

**THE RELATIONSHIP BETWEEN LEARNING STYLES AND PERCEPTIONS OF
BLENDED LEARNING: A CASE STUDY OF THIRD-YEAR ENVIRONMENTAL
SCIENCE STUDENTS AT RHODES UNIVERSITY**

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Abstract

The use of blended learning to support teaching and learning is growing globally. Few studies, however, have investigated the relation between students' learning styles and their perceptions of blended learning. This study used a case-study approach to investigate third year Environmental Science students' learning styles and perceptions of the online component of blended learning at Rhodes University. Vermunt's inventory of learning's styles instrument was used to assess the students' learning styles. Students' perceptions of online learning were assessed using an 84-item online experience questionnaire. Multivariate cluster analyses based on students' learning styles, perceptions of online learning and final coursework marks were done. The correlation between learning styles and perceptions of blended learning was assessed.

Students had been using computers for about 10 years. About 91% of students owned computers and 50% had access to Internet at home or in their residences. Internet and email were the most commonly used tools for student learning averaging about at least six times per week.

Three of Vermunt's four learning styles were identified. These were the meaning-directed, application-directed and reproduction-directed styles. The undirected learning style was absent. A major finding of this study was the dissonance in learning styles of students. For example, students with the meaning-directed style also scored high on reproduction-directed style. Students combined deep approaches with memorisation when learning.

I developed an instrument consisting of seven scales that described students' perceptions of online learning. The scales were epistemological judgements, multiple sources of information, learning goals, relevance, Internet experience, appropriate tool and student interaction. There was high within scale variability in students' perceptions of online learning.

The perception that the Internet provided multiple sources of information was positively associated with advanced models of epistemology that support the construction of knowledge. There was dissonance between the perception of the Internet as enhancing epistemological judgements and some components of learning style. A perception of epistemological judgements was positively correlated with both deep and surface cognitive processing strategies.

Table of Contents

Abstract	i
List of Tables	v
List of Figures.....	vii
Acknowledgements	ix
Chapter 1. Introduction.....	1
1.1 Introduction and background	1
1.2 Key research questions	4
1.3 Structure of thesis.....	4
Chapter 2. Epistemological and Psychological Assumptions Informing Blended Learning	5
2.1 Introduction	5
2.2 Concepts of knowledge and knowing.....	7
2.2.1 Developmental models of personal epistemology	7
2.2.2 Independent beliefs model of personal epistemology	12
2.2.3 An alternative model of epistemology: epistemological theories.....	14
2.2.4 Concluding remarks on the concept of epistemology	15
2.3 Concept of student learning	16
2.3.1 Conceptions of learning.....	16
2.3.2 Approaches to learning	18
2.3.3 Self-regulation of learning	21
2.4 Typology of learning styles	22
2.4.1 Cognitive-centred models of learning style	24
2.4.2 Learning-centred models of learning style.....	26
2.4.3 Integrative model of learning style	30
2.5 Using blended learning to support teaching and learning	32
2.5.1 Introduction.....	32
2.5.2 Types of blended learning	34
2.5.3 Theories supporting the use of a blended learning strategy to promote teaching and learning	34
2.5.4 Students' perceptions of blended learning.....	38
2.5.5 Relations between learning styles and perceptions of blended learning.....	38
2.5.6 Challenges of introducing blended learning	39
2.6 Conclusions	41

Chapter 3.	Methodology and Data Collection.....	43
3.1	Research methodology	43
3.2	Research context	43
3.2.1	Course structure	43
3.2.2	Participants.....	46
3.3	Learning management system.....	47
3.4	Students' learning styles.....	47
3.5	Students' perceptions of blended learning	49
3.6	Data analyses	49
3.6.1	Students' learning styles.....	49
3.6.2	Students' perceptions of blended learning.....	49
3.6.3	Relations between learning styles, perceptions of blended learning and course marks.....	50
3.6.4	Cluster analysis based on students' learning styles, perceptions of blended learning and final course marks	50
Chapter 4.	The <i>Moodle</i> Learning Management System.....	51
4.1	Introduction	51
4.2	Theoretical framework supporting the learning design I used	51
4.3	Course description	53
4.3.1	Overview of the course	53
4.3.2	Learning outcomes	53
4.3.3	Teaching and learning methods	54
4.3.4	Assessment of learning.....	54
4.4	The learning design I used for my course	54
4.5	The <i>Moodle</i> learning management system	55
4.5.1	Definition and philosophy underlying <i>Moodle</i>	55
4.5.2	<i>Moodle</i> login screen	56
4.5.3	Course screen in <i>Moodle</i>	57
4.6	Learning management features that I used	60
4.7	Challenges in using the <i>Moodle</i> learning management system.....	64
4.8	Conclusions	64

Chapter 5. Findings.....	65
5.1 Use of information and communication technologies for learning	65
5.2 Students' learning styles	66
5.3 Students' perceptions of the online learning component of blended learning.....	69
5.4 Factor structure for the online experience questionnaire items	71
5.5 Relationship between learning styles and perceptions of online learning component of blended learning.....	73
5.6 Cluster analysis of students' learning styles and perceptions of blended learning.....	75
 Chapter 6. Discussion and Conclusions	 77
6.1 Use of information and communication technologies for learning	77
6.2 Students' learning styles	78
6.3 Students' perceptions of the online learning component of blended learning.....	79
6.4 Relationship between students' learning styles and perceptions of blended learning.....	79
6.5 Cluster analysis of students' learning styles and perceptions of blended learning.....	81
6.6 Conclusions	81
6.7 Recommendations	82
 References	 83
 Appendices	 94
Appendix A: Environmental Science 302 Course Outline 2006	94
Appendix B. Online Experience Questionnaire	111

List of Tables

Table 2.1	Models of epistemological development (Adapted from Hofer and Pintrich 1997)	8
Table 2.2	Description of the four dimensions of the epistemological theories model showing its relationship with components of the developmental and system of beliefs models (Adapted from Hofer and Pintrich, 1997)	15
Table 2.3	Approaches to learning and studying (Adapted from Entwistle and Peterson 2004)	20
Table 2.4	Phases and areas of self-regulated learning (Adapted from Pintrich 2004).....	22
Table 2.5	The components of Vermunt’s learning styles (Adapted from Vermunt 1996).....	29
Table 2.6	Types of commonly used blended learning systems (Adapted from Graham 2006).....	34
Table 2.7	Areas of emphasis in traditional and constructivist learning environments in higher education (Adapted from Rovai 2004)	35
Table 2.8	Use of the Internet as a cognitive, metacognitive and epistemological tool (Adapted from Tsai 2004a)	37
Table 3.1	Scales of Vermunt’s (1996) Inventory of learning styles instrument.....	48
Table 5.1	Descriptive statistics of weekly use of information and communication technologies for learning purposes.....	65
Table 5.2	Estimated proportions of lectures that should be offered online rather than face-to-face in a blended learning environment	66
Table 5.3	Descriptive statistics of students’ cognitive processing strategies. Sample size was 26	66
Table 5.4	Descriptive statistics of students’ regulation strategies. Sample size was 26.....	67
Table 5.5	Descriptive statistics of students’ learning goals. Sample size was 26	67

Table 5.6	Descriptive statistics of students' mental models of learning. Sample size was 26.....	67
Table 5.7	Descriptive statistics of clusters of students based on Vermunt's (1996) scales of learning styles.....	69
Table 5.8	Descriptive statistics of students' perceptions of the online component of blended learning based on a priori scales. Sample size was 22.....	70
Table 5.9	What students liked and disliked with online learning and group work. Sample size was 22. freq = frequency. Frequencies add to more than 22 because each respondent was allowed to provide multiple responses.....	71
Table 5.10	Factor structure for the Online Experience Questionnaire items.....	72
Table 5.11	Pearson product-moment correlations between scale scores for students' perceptions of online learning, scores for learning styles and final course mark.....	74
Table 5.12	Descriptive statistics of clusters of students based on scales of perceptions of online learning, learning styles and final course marks.....	76

List of Figures

Figure 2.1	Conceptual framework showing factors influencing student learning (Adapted from Entwistle and Peterson 2004).....	5
Figure 2.2	A model of how personal epistemology influences learning (Adapted from Hofer 2001).....	7
Figure 2.3	The developmental model of personal epistemology (Adapted from Entwistle and Peterson 2004)	9
Figure 2.4	The independent beliefs model of personal epistemology (Adapted from Schommer 1990 and Schommer-Aikins 2004)	13
Figure 2.5	A multidimensional view of students' conceptions of learning (Adapted from Marton et al. 1993 and Duarte 2007).....	17
Figure 2.6	Kolb's (1984) learning cycle and learning styles defined by the comprehension dimension (concrete experience – abstract conceptualisation) and the transformation dimension (active experimentation – reflective observation)	27
Figure 2.7	Curry's (1987) multi-layer model of learning style.....	31
Figure 2.8	Factors influencing the quality of student learning in higher education (Adapted from Ginns and Ellis 2007).....	42
Figure 3.1	Radar chart showing the extent of blending in the Environmental Science 302 course in 2006	46
Figure 4.1	Typologies of constructivism (Adapted from Dalgarno 2001)	52
Figure 4.2	Login screen shot in Moodle	56
Figure 4.3	Lecturer view screen in Moodle	58
Figure 4.4	Student view screen	59
Figure 4.5	Participant screen view	60
Figure 4.6	Screen view of course management features.....	60
Figure 4.7	Screen view of some of the resources that were available to learners.....	61

Figure 4.8	Screen view of activities in Moodle.....	61
Figure 4.9	Screen view of assignments	62
Figure 4.10	Screen view of discussion forums	63
Figure 4.11	Screen view of a glossary.....	63
Figure 4.12	Screen view of surveys	63
Figure 5.1	The relation between the actual and perceived numbers of times (“hits”) students logged into the Moodle learning management system during the second semester in 2006. The diagonal is the equality line. Points above the diagonal are over-estimates while those below are under-estimates. Sample size was 22	65
Figure 5.2	Dendrogram showing clusters of students based on 20 scales of Vermunt’s (1996) Inventory of Learning Styles. The x-axis labels (C_1 to C_26) refer to codes for the students. The linkage distances are Euclidean	68
Figure 5.3	Dendrogram showing clusters of students based on course final marks, seven scales of the OEQ, 20 scales of Vermunt’s (1996) Inventory of Learning Styles. The x-axis labels (C_1 to C_20) refer to codes for the students. The linkage distances are Euclidean.....	75

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Chapter 1. Introduction

1.1 Introduction and background

The higher education sector is facing many challenges globally. These include increases in numbers and diversity of students and demand for skills for a knowledge economy (Castells 2000; Boughey 2004; Teferra and Altbach 2004; Winberg 2006). These pressures are more apparent in South Africa because of the legacy of the political system of apartheid that allocated resources to the education sector along racial lines, resulting in the majority black population being denied access to higher education. There were therefore calls for increased enrolment of particularly black students in South African universities when a new government was elected in 1994 (Waghid 2002; Winberg 2006). The increased numbers and diversity of students are in turn resulting in increased pressure on lecturers to use innovative methods to promote learning in tertiary institutions (Ramsden 1992; Boughey 2004).

The above challenges led me to introduce an online learning system in 2004 to complement the traditional face-to-face lectures I deliver to students at Rhodes University. I had experienced the benefits of a computer-based learning management system (LMS) during my studies for a Postgraduate Diploma in Higher Education at Rhodes University. I experienced how the system could complement the traditional face-to-face instruction. Therefore, I invested a lot of time in developing the course materials and in learning about the online LMS. I expected students to appreciate the innovation and highlight this when they evaluated my course. However, only three out of 35 students mentioned the online learning system as one of the major highlights of the course. Since I had pioneered the use of the LMS in my department, I was devastated at the students' lack of enthusiasm for this innovation. I therefore decided to investigate why students did not find the system useful in facilitating their learning.

Research on student learning during the last thirty years has advanced our theoretical understanding (Biggs 1999; Entwistle and Peterson 2004). For example, Marton and Säljö (1976) described the key concept of student approaches to learning. They described "deep" and "surface" strategies that students adopted when studying. This early work on student learning focussed mainly on cognitive processes and motivational aspects of learning (Entwistle and McCune 2004). Current research focuses on metacognition and self-regulation of learning as important constructs of students' learning styles (Lonka, Olkinuora and Mäkinen, 2004; Pintrich 2004). However, few studies have looked concurrently at the relationship between students' learning styles and their perceptions of

online learning. This is essential if we are to promote high quality learning (Lu, Yu and Liu 2003; Miller 2005; Ginns and Ellis 2007).

Good teaching requires the use of multiple teaching strategies (Ramsden 1992; McNerney and McNerney 2006). Online learning is a potentially useful teaching strategy that can be used to supplement traditional face-to-face instruction. Ally (2004, p. 5) defines online learning as:

“the use of the Internet to access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience”.

According to Van der Westhuizen (2004), online learning potentially offers benefits to both learners and facilitators. These include: (1) improved access to information, (2) increased interactivity and communication between learners and learning facilitators, (3) self-directed learning, (4) exposure to multi-sensory learning experiences, (5) wide geographical coverage, and (6) preparing students for a knowledge society. These expected benefits of online learning can contribute to the attainment of the critical cross-field learning outcomes as specified in the National Qualifications Framework (Boughey 2004). However, Van der Westhuizen (2004) warns teachers against dumping electronic copies of learning resources on the web and then hoping students will learn. Ally (2004) expresses similar sentiments when he argues that instructional strategy and not technology influences the quality of learning.

Van der Westhuizen (2004) describes three modes of online learning. First, online learning can be used to supplement conventional face-to-face classroom teaching. Additional learning materials are made available on the web. Second, online learning can be used as a substitute for face-to-face teaching. Such courses are referred to as web-based or fully online. Third, there is a hybrid mode where some components of learning are offered online and others are offered face-to-face. It is obvious that these modes of online learning will influence its design and delivery. For example, clear instructions are essential for learners in courses that are fully online, because learners do not have opportunities to discuss problems with instructors face-to-face.

LMSs are purported to facilitate high quality learning based on constructivist learning theories (Ally, 2004). The constructivist theory of learning views learners as active participants in the learning process (Hofer and Pintrich 1997; Palincsar 1998; Hofer 2001). Knowledge is viewed as being created by an individual. The instructor's role is seen as advisory and facilitatory. The constructivist theory of learning also views learning as contextual. Ally (2004) summarises the implications of the constructivist theory of learning for online learning. Firstly, learning should be an active process. This will result in high-level processing of information that may facilitate the creation of meaning.

Secondly, learners should construct their own knowledge rather than accept that given by the instructor. Knowledge construction is facilitated by interactive online teaching (van der Westhuizen 2004). For example, online discussion forums can be used to facilitate interaction among learners (Hodgkinson-Williams and Mostert 2005). Thirdly, collaborative learning should be encouraged to promote constructivist learning (Bitzer 2004). Working with peers gives learners the experience of working as a team is one of the critical cross-field outcomes of higher education (Boughey 2004). Fourthly, learners should be given control of the learning process. Fifthly, learners should be given opportunities to reflect on their learning. Reflective journals can be used to achieve this aim. Finally, learning should be interactive to promote higher-level learning and to help develop personal meaning (Ally 2004).

