a self-constructed questionnaire (based on the literature review; see Appendix A), focus group discussions (see Appendix B) and semi-structured interviews (see Appendix C) as data collection methods. The schedules used for the latter two data collection techniques were informed by the literature review and gaps identified from the analysis of the responses on the .questionnaire items.

3.2.4.1 Questionnaire (Appendix A)

A questionnaire is defined as a written document containing statements or questions that are used to obtain information on participant perceptions, attitudes, beliefs, values, perspectives and other traits (McMillan 2000:155). The self-constructed questionnaire used in this study was designed, contextualised, employed and administered to provide a reflective perspective of the students' first-year Chemistry experiences. This self-constructed questionnaire (see Appendix A) consisted mainly of quantitative (i.e. closed-ended questions on a five-response category Likert-type scale) and a few qualitative (i.e. open-ended questions to elaborate on the quantitative questions) questions. These questionnaires were piloted with 35 first-year Chemistry students to ensure that the questions designed would elicit the required information, and would satisfy requirements regarding the level of difficulty and comprehension (*cf.* Cohen, Manion & Morrison 2007; MacMillan & Schumacher 2006). It was not necessary for the questionnaire to be changed after the pilot.

3.2.4.2 Focus groups (Appendix B)

Focus groups are defined as "a form of group interview that capitalises on communication between research participants in order to generate data" (Kitzinger 1995:299). Maree (2007:90) explains that "in focus group and semi-structured interviews, participants are able to build on each other's ideas and comments to provide an in-depth view not attainable from individual semi-structured interviews”. It is also asserted that focus groups and semi-structured interviews “produce data rich in detail that is difficult to achieve with other research methods” (Maree 2007:90). It is for that reason that focus groups were used in this study to help clarify or expand on issues that emanated from the questionnaire. Two focus group discussions (see Appendix B) with involved first-year Chemistry students (CEM104) were held during the last week of the second semester (end of October). Although, all these students were invited to the focus groups, limited attendance of these focus groups were due to the upcoming examination. These discussions were voice recorded (with permission of the students) and then transcribed by the researcher for the purpose of data analysis [see 1.7.4] (*cf.* Maree 2007).

3.2.4.3 Semi-structured interviews (Appendix C)

An interview is defined as “a two-way conversation in which the interviewer asks the participant questions to collect data and to learn about the ideas, beliefs, views, opinions and behaviours of the participant” (Maree 2007:87). In this study semi-structured interviews were employed since the information gathered was to be compared and contrasted with information gained from the other data collection techniques (*cf.* Dawson 2009). As with the focus group interviews the proceedings of the semi-structured interviews were also recorded and transcribed for data analysis purposes. The participants in the interview were two lecturers involved in the teaching of first-year Chemistry at the UFS Qwaqwa campus. This hour interview was conducted by the researcher at the Qwaqwa campus of the UFS during June 2012.

3.2.5 Data analysis and interpretation

Data analysis is defined as ‘those procedures which enable you to organise and make sense of data in order to produce findings and an overall understanding of the case” (Simons 2009:117). In mixed methods “analysis occurs both within the quantitative and the qualitative approaches, and often between the approaches” (Creswell 2003:220). In this study (as stipulated in 1.7.4), the quantitative data from the questionnaires were analysed using the mean percentage of each response category in table format. Meanwhile, the qualitative data from the focus groups and semi-structured interviews (as stipulated in 1.7.4) were collated through thematic analysis and then reported on (see 4.4; 4.5) - thus "… not imposed by the researcher" (Dawson 2009:119). The data obtained from the different instruments were triangulated (see 4.6). Triangulation is defined as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000: 126). Triangulation of data was done because it "permits the researcher to be more certain of his/her findings and can unravel contradictions" (Onwuegbuzie & Leech 2007).

3.2.6 Reporting of data

"For a sequential study, mixed methods researchers typically organise the report of procedures into quantitative data collection and analysis followed by qualitative data collection and analysis (Creswell 2003:222). The results from the questionnaire are therefore presented in table format, while those from focus groups and semi-structured interviews are grouped in terms of emerging themes and then reported on (see 4.4; 4.5) - thus "… not imposed by the researcher" (Dawson 2009:119).

3.2.7 Trustworthiness of this study

Trustworthiness refers to the way in which the inquirer is able to persuade the audience that the findings in the study are worth paying attention to and that the research is of high quality (Lincoln & Guba, quoted by Maree 2007:297). In an effort to enhance the credibility of the study, the researcher produces findings that are believable and convincing, but also presenting negative or inconsistent findings (Maree 2007:297). The researcher used multiple methods of data collection in this study with the envisaged effect of enhancing trustworthiness (Maree 2007). Other steps taken by the researcher to establish trustworthiness included the following:

- Triangulation of data from quantitative and qualitative sources to verify the extent to which conclusions from the different sources support each other (*cf.* Maree 2007).
- The researcher used “rich thick descriptions” to convey findings.
- Negative or discrepant information that runs contrary to the themes are presented (*cf.* Creswell 2003:196)
- The researcher provided a more detailed methodological description, which will enable the reader to determine how far the data and constructs emerging from it may be accepted (*cf.* Shenton 2004:72).

These steps were taken to address the following as far as trustworthiness is concerned:

3.2.7.1 Validity

Validity is defined by McMillan (2000:132) as “an overall evaluation of the extent to which theory and empirical evidence support interpretations that are implied in given uses of the scores.” McMillan (2000:133) emphasised that “it is the inference that is valid or invalid, not the measure”, thus he said, validity is established by presenting evidence that the inferences are appropriate. Diverse kinds of validity exist, but in this study “internal validity” refers to accurate presentation of research, which can be supported by data collection (*cf.* Maree 2007:297). This study was conducted to elicit information from first-year Chemistry students and lecturers about how they felt about the teaching, learning and assessment practices, whilst taking care to accurately explain the results. Internal validity was facilitated via mixed methods (see 3.2.2; 3.2.4) and data triangulation (see 4.6) was done to obtain more clarity via verification. The completed questionnaires and transcripts of the focus group and semi-structured interviews were kept in a safe place for retrieval and/or use at a later stage, should it be required (*cf.* Cohen *et al.* 2008:136).

3.2.7.2 Reliability

Reliability is defined by Maree (2007:215) as "the extent to which a measuring instrument is repeatable and consistent." Lincoln and Guba (quoted by Maree 2007:80) maintained that there can be no validity without reliability, a demonstration of validity is sufficient to establish reliability. Reliability was ensured in this study through triangulation of research methods (by comparing questionnaire, focus group and semi-structured interview results) to produce conclusions that are "well-validated" (*cf.* Maree 2007:266). .

3.2.7.3 Objectivity

Paton (quoted by Shenton 2004:72) recognises the difficulty of ensuring real objectivity, since, as even tests and questionnaires are designed by humans, the intrusion of the researcher's biases is inevitable. This view is supported by Simons (2009:163) when she said that eliminating subjectivity is not achievable in any event, and goes further to suggest that "the more relevant approach to adopt in qualitative inquiry is to acknowledge its inherent subjectivity and concentrate on demonstrating how your values, predispositions and feelings impact upon the research." In order to address the objectivity issue the role of the researcher was clearly stated throughout the research process, and the measuring instrument was piloted to minimise any possible misconceptions and ensure sampling according to the mentioned criteria (see 3.2.3).

3.2.7.4 Transferability

Transferability or generalisability is defined by Durrheim and Wassenaar (quoted by Maree 2007:297) as "the degree to which generalisations can be made from the data and context of the research study to the wide population and settings." It is comparable to external validity, which is "concerned with the extent to which the findings of one study can be applied to other situations" (Shenton 2004:69). Shenton (2004:69) further pointed out that "since the findings of a qualitative project are specific to a small number of particular environments and individuals, it is impossible to demonstrate that the findings and conclusions are applicable to other situations and populations". This applies in this study too, especially since a case study design and non-probability were employed (see 1.7; 3.2.1; 3.2.7.4). This implies that the researcher is not in a position to make transferability claims because he is only aware of the context of this study (*cf.* Shenton 2004) and generalising the results is limited due to non-probability sampling (*cf*. Maree 2007).

3.2.8 Ethical considerations

"Ethics is how we behave or should behave in relation to the people with whom we interact" (Simons 2009:96). In research this boils down to "establishing throughout the research process a relationship with participants that respects human dignity and integrity and in which people can trust" (Simons 2009:96). In order to conform to the requirements of ethical behaviour in the study, written informed consent was obtained from the subject head of Chemistry at the UFS to conduct the study (see Appendix D). The students that were involved were informed about the study before they were requested to participate and were made aware that participation was totally voluntary. The participants were also assured of the fact that their responses would be dealt with strictly confidentially and their anonymity was guaranteed - no direct references to students' identities are made in either the report, or the transcriptions of the questionnaire responses, focus group discussions and semi-structured interviews.

3.3 CONCLUSION

In this chapter details of the empirical study were discussed in order to clarify the research process. Framed within an interpretevist and post-positivist paradigm (*cf.* 1.7.1), the researcher employed the case study (see 1.7) as the preferred research design and coupled that with the mixed methods methodology to achieve the objectives of the study (*cf.* 1.3). To this effect a questionnaire (with both open-ended and closed-ended questions) were used to elicit the students' views, (*cf.* 4.3) and the focus group discussions with students (*cf.* 4.4) to further clarified issues emanating from the questionnaire. By using the semi-structured interviews the lecturers' perceptions were collected (*cf.* 4.5). The main aim of all the above-mentioned research instruments was collecting data for designing a support programme for first-year Chemistry at the QwaQwa campus of the UFS (*cf.* Chapter 4). In addition, the use of the different methods of data collection helped to validate the results and enhances the trustworthiness of the study. Finally, all the potential ethical considerations were taken into account and were all adhered to (*cf.* 3.2.8).

The next chapter is dedicated to the results and findings from the different instruments employed in the empirical study.

CHAPTER 4

RESULTS AND FINDINGS OF THE EMPIRICAL STUDY

4.1 INTRODUCTION

The preceding chapter provided a discussion on how the empirical study would unfold, touching on the research design and methodology, instruments employed and how ethical and trustworthiness issues were taken care of. In this way two of the objectives (see 1.3) of this study were realised, namely to:

- Investigate and critically analyse the dual perceptions of fist-year Chemistry students and lecturers (as measured against the guidelines from literature) by means of a questionnaire, focus group discussions and semi-structured interviews.
- Suggest a support programme to address first-year Chemistry students' teaching, learning and assessment problems at QwaQwa campus (UFS).

In this chapter the analysis of data and findings of the study will be discussed.

4.2 REPORT OF THE RESEARCH FINDINGS

In order to achieve the aim of this study (see 1.3), the researcher formulated findings which were deduced from the analysis and interpretation of data collected by means of the questionnaire (see Appendix A), as well as through the focus groups (see Appendix B) and semi-structured interviews (see Appendix C). With this information available, it was possible to suggest a support programme to address first-year Chemistry students' teaching, learning and assessment problems at QwaQwa campus (UFS).

4.3 ANALYSIS AND INTERPRETATION OF DATA OBTAINED FROM THE QUESTIONNAIRE (APPENDIX A)

The questionnaire was distributed during class time in September 2010 to 113 students registered for CEM104. All the questionnaires were collected at the end of the class (response rate = 100%). The reporting of the questionnaire results will be according to the structure of the questionnaire (see Appendix A).

4.3.1 Biographic information of students

The biographical information of the respondents provided in Table 4.1 below was drawn from Section A of the questionnaire (see Appendix A) and served the purpose of clarifying the sample.

Table 4.1: Profile of first-year Chemistry students at UFS (Qwaqwa) [N=113]

Categories	Description	Percentage
Gender (A1)	Male	51%
	Female	49%
Age (A2)	15-19 years	41%
	20-24 years	40%
	25-29 years	19%
Home language (A3)	Southern Sotho	56%
	Zulu	39%
	Xhosa	3%
	Afrikaans	2%
Highest qualification obtained (A4)	Grade 12	100%
Achievement level for Chemistry in Grade 12 (A6)	Level 4	72%
	Level 5	15%
	Level 6	10%
	Other (no Chemistry in Grade 12)	3%

According to Table 4.1 the profile of the UFS (QwaQwa campus) first-year Chemistry students was evenly spread between males and females (51% and 49% respectively) with Southern Sotho speaking students being in majority (56%). Most of the respondents (72%) had obtained a level 4 in their Grade 12 Chemistry in the year preceding their registration at the UFS (QwaQwa campus). Few of the respondents (3%) did not do Chemistry in Grade 12. The age distribution of the respondents was clustered between 15 and 29 years, which, according to Erikson's psychosocial stages, falls in the adolescence and early adulthood stages (Louw 1997). The adolescence stage is characterised by "large advances in information processing abilities, increase in short-term memory capacity and development of a wide range of strategies, which increase their ability to remember and solve problems" (Louw 1997:511). Other attributes of this stage are that "peak performance on certain types of learning and memory tasks is reached during early adulthood" (Louw 1997:526), and the thinking at this stage is "more complex, more global and more adaptive" than in the adolescent stage (Duncan & van Niekerk 2008:99). An additional factor, that needed to be taken cognisance of in this study, is that the UFS (QwaQwa campus) first-year Chemistry students had to cope with the transition from being dependent on parents in a familiar schooling system to being independent students at university, which might have had an impact on their success or failure in the Chemistry course.