Although online learning has potential to support constructivist learning that results in high quality learning (Ramsden 1992; Garrison and Kanuka 2004; Tsai 2008), it is important to note that students have diverse learning styles (Felder and Brent 2005). Students' epistemological beliefs will influence their learning styles (Hofer 2001) which may in turn affect their perceptions of blended learning. For example, students who believe that knowledge is transmitted from the teacher to the student are likely to adopt learning styles that differ from those who believe that knowledge is constructed. There is therefore a need to understand the relationship between students' learning styles and their perceptions of online learning.

Despite the massive growth in the availability of information communication technologies globally (Castells 2000; Gipps 2005; Mayadas, Bourne and Bacsich 2009), in Africa (Cronjé 2006) and South Africa (Czerniewicz *et al.* 2005; Harding *et al.* 2006) during the last decade, their use in higher education has been relatively unspectacular (Yazon, Mayer-Smith and Redfield 2002). Nevertheless, the potential advantages of using online technologies for facilitating learning are clear (Graham 2006; Tsai 2008). The potential benefits of online learning motivated me to introduce the teaching strategy in all the courses that I teach. It is extremely important, however, to understand students' perceptions of online learning since these could influence their approach to learning (Ramsden 1992; Ginns and Ellis 2007).

Students have diverse learning styles. Increases in student numbers and diversity are likely to result in increased diversity of learning styles. Understanding the students' learning styles and their perceptions of online technologies will help me devise effective teaching and learning activities (Felder and Brent 2008).

1.2 Key research questions

The study aims to answer the following four key questions.

1. Which information and communication technologies do students use most frequently for learning?
2. What are the students' learning styles?
3. What are the students' perceptions of blended learning?
4. To what extent are students' learning styles and their perceptions of blended learning related?

1.3 Structure of thesis

The thesis consists of six chapters. Chapter 1 gives a general overview of the study and research questions. Chapter 2 gives a detailed literature review of the concepts of epistemology, learning, learning styles and blended learning. Chapter 3 describes the research methodology and instruments used to gather and analyse data. Chapter 4 gives a detailed description of the LMS. The findings of the study are given in chapter 5. Chapter 6 discusses the research findings and gives recommendations for research and improving my own teaching practice.

Chapter 2. Epistemological and Psychological Assumptions Informing Blended Learning

2.1 Introduction

Multiple factors interact to influence student learning in complex and unpredictable ways (Entwistle and Peterson 2004; Ginns and Ellis 2007). These can be divided into two broad categories (Figure 2.1). The first category consists of factors related to student characteristics. These include the student's previous experience of teaching and learning, instructional conceptions, perceptions of the teaching-learning environment, previous knowledge, conceptions of knowledge and learning, and student's approaches to learning and studying. These factors interact among themselves and with those related to the teaching-learning environment thereby increasing the complexity of student learning.

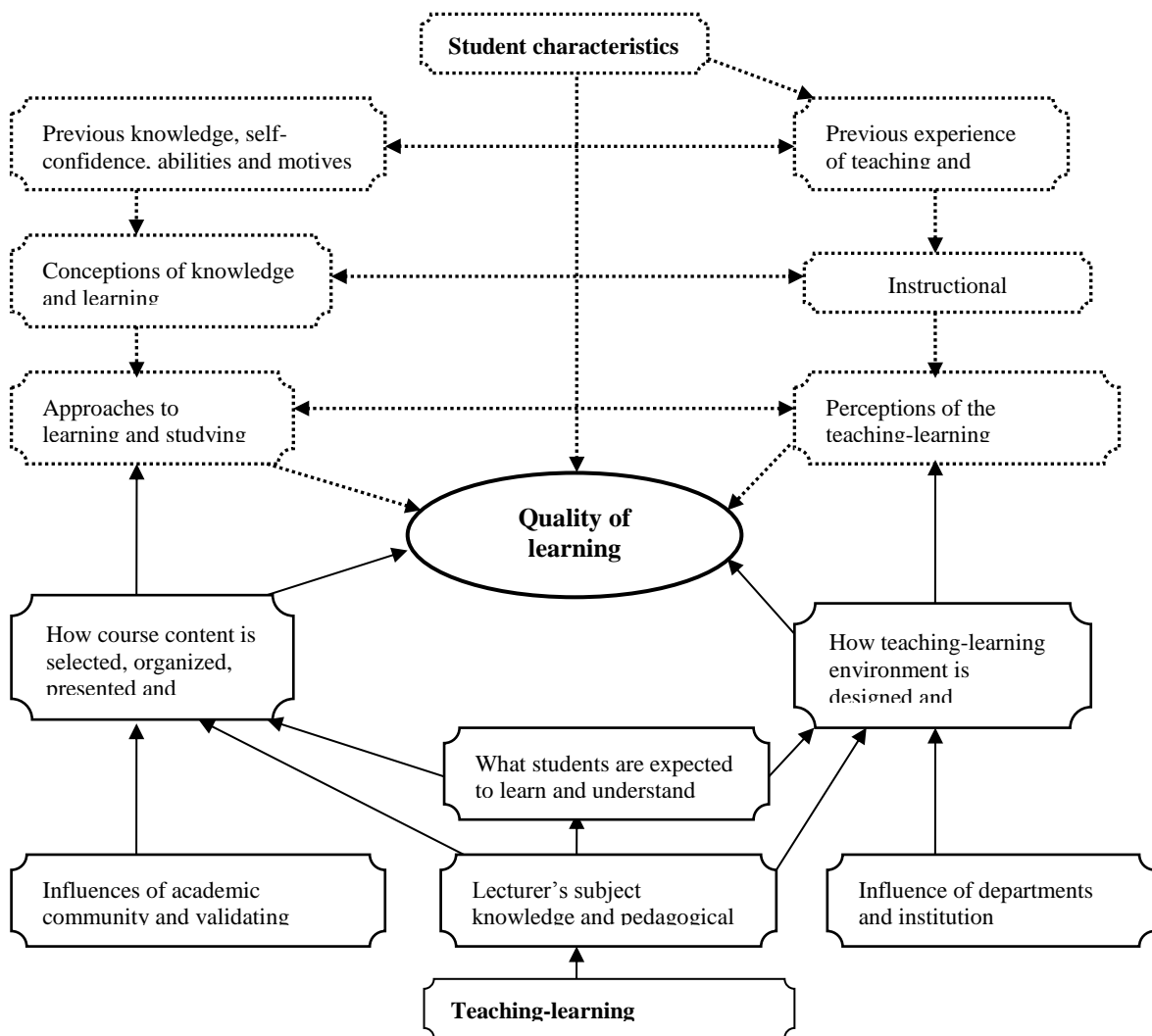


Figure 2.1 Conceptual framework showing factors influencing student learning (Adapted from Entwistle and Peterson 2004)

The second category of factors influencing learning consists of those that are related to the teaching-learning environment. These include the course content and its assessment, learning objectives, institutional quality control processes, and the lecturer's teaching methods and knowledge of the subject. The importance of aligning teaching-learning activities, learning objectives and assessment practices is well documented (Biggs 1999).

This study will focus on how students' epistemological beliefs, approaches to learning, learning styles and the teaching strategy (blended learning) influence learning outcomes. These factors also interact to influence learning. Epistemological beliefs have been shown to influence the degree to which individuals actively engage in learning, persist working on difficult tasks, comprehend written materials and cope with ill-structured tasks (Schommer 1994; Kardash and Scholes 1996; Hofer 2001). Furthermore, there is evidence that epistemological beliefs influence academic achievement (Schommer 1994; Tolhurst 2007). For example, Tolhurst (2007) found significant negative correlations between naïve beliefs in quick learning, simple knowledge and certain knowledge, and final coursework marks. In contrast, she found that students with more sophisticated epistemological beliefs attained higher coursework marks.

The degree of congruency between a teacher's and students' epistemological beliefs has a profound impact on student learning (Figure 2.2). A teacher's epistemological beliefs influence classroom tasks and pedagogical practices that are used (Brownlee *et al.* 2001; Hofer 2001). Classroom tasks and methods of teaching have been shown to influence students' epistemological beliefs (Kardash and Scholes 1996; Schraw 2001; Tolhurst 2007). Students' epistemological beliefs in turn influence their motivation, beliefs about education and learning, and ultimately the strategies they select for learning (Schommer 1994; Hofer 2001).

This chapter begins by describing the conceptions and models of epistemology. This is followed by a discussion of learning. Specifically, an overview of the conceptions of learning, approaches to learning, learning orientations and learning styles is given. A discussion on blended learning concludes the chapter.

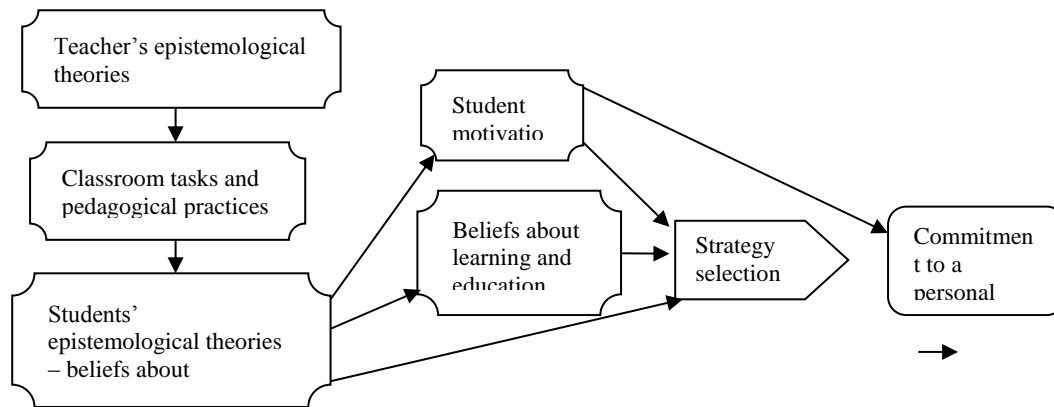


Figure 2.2 A model of how personal epistemology influences learning (Adapted from Hofer 2001)

2.2 Concepts of knowledge and knowing

Epistemology is the study of thinking and beliefs about knowledge and knowing and includes beliefs about the definition of knowledge, how it is constructed, how it is evaluated, where it resides and how knowing occurs (Hofer 2001). Extensive research has been conducted on the conceptualization of epistemology and how it is related to learning (Schommer 1994; Hofer and Pintrich 1997; Schommer-Aikins *et al.* 2006; Lodewyk 2007; Tolhurst 2007). Epistemological beliefs influence learning in many ways. For example, epistemological beliefs have been shown to influence how learners comprehend text, solve ill-structured problems, and actively participate and persist in learning (Schommer 1994; Kardash and Scholes 1996; Schraw 2001).

Although there is general agreement on the importance of considering epistemological beliefs in learning, there is still some debate on the conceptualization of epistemology (Hofer and Pintrich 1997; Hofer 2001; Schraw 2001; Schommer-Aikins 2004). Several models of personal epistemology have been proposed (Schommer 1994; Hofer and Pintrich 1997; Hofer 2001; Schraw 2001; Entwistle and Peterson 2004; Schommer-Aikins, 2004). These include developmental models, independent beliefs model and epistemological theories.

2.2.1 Developmental models of personal epistemology

Hofer and Pintrich (1997) and Hofer (2001) identified five models of epistemological development (Table 2.1). These are Perry's (1970) model, Belenky *et al.*'s (1986) ways of knowing, Kuhn's (1991) argumentative reasoning model, Baxter Magolda's (1992) epistemological reflection model and King and Kitchener's (1994, 2004) reflective judgement model. According to Hofer (2001), the models agree on two main issues. First, they demonstrate that individuals move through a regular sequence

or stages of development characterised by changes in their ideas about knowledge and knowing. Second, the models also agree on an interactionist, constructivist and cognitive developmental view of the world (Hofer and Pintrich 1997). Each of the five developmental models of epistemology is reviewed below.

Table 2.1 Models of epistemological development (Adapted from Hofer and Pintrich 1997)

Intellectual and ethical development (Perry 1970)	Women's ways of knowing (Belenky <i>et al.</i> 1986)	Epistemological reflection (Baxter Magolda 1992)	Reflective judgement (King and Kitchener 1994)	Argumentative reasoning (Kuhn 1991)
Dualism	Silence Received knowledge	Absolute knowing	Pre-reflective thinking	Absolutists
Multiplicity	Subjective knowledge	Transitional knowing	Quasi-reflective thinking	Multiplicists
Relativism	Procedural knowledge: (a) Connected knowing (b) Separate knowing	Independent knowing		Evaluatists
Commitment within relativism	Constructed knowledge	Contextual knowing	Reflective thinking	

Stages have been aligned to indicate similarity. Within a given column a model progresses from top to bottom.

Most of the early work on the development of university students' conceptions of knowledge and knowing is attributed to Perry (1970). He described nine views that are generally summarised as four main stages of development (Hofer and Pintrich 1997; Hofer 2001; Entwistle and Peterson 2004). These range from the simplistic dualist view of knowledge to the multiplist view, to the relativist and finally to the complex view involving commitment within relativism (Figure 2.3). The dualistic view characterises knowledge as either wrong or right and that it can be obtained from teachers or experts. The dualistic view is replaced with the multiplist view as students are exposed to different views and they begin to acknowledge the uncertainty of knowledge. Nevertheless, knowledge is still characterised as right or wrong (Hofer 2001).

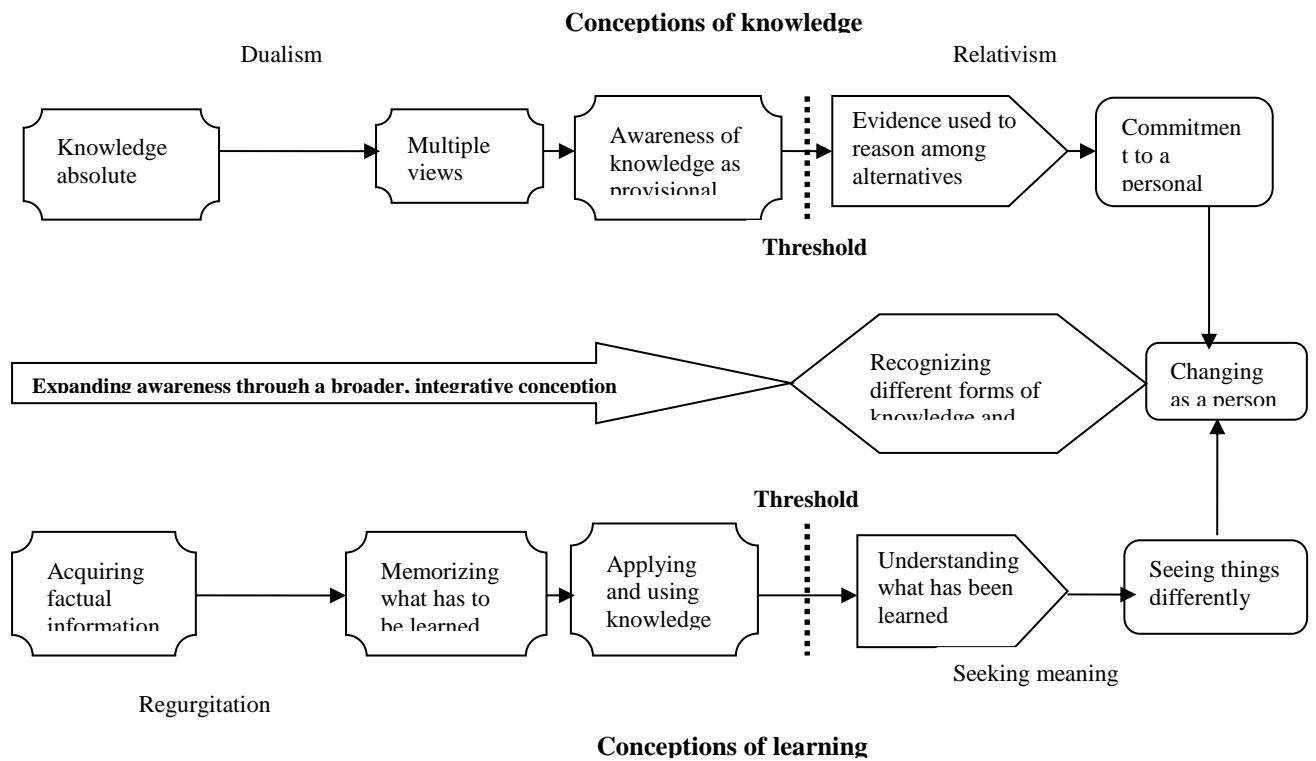


Figure 2.3 The developmental model of personal epistemology (Adapted from Entwistle and Peterson 2004)

A threshold in epistemological understanding is crossed when students move from a multiplist view to a relativist view of knowledge (Hofer and Printrich 1997). This movement results from a realisation that although there are multiple views of knowledge, some are better than others (Entwistle and Peterson 2004). Learners make a commitment to a personal view within relativism in the final stage of epistemological development (Hofer 2001; Entwistle and Peterson 2004). Few students take this last step in their epistemological development (Perry 1970; Schommer 1994). The movement from dualism to a personal commitment within relativism is characterised by an expanding awareness of a broader and integrative conception of knowledge and knowing (Entwistle and Peterson 2004). Entwistle and Peterson (2004, p. 410) highlight the significance of Perry’s work. They state:

“Perhaps the most important theoretical aspect of Perry’s work was the recognition that the developmental process involved an expanding awareness of the nature of knowledge, created through a broader conception of learning that integrated earlier conceptions within a more meaningful whole”.

Hofer and Pintrich (1997) have highlighted the shortcomings of Perry's (1970) seminal work on epistemology. These include the selection of mainly male participants from a white elitist institution; the upper position on commitment within relativism is outside the realm of epistemology; connotations of a structural developmental trajectory in epistemological beliefs, and lack of clear mechanisms triggering transitions between stages. Despite these shortcomings, developmental studies on students' epistemological beliefs are linked directly to Perry's (1970) work (Hofer 2001; Entwistle and Peterson 2004; Schommer-Aikins 2004).

Belenky *et al.* (1986) proposed the "women's ways of knowing" model to explain how women came to know by looking at their beliefs about knowledge, reality and authority. Unlike Perry (1970) whose sample consisted largely of males from an elite institution, Belenky *et al.* (1986) studied the epistemological beliefs of women from diverse backgrounds and institutions. Their model consists of positions that are similar to those of Perry (1970) as indicated in Table 2.1. The positions range from silence and 'received way of knowing' to the 'constructed way of knowing'.

Hofer and Pintrich (1997) give a detailed description of the five stages of Belenky *et al.*'s (1986) "women's ways of knowing" model. It focuses largely on the nature of knowing. I will give a brief overview of these stages. At the silence stage women perceive themselves as voiceless with all knowledge held by an authority. This stage is followed by the received knowledge stage where knowledge is either right or wrong and is obtained from experts. The next stage is the subjective knowledge still characterised by a dualistic view of knowledge. However, the self rather than an authority is now seen as the source of knowledge. The procedural knowledge position follows the subjective stage. Women at this stage demonstrate reasoned reflection and apply objective procedures for analysis (Hofer and Pintrich 1997). Procedural knowing takes the form of either separate knowing or connected knowing. Separate knowing is impersonal and detached while connected knowing is personal. The final stage in epistemological development in Belenky *et al.*'s (1986) model is constructed knowledge. Knowledge is seen as both subjective and objective and the self is seen as the maker of meaning. Knowledge and truth are seen as contextual. According to Hofer and Pintrich (1997), Belenky *et al.*'s (1986) model has contributed to epistemological understanding by focussing on the source of knowledge and self in constructing knowledge.

Baxter Magolda (1992, 2004) proposed the epistemological reflection model to explain how epistemological thinking develops in university students. Unlike Perry (1970) and Belenky *et al.* (1986) who conducted studies with males and females, respectively, Baxter Magolda (1992) focussed on possible gender differences in epistemological thinking by including both males and females in her study. The epistemological reflection model consists of four sequential ways of

knowing. These are absolute, transitional, independent and contextual ways of knowing. Although the ways of knowing were independent of gender, the first three stages of the model showed gender-related patterns (i.e., more common in either women or men).

Absolute knowers view knowledge as certain and dualistic, and experts as the source of knowledge. Within the absolute view of knowing, women showed a receiving pattern of knowing whereas men showed a mastery pattern. Transitional knowers accept that knowledge is uncertain and that authorities are not the only source of knowledge. Women showed an interpersonal pattern of transitional knowing whereas men showed an impersonal pattern. The next stage consists of independent knowers who realize that their own opinions are valid and that experts are not the only source of knowledge (Hofer and Pintrich 1997). Women showed inter-individual patterns of independent knowing whereas men showed individual patterns. Contextual knowers construct knowledge by judging evidence in context and evaluating expertise (Baxter Magolda 2004). Knowledge is viewed as contextual and it evolves by being continually reconstructed using new evidence. There were no gender related patterns for contextual knowers. Hofer and Pintrich (1997) argue that the main limitation of the epistemological reflection model is that it largely focuses on students' learning experiences rather than on nature of knowledge.

King and Kitchener's (1994, 2004) developed the epistemological reflective judgement model focusing on intellectual development and on how individuals cope with ill-structured problems. They identified seven stages of beliefs about knowledge and the processes for the justification of knowledge. The stages were clustered into three sequential categories namely pre-reflective, quasi-reflective and reflective thinking.

Pre-reflective thinking is characterised by a dualist and simple view of knowledge requiring no justification. During the later stages of pre-reflective thinking, temporary uncertainty is acknowledged with justification based on personal opinion (Hofer and Pintrich 1997). Quasi-reflective thinking acknowledges uncertain and contextual knowledge. Evidence is used to justify knowing. Reflective thinking is characterised by active construction of knowledge. Context is important when knowledge is constructed. Knowledge and evidence are used to solve ill-structured problems. Hofer and Pintrich (1997) have argued that the reflective judgement model is limited by its focus on perception and resolution of ill-structured problems, yet epistemological beliefs go beyond reasoning about ill-structured problems.

Kuhn (1991) proposed the argumentative reasoning model to explain how people solve ill-structured problems. She identified three epistemological stages that are related to argumentative reasoning.

The epistemological stages are similar to those of other developmental models (Perry 1970; Table 2.1). Hofer and Pintrich (1997) give a detailed review of Kuhn's (1991) model.

The absolute view of knowledge argues that knowledge is certain and absolute. Facts and expertise are used as the basis for knowing. The multiple view of knowledge sees experts as an uncertain source of knowledge. The third stage is the evaluative view of knowledge that is characterised by an uncertain view of knowledge by experts. However, viewpoints are compared and evaluated to assess their relative merits. Hofer and Pintrich (1997) have criticised this model of epistemological development because of its reliance on views about experts as a source of knowledge. The model did not focus on other dimensions of epistemology that are highlighted in the epistemological theories model (see section 2.2.3).

2.2.2 Independent beliefs model of personal epistemology

Schommer (1990) built on the work of Perry (1970), Schoenfeld (1983) and Dweck and Leggett (1988) to develop the beliefs model of epistemology. She argued that the major weakness of the stage-based developmental models was their implicit assumption of a sequential pattern of epistemological development. She identified a system of beliefs that may or may not develop synchronously. Asynchronous development implies that one may show complexity in some dimensions and naivety in others. This is not accounted for in developmental models that assume a sequential developmental pattern.

The independent beliefs model consists of several dimensions about the nature of knowledge, ways of knowing and beliefs about learning (Figure 2.4). The dimensions are organised in continua and are described from a naïve or simplistic view to a complex or sophisticated view that is associated with higher order thinking (Schommer 1990).

Beliefs about nature of knowledge consist of the dimensions of certainty, structure and source of knowledge. The belief about certainty of knowledge ranges from unchanging or absolute to tentative or evolving knowledge. Structure of knowledge is viewed as ranging from isolated bits and pieces to integrated concepts. Source of knowledge is seen as ranging from being handed down by an omniscient authority to knowledge being constructed using reason and empirical evidence.

Beliefs about learning consist of the dimensions of speed of learning and ability to learn. Speed of learning ranges from a belief that learning occurs quickly or not at all to a belief that learning occurs gradually. Ability to learn is viewed as ranging from a belief that ability is fixed at birth to a belief that ability to learn can be improved.

The belief about ways of knowing consists of the dimensions of connected knowing and separate knowing (Schommer-Aikins 2004). These dimensions highlight the possible linkages between the learner and the source of knowledge during learning. Schommer- Aikins (2004, p23) explained the concept of separate and connected knowing. She stated that:

“... Learners with a strong belief in connected knowing initially attempt to empathize with the knowledge source, take on the source’s perspective, and understand the point being made. Only after understanding the perspective are they ready to be more critical. In contrast, learners with a stronger belief in separate knowing take an adversarial perspective first. Functioning as a devil’s advocate, they question, doubt, and wait for evidence before they attempt to deeply understand the information”.

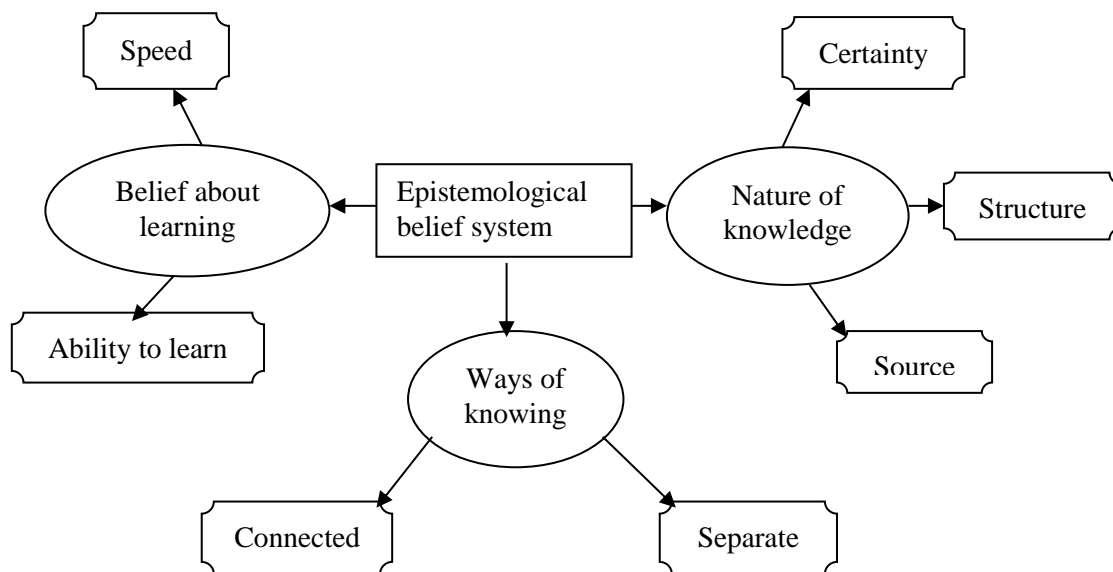


Figure 2.4 The independent beliefs model of personal epistemology (Adapted from Schommer 1990 and Schommer-Aikins 2004)

Schommer-Aikins (2004) has emphasised the need for balance among the different epistemological dimensions. For example, she argues that extreme views about certain knowledge can lead to dogmatism while extreme beliefs about tentative knowledge could result in open-mindedness to the point of “having no mind”. Her proposal that epistemological beliefs should be viewed as a frequency distribution rather than as a continuum (Schommer 1994) captures the importance of balance in understanding the concept of epistemological beliefs. Schommer-Aikins (2004, p 21) states:

“... individuals could believe that a large percentage of knowledge is changing, yet some knowledge is steadfast. These individuals would have the propensity to assume and function as if knowledge will change. Yet, they would still [be] able entertain the notion of some stability in what they know”.

Hofer and Pintrich (1997) and Hofer (2001) strongly criticised the inclusion of the dimensions of learning under the realm of epistemology since the two concepts are separate. Schommer-Aikins (2004) argued that epistemology cannot be separated from other important cognitive and affective dimensions that influence student learning. She has thus proposed an even broader “embedded systemic model” of epistemological beliefs. This broader model highlights interactions among six sub-systems. These are: (a) cultural relational views; (b) beliefs about ways of knowing; (c) beliefs about knowledge; (d) beliefs about learning; (e) classroom performance, and (f) self-regulated context. These arguments clearly demonstrate the complexity of the concept of epistemology. Part of the controversy may be attributed to multiple factors that interact to influence epistemological beliefs.

2.2.3 An alternative model of epistemology: epistemological theories

The study of epistemological beliefs has resulted in two general types of models. These are developmental models and the independent beliefs model (Hofer and Pintrich 1997). The developmental models are characterised by stages that change from simple to complex and contextual views about the nature of knowledge and the nature of knowing as students progress in their university studies (Perry 1970; Belenky *et al.* 1986; Kuhn 1991; Baxter Magolda 2004; King and Kitchener 2004). In contrast, some authors view epistemological beliefs as a system of more or less independent beliefs (Schommer 1990, 1994; Schommer-Aikins 2004). Hofer and Pintrich (1997) reviewed these models and highlighted their shortcomings. The shortcomings include the notion of invariant stage-like developmental pathways; lack of explanatory mechanisms of transitions between stages, and the inclusion of dimensions related to learning and intelligence that are not part of epistemology (Hofer 2001).