4.3.2 Student-related factors

The results of Section B of the questionnaire (see Appendix A) will now be discussed according to the relevant student learning, preparedness and motivation categories, which are inherent student factors that have an effect on a student's academic performance. Table 4.2 below provides an overview of the results for Section B of the questionnaire (see Appendix A) followed by comments on each of the questions in the section.

Table 4.2: Student preparedness, motivation and learning

Question	Agree	Not sure	Disagree
(B1) I feel that I was well prepared for studying at university	83%	7%	10%
(B3) I attend lectures regularly	95%	3%	2%
(B4) I attempt all tutorials before attending the tutorial class	70%	22%	8%
(B5) I tend to read the minimum beyond what is required to pass	32%	16%	52%
(B6) I go to the class well prepared	50%	40%	10%
(B7) I go to the practical session well prepared	83%	16%	1%
(B8) I am not interested in Chemistry course, I am only taking it to obtain credits	10%	4%	86%
(B9) I do not find it difficult to motivate myself to learn Chemistry	60%	32%	8%

4.3.2.1 Preparedness for university

The majority of first-year Chemistry students (83%) (see question B1 of Appendix A) felt that they were adequately prepared for university during their first-year (see Figure 4.1).

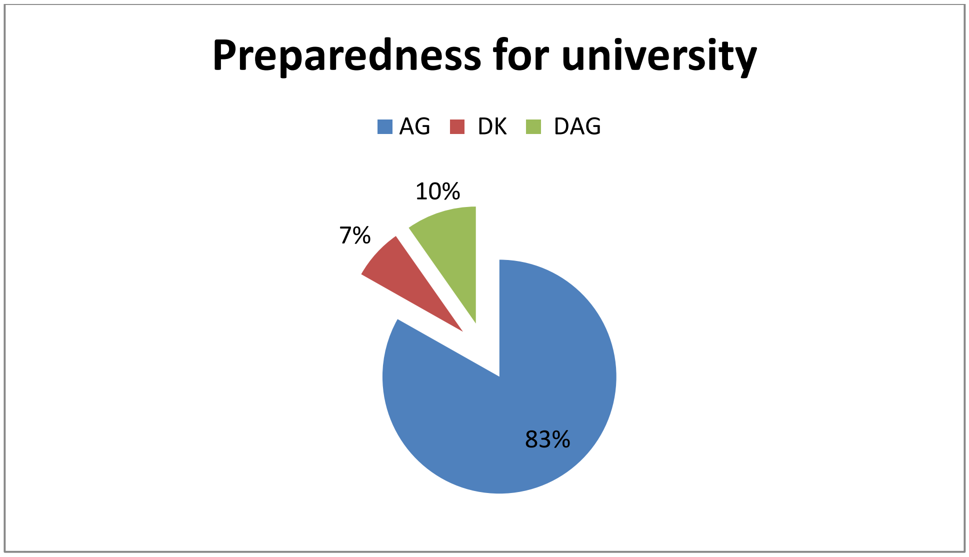

Figure 4.1: Preparedness for university

(In Figure 4.1 above AG stands for agree, DK stands for don't know and DAG stands for disagree.)

Comments: The questionnaire was distributed towards the end of the year (in September). Therefore these UFS (QwaQwa campus) first-year Chemistry students (having experienced three terms at university) were in a position to make an informed judgement of their preparedness for university study. The majority of these students (83%) indicated that they were well prepared for studying at university. This high percentage may be due to the fact that students had had time to adjust to the demands of university studies. This is a positive factor since the more prepared students feel, the more confident they become of their chances for success (2.3.2.1). However, it is not clear if there was anything which was done by the university to help them adjust to the new environment.

4.3.2.2 Interest in Chemistry

The majority of UFS (QwaQwa campus) first-year Chemistry students (86%) (see question B8 of Appendix A) stated that they were doing Chemistry because of interest in the subject, and not only for credit-bearing purposes.

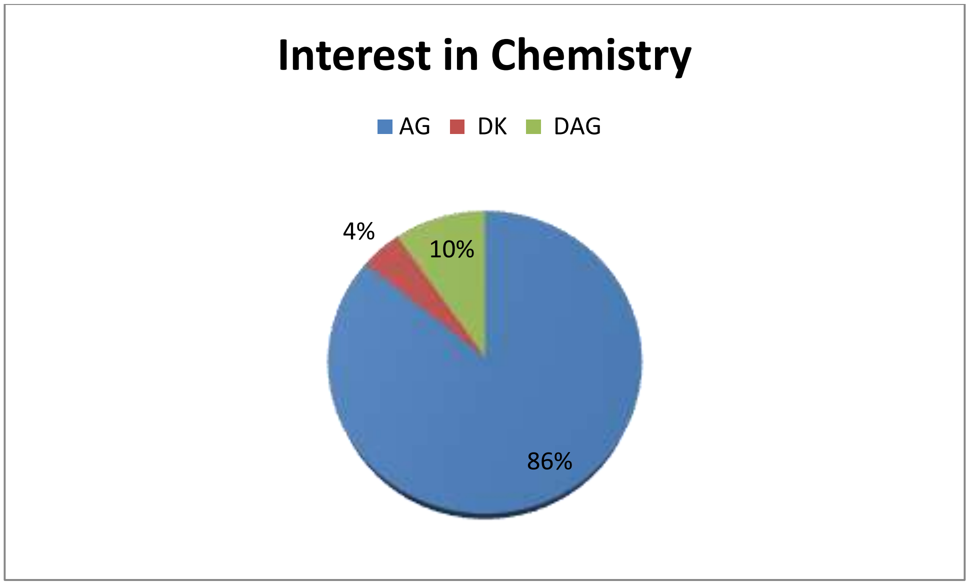

Figure 4.2: Interest in Chemistry

(In Figure 4.2 above AG stands for agree, DK stands for do not know and DAG stands for disagree)

Comments: Interest (or affect) in the subject is viewed as one of the components of student motivation (see 2.3.2.2) and these components are, according to Zusho, Pintrich and Coppola (2003:1083), linked to deeper cognitive processing as well as higher levels of achievement. This implies that students who are interested in the subject apply a deep learning approach in the subject, which increases the chances of success in the subject.

4.3.2.3 Students' motivation towards Chemistry

A number of questions (B3, B4, B5, B6, B7 and B9 of Appendix A) were asked to establish students' motivation towards learning Chemistry (see Figure 4.3). Most of the UFS (QwaQwa campus) first-year Chemistry students (95%) indicated regular class attendance, 83% of them indicated that they were well prepared before attending the practicals, while 70% said that they prepared their tutorial exercises before attending the tutorial session. Only 50% of the UFS (QwaQwa campus) first-year Chemistry students prepared before attending class, while 52% of these students only read just enough to pass. 40% of UFS (QwaQwa campus) first-year Chemistry students remained neutral when requested whether preparation had been completed before class attendance.

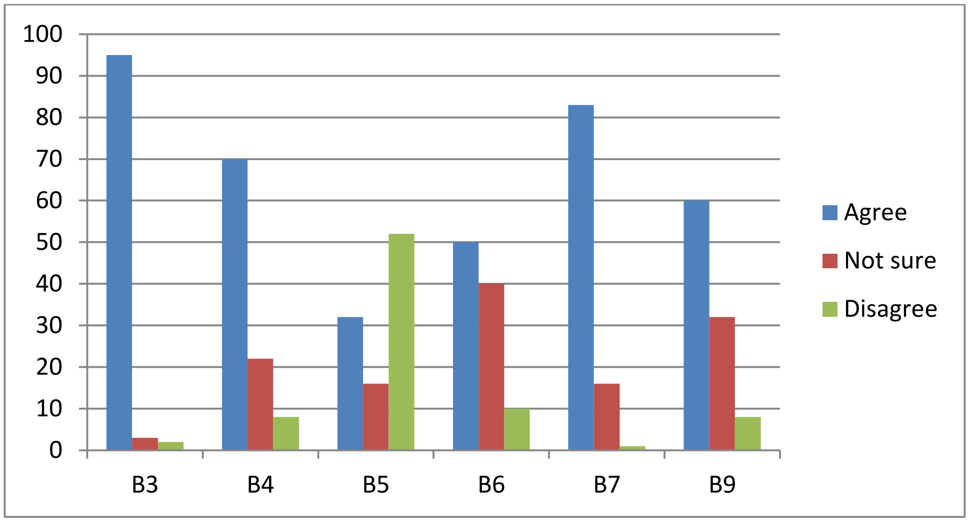

Figure 4.3: First-year Chemistry students' motivation

In the open-ended question (question B10 of Appendix A) respondents suggested the following as some of the steps that could be taken to motivate them to learn Chemistry:

- Some students (23%) felt that they could and/or should motivate themselves, because they were satisfied with the lecturers' motivation.
- A number of students (22%) said that the attitude of the lecturer could play a significant role in ensuring that they are motivated.
- Several students (16%) argued that the provision of information about Chemistry (e.g. job opportunities, relation to real life, etc.) would contribute to their continued motivation to study Chemistry.
- Other students (11%) felt that being allowed to do research and/or practicals would assist in sustaining their motivation.
- Few students (3%) were of the view that compulsory class and tutorial attendance; and proper assessment feedback were essential for motivating students.
- Each of the following was proposed by 1.4% of the UFS (QwaQwa campus) first-year Chemistry students as important aspects for student motivation, namely

provision of bursaries; equipment (e.g. books); previous question papers and extra assistance, as well as making group work compulsory.

Comments: The significance and importance of motivation in student learning were highlighted in the literature review (see 2.3.2.2). The results of this study confirmed most of the motivation indicators in this study (see Figure 4.3). The fact that half of the UFS (QwaQwa campus) first-year Chemistry students did not prepare (50%) before coming to class (see Figure 4.3), might mean that they were not participating fully during class time and thus could get away with not preparing (see 2.3.2.1). This is a negative reflection on the class environment, because Davis (2010) said that the class environment can transform student motivation for better or worse. It is apparent from the open-ended question that only 23% of the UFS (QwaQwa campus) first-year Chemistry students felt that they should motivate themselves (intrinsic motivation) and the other 21% expected the motivation from lecturer(s), while the rest had other views as to what could be done to motivate them (mostly related to extrinsic motivation). This observation is consistent with the view of Huddle (2000) that students are becoming more dependent on lecturer(s) to make them learn (see 2.3.2.2).

4.3.3 Course-related factors

Sections C and D of Appendix A are dedicated to dealing with the teaching and assessment part of the first-year Chemistry course and the results thereof. Assessment is dealt with first, because, according to Bennett (2004:52), “assessment is a (if not the) major driver for students in higher education.”

4.3.3.1 Assessment

As far as student assessment is concerned, respondents were asked three questions (see questions D1, D2 and D3 of Appendix A) and Figure 4.5 is a graphical depiction of the responses.

Table 4.3: Student assessment

Question	Agree	Not sure	Disagree
(D1) The assessment is related to the expected outcomes	79%	18%	3%
(D2) I find that I spend too much time on studying for assessments	64%	26%	10%
(D3) The assessment tasks help me to improve my learning	89%	6%	5%

UFS (Qwaqwa Campus) first-year Chemistry students indicated the following views on student assessment:

- Most of the respondents (79%) felt that the assessments had been related to the expected outcomes of the course.
- Majority of the respondents (88%) believed that assessment helped to improve their learning.
- Most of the respondents (64%) maintained that they spent too much time on assessment, which might mean assessment overload (e.g. students spending more time in preparing for assessments rather than understanding the work).

In Figure 4.4 the findings on the questions regarding assessment are depicted in a graph.