Hofer and Pintrich (1997) proposed the epistemological theories model as an alternative to the developmental and independent beliefs models of epistemology (Table 2.2). The epistemological theories model consists of four dimensions that are clustered under nature of knowledge and nature of knowing. Nature of knowledge consists of the dimensions certainty of knowledge and simplicity of knowledge while nature of knowing contains the dimensions source of knowledge and justification for knowing. The four dimensions are viewed as continua ranging from simplistic to complex nuanced views about the nature of knowledge and knowing.

Table 2.2 Description of the four dimensions of the epistemological theories model showing its relationship with components of the developmental and system of beliefs models (Adapted from Hofer and Pintrich, 1997)

Researcher	Core dimensions of epistemological theories	
	Nature of knowledge	Nature of knowing
Perry (1970)	Certainty of knowledge Absolute ↔ contextual relativism	Source of knowledge Authorities ↔ self
Belenky <i>et al.</i> (1986)		Source of knowledge Received ↔ constructed Outside self ↔ self as maker of meaning
Baxter Magolda (1992)	Certainty of knowledge Absolute ↔ contextual	Source of knowledge Reliance on authority ↔ self
King & Kitchener (1994)	Certainty of knowledge Certain, right/wrong ↔ uncertain, contextual	Justification for knowledge Received or mastery ↔ evidence judged in context
	Simplicity of knowledge Simple ↔ complex	Source of knowledge Reliance on authority ↔ knower as constructor of meaning
Kuhn (1991)	Certainty of knowledge Absolute, right/wrong ↔ knowledge evaluated on relative merits	Justification for knowledge Knowledge requires no justification ↔ knowledge is constructed, judgements are critically evaluated
Schommer (1990)	Certainty of knowledge Absolute ↔ tentative, evolving	Source of knowledge Experts ↔ experts critically evaluated
	Simplicity of knowledge Isolated, unambiguous bits ↔ interrelated concepts	Justification for knowledge Acceptance of facts, unexamined expertise ↔ evaluation of expertise
		Source of knowledge Handed down from authority ↔ derived from reason

Views about certain knowledge range from absolute, right or wrong to uncertain, contextual and evolving. Simple knowledge ranges from simple, isolated bits of information to complex and interrelated concepts. Views about source of knowledge range from authorities or experts to self as constructor of meaning. Justification of knowledge ranges from acceptance of facts, unexamined expertise to evaluation of expertise.

2.2.4 Concluding remarks on the concept of epistemology

The nature of knowledge and the ways of knowing have been explained using diverse models as described above. No single model can explain the complex concept of epistemology. Nevertheless,

the epistemological theories model proposed by Hofer and Pintrich (1997) offers a useful framework for analyzing the concept of epistemology by focusing on the core dimensions of the nature of knowledge and nature of knowing. The models of epistemology that I have reviewed here can be analysed using this framework as shown in Table 2.2. A limitation of the epistemological models I reviewed is their lack of emphasis on the social dimension of knowledge. Cultural knowledge goes beyond the notion of experts or self as the source of knowledge.

2.3 Concept of student learning

Learning consists of different components and processes. These are the strategies and processes that students use to achieve learning. Students have been shown to use different approaches to studying, metacognitive strategies, cognitive and affective processes during the learning process (Marton and Säljö 1976; Vermunt 1996; Vermunt and Vermetten 2004). Furthermore, students' goals and reasons for learning may influence their motivation and thus their learning (Beatty *et al.* 1997). The concept of learning is complex because many components and processes interact to influence how students learn (see Figure 2.1).

This section will start by reviewing four constructs that are related to the concept of learning. It starts by describing students' conceptions of the nature of learning. This is followed by an explanation of how students approach learning and studying. The strategies students use to regulate their learning are then discussed. A description of the types of students' learning styles concludes the section.

2.3.1 Conceptions of learning

The construct "conception of learning" has been defined in ways that reflect the different scales from which one can view the concept of learning. At a broad scale, conception of learning can be viewed as a system whereas at a fine scale it can be viewed as a process of acquiring information. Vermunt and Vermetten (2004, p.362) define conception of learning as:

"a coherent system of knowledge and beliefs about learning and related phenomena (e.g., knowledge and beliefs about oneself as a learner, learning objectives, learning activities and strategies, learning tasks, learning and studying in general, and about the task division between students, teachers, and fellow students in learning processes)".

Vermunt and Vermetten's (2004) definition is at a broad scale and shows the different components that are part of a system of knowledge and beliefs about learning. In contrast, Entwistle and Peterson's (2004) definition of conception of learning focuses at a fine scale on the process of how students acquire knowledge. They define conception of learning as a continuum ranging from

regurgitation of information to seeking meaning from information (see Figure 2.3). Clearly there is no single correct scale of looking at conceptions of learning. Thus, although clear dimensions of conceptions of learning have been identified (see below), one should remember that conception of learning includes both beliefs about knowledge and the processes of acquiring that knowledge that are influenced by the strategies that students employ to learn and lecturers apply to promote learning.

Marton *et al.* (1993) identified two broad conceptions of learning each consisting of three dimensions. The broad conceptions are the quantitative and qualitative views of learning (Figure 2.5). The quantitative conception of learning describes learning as the accumulation of knowledge with the aim of reproducing information. The three components of the quantitative conception of learning views learning as: (a) increasing one’s knowledge; (b) memorising and reproducing information, and (c) applying information. This view of learning is considered undesirable for university education. For example, in South Africa the National Qualifications Framework (NQF) expects universities to produce skilled graduates who are also critical thinkers (Boughey 2004). Thus critical thinking skills are a core learning outcome at tertiary level. The qualitative conception of learning views learning as: (a) increased understanding; (b) seeing things in a different way, and (c) changing as a person. The qualitative conception of learning is what university education strives to achieve (Vermunt and Vermetten 2004).

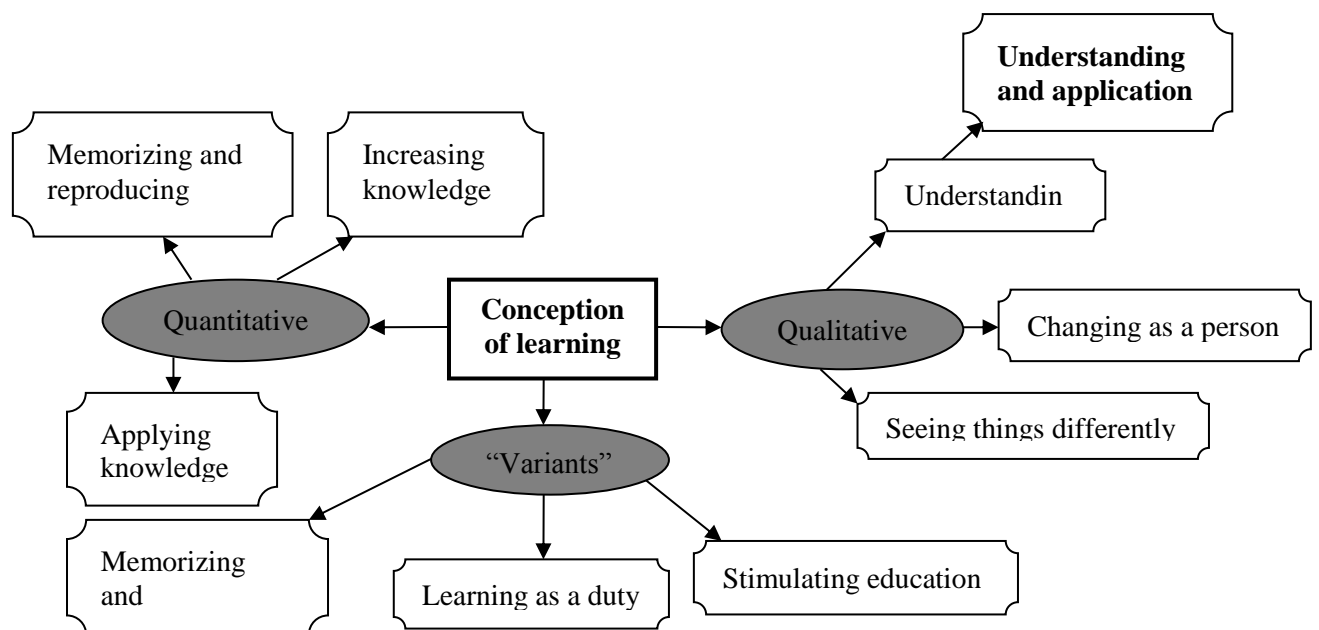


Figure 2.5 A multidimensional view of students’ conceptions of learning (Adapted from Marton et al. 1993 and Duarte 2007)

Other authors (Boulton-Lewis *et al.* 2003; Entwistle and Peterson 2004) have found evidence of the six conceptions of learning described by Marton *et al.* (1993). However, Duarte (2007) argues that he found a new conception of learning among Portuguese students. He named this conception of learning as understanding and application of knowledge (Figure 2.5). This finding may be evidence of cultural differences in conceptions of learning.

Entwistle and Peterson (2004) argue that the six conceptions of learning mirror Perry's stages of epistemological development (see Figure 2.3). They allude to a developmental pattern as shown by the following statement when referring to learning as seeing things differently and as changing as a person:

"The last two conceptions can be seen as the culmination of a process of broadening the awareness of the nature of learning in which earlier conceptions are integrated within a more complete one (as in Perry's scheme). But the earlier conceptions are rooted in specific learning experiences, and so the recurrence of similar situations may re-activate those conceptions, even when late ones have also been developed. ... This awareness [of learning and ability to adopt processes appropriate to varying tasks] can be seen as an emergent property of a developmental trend in conception of learning)" [p. 411]

Entwistle and Peterson (2004) argue that the transition from a view of learning as applying and using knowledge to learning as understanding what has been learnt (see Figure 2.3) represents a threshold in one's conceptual development.

Although developmental models of knowledge and learning are plausible (Entwistle and Peterson 2004), they have been criticised for implying linearity and predictability in their evolution (Hofer and Pintrich 1997). Knowledge and learning are multidimensional and complex concepts as shown by variants of the commonly accepted dimensions (Duarte 2007).

The next sections describe how students learn. I begin by reviewing the concept of approaches to learning. This is followed by a review of the concept of learning styles.

2.3.2 Approaches to learning

Learning approaches refer to how students learn. Learning consists of three related processes and activities (Vermunt 1996; Vermunt and Verloop 1999). These are cognitive, affective and metacognitive activities. I summarise the main components of each of these learning activities based on Vermunt (1996). Cognitive activities are mental activities that are used to process learning content. They include relating, selecting, analysing, critical processing, memorizing, concretizing and applying learning content. The outcome of cognitive processing activities may be knowledge, skills and understanding. Affective activities include attributing, motivating, concentrating, judging

oneself, appraising, exerting effort and generating emotions. Metacognitive activities are used to regulate both cognitive and affective learning activities. They include orienting, planning, testing, diagnosing, adjusting, monitoring, evaluating and reflecting on the progress of learning and adapting the learning processes when necessary (Vermunt 1996). The learning approaches students use can be differentiated on the basis of the learning activities they use.

Marton and Säljö (1976, 1997) identified two key approaches students use to learn. They identified the surface and deep approaches to learning. These two approaches differ in terms of the students' intentions during the learning process and the components of the learning activities they use.

Enwistle and Ramsden (1983) and Biggs (1987) built on this seminal work by studying how assessment influenced students' approaches to learning. They identified a third approach that they named the strategic or achievement approach to learning. Several other studies have identified these approaches to learning (Kember *et al.* 2004; Heikkila and Lonka 2006; Duarte 2007). The characteristics of the three approaches to learning and studying are outlined in Table 2.3.

Table 2.3 Approaches to learning and studying (Adapted from Entwistle and Peterson 2004)

Approach	Characteristics
Deep	<ul style="list-style-type: none">• Seeking meaning• Intention is to understand ideas for oneself• Holistic process that looks at the broad picture:<ul style="list-style-type: none">- relating ideas to previous knowledge and experience- looking for patterns and underlying principles• Serialist process - cautious and logical:<ul style="list-style-type: none">- checking evidence and relating it to conclusions- examining logic and argument cautiously and critically• Monitoring understanding as learning progresses• Engaging with ideas and enjoying intellectual challenge
Surface	<ul style="list-style-type: none">• Reproducing content• Intention is to cope with course requirements• Treating the course as unrelated bits of knowledge• Routinely memorising facts and carrying out procedures• Seeing little value or meaning in either the course or tasks set• Studying without reflecting on either purpose or strategy• Feeling undue pressure and anxiety about work
Strategic	<ul style="list-style-type: none">• Putting effort into organized studying• Intention is to do well in the course or achieve personal goals• Self-regulation of studying:<ul style="list-style-type: none">- organising studying thoughtfully- managing time and effort effectively- forcing oneself to concentrate on work• Awareness of learning in its context:<ul style="list-style-type: none">- being alert to assessment requirements and criteria- monitoring the effectiveness of ways of studying- feeling responsibility to self, or others for working hard consistently

The surface approach to learning is characterised by an intention to cope with course requirements. It is based on reproducing learning content and treats knowledge as unrelated pieces of information. It is also characterised by little interest in the learning material and by a feeling of undue pressure and anxiety. In contrast, the deep approach to learning is characterised by the desire to understand and an intrinsic interest in the subject. Cognitive processing activities include looking for patterns and relating ideas to previous knowledge and experience. Arguments are critically examined and evidence is used to assess the conclusions that are drawn. A deep approach to learning is the hallmark of university learning and is one of the critical learning outcomes (McInerney and McInerney 2006).

Unlike the surface and deep approaches to learning, the strategic approach is characterised by an intention to do well in a course or achieve personal goals. Students using this approach put a lot of

effort into organized studying. They regulate their studying by managing time and effort effectively and forcing themselves to concentrate on studying. Students adopting the strategic approach are also alert to assessment requirements and criteria, and monitor their studying.

There have been recent calls to investigate other important variables that are hypothesised to influence students' approaches to learning. These include emotions (Entwistle and Peterson 2004), collaborative learning (Lonka *et al.* 2004), self-regulated learning (Heikkilla and Lonka 2006) and personal and contextual factors (Vermunt and Vermetten 2004; Duarte 2007).

Some authors (Entwistle and Peterson 2004) have cautioned against viewing the three approaches to studying as unchanging or stable. For example, they argued that students who use the deep approach to learning can also use memorisation as a cognitive processing strategy depending on the context. Furthermore, it has been observed that students' approaches to learning may also vary with courses (Case and Marshall 2004; Vermunt and Vermetten 2004) and learning context (Duarte 2007).

Many models of students' learning styles now include self-regulation of learning as a key variable that influences learning and academic achievement (Vermunt 1996; Entwistle and McCune 2004; Vermunt and Vermetten 2004). The next section discusses the concepts of self-regulation of learning and the different types of learning styles.