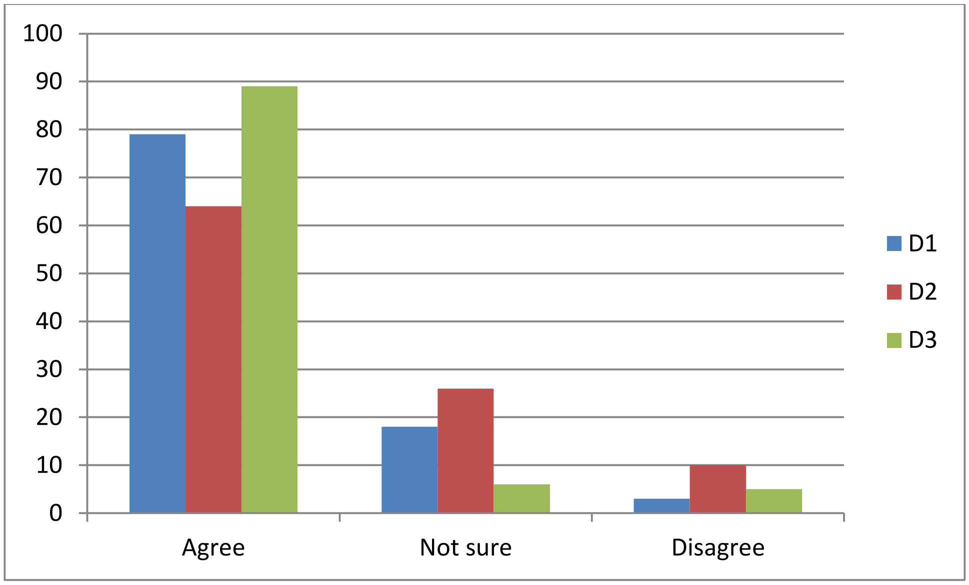

Figure 4.4: Assessment of first-year Chemistry

In response to the open-ended question (see question D6 of Appendix A), the respondents suggested the following measures to ensure that assessment supports student learning of first-year Chemistry:

- Some of the respondents (32%) were of the opinion that for learning to occur, the number of assessment tasks should be increased, while 20% felt that the *status quo* must be maintained.
- Several respondents (13%) felt that constructive feedback on the assessment tasks would help them learn.
- A number of respondents (11%) viewed the availability of lecturers to assist with some of the assessments as crucial.
- Few of the respondents (6%) said that there should be revision before tests,
- Few respondents (4%) regarded the provision of previous question papers, as well as discussion thereof as a necessity.
- While the other (3%) said that they had no idea what could be done.
- Even fewer respondents (2%) felt that questions asked should not be tricky and that student feedback should be sought after every assessment.

Comments: There appeared to be a general positive feeling among the UFS (QwaQwa campus) first-year Chemistry respondents that assessment does what it purports to do. It was evident that these students (64%) felt that they spent too much time on assessments, but it is not clear whether this is for all courses or for Chemistry only. This might be one of the reasons why students cannot prepare before coming to class (see 2.3.2.5; Table 4.3 and Figure 4.4). This was in contrast to 31% of the respondents in the open-ended question who proposed that assessment tasks should be increased, as one way to ensure that assessment supports learning.

4.3.3.2 Feedback on assessment

Feedback on student assessment (see questions D4 and D5 of Appendix A) will now be discussed.

Table 4.4: Feedback on student assessment

Question	Agree	Not sure	Disagree
(D4) The feedback I receive from my lecturers is timeous	64%	28%	8%
(D5) The feedback on assessment is constructive	67%	21%	12%

UFS (QwaQwa campus) first-year Chemistry students revealed a generally positive feeling towards the feedback on assessment tasks. 64% of the respondents stated that the feedback was received in good time, while 67% asserted that it was constructive (see questions D4 and D5 of Appendix A). Below (Figure 4.5) is a graphical depiction of the responses on student assessment feedback.

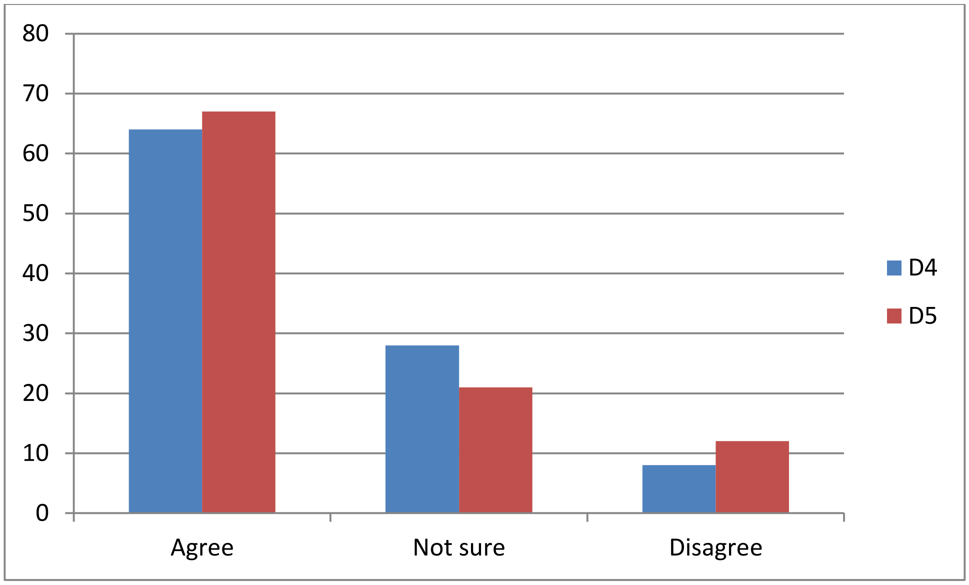

Figure 4.5: Feedback on assessment of first-year Chemistry

Comments: The turn-around time for and the quality of the assessment feedback were found to be satisfactory by most of the respondents (see Table 4.4 and Figure 4.5). This implies that the proposed seven principles of good feedback practice were in place (see 2.3.2.5).

4.3.3.3 Lecturing staff

The UFS (QwaQwa campus) first-year Chemistry respondents were also questioned about their views regarding the lecturers responsible for the first-year Chemistry course (see questions C1,C2,C3,C4,C8,C9,C10,C11,C12,C13 and C15 of Appendix A). Most of these respondents (70%) were satisfied with their first-year Chemistry lecturers (see Table 4.5).

The processed responses to questions C1, C2, C3, C4, C8, C9, C10, C11, C12, C13 and C15 (Appendix A) provided the following results: (also see Figure 4.6):

- 81% felt that lecturing staff was encouraging to students.
- 71% were happy with the competency of the staff.
- 64% agreed that the staff used different methods of learning facilitation.

- As far as group work is concerned only 56% of the respondents felt that this was encouraged during classes.
- 88% said that the lecturers were understandable.
- 73% felt that lecturing staff was approachable.
- 84% said that the lecturers had consultation times and 71% stated that the lecturers were available during those stipulated times.
- 77% felt that lecturers cared about the welfare and progress of students.
- 70% of the students surveyed felt that the lectures helped them identify and deal with any misconceptions that they might have had.
- 84% of the respondents maintained that lecturers encouraged them to think about the problem instead of just giving them the solutions (i.e. the lecturers asked students questions that would intentionally guide students to the solution instead of providing the solution).

Table 4.5: Lecturing staff

Question	Agree	Not sure	Disagree
(C1) The lecturing staff encourages first-year Chemistry students to learn	81%	11%	8%
(C2) The first-year Chemistry lecturers appear to be competent	71%	24%	5%
(C3) The first-year Chemistry lecturers use different learning facilitation methods	64%	18%	18%
(C4) The first-year Chemistry lecturers use group work in class	56%	26%	18%
(C8) The first-year Chemistry lecturers are understandable	88%	4%	8%
(C9) The first-year Chemistry lecturers are approachable	73%	24%	13%
(C10) The first-year Chemistry lecturers have time for consultation	84%	8%	8%
(C11) The first-year Chemistry lecturers are available during consultation times	71%	26%	3%

Question	Agree	Not sure	Disagree
(C12) The first-year Chemistry lecturers seem to care about the welfare and progress of students	77%	13%	10%
(C13) The first-year Chemistry lecturers encourage me to think instead of providing the answers	84%	6%	10%
(C15) The first-year Chemistry lecturers help me deal with misconceptions that I may have	72%	22%	6%

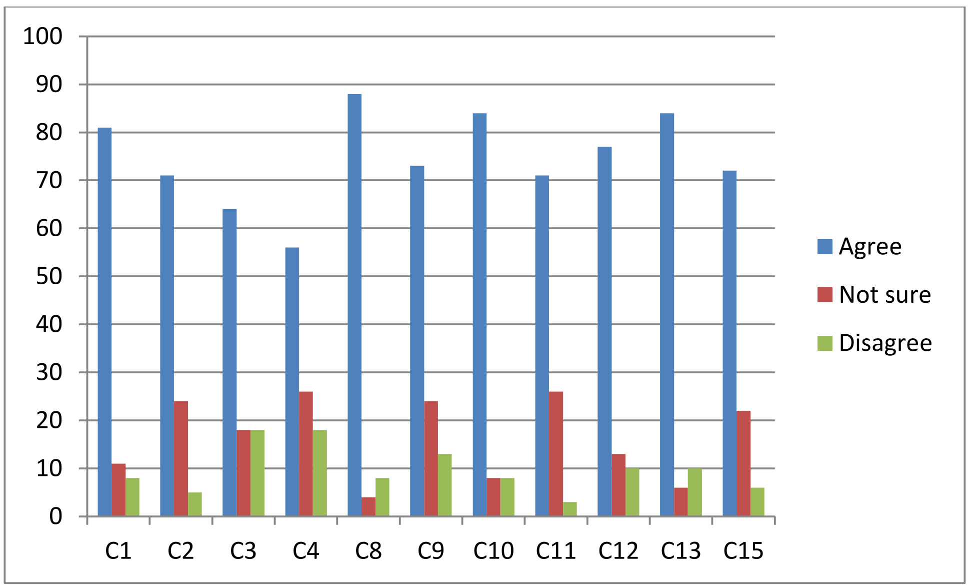

Figure 4.6: Responses regarding lecturing staff in first-year Chemistry

Comments: The attitude of the majority of these respondents was positive towards the lecturing staff, their approach to learning facilitation and their attitude(s) towards students (see Table 4.5 and Figure 4.6). This is important for student success since the lecturers are seen by students as the custodians of the course (see 2.3.2.4). The respondents (70%) felt that the lecturers assisted them to identify and deal with the misconceptions that they might have had (see 2.3.2.3) and that they were encouraged (84%) to attempt to solve the problems themselves rather than being provided with the solutions by the lecturer.

4.3.3.4 Lectures and tutorials

This section concerns itself with the views of the respondents regarding the contact sessions (i.e. lectures and tutorial sessions) of the first-year Chemistry course. These views were addressed by questions C5, C6, C7 and C14 of the questionnaire (see Table 4.6 below).

Table 4.6: Lectures and tutorials

Question	Agree	Not sure	Disagree
(C5) The first-year Chemistry lectures are interesting	72%	22%	6%
(C6) The first-year Chemistry topics appear to be relevant	70%	26%	4%
(C7) The first-year Chemistry tutorials are more beneficial than lectures	40%	32%	28%
(C14) The first-year Chemistry learning activities encourage dialogue with lecturers, tutors and fellow students rather than passive listening	70%	18%	12%

Most of the UFS (QwaQwa campus) first-year Chemistry respondents (81%) agreed that there was alignment between theory and practicals. 70% of the respondents recognised the relevance of topics that were taught. Furthermore, 70% of these respondents affirmed that the lectures were interesting and that learning activities encouraged dialogue with lecturers and among students. The respondents who felt that tutorials were more beneficial than lectures were in the minority (36%) [see Figure 4.7 for a graphical presentation of the results].