2.3.3 Self-regulation of learning

Self-regulation of learning is key to study success (Vermunt 1996). Models of self-regulated learning posit four assumptions (Pintrich 2004). First, the active or constructive assumption views learners as active participants in the learning process. They are assumed to construct their own meaning, goals and strategies. This assumption agrees with the advanced concepts of epistemology that view knowledge as being constructed from many sources (Perry 1970; Hofer and Pintrich 1997; King and Kitchener 2004). Second, the potential for control assumption states that learners can monitor, control and regulate some aspects of their cognition, motivation, behaviour and the context of the learning environment (Pintrich 2004). Third, the goal, criterion or standard assumption states that there is a goal or criterion that learners can use to gauge the progress of the learning process. And fourth, self-regulation of one's cognitive activities, motivation and behaviour is assumed to influence the relationship between personal or contextual variables and actual achievement or performance. A conceptual framework of how students can regulate their learning is described below.

Pintrich (2004) developed a “4 x 4” conceptual model of self-regulated learning (Table 2.4). It highlights four phases and four areas of regulation during the learning process. The four areas for regulation are cognition, motivation/affect, behaviour and context. The first phase involves planning and activating the four areas for regulation. It includes setting targets, activating prior knowledge, metacognitive knowledge, interest and time management. The second phase consists of monitoring cognition, motivation and affect, effort, time use and the task conditions. The third phase involves selecting and adapting cognitive strategies for learning and thinking and strategies for managing motivation or affect. It also involves increasing or decreasing effort to do a task, persisting in the task, seeking help or renegotiating the task. The fourth phase involves evaluating the cognitive activities, motivation, behaviour and the task.

Table 2.4 Phases and areas of self-regulated learning (Adapted from Pintrich 2004)

Phases	Areas for regulation			
	Cognition	Motivation/affect	Behaviour	Context
Phase 1 Forethought, planning and activation	<ul style="list-style-type: none"> • Setting target goal • Activating prior knowledge • Activating metacognitive knowledge 	<ul style="list-style-type: none"> • Goal orientation adoption • Efficacy judgements • Perception of task difficulty • Task value activation • Interest activation 	<ul style="list-style-type: none"> • Time and effort planning • Planning for self-observation of behaviour 	<ul style="list-style-type: none"> • Perception of task • Perceptions of context
Phase 2 Monitoring	<ul style="list-style-type: none"> • Metacognitive awareness and monitoring of cognition 	<ul style="list-style-type: none"> • Awareness and monitoring of motivation and affect 	<ul style="list-style-type: none"> • Awareness and monitoring of effort, time use, need for help • Self-observation of behaviour 	<ul style="list-style-type: none"> • Monitoring changing task and context conditions
Phase 3 Control	<ul style="list-style-type: none"> • Selection and adaptation of cognitive strategies for learning, thinking 	<ul style="list-style-type: none"> • Selection and adaptation of strategies for managing motivation, and affect 	<ul style="list-style-type: none"> • Increase/decrease effort • Persist, give up • Help-seeking behaviour 	<ul style="list-style-type: none"> • Change or renegotiate task • Change or leave context
Phase 4 Reaction and reflection	<ul style="list-style-type: none"> • Cognitive judgements 	<ul style="list-style-type: none"> • Affective reactions 	<ul style="list-style-type: none"> • Choice behaviour 	<ul style="list-style-type: none"> • Evaluation of task

2.4 Typology of learning styles

Individuals differ in how they learn (Felder and Brent 2005). Individual differences in turn influence students’ learning outcomes. Extensive research has been conducted on individual differences in learning during the last forty years (Witkin *et al.* 1977; Riding and Cheema 1991; Rayner and Riding 1997; Cassidy 2004; Desmedt and Valcke 2004). The widespread research has resulted in a plethora of constructs and definitions of learning style (Smith 2002; Cassidy 2004; Price 2004). Desmedt and Valcke (2004) use the term “learning style jungle” to describe the confusion in terminology and

constructs describing individual differences in learning. Sadler-Smith (2001a) also highlights the confusion in the usage of the term learning style:

“... learning style is used as a portmanteau term for a range of individual difference constructs encompassing, among other things, learning preferences, learning strategies, approaches to studying and cognitive style” (p. 292).

Riding and Cheema (1991) and Cassidy (2004) also argue that cognitive style, learning style and learning strategy are sometimes used interchangeably although they are different constructs. For example, despite calling for rigour in use of the term learning style, Smith (2002) contradicts himself by equating the construct of approach to learning (Marton and Säljö 1976) with learning style. This practice clearly adds to the confusion. Several authors argue that such confusion may hamper progress in our understanding of the concept of learning style that influences many aspects of education (Witkin *et al.* 1977; Cassidy and Eachus 2000; Sadler-Smith 2001a; Desmedt and Valcke 2004; Cuthbert 2005). This section of the review defines the term learning style, provides a framework for understanding the concept of learning style and presents an integrative model of learning style.

There are many definitions of learning style. These range from narrow ones focussing on information processing (Sadler-Smith 2001a) to broad ones focusing on multiple factors that influence learning (Dunn 1984; Vermunt 1996). Since many factors influence how individuals learn (see Figure 2.1), the definition of the term learning style should therefore reflect the complexity of learning. Vermunt's (1996, p. 29) definition reflects the complexity of learning:

“The term learning style is usually used in a narrower sense, for example, in the sense of the learning activities students usually employ to learn ... Here the concept is used in a broad sense, and also includes students' mental models of learning and learning orientations. Learning style means here a coherent whole of learning activities that students usually employ, their learning orientation and mental model of learning; a whole that is characteristic of them at a certain period. Within this broader meaning learning style is thus a coordinating concept, in which the interrelations among cognitive, affective and regulative learning activities, mental models of learning and learning orientations are united. Learning style is not conceived of as an unchangeable personality attribute, but as the result of the temporal interplay between personal and contextual influences”.

In this thesis I use Vermunt's (1996) broad definition of learning style because it includes key factors that are known to influence learning (Pintrich 1994; Entwistle and Peterson 2004). Indeed several authors have argued that learning style consists of multiple factors (Riding and Cheema 1991; Sadler-Smith 1997; Cassidy 2004; Desmedt and Valcke 2004; Price 2004).

The high number of constructs and models of learning style requires an organising framework to reduce confusion on this concept. Rayner and Riding (1997) and Cassidy (2004) proposed a framework based on cognitive-centred, learning-centred and personality-centred approaches of learning style. Cognitive-centred approaches define learning style based on how individuals differ in their cognitive processing of information. Riding and Cheema (1991) identified two fundamental dimensions of cognitive style (see next section).

Three types of learning-centred models namely: process-based (Pask 1972; Kolb 1984), preference-based (Dunn 1984) and cognitive skills-based (Witkin *et al.* 1977) have been described (Rayner and Riding 1997; Cassidy 2004). Process-based models are defined in terms of how information is perceived and processed. Preference-based models focus on learners' preferences for different learning situations.

Cognitive-based models describe the cognitive styles used during learning (Cassidy 2004). The next section describes cognitive-centred and learning-centred models of learning style that form the basis of Vermunt's (1996) instrument for assessing learning styles that I used in this study. I therefore did not review the personality centred approach. A description of an integrative model of learning style concludes the section.

2.4.1 Cognitive-centred models of learning style

Cognitive style is defined as an individual's typical or habitual way of problem-solving, thinking, perceiving and remembering (Witkin *et al.* 1977; Riding and Cheema 1991). A multitude of models of cognitive style have been proposed (Riding and Cheema 1991; Rayner and Riding 1997; Riding, 1997; Cassidy 2004; Desmedt and Valcke 2004). Riding and Cheema (1991) proposed two fundamental dimensions of cognitive style. These are the wholist-analytic dimension and the verbaliser-imager dimension.

The wholist-analytic dimension describes how individuals generally process information. Analytics tend to break information into component parts whilst wholists tend to maintain a global view when processing information (Riding and Cheema 1991; Rayner and Riding 1997). Sadler-Smith (2001b) highlighted the shortcomings of wholist and analytic styles. He argued that for wholists there is a danger of a blurred distinction between parts while for analytics there may be a biased focus on one part at the expense of others, thereby exaggerating its relative importance. The verbaliser-imager dimension describes how individuals represent information in memory (Riding and Cheema 1991). Verbalisers represent information in memory in words while imagers represent it pictorially.

Riding and Cheema's (1991) fundamental dimensions are orthogonal. They have been used to identify nine cognitive styles (Sadler-Smith 1997). These styles describe how individuals process and represent information. They are (1) wholist-verbaliser, (2) wholist-bimodal, (3) wholist-imager, (4) intermediate-verbaliser, (5) intermediate-bimodal, (6) intermediate-analytic, (7) analytic-verbaliser, (8) analytic-bimodal, and (9) analytic-imager. Cognitive style models that fall under the wholist-analytic family of models (Pask 1972; Witkin *et al.* 1977) are described below.

Witkin *et al.* (1977) identified two cognitive styles defined by how individuals perceive objects spatially. They state:

"... the common denominator underlying individual differences in performance in these various tasks is the extent to which the person perceives part of a field as discrete from the surrounding field as a whole, rather than embedded in the field; or the extent to which the organisation of the prevailing field determines perception of its components, ... Because at one extreme of the performance range perception is strongly dominated by the prevailing field, that mode of perception was designated "field dependent". At the other extreme, where the person experiences items as more or less separate from the surrounding field, the designation "field independent" was used. Because scores from any test of field-dependence-independence form a continuous distribution, these labels reflect a tendency, in varying degrees of strength, toward one mode of perception or the other. There is no implication that there exist two distinct types of human beings" (p. 6-7).

The field independent and field dependent cognitive styles have important implications for teaching/learning. The styles indicate learners' preferences for and responses to different types of teaching/learning methods and social interaction (Witkin *et al.* 1977). Witkin *et al.* (1977) and Cassidy (2004) described the characteristics of field independent and field dependent learners. Field dependent individuals prefer to learn in groups and to interact with one another and with the teacher while field independent individuals prefer more independent and more individual approaches to learning (Witkin *et al.* 1977). Furthermore, field independent learners prefer situations requiring impersonal analysis while field dependent learners prefer situations requiring social perceptiveness and interpersonal skills (Witkin *et al.* 1977; Riding and Cheema 1991).

According to Witkin *et al.* (1977), field independent individuals show interest in domains where analytical and structuring skills are required and where relations with people are not essential. Thus field independent individuals are associated with mathematics and 'hard' science domains such as physics, chemistry, biology and engineering. In contrast, field dependent individuals favour domains that emphasise social perspectives and interpersonal relations and where analytical and structuring skills are not emphasised (Witkin *et al.* 1977).

Witkin *et al.* (1977) and Cassidy (2004) highlight other important characteristics of field dependent and field independent cognitive styles. They present evidence showing that field independent learners tend to be intrinsically motivated, set their own goals, structure their learning and define their own study strategies. In contrast, field dependent learners are extrinsically motivated, respond to externally-defined performance goals, need the instructor to structure and guide learning, and desire to interact with other learners. Cassidy (2004) states that Witkin *et al.*'s (1977) theory of field dependent and field independent cognitive styles has been criticised for 'over-extending theory' by generalising performance on perceptual tasks to personality and social behaviour. Nevertheless, research indicates that Witkin *et al.*'s (1977) theory has improved our understanding of the cognitive processing of information (Desmedt and Valcke 2004).

Pask (1972) identified the holist and serialist cognitive information processing styles. Serialists use a step-by-step approach to learning by dealing with small amounts of information or issues at a time and linking these to achieve understanding (Pask 1972; Cassidy 2004). In contrast, holists use large amounts of information and focus on major patterns in the data (Riding and Cheema 1991; Cassidy 2004). Pask (1972) identified pathologies associated with the excessive use of either the holist or serialist styles. Individuals who rely solely on the serialist style and thus fail to see the "big picture" are likely to show the "improvidence" pathology. In contrast, those relying mainly on the holist style are likely to make decisions based on insufficient evidence leading to the "globe-trotting" pathology (Pask 1972). Pask's (1972) model of cognitive style has been criticised for being derived from a small sample (Riding and Cheema 1991; Cassidy 2004).

2.4.2 Learning-centred models of learning style

Kolb (1984) proposed a process-based "4 x 4" learning style model. Four stages make up the learning cycle that describes how information is perceived and processed (Figure 2.6). The stages are, in turn, used to define four learning styles. The stages are concrete experience (experiencing), reflective observation (reflecting), abstract conceptualisation (thinking) and active experimentation (doing). Keller and Cernerud (2002) and Cassidy (2004) describe the characteristics of each of the stages of the learning cycle. The concrete experience stage is characterised by experiential learning. The reflective observation stage is characterised by reflection on a task and potential solutions before there is an attempt at action. At the abstract conceptualisation stage conceptual and analytical thinking is applied to achieve understanding. The active experimentation stage involves active trial and error learning. The four stages form two bipolar dimensions that are used to define four learning styles.

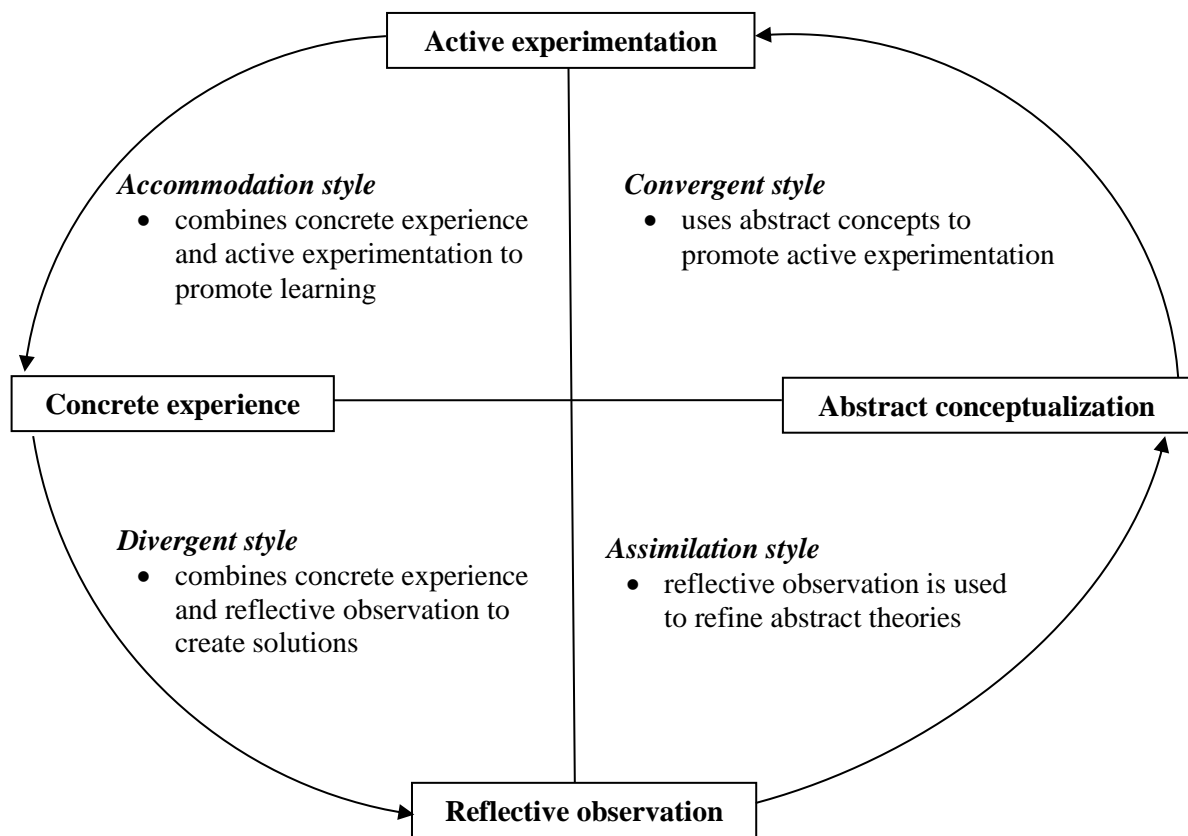


Figure 2.6 Kolb's (1984) learning cycle and learning styles defined by the comprehension dimension (concrete experience – abstract conceptualisation) and the transformation dimension (active experimentation – reflective observation)

The stages concrete experience and abstract conceptualisation define the first bipolar dimension also referred to as the “comprehension” or “prehension” dimension (Smith 2001a; Cassidy 2004). The second bipolar dimension is defined by the stages reflective observation and active experimentation and is referred to as the “transformation” dimension (Smith 2001a). Four learning styles have been proposed based on the position along the two dimensions (Figure 2.6). Rayner and Riding (1997) described the characteristics of the learning styles and these are summarized below.

The divergent learning style is defined by the concrete experience and reflective learning stages of Kolb's (1984) learning cycle. Individuals with the divergent style generally perceive information concretely and process it reflectively. The assimilation style is defined by the reflective observation and abstract conceptualization stages. Learners with the assimilation style perceive information reflectively and process it abstractly. The convergent style is defined by the abstract conceptualization and active experimentation stages. Individuals with the convergent style perceive information abstractly and process it actively. The accommodation style is defined by the active experimentation and concrete experience stages. Individuals with this style perceive information concretely and process it actively.

Kolb's (1984) learning style model has been criticised by many authors (Rayner and Riding 1997; Garner 2000; Cassidy 2004; Cuthbert 2005; Ayyokulu and Soylu 2008). The major criticism is the poor validity and reliability of Kolb's (1985) instrument for assessing the learning styles. Despite these shortcomings, Kolb's (1984) learning style model is still popular (Desmedt and Valcke 2004).

Vermunt's (1996) learning style model has been used extensively to study student learning (Desmedt and Valckle 2004). According to Entwistle and McCune (2004) the model is one of the new conceptualizations of student learning that include dimensions that emphasize the importance of self-conscious reflection on approaches to learning and studying.

Vermunt (1998), Entwistle and McCune (2004) and Vermunt and Vermetten (2004) give detailed accounts of Vermunt's (1996) learning styles. Five variables are used to define Vermunt's (1996) four learning styles (Table 2.5). The variables are cognitive processes, regulation strategies, affective processes, mental learning models and learning orientations of learners. I will describe the four learning styles from the most desirable to the least desirable in terms of learning skills expected of University graduates (Vermunt and Vermetten 2004). They are: the meaning-directed style, application-directed, reproduction-directed and undirected style. It is important to remember that these styles are not fixed characteristics of learners. Thus, Vermunt (1996, p. 32) states:

"These four learning styles are prototypical styles, in the sense that a student can manifest features of different styles".

Table 2.5 The components of Vermunt’s learning styles (Adapted from Vermunt 1996)

Variables	Learning style			
	Meaning-directed	Reproduction-directed	Application-directed	Undirected
Cognitive processes	Deep processing	Stepwise (surface) processing	Concrete processing	Processing not identified
Affective processes	Intrinsic interest	Fear of forgetting	Practical interest	Low self-esteem and expectation of failure
Regulation of learning	Mostly self-regulation	Mostly external regulation	Both internal and external regulation	Lack of regulation
Mental model	Construction of knowledge	Intake of knowledge	Use of knowledge	Relying on teachers or other students
Learning orientation	Personal (intrinsic academic)	Certificate (extrinsic)	Vocational (intrinsic)	Ambivalent (unmotivated)

Vermunt and Vermetten (2004) describe the five variables that are used to define the learning styles. Cognitive processes are the thinking activities learners use to process learning material and include looking for salient points, patterns and examples. Cognitive activities may result in knowledge, understanding and skills. Vermunt (1996) identified three main cognitive strategies namely deep processing, stepwise processing and concrete processing. The deep processing strategy consists of relating, structuring and critical processing of subject matter. The stepwise processing strategy consists of analysing and memorising of subject matter. Concrete processing refers to concretising and applying subject matter to new situations and by linking it to one’s experience.

Affective activities address emotions that may arise during learning. Emotions may have positive or negative effects on learning. Intrinsic interest in a subject may promote positive feelings that stimulate learning. In contrast, emotions such as fear may adversely affecting learning. An ability to block negative emotions may be crucial for successful learning.

Regulation activities are used to regulate learning contents, processes and outcomes. Examples of regulation activities include planning learning activities, monitoring progress, diagnosing problems, testing one’s outcomes, reflecting and consulting literature outside the syllabus. Vermunt (1996) identified three main regulation strategies. These are self regulation of learning, external regulation and lack of regulation. Self regulation is done by the learner while external regulation is done by teachers or when the learner follows instructions in books. Lack of regulation is self explanatory.

Mental models refer to learners' conception of learning and knowledge. These concepts were described in detail earlier (see Figure 2.5) and include conception of learning as construction of knowledge, intake of knowledge, use of knowledge and cooperative learning.

Beatty *et al.* (1997) described students' learning orientations. Learning orientations refer to learners' aims and goals of learning. They identified five learning orientations namely, personally interested, certificate orientated, self-test oriented, vocation oriented and ambivalent.

Learners using the meaning-directed style view learning as constructing knowledge, have an intrinsic academic interest in the subject, self-regulate their learning and use deep cognitive processing strategies when learning. Application-directed learners view learning as the use of knowledge, have a vocational interest in the subject, use both self and external regulation of learning, and use concrete processing strategies. Learners adopting a reproduction-directed style view learning as intake of knowledge, are interested in the subject to obtaining a certificate, their learning is regulated externally, they use stepwise cognitive processing of subject matter and fear forgetting the subject matter. Learners using an undirected learning style rely on other students or teachers for their learning, are unmotivated, lack regulation of their learning activities and have low self-esteem and expect to fail.

Although the validity of Vermunt's (1996) learning styles has been demonstrated in several studies (Cassidy 2004; Vermunt and Vermetten 2004), some authors have reported the phenomenon of dissonance (Lindblom-Ylänne and Lonka 2000; Vermunt and Verlop 2000; Vermunt and Minnaert 2003). Meyer (2000 cited in Vermunt and Vermetten 2004, p. 373) described dissonance as:

“unexpected, theoretically incompatible combinations of particular motives, intentions, strategies, regulatory mechanisms, contextual perceptions, learning conceptions and so on”.

Lindblom-Ylänne and Lonka (2000) attributed dissonance to “friction” between teaching strategies and learning strategies. The phenomenon of dissonance may be an indication that the learning styles that students adopt are adaptable as highlighted in Vermunt's (1996) definition of learning styles. The context under which learning occurs may thus influence what combination of styles students display.

2.4.3 Integrative model of learning style

Curry (1983, 1987) proposed a multi-layered model of learning style (Figure 2.7). The model has also been referred to as the style onion (Cassidy 2004). The innermost layer is the cognitive personality style which is thought to be the most stable. The next layer is the information processing style and

refers to the cognitive style for processing information (see earlier discussions). It is influenced by the cognitive personality style. The social preference layer refers to a learner's preference for social interaction during learning such as either independent or collaborative learning. Instructional preference is the outermost layer that describes an individual's preference for a learning environment. It is the most observable and least stable of the four layers (Curry 1983; Sadler-Smith 1997; Price 2004).

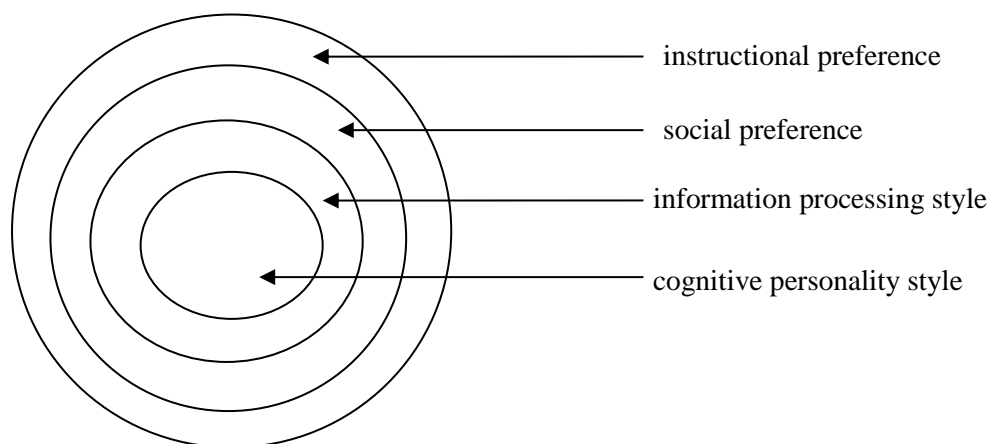


Figure 2.7 Curry's (1987) multi-layer model of learning style

The need for an integrative model of learning style is acknowledged by many authors (Cassidy 2004; Desmedt and Valcke 2004; Price 2004; Cuthbert 2005). The renewed interest in an integrative model of learning style agrees with Rayner and Riding's (1997) earlier call for the development of "fundamental dimensions" of learning style when they state:

"We suggest that Lewis (1976) is right and further development of a 'style' model comprised of super-ordinate dimensions is the way forward. Further, if we are to make sense of style, find meaning in theory and realise the 'operationalisation' of style in the educational system, the notion that 'learning style' is an individual, stable and person-centred construct, needs re-emphasising, with a view to developing a profile for an individual learner's style. This profile should be 'basic', containing 'primary' features of the individual's learning repertoire which will reflect cognitive style and learning preferences; it should be 'manageable', 'accessible' and 'geared' to the 'real' world of education and training; and it should be linked to an assessment procedure which is 'user-friendly' for both the teacher and student.

The suggestion is then that such a construct will ideally reflect a set of primary individual differences that include cognitive, behavioural and affective features combining to form the learner's learning style. The latter will represent a key consideration in curriculum design, assessment-based teaching and differentiated learning. The student's role in learning will surely involve the formation and refinement of learning strategies which reflect their own particular learning style and the learning task. The teacher's role in learning must then surely

be to incorporate an awareness of style in their approach to the task of teaching and learning. The final purpose of an assessment of learning style will be the enhancement of individuality in the process of teaching and learning” (p. 12).

One of the major challenges in developing an integrative model of learning style is the need for a single instrument to assess the learning style. Cassidy (2004) describes examples of instruments that have been used to assess each of the four layers of Curry’s (1987) learning style. He has also highlighted the shortcomings of some these instruments in terms of their psychometric properties.

Individuals differ in how they learn. The review above shows that our understanding of the complex concept of learning has improved. The concept of learning styles is useful in highlighting the key dimensions that influence learning. Vermunt (1996) addressed the complexity of how individuals learn by defining learning styles on the basis of five variables that have been shown to influence learning. According to Desmedt and Valckle (2004) and Entwistle and McCune (2004), Vermunt’s (1996) inventory of learning styles has been widely used to study student learning. I therefore chose to use Vermunt’s (1996) inventory of learning styles so that my findings could be compared to those of other authors.

As highlighted in Curry’s (1987) model of learning styles, individuals also differ in their instructional preference. The next section looks at the use of blended learning to support teaching and learning.

2.5 Using blended learning to support teaching and learning

2.5.1 Introduction

Graham (2006) defines blended learning as the combination of face-to-face instruction with computer-mediated instruction. Although the definition is simple, it hides the complexity that is inherent in the limitless ratios of face-to-face to online teaching and learning within a blend (Christensen 2003; Osguthorpe and Graham 2003; Harding *et al.* 2006). Blended learning lies between two ends of a continuum: face-to-face learning and fully online learning (Graham 2006).

The phenomenal increase in the use of blended learning is unquestionable (Bonk *et al.* 2006; Graham 2006; Harding *et al.* 2006; Spector 2008). The following two quotations are evidence of its increasing importance. Garrison and Kanuka (2004, p. 96) state:

“We posit that blended learning is an effective and low-risk strategy which positions universities for the onslaught of technological developments that will be forthcoming in the next few years. As society and technology fundamentally alter the manner in which we communicate and learn, this inevitably alters how we think. This is being driven further by the expectation placed on higher education to meet the need for intellectual talent. Forms of communication and our ability to manage information challenge our cognitive abilities and

the traditional classroom paradigm. Institutions of higher education need to discover their transformative potential. Internet information and communication tools provide flexibility of time and place and the reality of unbounded educational discourse. This does not represent the demise of the campus-based institution, but will cause us to recognize how best to utilize both face-to-face and online learning for purposes of higher education.

Similarly, Ellis *et al.* (2006, p. 244) state:

“No longer is it sensible to ask the question ‘Why should students use eLearning since they are coming on campus?’ but rather ‘How is eLearning contributing to the quality of their campus-based experience?’ This question is growing in significance ...”

The increased use of blended learning in higher education is attributed to several factors (Osguthorpe and Graham 2003; Bonk *et al.* 2006; Ellis *et al.* 2006; Ginns and Ellis 2007). These include pedagogical richness, access to knowledge, social interaction, personal agency, cost-effectiveness, ease of revision, and students’ expectations that eLearning resources are made available to support their campus-based experience. Osguthorpe and Graham (2003) give detailed explanations of these factors.

By facilitating the development of a community of inquiry, blended learning contributes to pedagogical richness (Osguthorpe and Graham 2003; Garrison and Kanuka 2004). Garrison and Kanuka (2004, p. 97) state:

“What makes blended learning particularly effective is its ability to facilitate a community of inquiry. Community provides the stabilizing, cohesive influence that balances the open communication and limitless access to information on the Internet. Communities also provide the condition for free and open dialogue, critical debate, negotiation and agreement – the hallmark of higher education. Blended learning has the capabilities to facilitate these conditions and adds an important reflective element with multiple forms of communication to meet specific learning requirements. For example, at the beginning of a course, it may be advantageous to have a face-to-face class to meet and build community. In contrast, discussing a complex issue that requires reflection may be better accomplished through an asynchronous Internet discussion forum”.