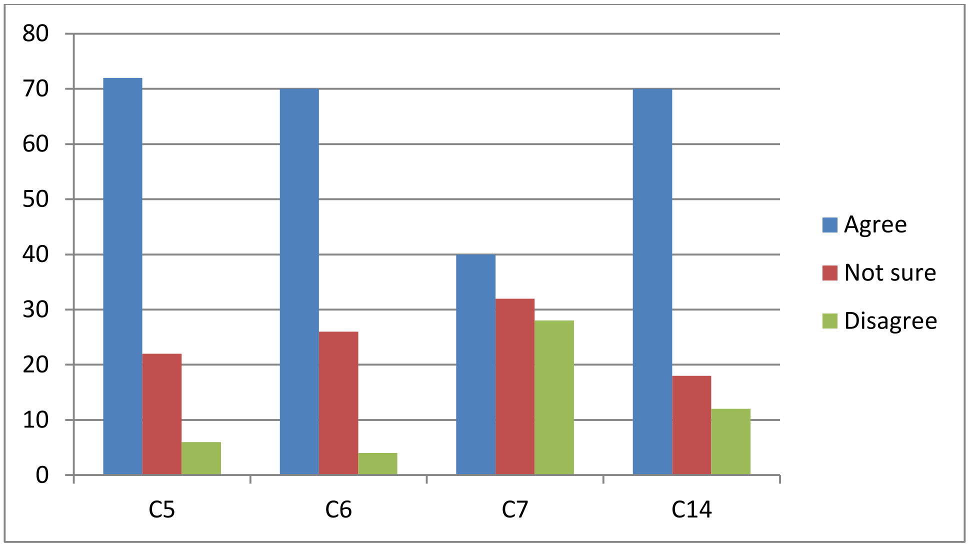

Figure 4.7: Lectures and tutorials

The UFS (QwaQwa campus) first-year Chemistry respondents had the following suggestions regarding what could be done to ensure that students are actively involved in class (see question C17 of Appendix A):

- Some of these respondents (32%) felt that the lecturer is central to ensuring active involvement of students in the class. This was evidenced by some of the statements by UFS (QwaQwa campus) first-year Chemistry respondents regarding what the lecturer could do:

> -"make classes more exciting"
> -"... make them (students) feel more comfortable. Let them know that all their views are important and that no question is too silly to ask nor opinion too wrong to consider".
> -"Open more time of lecturer talking to students like lecturer going to student during activity time and see if the activity is done or not".
> -"... involve them during lectures and create that relationship between them".

- A few of these respondents (10%) were of the view that groups should form an integral part of the course, as indicated in the following statements:

> -".. have more facilities and to be compulsory to have a study group."
> -"Students should be divided into small groups so that each and everyone can partake in class."

-”Group discussion”.

- A few of these respondents (10%) posited that students should be given assignments on topics of interest and be afforded a chance to present their findings, as indicated in the following statements:

-“We should be given topics in class that we should seek information about, then the lecturer will choose randomly people who will crack the topic.”
-“At least have debate by groups at the lectures”.

- A few of these respondents (7%) suggested that the lecturer should allow students to attempt the work first before giving them assistance, as indicated in the following statement:

-”If the lecturer can make students do the work before and ask only where they have problems.”

- A minimum of the respondents (5%) indicated that weekly tutorial classes afforded them a chance to actively interact with the course material.
- Only a few of the respondents (5%) felt that making the course more practical could enhance their active involvement.
- A bare minimum of the respondents (5%) were of the view that students should be encouraged to come to class prepared; they should be afforded a platform to present what they had read about that day’s work before the lecture started.
- A few of the respondents (4%) thought that the following measures were necessary for active involvement of students in class, as indicated by the following statements:

- More resources to help them learn
- More assessment opportunities.
- Compulsory class attendance.

Comments: The UFS (QwaQwa campus) first-year Chemistry respondents appeared to be positive towards the contact sessions such as lectures, tutorials and practicals (see Table 4.6 and Figure 4.7). 36% of the respondents felt that the tutorials were more beneficial than the lectures. This might be due to the fact that tutorials afford students an opportunity to engage with the work covered during the lectures and allow for individual interaction with the lecturer. The respondents in the open-ended question (see C17 of Appendix A) were of the view that the lecturer(s) were mainly responsible for creating an engaged-learning class environment that encourages active participation and most suggestions made implied student-centred approaches (see 2.3.2.4; 2.4). The proposals ranged from giving students assignments on topics of interest and allowing them to present their findings; to allowing students to present their understanding of the topic of the day before the lecturer makes his/her presentation and to bring in group work as an integral part of the lectures (contact time) (see 2.4).

4.3.4 Academic support

Most of the UFS (QwaQwa campus) first-year Chemistry respondents (63%) felt that the academic support (see question B2 of Appendix A) provided for them was adequate (see Figure 4.8 for a graphic presentation of the results).

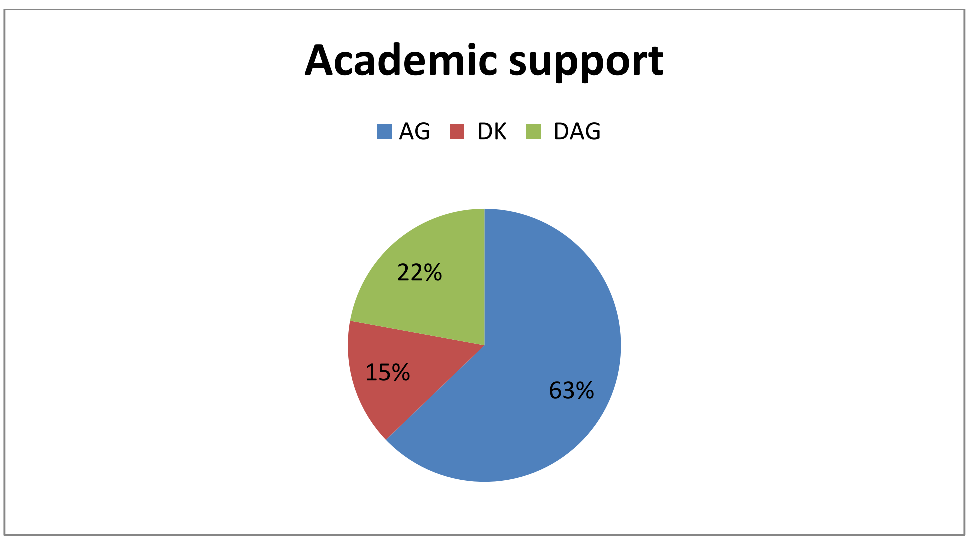

Figure 4.8: Academic support

(In Figure 4.8 above AG stands for agree, DK stands for do not know and DAG stands for disagree.)

Comments: The respondents (63%) seemed to be satisfied with the academic support provided by the institution, but the first-year Chemistry course was identified as one of the courses where students needed extra support. Currently the New Academic Tutorial Programme (NATP) offered at the UFS provides such support. In the NATP tutors are trained and provided with administrative support to enable them to provide academic support to students in selected courses. This possibly could be one of the reasons why the majority of the respondents were satisfied with the academic support.

4.3.5 Proposed changes to the course

The UFS (QwaQwa campus) first-year Chemistry respondents were requested to propose changes for the UFS (QwaQwa campus) first-year Chemistry course (see C16 of the questionnaire in Appendix A), and the following were put forward:

- It emerged that some of these respondents (25%) were satisfied with the way the course was being run and did not want anything changed, as demonstrated in the following the statements:

> -"Nothing, everything is up to standard."
> -"For me everything is perfect just that we students are lazy."
> -"Nothing, but communication among students and lecturer during classes."

- Some of these respondents (23%) had issues with the staff that assisted them with the course. The issues ranged from the attitude of assistants to the way the lecturers conducted themselves as indicated in the following statements:

> -"Staff should be more accessible to students at all times."
> -"Instructors in the practical sessions should not be so intimidating. Students cannot perform to the best of their abilities if they are afraid with every move they make."
> -"Tutors, they have the biggest attitude and they treat us like we stupid."
> -"I would change this thing of lecturers and students always being formal, we need to relax and have fun."

- A few of these respondents (15%) would like to see changes with the way practical sessions are conducted as indicated in the following statements:

> -“The theory classes can take less time and make practical sessions more in order to make understanding more easy.”
> -“The kind of practicals that we are doing. At times it feels like I did not gain a thing in the practicals, I just performed for the sake of performing.”

- For a few of these respondents (15%), the timetable seemed to be a cause for concern, because of the clashes and the complexity of the time table for a first-year student. The respondents indicated that in some of the courses there appeared to be clashes. Since the time-table was not faculty specific, they found it rather complicated at the beginning; at school they were only provided with the time-table that applied to their class directly, not the whole school’s time-table.
- Only a few of these respondents (6%) saw the number of tests as something that needed to be changed. However there appeared to be differences in opinion whether the number of tests should be decreased or increased as indicated by the following statements:

> -“Minimising number of tests.”
> -”Writing two semester tests is kind of scary because it puts too much pressure on you as a student and you end up not performing well. Would prefer to write at least 4, one to improve marks”.

- A minimum of the respondents (5%) proposed changes to the course and its content, with concerns raised about the abstract nature of the course and the amount of information that had to be mastered in a limited timeframe.
- The number of tutors and class size were disconcerting to a few respondents (3%), with the students believing that there were too few tutors available and that the class size was too big, thus negatively impacting on their learning.
- The bare minimum of the respondents (1.5%) were concerned with the students’ attitude towards Chemistry; the other concern was due to the lack of research, and one student proposed that tutorial attendance should be compulsory.

Comments: The changes proposed by these respondents covered a whole range of issues, which included, amongst others, the attitude of lecturers and tutors, the timetable, the practical sessions, etc. There was a concern raised about the manner in which tutors and assistants interacted with the students and the accessibility of lecturers. According to the literature the above-mentioned could negatively impact on students' motivation to learn (see 2.3.2.2). As far as the assessment is concerned there was no consensus with regard to increasing or decreasing the assessment tasks. The literature does not emphasise quantity of assessment tasks, but provides principles of good assessment, which will ensure that assessment supports learning (see 2.3.2.5).

4.4 ANALYSIS AND INTERPRETATION OF DATA OBTAINED FROM FOCUS GROUPS (APPENDIX B)

Two large focus groups (see 3.2.4.2) were conducted at the UFS (Qwaqwa campus) to address the overarching and subsidiary questions (see 1.2.1-1.2.2). These qualitative data collection techniques were implemented during the last week of the second semester (end of October) 2011 (see 3.2.4.2). The preoccupation of these students with the upcoming examinations played a role in the attendance of these participants. The reasons for conducting these focus groups were to explore the experiences of UFS (QwaQwa campus) first-year students and lecturers of the teaching, learning and assessment employed in the Chemistry subject and how possible shortcomings could be addressed (see 1.2.1).

The focus group interview schedule consisted of five sections (see detail in Appendix B), while the semi-structured interview schedule consisted of four sections (see details in Appendix C). The proceedings were duly recorded and the recordings were transcribed verbatim by the researcher. All the data from both the focus group discussions and semi-structured interviews were analysed and then categorised according to qualitative methods. The reporting of the focus group results (see Appendix B) is done according to the relevant categories identified from the transcriptions.

4.4.1 Interest in and motivation for doing Chemistry

The majority of the UFS (Qwaqwa campus) first-year Chemistry participants expressed a variety of reasons why they were interested in Chemistry, except for one who stated that Chemistry was part of the academic package. Their motivation for studying Chemistry, though supported by interest, ranged from the opinion that Chemistry would help the participants realise their future plans, to the students being able to go back to schools or communities to change the belief that Chemistry was difficult. This became evident from the following statements by some of the participants:

"I chose Chemistry for the fact of discovery. I want to discover new things in life so it would help in terms of being versatile and help me think outside the box because that is what Chemistry does to us as students."

"Personally I did not want to do Chemistry but it came with the package. I was interested in IT, but I found that for the first-year I had to do Chemistry."

"Doing Chemistry for my sake from my background I know that most of the learners consider the likes of maths and science difficult so I want to be a living example that you can still achieve it even though most people are pessimistic towards Chemistry, so if I have majored in it I will be able to pass it to other learners so that they can like it as I do."

Comments: It is apparent that for all the participants except one, studying Chemistry was a conscious choice based on interest and this correlates with the findings from the questionnaire (see 4.2.3.2), where 86% of the respondents confirmed that they were doing Chemistry because of interest and not just for the sake of credits.

4.4.2 Library and information services

This section about the library has a few sub-sections. Thus, the reporting thereof will be based on the responses from the UFS (Qwaqwa campus) first-year Chemistry participants and not in the order of the probes. There is a comment made by one of these participants that brings into question the centrality of library's role in learning (see 2.3.2.6), namely: "I was not at the library orientation, I do not like libraries; I do not like being near them anything that has library in it I won't be there at all. So for me the library I am not sure how they work and I am not sure about anything that is in there." This causes concern: How can a student at a higher education institution complete an academic year of study without having used the library?

4.4.2.1 Staff

In general, the focus group participants agreed on the positive attitude and helpfulness of staff in the library. However, there appears to be concerns regarding the "punishment" for not attending the library orientation sessions (e.g. denial of access to some of the library services). In addition, some library staff was reported to take it for granted that all students were computer literate, but to those who were computer illiterate the library was not found to be user-friendly. This is evidenced by the remarks by the focus group participants reflected in the box below:

> "They are helpful, but some of the things we can do ourselves like finding the right book, when needed, they are perfect."
> "Most of them are pretty helpful as it is their job, but sometimes because they are dealing with students regularly so some tend to get easily irritated."
> "The other thing is they are not well informing because if you are looking for a book for some of us who are coming from the rural areas you would have to use the computer and you do not know where to start."

Comments: The UFS (Qwaqwa campus) first-year Chemistry participants were satisfied with the library staff and the level of service they rendered. There did not seem to be a working relationship between the lecturer(s) and the library staff regarding first-year Chemistry-specific issues, as suggested in the literature (see 2.3.2.6).

4.4.2.2 Operating hours

In general, the UFS (Qwaqwa campus) first-year Chemistry participants felt that the operating hours of the library were not adequate. There appeared to be a number of reasons, which include, amongst others, the limited operating hours for those students who are involved in sport, especially the photocopying facilities, which are only available during library working hours. The following statements evidenced these opinions:

> "And even the working hours of the library, just like me I am taking part in sports and I cannot study during the day I study at night and the library closes at nine."
> "Concerning non-resident students it is inadequate because some arrive at 7:00 and the library is still closed."
> "For me the time is right because I do not arrive early on campus I also like the fact that it closes late even though I do not stay on campus. But I thought it would be nice if they could find the means of being open 24/7 it could be helpful.

Comments: UFS (Qwaqwa campus) first-year Chemistry student participants expressed the opinion that the daily operating hours of the library were limited (with special reference to the photocopying and printing facilities). The UFS (Qwaqwa campus) first-year Chemistry lecturers had opposite opinions – one was satisfied, but the other expressed the opinion that the operating hours should be extended to a 24/7 system (see 4.5.2). The possibility of extending the operating hours of the library, possibly before and after lectures, should be considered, although some felt that a 24/7 system was required.

4.4.2.3 Infrastructure

The space for studying and the ventilation in the library were found by the UFS (Qwaqwa campus) first-year Chemistry participants to be highly inadequate. The following sentiments were expressed by some of the participants:

> "There is a problem with the infrastructure of the library, the fans are not working and you cannot study in a hot place. And the library is too small when you want to study in the library you find it is full."

Comments: The UFS management should prioritise the air-conditioning in the existing library and the expansion of the library should be considered (with special reference to study space). This issue had not been raised in either the questionnaire responses (see 4.3) or the semi-structured interview responses (see 4.5).

4.4.2.4 Resources (books, computers, photocopying)

The library seemed to be adequately resourced with relevant books for this course. What seemed to be the problem was that students had not been informed properly as to how the library operates (e.g. the difference between short loan and general library books, how the interlibrary loan works, etc.). This might be due to the fact that students did not attend library orientation sessions.

The participants agreed that copying was reasonably priced, but the long queues made it almost impossible to make use of this service. The alternative copying services appeared to be too expensive. In addition, some participants indicated that students with money in their accounts were advantaged, because they were able to swipe their student cards and thus could make copies after 16:30 when Xerox closed. However, the attitude of staff working with copying seems to be not acceptable to students who found them very rude. This is evidenced by the remarks in the box below:

> "They (photocopying facilities) are extremely good for only 30c a copy it saves you a lot when you have to do lots of copies."
> "Another thing is that Xerox closes at 16h30 so at times when you have classes from 11h00 to 17h00, the only option for making copies is the ground floor then because you do not use the swiping system you cannot get information."
> "Those are not good because we stand on long queues."
> "And people are so rude, they are so rude. They are unhelpful and are short fused."

Comments: The UFS (Qwaqwa campus) first-year Chemistry students felt that the library had sufficient resources they needed for the first-year Chemistry course. As far as making copies these participants felt that the price was affordable, but the fact that the copies can only be made between 8h00 and 16h30 and the issue of long queues were cause for concern (as already highlighted in 4.4.2.2).

4.4.3 Course or subject related issues

This section will look at those factors that are inherent in the course, which impact on students' success.

4.4.3.1 Stressors

The UFS (Qwaqwa campus) first-year Chemistry participants highlighted several issues they regarded as stressors during their first-year of studying Chemistry. The issues include, amongst others, the negative influences from senior students, class size, complicated and clashing time-tables the lecturers with their different approaches to learning facilitation as well as the feeling among some of the students that they spent too much time on assessment. Testimony of this is evident in the following statements made by the participants:

> "I think most of the students are confused by those seniors from last year, because they always tell others how bad or how difficult Chemistry or bad this lecturer is."
> "I think the problem for other people like myself was asking questions in a loud way because when look at the crowd you start to lack confidence and it becomes difficult for you to ask questions whereas you do not understand."
> "The time-table in January, it tells you the period is in L6 you do not know that venue. It was so complicated."
> "The most stressful thing for me was trying to adjust to different personalities of our lecturers."

In addition, the mechanisms (in Organic Chemistry), too many equations and the manner in which questions were asked were also mentioned as areas of concern by these participants, as stated in the box below:

> "For me in the last semester organic Chemistry all those primary, secondary those tertiary equations I got confused. And in the second semester there are many equations that we had to learn so for some of us who went to the US, it was difficult to catch up on those

equations and they are a lot."
"People get confused by a lot of unnecessary information provided in questions especially in CHE 142, thus they fail."
"Besides mechanisms I am thinking naming the compounds because some of the people who are doing Chemistry right now did not do Chemistry like did not do physical science."

Comments: The UFS (Qwaqwa campus) first-year Chemistry students reported several stressors experienced during their first year of Chemistry studies; for example, teaching, assessment, de-motivating sentiments from senior students, class size, class time-table clashes and too much information that had to be processed (see 2.3.2.2; 2.3.2.4 and 2.3.2.5).

4.4.3.2 Valuable experiences

The participants expressed different views as to what they viewed as valuable experiences in their first-year Chemistry class. This was evidenced by the following statements in the box below:

"I can say for myself that firstly I valued group work, because as we are all from different areas I got new friends through Chemistry since we can help one another. But what I value the most is that for me I got out of that comfort zone or my pride of saying I can do that by myself but now I know that when I have a problem I can go to any of my classmates and he can help me."
"I have learnt that it is important to have time management because if you have a schedule you know that today I am doing this and tomorrow I am doing that so it helped a lot and to work under pressure because I am not doing Chemistry only."
"What I experienced is to be independent because last year the teacher always gave you homework and ask you to do the correction in class. And the self study I did not do the self study when I was at high school but now I can read things for myself and understand much better."

Comments: Working under pressure, group work, time management and being independent are some of the experiences that the participants felt were of value to them in this first-year Chemistry course (see 2.4).

4.4.3.3 Lecturers

The attitudes or perceptions of the participants are looked at in this section. These views are captured in the following statements in the box below:

> "One of the lecturers was kind of playful I did not understand him."
> "I disagree because I think that lecturer was perfect, he was not just doing Chemistry he was mixing these things you can have a great time and revert back to Chemistry. What I realised is if a lecturer comes into class a talk Chemistry only others fall asleep."
> "I think the lecturers are great. Personally I had a great time with almost all of them. I had a problem in the first semester with one of them because I felt the lecturer was just too friendly with the students, you attend the lecture but he is too playful, yes there should be humour, breaking the monotony and interacting with the people, but there is a line that you do not cross. I felt that lecturer cross that point to the point where you come to the lecture it was irritating that you would spend half lecture just making jokes. I think we should moderate how we interact."
> "The lecturers are excellent as my colleagues have said but what I did not like about the lecturers is that they do not care if you participate in class or not."
> "All the lecturers I am comfortable with them but there is only one lecturer whose comments are really killing."

Comments: There appeared to be a general satisfaction with the lecturing staff in this course, but it became apparent that UFS (QwaQwa campus) first-year Chemistry participants preferred different methods of learning facilitation. There was a concern, though, that the lecturers did not put much effort to ensure that everybody participated in class (see 2.3.1; 2.3.2.4). The observed attitude of the participants towards the lecturers was similar to that found from the questionnaire response analysis (see 4.3.3.3)

4.4.3.4 Reasons for discontinuation and feeling(s) about the course

Most of the UFS (QwaQwa campus) first-year Chemistry participants reported they had had no reason for discontinuation of the course, but the reasons provided for considering discontinuation were that at the beginning the course was found to be too difficult (i.e. supporting the allegation(s) made by senior students). Another reason was a participant considered to transfer to another degree, because of personal interest in business. Testimonies of this are the following statements by some of the participants:

> "I thought of discontinuing Chemistry because I was told that it is very difficult and I am not going to make it and I am going to take long to graduate."
> "The pressure of the first semester Chemistry for me I told myself if I do not pass CHE132 because it was the most difficult part I am leaving Chemistry for the rest of my life."
> "I have thought of it not because it was difficult but because I thought of transferring to BCom due to my interest in business."

Most of these participants were satisfied with the course, except for one, due to the uncertainty regarding the rules around prerequisites for continuing with subsequent years of study. This was evidenced by the following statements:

> "The studies are good but the problem is this one of when you fail this one you will not be able to continue with the other one, because you have to wait until you pass this one."
> "Well I am okay, however I am the kind of person that if I get into something I want to master the craft so in terms of mastering the principles I am not where I want to be."

Comments: The problem of first-year Chemistry being perceived to be difficult seemed to be the major reason why students considered discontinuation of their Chemistry studies. This then poses a challenge to the UFS (QwaQwa campus) first-year Chemistry lecturers to find ways to communicate a positive message to students very early in the year that Chemistry is not difficult (see 2.3.2.2 and 2.3.2.5). Other participants expressed a feeling of satisfaction regarding their first-year Chemistry studies.

4.4.3.5 Academic support

This sections looks at the participants' views regarding the academic support that they would prefer, and they expressed the following sentiments in this regard:

> "If we can be taken to companies that are working with Chemistry we can be much motivated and comfortable and we can work harder so that we can achieve to reach that level."
>
> "The other thing is if we are doing just like the titration we should relate the things to real life things. When we are dealing with a given concept we should be told where it is going to help us then I think we can be motivated not only solving for x what is that x. Solving for x from primary until university, but you do not know what x that is."
>
> "Chemistry tutors are too few and we rarely meet them as compared to Maths where they are always available."
>
> "I have a huge problem with the internet for one the internet connection is slow and secondly there are some websites that are blocked even though we want them."
>
> "What I do not like about the internet is that you cannot access the Wireless network when you are in the residences and the library closes at 21:00."

Comments: The UFS (QwaQwa campus) first-year Chemistry participants agreed upon the following kind of academic support, namely:

- The course should relate the theory to real life,
- the number of tutors should be increased,
- the students should be able to download previous question papers from the university or departmental website, and
- the practicals should be done the same year as theory.

In addition, these participants also expressed concerns about the limited access to the internet (no wireless internet access in the residences) and the slow connectivity of the internet. One of the observed academic support aspects (i.e. with regard to tutors) by the participants appeared to differ to that found from the questionnaire analysis (see 4.3.4).

4.4.4 Proposed changes

The majority of the participants had no problems with the study guide (notes) provided for the course and they agreed that the lecture schedule (which details what sections will be done in class on a given day) was very helpful. The one proposal was that of having fun while learning rather than being in a long, boring lecture (see 2.3.1). It was stressed though that there should be a balance between the fun and the teaching/learning process. The other proposal was that of organising an informal outing to allow the lecturing staff and students to interact in a relaxed non-threatening environment. Furthermore it was proposed that the marks should be published after every assessment as a form of motivation for the best performers to keep it up and the poor performers to improve (see 2.3.2.5). The lecturing staff should engage the students who have not performed well so as to establish their difficulties or problem area(s). The lecturer could also pair up the struggling students with the good performers as a supportive buddy system. As in the questionnaire results, most participants were satisfied with the *status quo* within the course (see 4.3.5). The participants also made proposals to encourage closer interaction between students and lecturers and among students themselves (see 2.4).

4.5 ANALYSIS AND INTERPRETATION OF DATA OBTAINED FROM SEMI-STRUCTURED INTERVIEWS (APPENDIX C)

This section deals with the analysis of data obtained from two semi-structured interviews with UFS (QwaQwa campus) first-year Chemistry lecturers who were responsible for the first-year Chemistry courses for 2011 and 2012 (see Appendix C). The semi-structured interviews were conducted during June 2012 (see 3.2.4.3).

4.5.1 Interest in Chemistry

One of the interviewed lecturers said he/she was interested in Chemistry because it allows you “to explore new ideas and to understand the manner in which different reactions unfold”. The other lecturer stated that he/she was “fascinated by the practicability of Chemistry and the fact that Chemistry is everywhere in our daily lives”. These lecturers also indicated that their reasons for teaching first-year Chemistry are that it afforded them an opportunity to impart the necessary basics that are important for students to navigate their way through subsequent years of study and it also helped the lecturers involved in the latter years with continuity, because they would be aware of what had been covered in the first-year. The lecturers, like the students, seem to have done Chemistry because of interest (see 4.3.2.2), and from the literature it is apparent that doing a course because of interest is important for motivation (see 2.3.2.2).