Garrison and Kanuka (2004) further argue that the diversity and quality of interactive dialogue that blended learning promotes, may lead to the development of critical thinking and higher-order learning skills. These are the skills that are expected of university graduates (McInerney and McInerney 2006).

The next section describes the models and types of blended learning. This is followed by an overview of theories that support the use of blended learning. A discussion of students’ perceptions of blended learning then follows. The relation between learning styles and blended learning is then

discussed. An overview of the challenges of using blended learning concludes the review of blended learning.

2.5.2 Types of blended learning

Blended learning can occur at four levels (Graham 2006). These are activity, course, programme and institutional levels. At activity level, learning activities occur during face-to-face sessions and also involve use of computers (Oliver *et al.* 2006). Blending at course level combines specific face-to-face and online activities (Cottrell and Robinson 2003; Harding *et al.* 2006). This is the commonest level of blending. Blending at programme level may allow learners to choose either combinations of face-to-face and online courses or such combinations may be prescribed for the programme (Jung and Suzuki 2006). Blending at institutional level is usually applied for distance learning courses. It may involve face-to-face classes at the beginning and end of a course with online learning in between (Lindquist 2006).

Graham (2006) identified three types of blended learning systems. These are enabling, enhancing and transforming blends. The characteristics of the blended systems are summarised in Table 2.6.

Table 2.6 Types of commonly used blended learning systems (Adapted from Graham 2006)

Type of blend	Key characteristics of the blend
Enabling blends	Focus mainly on addressing issues of access and convenience. Some of these blends aim to provide additional flexibility to learners
Enhancing blends	Allow for incremental changes to the pedagogy but do not radically change the way teaching and learning occurs. In traditional face-to-face classes additional learning resources may be provided online.
Transforming blends	These allow a radical transformation of the pedagogy. For example, this may entail a change from a model where learners are receivers of information to a model where they actively construct knowledge through dynamic interactions. These types of blends allow intellectual activity that was not possible without the technology.

2.5.3 Theories supporting the use of a blended learning strategy to promote teaching and learning

Constructivism is both an epistemological and a pedagogical philosophy supporting blended learning. Constructivist epistemology argues that learners actively construct knowledge. There are many types of constructivism (von Glasersfeld 1989; Salomon and Perkins 1998; Windschitl 2002). This partly reflects the contested nature of knowledge (Niaz 2008). Examples of constructivism include personal constructivism, social constructivism and information-processing constructivism

(McInerney and McInerney 2006). The types of constructivism differ in terms of the process and context in which knowledge construction occurs. Personal constructivism emphasises an individual's internal mental state, whereas social constructivism focuses on the social context and information-processing constructivism focuses on how learners select, organise and integrate incoming experience with existing knowledge to create understanding (Rovai 2004; McInerney and McInerney 2006).

Constructivist pedagogy is gaining importance in higher education because it can promote more effective teaching and learning than traditional teaching (von Glasersfeld 1989; McInerney and McInerney 2006). There are vast differences in classroom practice between traditional and constructivist learning environments (Table 2.7).

Table 2.7 Areas of emphasis in traditional and constructivist learning environments in higher education (Adapted from Rovai 2004)

Traditional	Constructivist
Instructional emphasis	
<ul style="list-style-type: none"> Teaching, knowledge reproduction, independent learning, competition 	<ul style="list-style-type: none"> Learning, knowledge construction, collaboration, reflection
Classroom activities	
<ul style="list-style-type: none"> Teacher-centred, direct instruction, didactic, individual work 	<ul style="list-style-type: none"> Learner-centred, Socratic, authentic, individual and group work
Instructor roles	
<ul style="list-style-type: none"> Expert, source of understanding, lecturer 	<ul style="list-style-type: none"> Collaborator, tutor, facilitator, encourager, community builder
Student roles	
<ul style="list-style-type: none"> Passive, listener, consumer of knowledge, note taker 	<ul style="list-style-type: none"> Active, collaborator, constructor of knowledge, self-monitoring
Assessments	
<ul style="list-style-type: none"> Fact retention 	<ul style="list-style-type: none"> Authentic knowledge application, portfolios, projects, performances

Tenenbaum *et al.* (2001) identified seven key features of constructivist pedagogy. These are: (1) allowing for arguments, discussions and debates; (2) causing conceptual conflicts and dilemmas; (3) encouraging the sharing of ideas with others; (4) including materials and measures targeted toward solution of problems; (5) stimulating reflection and investigation of concepts; (6) meeting learners' needs, and (7) emphasising the development of understanding through the use of real life examples. Tsai (2008) also emphasises the importance of these features in promoting constructivist learning environments.

Despite acknowledgement of the importance of constructivism in promoting effective teaching and learning, Tenenbaum *et al.* (2001) found little evidence of its application in higher education. There is a need to understand how blended learning could promote constructivist pedagogy. The Internet and information communication technologies component of blended learning contain features that support constructivist epistemology and pedagogy (Pear and Crone-Todd 2002; Christensen 2003). According to Tsai (2008), the following features of the Internet promote constructivism:

- hypertexts provide flexible ways of learning to fulfil individual needs;
- individuals can control the time and pace of learning, learning objectives and outcomes, and
- Internet-based communication (email, chat, online discussion forums) facilitates learner-to-learner and learner-to-teacher interaction.

The interaction promotes the establishment of a community of inquiry and cognitive apprenticeship that teachers, experts and experienced peers offer (Garrison and Kanuka 2004).

Section 2.2 of this review showed the importance of epistemological beliefs for student learning. One of the critical learning outcomes of higher education is that learners should demonstrate sophisticated concepts of knowledge and knowing when they graduate (Entwistle and Peterson 2004; McInerney and McInerney 2006). Although the Internet has largely been used in higher education as a cognitive and metacognitive tool, there is clear evidence that it is a key epistemological tool (Garrison and Kanuka 2004; Rovai 2004; Tsai 2008).

As a learning environment, the Internet can be viewed as an epistemological “jungle” characterised by diverse perspectives, information and knowledge. This environment challenges learners’ beliefs about knowledge and knowing because it requires them to answer the following six questions (Tsai 2004a):

1. Which information is more important than the other?
2. Which information or knowledge items are more reliable or valid than others?
3. What counts for knowledge?
4. What is the nature of their knowledge and learning?
5. How to resolve conflicts among various perspectives of knowledge?
6. How to effectively integrate all types of knowledge into a coherent framework?

Answers to these questions require learners to develop what Tsai (2004a) calls epistemological and information commitments. He distinguished the concept of “epistemology” from that of “epistemological and information commitments”. Epistemology is a broader concept concerning general beliefs about the nature of knowledge (Schommer 1994; Hofer 2001) whereas epistemological and information commitments refers to evaluative standards that are used to judge the merits of information and knowledge. The methods that show how the Internet can be used as an epistemological tool are summarised in Table 2.8.

Table 2.8 Use of the Internet as a cognitive, metacognitive and epistemological tool (Adapted from Tsai 2004a)

	Purposes	Possible methods
Cognitive tool	<ul style="list-style-type: none"> • Acquire information • Acquire knowledge and comprehension • Construct or co-construct knowledge • Develop reasoning and problem-solving skills 	<ul style="list-style-type: none"> • Information search • Visualisation or virtual reality • Test bank • Synchronous and asynchronous conferencing
Metacognitive tool	<ul style="list-style-type: none"> • Select and filter information • Reorganise knowledge • Conceptual change • Make connections with previous and other knowledge and experiences • Learn how to learn and how to apply knowledge 	<ul style="list-style-type: none"> • Concept maps • System modelling • Hypermedia or database construction • Providing learning profiles of web navigation for learners’ review
Epistemological tool	<ul style="list-style-type: none"> • Commitments or judgemental standards to information and knowledge • Develop ideal or explanatory models • Understand the nature of technology, learning and teaching • Promote integrated or interdisciplinary epistemological commitments • Shape philosophy and worldviews 	<ul style="list-style-type: none"> • Reflective judgements in web navigation • Decision making in web contexts • Meaningful interactions with web materials and peers or experts

Tsai (2004b) made two important assertions on the use of the Internet as an epistemological tool. The first is that learners with different epistemological beliefs benefit directly from Internet-based instruction. He argues, however, that the assertion applies to students with advanced epistemological beliefs such as relativism and commitment within relativism (Hofer 2001; Entwistle and Peterson, 2004) who may find the Internet learning environment less daunting because they can develop epistemological and information commitments. In contrast, students with simple epistemological beliefs such as dualist or multiplist may benefit most through traditional face-to-face teaching. This is further evidence why blended learning has potential to transform learning experiences because it uses both modes of teaching and learning (Garrison and Kanuka 2004).

The second assertion is that the use of Internet-based instruction will change or reshape learners' epistemologies. Diverse views and information on the Internet challenge learners to evaluate their views on knowledge and knowing. This may assist learners to attain one of the major goals of higher education which is the development of advanced views of knowledge and knowing that promote critical thinking and higher order learning outcomes (Bloom *et al.* 1956; Ramsden 2002; McInerney and McInerney 2006).

2.5.4 Students' perceptions of blended learning

Students are likely to differ in their perceptions of teaching and learning practices such as blended learning that are increasingly being used in higher education (Graham 2006). Felder and Brent (2005) have highlighted students' differences that are likely to influence perceptions of their learning environment. These differences include gender, age, learning style, prior experience and culture. Rogers (1995) described the theory of technology acceptance that shows that individuals can be classified as innovators, early adopters, early majority, late majority and laggards. It is therefore important to understand how learners perceive blended learning.

Several authors have demonstrated generally positive perceptions of blended learning (Cottrell and Robison 2003; Waddoups *et al.* 2003; Harding *et al.* 2006). In contrast, other authors have reported mixed findings (Keller and Cernerud 2002; Ginns and Ellis 2007). For example, Keller and Cernerud (2002) found that positive perceptions of the blended learning environment were associated with increased access to information, flexibility in terms of time and place of learning, and increased interaction among learners. The negative perceptions were attributed to inconsistent use of blended learning across courses and technical problems.

The Internet is a key component of blended learning. Tsai (2007) demonstrated that students' perceptions of the Internet were influenced by technical issues such as ease of use, web content (relevance, diversity of information sources) and cognitive aspects (facilitation of inquiry learning). Understanding how learners perceive blended learning will assist teachers in designing effective learning environments (Garrison and Kanuka 2004; Graham 2006).

2.5.5 Relations between learning styles and perceptions of blended learning

There are diverse learning styles (see Section 2.4) that are likely to interact with learners' views of blended learning. This review cited several studies on learning styles and blended learning. Few studies, however, have investigated the relationship between learning styles and perceptions of blended learning. Some authors (Terrell and Dringus 1999; Simpson and Du 2004; Poole 2006;

Akkoyunlu and Soylu (2008) have reported mixed findings on the relations between learning style and perceptions of blended learning. Comparisons of the findings of these authors are complicated by the use of different instruments to measure learning styles.

Akkoyunlu and Soylu (2008) used Kolb's (1984) inventory of learning styles to assess learning styles. They found that learning style influenced learners' views on blended learning. Assimilators and divergers differed in their views on ease of use of the web, online environment, face-to-face learning and on their contributions to forum discussions. Divergers scored lower than assimilators in all the variables they assessed.

Baldwin and Sabry (2003) used Felder and Soloman's (1999) index of learning styles. They found that sequential and global learners differed in their use and perceptions of web-based interaction. Global learners had a higher frequency of use of learner-information, learner-tutor and learner-learner interaction than sequential learners. Furthermore, global learners perceived learner-information and learner-learner interactions to be more important than sequential learners did.

Poole (2006) used Honey and Mumford's (1992) instrument to assess learning styles. She found weak correlations between learning style and modes of engagement with web-based learning. Activists were shown to be more likely to work online while reflectors or theorists were likely to print material for reading later (i.e., work offline). She concluded that a higher proportion of web content relative to face-to-face content may discriminate against learners with reflector or theorist learning styles.

The studies cited above clearly indicate that learners have diverse learning styles that influence how they engage with their learning environment. It is therefore important to consider individual differences when designing learning environments (Felder and Brent 2005). Blended learning is more likely to cater for individual differences than traditional face-to-face learning because it adds diverse teaching and learning methods.

2.5.6 Challenges of introducing blended learning

Graham (2006) outlined six major issues that should be considered when designing blended learning systems. These are:

- role of live interaction;
- models for support and training;
- dealing with the digital divide;

- balance between innovation and production;
- cultural adaptation, and
- role of learner choice and self-regulation.

A brief overview of each of these challenges is given below, followed by a synopsis of future trends in blended learning.

There is evidence that traditional learners generally prefer live interaction during face-to-face sessions of blended learning (Hansen and Clem 2006; Hofman 2006; Owston *et al.* 2006). This finding emphasises the need to consider the balance between face-to-face and online components of blended learning (Christensen 2003). Each blended learning environment, however, is unique and thus there is no one size fits all solution to this challenge.

A sustainable blended learning environment requires support and training for instructors and learners. According to Graham (2006) other issues to consider include: increased demand on the instructor's time; providing learners with technological skills; providing professional development for instructors, and changing organisational culture to accept blended learning approaches.

Dealing with cultural adaptation and the digital divide among individuals and societies is a major challenge. Learning materials need to be culturally relevant to increase the chances of their successful use (Selinger 2006). Access to information and communication technologies is usually limited (Massy 2006). This is more pronounced in developing countries that face dire economic challenges. However, it is in these countries that there is a need to increase the numbers of students in higher education institutions. The massification of higher education ironically places a need to improve the quality and effectiveness of teaching and learning which blended learning is purported to do (Garrison and Kanuka 2004; Ross and Gage 2006).

The constructivist philosophy argues that learners should play a key role in the development of the curriculum and learning outcomes (McInerney and McInerney 2006). Blended learning has been shown to have attributes that promote constructivist pedagogy (Tenenbaum *et al.* 2001; Tsai 2008). Graham (2006) has shown that learners generally choose blended learning based on convenience and access yet fully online learning requires a high level of self-regulation and discipline among learners.

Graham (2006) argues that there is a need to balance innovation and production. Due to pressures to increase student numbers in higher education institutions, there is a danger that blended learning

is perceived as a means of managing increasing enrolments (Felder and Brent 2005; Graham 2006). Blended learning should be seen primarily as a system for enhancing effective teaching and learning.

There are daunting challenges facing blended learning. However, Graham (2006) highlights its significance in higher learning:

“We live in a world in which technological innovation is occurring at breakneck speed and digital technologies are increasingly becoming an integral part of our lives. Technological innovation is also expanding the range of possible solutions that can be brought to bear on teaching and learning. Whether we are primarily interested in creating more effective learning experiences, increasing access and flexibility, or reducing the cost of learning, it is likely that our learning systems will provide a blend of both face-to-face and computer mediated experiences” (p. 16).