4.5.2 Library

There were consensus among the lecturers that the library staff (see 4.4.2.1) was supportive to library users and that a wide variety of books was available for UFS (QwaQwa campus) first-year Chemistry students (this was also confirmed with the focus groups see 4.4.2.4), though one of the lecturers expressed a concern that the library seemed to have an insufficient quantity of prescribed textbooks. The lecturers had differing views when it came to the operating hours of the library, with one being satisfied and the other one suggesting that the library should operate for 24 hours a day (see 4.4.2.2). The daily operating hours of the library seemed to be too limited for the participants in this study, with special reference to the photocopying and printing facilities (see 4.4.2.2).

The issue of space for studying in the library seemed to be a major problem, with the limited space available found to be not conducive to study due to the lack of proper air conditioning (see 4.4.2.3). The photocopying facilities, according to the lecturers, were inadequate, because of the long queues that students were subjected to.

4.5.3 Course related issues

The lecturers' perspectives on the first-year Chemistry at the UFS (Qwaqwa campus) were sought and are dealt with in the following sections:

4.5.3.1 First-year experience

According to the lecturers the most valuable experience for the UFS (QwaQwa) first-year Chemistry student is to master as much of the work covered as possible, because it forms the basis for subsequent years of study. These participants also stated that the most valuable experience was to be able to find the balance between being independent and being part of a group. This is similar to the sentiments expressed by the students (see 4.4.3.2).

The large class size was identified as one of the factors that might be contributing to the stress of the first-year students, which is in agreement with the students' perspective (see 4.4.3.1). The apparent lack of orientation was also posited as a stressor for students, because the students seemed not to be informed about their courses, the timetable and class venues. The late issuing of study material to students was seen as adding to the confusion that already existed. The lecturers also felt that the need for students to adjust (from school to university) to a different way of doing things was found by some students to be stressful (see 2.3.2.1).

4.5.3.2 Teaching and learning in first-year Chemistry

Both lecturers are of the opinion that there is a mixture of prepared (hyper) and under-prepared (hypo) students, with those that are said to be under-prepared needing more time to come to grips with the content (see 2.3.2.1). The lecturers suggested the following as some of the reason that led to students discontinuing their Chemistry study:

- The lecturers, who are discouraging to students and convey a message that the students are going to fail the course (see 2.3.2.2).
- The senior students who feed first-year students with negative information about the first-year Chemistry course being difficult (see 4.4.3.4).
- The complexity of the content, with some of the students finding the content too complex (see 1.1 and 4.4.3.4).
- Students do not cope with the way assessment is/was done in the course (see 2.3.2.5).
- The students' attitude and passion towards the course (see 2.3.2.2).
- Consistent poor performance by a student resulting in the student losing hope of ever passing the course (see 2.3.2.2).

The following were suggested as the kind of support that could benefit the students:

- Tutors who will help facilitate tutorials and lectures, as well as post-graduate students to act as mentors. The post-graduate students and tutors have to be properly prepared for this supportive role lest they do more damage than good, because of their attitude (see 2.4 and 4.4.3.5).
- Computers, e-mail and internet to improve communication between lecturer and students and to allow students access to on-line resources.
- Psychological and financial support to students who need them.
- DVDs and field trips that will help integrate the theory with the real world of work (see 4.4.3.5).

The lecturers generally expressed satisfaction with the UFS (QwaQwa campus) first-year Chemistry students, but were concerned with the time some of the students dedicated to their studies. The issue of large class size was highlighted as something that the lecturers were also found a hindering factor in effective teaching.

4.5.4 Proposed changes

The following were proposed as changes that these interviewees felt would positively impact on the academic performance of UFS (QwaQwa campus) first-year Chemistry students. These recommendations are in line with the students' proposals (see 4.3.5):

- Reduction of class size;
- increased contact time by introducing more tutorials;
- more innovative practical sessions so as to enhance students' interest, and students should do theory and practicals concurrently; and
- time-table clashes to be avoided, so that class attendance could be enhanced.

4.6 DATA TRIANGULATION OF QUESTIONNAIRE, FOCUS GROUPS AND SEMI-STRUCTURED INTERVIEWS RESULTS

Triangulation is defined to be "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller 2000:126). In this study data triangulation was applied (see 3.2.5), as demonstrated in the following brief, summarised table (Table 4.7).

Table 4.7: A summary of data triangulation results

Aspects of a support programme for first-year Chemistry	Quantitative (Quant.) Data results (Method 1)	Qualitative (Qual.) Data results (Method 2)	Qualitative (Qual.) Data results (Method 3)	Issues confirmed by either Quant. or Qual. Data
Student preparedness to study at university	First-year Chemistry students are satisfied with their preparedness to study at university.	Not applicable.	First-year Chemistry lecturers indicated a mix of preparedness and under-preparedness to study at university	Academic implications for under-prepared first-year Chemistry students (Qual. Data).
Student motivation	First-year Chemistry students indicated a mix of intrinsic and extrinsic motivation.	Most of the first-year Chemistry students indicated intrinsic motivation (i.e. interest in Chemistry).	First-year Chemistry lecturers expressed concerns about the limited motivation to spend enough time on their studies.	The majority of the first-year Chemistry students seem to have the necessary motivation, but the onus is thus on these lecturers to help students sustain it (e.g. attitudes/learning environment) (Quan. Data).
Academic support	Most of the first-year Chemistry students indicated that they were satisfied with the academic support provided.	The first-year Chemistry students proposed additional academic support (more tutors, relating of theory with real life applications, access to previous question papers and improved access to computers/internet).	The first-year Chemistry lecturers proposed the following additional academic support: more tutors, improved access to computers/internet and arranging field trips for students to expose them to the world of work.	

Aspects of a support programme for first-year Chemistry	Quantitative (Quant.) Data results (Method 1)	Qualitative (Qual.) Data results (Method 2)	Qualitative (Qual.) Data results (Method 3)	Issues confirmed by either Quant. or Qual. Data
Lecturers	The first-year Chemistry students are satisfied with lecturers, but suggested more diverse learning facilitation methods.	The first-year Chemistry students are satisfied with lecturers, but suggested more active engagement in the classes.	Not applicable.	The first-year Chemistry lecturers should employ different methods of learning facilitation (Quan. Data). The first-year Chemistry lecturers should put more effort into ensuring that all students participate in class actively (Qual. Data).
Assessment	Most of the first-year Chemistry students agreed that assessment was related to expected outcomes and improved their learning. Some first-year Chemistry students indicated assessment overload. The majority of the first-year Chemistry students are satisfied with the assessment feedback.	Not applicable	Not applicable.	Assessment should relate to the expected outcomes and should support learning (Quan. Data). Prevent assessment overload (Quan. Data). The assessment feedback must be timeous and constructive (Quan. Data).

Aspects of a support programme for first-year Chemistry	Quantitative (Quant.) Data results (Method 1)	Qualitative (Qual.) Data results (Method 2)	Qualitative (Qual.) Data results (Method 3)	Issues confirmed by either Quant. or Qual. Data
Best teaching method for learning Chemistry	Some of the first-year Chemistry students agreed that group work and tutorials were more beneficial than lectures. The first-year Chemistry students suggested more active participation (e.g. student presentation, group work).	The first-year Chemistry students were concerned about big class size and time-table clashes.	The first-year Chemistry lecturers also were concerned about the large class size and time-table clashes.	More active participation in class (Quan. Data).
Library and information services	Not applicable	The first-year Chemistry students are positive about the library staff, their service level and the resources available for the Chemistry course. However, these students are concerned about the study space, air-conditioning, operating hours of the library and the photo-copying facilities.	The first-year lecturers were satisfied with the library staff and their service and learning material/sources. But these lecturers are concerned about the long queues for photo-copies and the rather limited study space and operating hours of the library.	

Table 4.7 provided an overview of the themes identified from the results gained from the responses using different instruments and where possible, these were compared to determine the findings were confirmed or not. For most of the themes there appeared be a positive correlation between findings from different instruments.

4.7 CONCLUSION

This chapter has focused on the results and analysis of an adapted sequential explanatory mixed methods design (data were collected via a questionnaire, focus groups (students) and semi-structured interviews with lecturers). The number of participants in the focus group discussions [seven (7) and six (6) students participated in the two sessions respectively] was negatively affected by the examinations that students were engaged in and a general reluctance by some to be part of the study.

The data analysis provided the researcher with information pertaining to the perceptions of students and academic staff as to the factors that influence first-year Chemistry students' academic performance and the possible changes that might improve the first-year Chemistry experiences (see 5.3.2.1 and 5.3.2.2).

In the next chapter the focus will be on the interpretation of these results in terms of a proposed support programme for first-year Chemistry students and lecturers at the Qwaqwa campus (UFS).

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS WITH REGARD TO THE PROPOSED SUPPORT PROGRAMME

5.1 INTRODUCTION

The issue of low throughput and high drop-out rates in higher education is cause for concern for all who are involved in the sector, especially for Chemistry lecturers (see 1.1). This study has attempted to gain insight into the factors that contribute to the low pass rate(s) experienced in the first-year Chemistry courses at the Qwaqwa campus of the UFS, with the aim of proposing a support programme that will assist in improving the learning, teaching and assessment of first-year Chemistry students and lecturers (see 1.1).

This chapter sets out to demonstrate the extent to which the objectives of this study (see 1.3) have been achieved. Conclusions and recommendations emanating from this study will be presented, based on the literature review (Chapter 2), the empirical study (Chapter 4), the analysis of the questionnaire (Appendix A; 4.3), focus groups (Appendix B; 4.4) and semi-structured interviews (Appendix C; 4.5) responses. The chapter is concluded by suggesting a possible support programme for learning, teaching and assessing first-year Chemistry.

5.2 OBJECTIVES OF THE STUDY

In order to achieve the aim (as stipulated in 1.3) of this study, specific objectives (see 1.3) had to be met. The overarching aim was to investigate the perceptions of barriers to success in the first-year Chemistry course(s) at the UFS (Qwaqwa campus) by both the students and lecturers. The study then set out to propose a support programme that would improve the learning, teaching and assessment in first-year Chemistry (see 1.1; 2.4). A literature review was conducted in order to establish the factors that negatively impact on the success of first-year Chemistry students (Chapter 2). Subsequent to the literature review an empirical study was done to establish the perceptions of both students and lecturers on the barriers to success in the first-year Chemistry course(s). The empirical study consisted of a questionnaire (Appendix A) and focus group interviews (Appendix B) which complemented each other to elucidate the perceptions of student; as well as semi-structured interviews (Appendix C) for establishing the lecturers' perceptions. The results of the empirical study were analysed and reported on in Chapter 4. The resultant conclusions will be attended to in the following sections.

5.3 CONCLUSIONS FROM THIS STUDY

In this section of the study the findings from both the literature review and the empirical study are discussed in order to address the research questions (see 1.2), keeping the main aim and objectives in mind (see 1.3).

5.3.1 Findings from the literature review

The literature review indicated several factors that influence first-year Chemistry students' academic performance. For the purposes of this study only those factors that can be rectified by the Chemistry department and students were addressed.

The following factors which influence first-year Chemistry students' academic performance were identified in the literature, namely: student inherent factors such as preparedness (2.3.2.1), motivation (2.3.2.2) and existing conceptions (2.3.2.3). The remainder of the identified factors can be classified as course-inherent factors, namely teaching (2.3.2.4) and assessment (2.3.2.5). It was further established from the literature review that strategies that support student learning are those that involve students actively in their learning. The following relevant strategies for learning Chemistry were identified, namely: collaborative learning (2.4.1), problem based learning (2.4.2), peer assisted learning (2.4.3), which manifests in a number of ways, and concept maps (2.4.4). All these proposed strategies are based on the constructivist view to teaching and learning (see 2.2).

The role of the library as a support service to the teaching and learning process and how best that role can be discharged was looked at as part of the literature study (see 2.3.2.6). The developments are pointing in the direction of the library being integrated into the teaching and learning process rather than it playing the traditional role of just being a book bank.

5.3.2 Findings from the empirical study

The empirical study followed an adapted, sequential explanatory mixed methods research design, in which both students and lecturers were respondents/participants. The quantitative questionnaire (with open-ended questions) was administered first (Appendix A), followed by the focus groups with students (Appendix B) and then the lecturers were interviewed (Appendix C). This section will therefore look at the findings of the empirical study.

5.3.2.1 Findings from the questionnaire and focus groups

In this section the findings from the questionnaire (see Appendix A; 4.3) and focus groups (see Appendix B; 4.4) and semi-structured interviews (see Appendix C; 4.4) are dealt with. The following conclusions were drawn from the UFS (QwaQwa campus) first-year Chemistry students of 2010:

- The majority of these student respondents stated that they enrolled in Chemistry due to interest and provided reason for their interest during the focus group discussions (see 4.2.2.2; 4.4.1).
- Most of the student respondents were of the view that they were adequately prepared for first-year Chemistry (see 4.3.2.1).
- Some of the motivation indicators like class attendance, preparation for practical sessions and tutorials were positive, but it was cause for concern that only half

the student respondents prepared the work before going to class and the same number read just enough to pass the tests (see 4.3.2.3; 4.4.1).

- As far as self-motivation is concerned the views varied from those who felt that they should motivate themselves to the ones who felt that the lecturers' attitude was the determinant for students' motivation. There was a feeling that provision of information about Chemistry, future prospects and exposure to the "real world" through industry visits would go a long way in enhancing student motivation (see 4.3.2.3; 4.4.1).
- Assessment is generally viewed positively by the student respondents, even though some felt that they spent too much time on assessment (see 4.3.3.1).
- Most of the respondents felt that the lecturers, their approach to learning facilitation as well as their attitude to students was of an acceptable standard. Some, though, would appreciate it if the lecturers could put more effort into ensuring that all students were actively involved in class. It was also evident from the focus group discussions that students preferred different approaches to learning facilitation (see 4.3.3.3 and 4.4.3.3).
- Most of the students felt that lectures were more beneficial than tutorials, and they further stated that they realised the relevance of the topics dealt with in the lectures (see 4.3.3.4).
- The students felt that the lecturers should create an environment conducive to active participation, and felt that group work and being afforded an opportunity to do presentations on topics of interest could enhance active participation by students (see 4.3.3.4).
- Though some students were satisfied with the *status quo,* some concerns were raised about the accessibility of staff, attitudes of assistants, lecturers being too formal, the way practicals were conducted and the type of practicals that they were doing (see 4.3.3.3; 4.3.3.4).
- The majority of the participants were satisfied with the academic support provided by the university (see 4.3.4; 4.4.3.5).
- There were mixed feelings about the library staff and their service (see 4.4.2; 4.4.2.1).

- As for the library's operating hours and infra-structure it was felt that they were inadequate, with the limited space for studying and poor ventilation in the library being singled out (see 4.4.2.2; 4.4.2.3).
- The students were of the view that there was sufficient material for this course in the library (see 4.4.2.4).
- There was real concern about the photocopying facilities, which are characterised by long queues and negative attitudes from the staff working in that division (see 4.4.2.4).
- The students mentioned the following issue as stressors during their first-year: negative influence from some senior students, class size, time table (clashes and complexity), adjusting to different ways of learning facilitation and over-assessment (see 4.4.3.1).
- Working under pressure, group work, being independent and time management was mentioned as some of the skills students had acquired (see 4.4.3.2).
- The only reason provided for considering discontinuing the course was the fact that the course seemed too difficult at the beginning (see 4.4.3.4).
- The kind of support needed included more tutors, access to previous question papers, access to wireless internet and faster connectivity (see 4.4.2; 4.4.3.5).

5.3.2.2 Findings from semi-structured interviews

The following are the findings that emanated from the semi-structured interviews with the lecturing staff that were involved in the teaching of first-year Chemistry at the UFS (Qwaqwa campus):

- Teaching first-year affords lecturers the opportunity to equip students with the basics needed to continue with Chemistry and allows the lecturer who is teaching subsequent years to bridge the transition from first-year to subsequent years of study (see 4.5.1).

- The lecturers were satisfied with the library staff and their service as well as the first-year Chemistry books in the library, with a concern raised on the number of prescribed books that are available (see 4.5.2).
- The participants had differing views on the operating hours of the library with one expressing the opinion that these hours appeared to be adequate, and the other suggesting that these hours should be increased to 24 hours (see 4.5.2).
- The lecturers agreed with the students about the inadequacy of study space and lack of proper ventilation (see 4.5.2).
- Photocopying facilities were found to be inadequate, resulting in long queues (see 4.5.2).
- Being able to master most of the work covered and being able to balance working independently and in a group were viewed as the most valuable experiences (see 4.5.3.2).
- The following were considered by the lecturers as the stressors: Large classes, lack of orientation, late issuing of study material and adjusting to a different way of doing things (see 4.5.3.2).
- The lecturers provided the following as reasons that might result in discontinuation of the course: Lecturers, negative influence from senior students, content complexity for under-prepared students, assessment, consistent poor performance and students' attitude and passion for the course (see 4.5.3.2).
- The proposed support entailed: Well trained tutors, access to computers, e-mail and internet, psychological and financial support, DVDs and field trips (see 4.5.3.2).
- The changes that were suggested by the lecturers are: Having smaller classes, more tutorials, introduction of innovative practicals and a timetable without clashes (see 4.5.4).

5.4 PROPOSED SUPPORT PROGRAMME

The final objective of this study was to suggest a support programme to remedy first-year Chemistry students' teaching, learning and assessment problems at QwaQwa campus (UFS). From the findings it is apparent that both students and staff need to be supported in one form or another to achieve the desired improvement in the learning, teaching and assessment of UFS (QwaQwa campus) first-year Chemistry. The proposed support programme will thus be divided into two sections, indicating the related support for students and for staff respectively:

5.4.1 A support programme for first-year Chemistry students (focusing on learning Chemistry)

Currently first-year higher education students are not only confronted with transition from high school to university, but also the tricky, complicated and abstract nature of Chemistry (see 1.1, Chapter 2). This scenario results in poor success rates, which confirms the need for a support programme for learning first-year Chemistry.

This support programme should include the following aspects, which were suggested:

5.4.1.1 An effective learning-teaching environment

An effective learning-teaching environment requires first-year Chemistry students to become active learners, who are constructing their own learning by "learning with and from others" (see 2.4) However, this is a two-way process, where the first-year Chemistry lecturer's responsibility in this environment will be discussed later (see 5.4.2.) and additional learning support will now be discussed.

5.4.1.2 Adequate academic support

The student participants suggested the following as required academic support: The provision of proper study spaces, longer library hours, adequate photocopying facilities, and access to computers, email and internet, which is critical in the learning and teaching environment (see 2.3.2.4; 2.4.4; 4.4.2.1; 4.4.2.2; 4.4.2.3; 4.5.2) .

5.4.1.3 Student recommendations for active learning participation

The student participants indicated the following to enhance student participation: The introduction of presentations (in groups) on selected topics of interest, allowing students to present their understanding of the day's lecture before the lecture, and encouraging group work (see 4.3.3.4).

5.4.1.4 Senior students as tutors

The student participants suggested that there should be well-trained and meticulously selected senior students who will serve as tutors, assistants and mentors to the first-year Chemistry students to counter the negative influence from the other senior students (see 2.4, 4.5.3.2).

5.4.2 A support programme for first-year Chemistry lecturers (focusing on the teaching and assessment of Chemistry)

5.4.2.1 Student preparedness

Student preparedness (see 2.3.2.1), according to the literature review, is one of the factors that may adversely affect student success in first-year Chemistry. However, in the empirical study (see 5.3.2.1) it appeared that most of the students felt that they were prepared for university. To address this problem of student preparedness the following is suggested by lecturer participants:

- Supporting the NATP offered at the UFS as a quality assurance tool for training and supporting tutors (see 4.3.4) and then to use them as mentors (see 4.5.3).
- Computers, e-mail and internet facilities to improve communication between lecturer and students and to allow students access to on-line resources (see 4.5.3.2).
- Providing psychological and financial support services to students, for example during orientation (see 4.5.3.1; 4.5.3.2).
- Academic support should not only focus on the development of learning facilitation skills (see 2.3.2.4), but the Chemistry department should also adopt a common approach to teaching and learning (with special reference to large classes see 4.5.3.1) so as to avoid confusion for the students - in this case the constructivist approach is recommended (see 2.2); professional development with regard to the developments in the teaching and learning of Chemistry (see 2.4), and introducing teaching and learning seminars (e.g. one seminar per semester on teaching and learning or world of work). In addition, a training manual for tutors, practical demonstrators and mentors (see 2.4; 4.5.4) was suggested. This manual should first be based on the UFS Teaching and Learning and Assessment policies (see 2.3.2.4; 2.3.2.5). Additionally, this manual should include a whole spectrum of aspects such as supporting Constructivist teaching/facilitation strategies (see 2.2; 2.3.2.4; 2.4) to become self-motivated (feedback, tasks, material, atmosphere, etc. - see 2.3.2.2), independent first-year Chemistry learners without any misconceptions based on existing conceptions (especially due to the abstract nature of Chemistry see 2.3.2.3) in order to establish an effective teaching, learning and assessment environment and approaches (see 2.3.2.4; 2.3.2.5; 2.4.4).
- Lecturers indicated a concern about an insufficient quantity of prescribed textbooks in the library, but the opinion was expressed that the operating hours of the library (see 4.4.2.2), especially the limited daily operating hours of the library for photocopying and printing (see 4.4.2.2) were inadequate and resulted in long queues. The limited space for studying and the lack of proper air conditioning available were found to be not conducive to study (see 4.4.2.3).

In addition, the researcher would like to add to the above-mentioned recommendations the following as suggested by literature or by researcher's own experience:

- The implementation of a compulsory benchmarking test for all first-year Chemistry students at the UFS (Qwaqwa campus) to establish their level of preparedness so as to inform development and delivery of curriculum (see 2.3.2.1).
- The formation of partnerships between the Chemistry department at the UFS (Qwaqwa campus) and the schools in the campus' catchment area which will afford students access to Chemistry facilities even before they are admitted to the UFS. This cooperation with schools will go a long way in addressing the issue of under-preparedness of students.

5.4.2.2 Applying Chemistry in the world of work

To foster the application of Chemistry, lecturers suggested that students should be taken for at least one industry visit (field trip) to expose them to the world of work and what it means to be a chemist in the real world. In addition, exciting videos on core curriculum topics should be introduced (see 4.3.2.3; 4.5.1) to stimulate interest in Chemistry (see 4.5.1). These lecturers indicated the introduction of more innovative practical regimen that should move away from the "cook book" style that is being used now, and would assist students to develop research and report writing skills early on in their studies.

5.5 CONCLUSION

The problem of student success in the higher education sector cannot be blamed on factors outside the higher education sector alone - the sector has to address this problem. This study hoped to contribute to efforts made to address the problems of learning, teaching and assessment in Chemistry first-year courses at the Qwaqwa campus of the UFS, thereby improving the current practices.

The factors that influence student success were addressed both in the literature review and the empirical study. The study concentrated on a limited scope of factors that impact on the academic performance of students to the exclusion of the factors that were regarded beyond the control of the Chemistry department. From the findings of the study a support programme for both staff and students was proposed. Due to the fact that this was a case study at UFS (Qwaqwa campus) the support programme should not be generalised to all first-year Chemistry students and lecturers.

A total rethink of the library's role (not just to be a book bank) in supporting the core business of the institution that will allow departments to integrate the library into the curriculum is strongly advised (see 2.3.2.6). This must be an institution wide initiative, because it may involve either hiring new staff or retraining the current staff at the library.

Further studies have to be conducted that should look at other factors like accommodation and financial and social issues that may also have an impact on the learning, teaching and assessment of first-year Chemistry students.

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APPENDIX A

QUESTIONNAIRE ON QWAQWA FIRST-YEAR STUDENT EXPERIENCES OF CHEMISTRY OCTOBER 2011

For office use only				
				1-4

DEAR STUDENT

THE PURPOSE OF THIS QUESTIONNAIRE IS TO OBTAIN INFORMATION ABOUT HOW YOU (QWAQWA: FIRST-YEAR STUDENT) EXPERIENCE THE CHEMISTRY COURSE AT THE QWAQWA CAMPUS. THEREFORE THERE ARE NO RIGHT OR WRONG ANSWERS. YOUR OPINION IS WHAT IS EXPECTED. PLEASE MAKE SURE YOU ANSWER ALL THE QUESTIONS. **ENCIRCLE** THE APPROPRIATE NUMBER FOR THE VARIOUS ITEMS OR PROVIDE GENERAL COMMENTS OR SUGGESTIONS FOR IMPROVEMENT IN THE OPEN SPACES.

SECTION A: BIOGRAPHICAL INFORMATION OF STUDENT			
A1. Gender			
a. Male	**1**		
b. Female	**2**		**1**
A2. Age category			
a. 15-19 years	**1**		
b. 20-24 years	**2**		
c. 25-29 years	**3**		
d. 30-35 years	**4**		
e. 36+ years	**5**		**2**
A3. Home language			
a. Afrikaans	**1**		
b. English	**2**		
c. Ndebele	**3**		
d. Northern Sotho	**4**		
e. Southern Sotho	**5**		
f. Swati	**6**		
g. Tsonga	**7**		
h. Tswana	**8**		
i. Venda	**9**		
j. Xhosa	**10**		
k. Zulu	**11**		
l. Other (please specify) ………………………………	**12**		**3**
A4. Highest qualification obtained			
a. Standard 10/ Grade 12	**1**		
b. Diploma	**2**		
c. B. Degree	**3**		
d. Honours degree	**4**		
e. Post-graduate diploma	**5**		
f. Master's degree	**6**		
g. Ph. D degree	**7**		
h. Other (please specify) ………………………………	**8**		**4**
A5. Medium of instruction in High School			
a. English Home Language	**1**		

b. English Additional Language	2		
c. Afrikaans	3		
d. Other (please specify) ………………………………	4		5
A6. What achievement level did you obtainin Grade 12 for Chemistry			
a. 1 (0-29%)	1		
b. 2 (30-39%)	2		
c. 3 (40-49%)	3		
d. 4 (50-59%)	4		
e. 5 (60-69%)	5		
f. 6 (70-79%)	6		
g, 7 (80-100%)	7		
d. Other (please specify) ………………………………	8		6

SECTION B: STUDENT LEARNING, PREPARATION AND MOTIVATION

ENCIRCLE THE APPROPRIATE NUMBER FOR THE VARIOUS ITEMS ACCORDING TO THE FOLLOWING SCALE:

1 = STRONGLY DISAGREE; 2= DISAGREE; 3 = ; 4 = AGREE; 5 = STRONGLY AGREE

B1 I feel that I was well prepared for studying at university	1	2	3	4	5		7
B2 The university provides enough support to first-year students with their studies	1	2	3	4	5		8
B3 I attend lectures regularly	1	2	3	4	5		9
B4 I attempt all my tutorials before attending the tutorial class	1	2	3	4	5		
B5 I tend to read the minimum beyond what is required to pass	1	2	3	4	5		11
B6 I go to the class well prepared	1	2	3	4	5		12
B7 I go to the practical sessions well prepared	1	2	3	4	5		13
B8 I am not interested in the Chemistry course, I am only taking it to obtain credits	1	2	3	4	5		14
B9 I do not find it difficult to motivate myself to learn Chemistry	1	2	3	4	5		15

B10 What do you think can be done to motivate you to learn Chemistry?			
			16-17
			18-19
			20-21

SECTION C: STUDENT TEACHING OF CHEMNISTRY

ENCIRCLE THE APPROPRIATE NUMBER FOR THE VARIOUS ITEMS ACCORDING TO THE FOLLOWING SCALE:

1 = STRONGLY DISAGREE; 2= DISAGREE; 3 = ; 4 = AGREE; 5 = STRONGLY AGREE

C1 The lecturing staff encourage first-year Chemistry students to Learn	1	2	3	4	5		22

C2 The first-year Chemistry lecturers appear to be competent	1	2	3	4	5		23
C3 The first-year Chemistry lecturers use different teaching/ facilitation methods	1	2	3	4	5		24
C4 The first-year Chemistry lecturers use group work in the class	1	2	3	4	5		25
C5 The first-year Chemistry lectures are interesting	1	2	3	4	5		26
C6 The first-year Chemistry topics appear to be relevant	1	2	3	4	5		27
C7 The first-year Chemistry tutorials are more beneficial than the Lectures	1	2	3	4	5		28
C8 The first-year Chemistry lecturers are understandable	1	2	3	4	5		29
C9 The first-year Chemistry lecturers are approachable	1	2	3	4	5		30
C10 The first-year Chemistry lecturers have time for consultation	1	2	3	4	5		31
C11 The first-year Chemistry lecturers are available during consultation times	1	2	3	4	5		32
C12 The first-year Chemistry lecturers seem to care about the welfare and progress of students	1	2	3	4	5		33
C13 The first-year Chemistry lecturers encourage me to think instead of providing the answers	1	2	3	4	5		31
C14 The first-year Chemistry learning activities encourage dialogue with fellow students, lecturers, and tutors (as opposed to passive listening)	1	2	3	4	5		32
C15 The first-year Chemistry lecturers help me to deal with misconceptions that I may have	1	2	3	4	5		33

C16 If you could change one thing in the Chemistry course, what would it be?			
			34-35
			36-37
			38-39
C17 What do you think can be done to make students more actively involved in Chemistry lectures?			
			40-41
			42-43
			44-45

SECTION D: STUDENT ASSESSMENT OF CHEMNISTRY							
D1 The assessment is related to the expected outcomes	1	2	3	4	5		45
D2 I find that I spend too much time on studying for assessments	1	2	3	4	5		46
D3 The assessment tasks helps me to improve my learning	1	2	3	4	5		47
D4 The feedback I receive from my lecturer is timeous	1	2	3	4	5		48
D5 The feedback on assessment is constructive	1	2	3	4	5		49

D6 What in your view can be done so that assessment supports student learning?			
			50-51
			52-53
			54-55

Thank you for taking the time to complete this questionnaire.
What you have to say will help to improve learning first-year Chemistry at the QwaQwa campus.

APPENDIX B

FOCUS GROUP INTERVIEW SCHEDULE

OCTOBER 2011

TITLE: A SUPPORT PROGRAMME FOR FIRST-YEAR CHEMISTRY STUDENTS: A CAMPUS CASE STUDY

TARGET POPULATION(S): 1ST YEAR CHEMISTRY STUDENTS (UFS, QWAQWA CAMPUS)

SECTION A: GENERAL

1. Why are you interested in Chemistry?

Probes (provide reasons for your interest)**:**

2. What is you motivation for doing a Chemistry module?

Probes (provide motivation for doing this module)**:**

3. How do you experience the library?

Probes

- Range and up-to-datedness of books/magazines/journals/etc.
- Relevance of material for first-year Chemistry studies
- Helpfulness of library staff
- Online catalogues
- Length of loan periods
- Inter-library loans
- Photocopying facilities
- Opening hours for study purposes
- Study facilities

SECTION B: CHEMISTRY FIRST-YEAR EXPERIENCES AT UFS (QWAQWA CAMPUS)

4. What do you identify as the main stressor(s) in studying Chemistry during your first-year at UFS (QwaQwa campus)?

Probes (possible stressors)**:**

- Large classes (preparation, tests, exam)
- Tutorials (preparation, value, competence of tutors)
- NATP tutorials (experiences, value)
- Practicals (safety, cookbook-approach, value, competence of assistance)

5. What do you identify as the most valuable experience(s) during your first – year studying Chemistry at UFS (QwaQwa campus)?

Probes

- Learning to stand on my own (academically and personally)
- Learning to work as a team with others
- Integrating theory and practice of Chemistry
- Anything else?

6. What would you like to change, if possible, to improve you role as a first-year Chemistry student at UFS (QwaQwa campus)?

SECTION C: FIRST-YEAR CHEMISTRY: TEACHING, LEARNING AND ASSESSMENT PRACTICES

7. How do you find the Chemistry lecturer at UFS (QwaQwa campus)?

Probes

- Approachable
- Understandable
- Teaching method
- Assessment method(s)

8. What kind of support could be beneficial for learning Chemistry?

Probes

- Availability of computers
- Reliability of computers
- Availability of e-mail facilities
- Availability of internet access
- Helpfulness of support staff, tutors, practical assistants and technicians
- More tutorials
- Practical experience
- Integration of theory and world of work (DVDs, Field trips, etc.)

9. If you ever thought of discontinuing your Chemistry studies, what would have been the main reason behind the thought?

Probes

- Complexity and difficulty of content
- Frame of reference
- Workload
- Additional reasons?

10. At this stage how do you feel about your Chemistry studies?

Probes (also provide reasons why these feelings are present):

- Satisfied
- Not sure
- Dissatisfied

11. Do you struggle with the following aspects as a first-year Chemistry student at UFS (QwaQwa campus)?

Probes (provide reasons for your struggle)**:**

- The medium of instruction

SECTION D: ACADEMIC PERFORMANCE

12. How would you describe your academic performance during your first- year Chemistry at UFS (QwaQwa campus)?

Probes (possible factors that played a role)**:**

- Diversity (in lecturers and colleagues)
- Lack of support system
- Having/lack of academic resources
- Family commitments (being a wife, parent, child, etc.)
- Any other factors that played a role?

13. What would you change in the current first-year Chemistry module to improve academic performance?

Thanks for your participation in this study!

APPENDIX C

INTERVIEW SCHEDULE
JUNE 2012

TITLE: A SUPPORT PROGRAMME FOR FIRST-YEAR CHEMISTRY STUDENTS: A CAMPUS CASE STUDY

TARGET POPULATION(S): 1ST YEAR CHEMISTRY LECTURERS (UFS, QWAQWA CAMPUS)

SECTION A: GENERAL

1. **Why are you interested in Chemistry?**

Probes (provide reasons for your interest)**:**

2. **What is you motivation for lecturing/facilitating a first-year Chemistry module?**

Probes (provide motivation for doing this module)**:**

3. **How do you experience the library as support for your first-year Chemistry module?**

Probes

- Range and up-to-datedness of books/magazines/journals/etc.
- Relevance of material for first-year Chemistry studies
- Helpfulness of library staff
- Online catalogues
- Length of loan periods
- Inter-library loans
- Photocopying facilities
- Opening hours for study purposes
- Study facilities

SECTION B: CHEMISTRY FIRST-YEAR EXPERIENCES AT UFS (QWAQWA CAMPUS)

4. **What do you identify as the main stressor(s) for students in studying Chemistry during their first-year at UFS (QwaQwa campus)?**

Probes (possible stressors)**:**

- Large classes (preparation, tests, exam)
- Tutorials (preparation, value, competence of tutors)
- NATP tutorials (experiences, value)
- Practicals (safety, cookbook-approach, value, competence of assistants)

5. **What do you identify as the most valuable experience(s) for students during their first–year studying Chemistry at UFS (QwaQwa campus)?**

Probes

- Learning to stand on my own (academically and personally)
- Learning to work as a team with others
- Integrating theory and practice of Chemistry
- Anything else?

6. **What would you like to change, if possible, to improve your role as a first-year Chemistry lecturer/facilitator at UFS (QwaQwa campus)?**

SECTION C: FIRST-YEAR CHEMISTRY: TEACHING, LEARNING AND ASSESSMENT PRACTICES

7. **How do you find the first-year Chemistry students at UFS (QwaQwa campus)?**

Probes

- Approachable
- Understandable
- Teaching method
- Assessment method(s)

8. **What kind of support could be beneficial for learning Chemistry during their first-year?**

Probes

- Availability of computers
- Reliability of computers
- Availability of e-mail facilities
- Availability of internet access
- Helpfulness of support staff, tutors, practical assistants and technicians
- More tutorials
- Practical experience
- Integration of theory and world of work (DVDs, Field trips, etc.)

9. **What do you think would have been the main reason behind the discontinuing of first-year Chemistry studies?**

Probes

- Complexity and difficulty of content
- Frame of reference
- Workload
- Additional reasons?

10. **At this stage how do you feel about your first-year students' Chemistry studies?**

Probes (also provide reasons why these feelings are present):

- Satisfied
- Not sure
- Dissatisfied

11. Do you struggle with the following aspects as a first-year Chemistry lecturer/facilitator at UFS (QwaQwa campus)?

Probes (provide reasons for your struggle)**:**

- The medium of instruction

SECTION D: ACADEMIC PERFORMANCE

12. How would you describe the academic performance of first-year Chemistry students at UFS (QwaQwa campus)?

Probes (possible factors that played a role)**:**

- Diversity (in lecturers and colleagues)
- Lack of support system
- Having/lack of academic resources
- Family commitments (being a wife, parent, child, etc.)
- Any other factors that played a role?

13. What would you change in the current first-year Chemistry module to improve their academic performance?

14. Any other comments on the first-year Chemistry module or students?

Thanks for your participation in this study!

APPENDIX D

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE
YUNIVESITHI YA FREISTATA

Faculty
Natural & Agricultural Sciences

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23 July 2010

Mr RG Moji
Department of Chemistry
Natural & Agricultural Science
University of the Free State

Dear Mr Moji

Request for permission to conduct research in the Faculty of Natural and Agricultural Sciences at the Qwaqwa campus at University of the Free State

I acknowledge with thanks receipt of your letter on the above.

It gives me great pleasure to inform you that permission is hereby granted that you may conduct research as requested.

I wish you success in your studies.

Yours Sincerely

Mr. TA Tsotetsi

Subject Head: Chemistry