Ross and Gage (2006) state that the question is no longer whether to blend or not to blend but rather by how much we should blend. Mayadas *et al.* (2009, p. 85) sum up the views about the future of online learning, a key component of blended learning:

“Online education is established, growing, and here to stay. It is creating new opportunities for students and also for faculty, regulators of education, and the educational institutions themselves.”

2.6 Conclusions

This literature review has demonstrated the complex interplay of several factors impacting on teaching and learning (Figure 2.8). The students’ prior experience, conceptions of knowledge and learning, and learning orientations influence their approaches to studying and perceptions of teaching/learning. These in turn, influence the quality of learning achieved. The teacher’s knowledge and conceptions of teaching influence the course design and the teaching/learning environment that is provided. The course design and learning environment have been shown to influence the quality of learning achieved (Entwistle and Peterson 2004; Ginns and Ellis 2007).

The phenomenal developments in information and communication technologies have extended the boundaries of what teachers and learners can do to promote high quality learning outcomes (Mayadas *et al.* 2009). My study focused on students’ learning styles and how these were associated with their perceptions of blended learning with a view to improving my teaching practice.

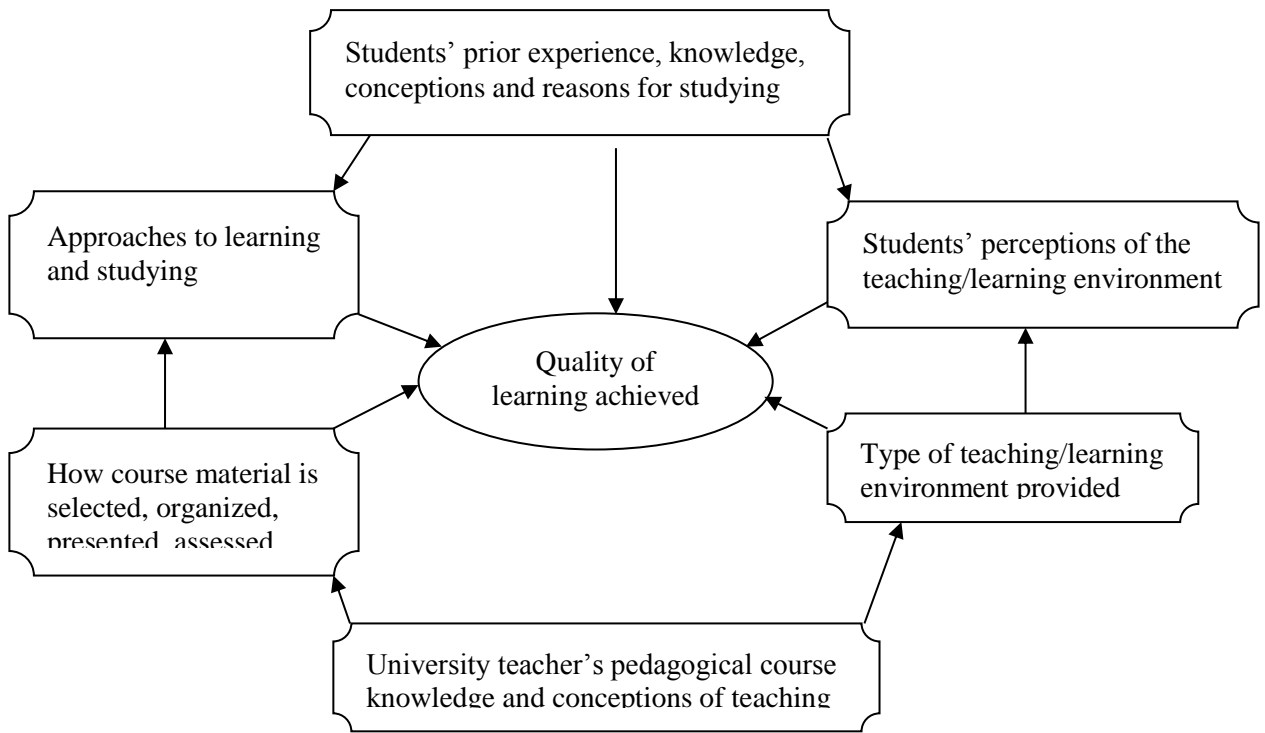


Figure 2.8 Factors influencing the quality of student learning in higher education (Adapted from Ginns and Ellis 2007)

Chapter 3. Methodology and Data Collection

3.1 Research methodology

The study was conducted using the case study methodology (Stake 1995). Yin (1994, p. 13) defines a case study as:

“an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not too clearly defined”.

The methodology was chosen for two reasons. Firstly, as implied by the definition, the contextual conditions were an important component of interest. And secondly, the purpose of the study was to understand the learners’ perceptions of the blended learning environment with a view to improving my practice as a lecturer. The case study methodology enabled me to collect in-depth information within the specific context of the blended learning environment thereby revealing the sense that participants make of their experiences and the meanings they attribute to their actions and interactions (Stevenson 2004).

The study falls largely within the quantitative research paradigm (Babbie and Mouton 2006). Structured questionnaires consisting largely of close-ended questions were used to measure both students’ learning styles and online experiences. The online experience questionnaire that I developed also contained open-ended questions that enabled me to gain a deeper understanding of the learners’ experiences of online learning. I used simple and multivariate descriptive statistics to analyse quantitative data. The qualitative data I collected using open-ended questions were analysed using content analysis.

3.2 Research context

3.2.1 Course structure

The environmental science curriculum is designed by all staff members in my department. At the end of each year the department conducts a planning meeting where we invite stakeholders from the private sector and from within the university to participate in the review of all the courses we teach. Course evaluations from students and the external examiner are considered when reviewing the curriculum. For example, based on evaluations from current and past students, the department decided to introduce a new first semester course in 2007.

The study was conducted at Rhodes University with 32 students doing the Environmental Science 302 course in 2006. The course was modular and was offered during the second semester. It

consisted of eight components (seven theory components and one practical component) (Appendix A). The theory components were: (1) Environmental Policies; (2) Environmental Ethics; (3) Participatory Natural Resource Management; (4) Integrated Pollution and Waste Management; (5) Integrated Environmental Management Tools; (6) Integrated Environmental Planning Tools, and (7) Synthesis. I taught the first three theory components (made up 46% of all lectures) while practising professionals working in the private sector were contracted to teach the Integrated Environmental Management Tools and Integrated Environmental Planning Tools (made up 32% of all lectures). The other components were taught by two lecturers employed at Rhodes and working in my Department of Environmental Science (made up 22% of all lectures). The synthesis component was based on a case study of a rural site where our post-graduates had conducted several studies on environmental management and people's livelihoods. All those who taught the theory components were required to supervise one group of students doing the year-long practical project component. Each group consisted of 4-5 students. I was the course coordinator and thus I was responsible for compiling the course outline, organising the marking of assignments, setting of the examinations and other general administration duties.

The course focused on environmental management in practice – hence the involvement of practicing professionals in the teaching of the course. The aim was to develop applied professional skills, coupled with rigorous analysis, to promote effective environmental management. The emphasis was on methodologies and conceptual frameworks to evaluate, understand and study environmental impacts and resource use patterns. Critical analysis and consideration of counter-viewpoints were also important aims of the course. This was done at the global, regional and national level, whilst also drawing on local case-studies. The first lecture of Environmental Science 302 was an introduction and overview of the course, learning outcomes and expectations, marking, and administration.

The course had a credit value of 15. It was assumed that the 'average' learner would need approximately 10 hours to complete one credit's worth of learning. The 10 hours would include lecture attendance, practicals, self study and work on assignments. The skills covered in second year Environmental Science 201 and 202 during the previous year were particularly relevant, especially those relating to systems analysis, team work, and interdisciplinarity.

Teaching and learning consisted of formal face-to-face lectures that were complemented with an online learning component in a blended learning format. Lectures (63) were taught over a period of 13 weeks. Each lecture lasted 45 minutes. Lecture notes in the form of PowerPoint slides, course programme, scientific literature and hyperlinks to important websites were uploaded or published

on the course website. The *Moodle* LMS (see Chapter 4) was used to manage the course. Students were required to contribute at least twice to a forum discussion on a given topic. This was a group assignment. Discussion fora have been shown to promote higher level learning skills (Ellis *et al.* 2004; Gilbert and Dabbagh 2005; Ellis *et al.* 2007). Students were also required to keep a reflective journal on their learning experiences. Reflective journals help students develop critical thinking skills that university graduates are expected to possess (Fisher 2003; Chitpin 2006; Allard *et al.* 2007).

The extent of blended learning is shown in Figure 3.1. Six radials each representing the extent of online dynamics, assessment, communication, content, richness and independence from face-to-face contact were used as suggested by Harding *et al.* (2006). Each radial has a maximum score of five. Dynamics refers to the frequency of access necessary for success in the course. Assessment refers to how much assessment is done online. Communication refers to how much of the communication happens online. Content refers to how much of the course content is available online. Richness refers to how many enriching components the online component of the course has. Independence refers to how independent success in the course is from face-to-face contact. The scores for each radial were calculated as suggested by Harding *et al.* (2006) and refer to the Internet component of the blended course. The larger the area, the bigger the Internet component and the smaller the area, the bigger the face-to-face component. A convex shape partially filling the chart area would indicate a well-balanced course.

My blended course was lopsided in favour of face-to-face learning. The proportion of online assessment tasks, richness of the online environment and independence were low considering that the maximum score for each radial is five.

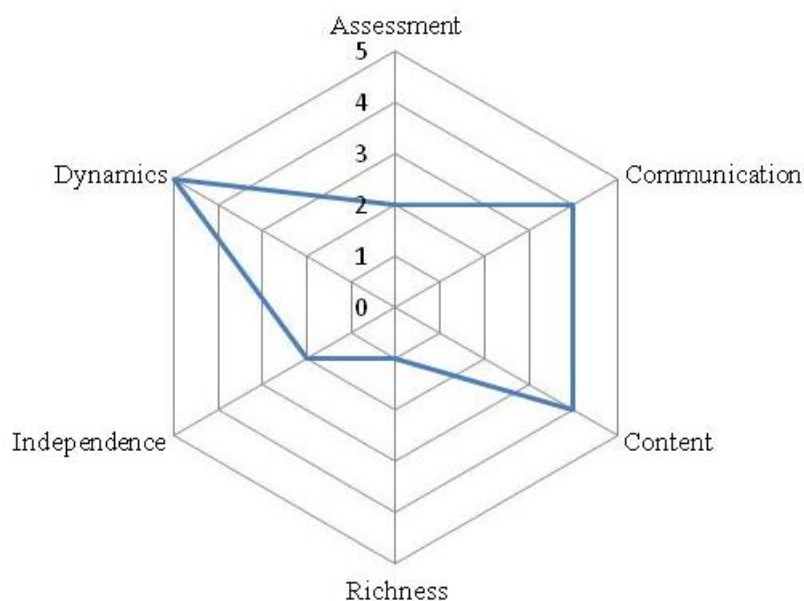


Figure 3.1 Radar chart showing the extent of blending in the Environmental Science 302 course in 2006

Course marks were calculated from assignments and two theory examinations written at the end of the semester. The assignments consisted of a review of a scientific paper (contributing 6% to the final course mark), reflective journal (1%), postings to online discussion forum (4%), essay (12%) and year-long practical (33%). The examination papers contributed 44% to the final course mark. Postings to the discussion forum and the year-long practical were group assignments.

3.2.2 Participants

Participants were 32 third-year undergraduate students at Rhodes University with a total enrolment of about 6000 undergraduate students. The students were all doing the Environmental Science 302 course described above. The average age of students was 22.2 years (standard deviation = 3.16). The majority of students were male (59.4%). The ethnic composition of the students was 81.2% Caucasian, 9.4% African and 9.4% Indian. The majority of students were doing a BSc degree (71.9%) with 18.7% doing BA, 6.3% BSS and 3.1% doing SP degrees.

Students were divided into five groups of about six students. These groups were required to work together on their practical projects and other group assignments for a full year. One group consisted of individuals who had difficulties working together. There was a lot of tension in this particular group.

Since my study involved human subjects, I followed the guidelines outlined in the Rhodes University Ethics policy. I explained my research project to the whole class during the first lecture of the

semester. I asked for volunteers to participate in the study. Students were informed of their rights to consent or refuse to participate in the study. Those who agreed to participate were required to reveal their identities when completing the questionnaires so that their responses could be evaluated in relation to their final course marks. Students were informed that their identities would not be revealed in the thesis or any publications arising from the study. Those who participated in the study completed two questionnaires: Vermunt's (1996) Inventory of Learning Styles and the Online Experience Questionnaire that I developed (see details in sections 3.5).

3.3 Learning management system

The *Moodle* LMS was used to implement the online component of the blended learning programme. *Moodle* is an open-source course management system (Cole 2005). Students were introduced to this course management system when they were doing Environmental Science 201 and 202 courses in the previous year. Details about the course management system are given in Chapter 4.

3.4 Students' learning styles

Students' learning styles were assessed using Vermunt's (1996) Inventory of Learning Styles instrument. The 100-item version was used. The instrument assesses four learning styles (undirected, reproduction-directed, meaning-directed and application-directed). These styles are described in Table 2.5 (Chapter 2). Furthermore, Vermunt (1996) and Vermunt and Vermetten (2004) give detailed descriptions of the instrument. Professor Vermunt (Utrecht University, IVLOS – Institute of Education, P.O. Box 80.127, 3508 TC Utrecht, The Netherlands. Email: j.d.vermunt@ivlos.uu.nl) kindly gave me permission in 2006 to use the instrument and provided the scoring key. Since the Inventory of Learning Styles is copyrighted, I will not provide a copy of the instrument and scoring key.

A summary of the domains, scales and subscales of the instrument are given in Table 3.1. Briefly, the four learning styles are differentiated based on 16 scales measuring cognitive processing strategies, regulation strategies, learning orientations and conceptions of learning. These concepts were reviewed in chapter 2 and thus will not be discussed in this chapter. Some scales are divided into subscales as shown in Table 3.1. The number of items (i.e., 'questions') that students answered is indicated.

Table 3.1 Scales of Vermunt’s (1996) Inventory of learning styles instrument

Domain	Scale	Subscale	Number of items
Processing strategies	Deep processing	Relating and structuring	6
		Critical processing	4
	Stepwise processing	Memorising and rehearsing	6
		Analysing	4
Concrete processing		5	
Regulation strategies	Self regulation	Self regulation of learning processes and results	6
		Self regulation of learning content	4
	External regulation	External regulation of learning processes	5
		External regulation of learning results	5
Lack of regulation		5	
Learning orientations	Personally interested		5
	Certificate-directed		5
	Self-test-directed		5
	Vocation-directed		5
	Ambivalent		5
Mental model of learning	Construction of knowledge		5
		Intake of knowledge	5
	Use of knowledge		5
	Stimulating education		5
	Cooperation		5

The Inventory of Learning Styles (ILS) instrument is divided into two parts (A and B). Part A is concerned with the activities students undertake in the context of their studies. It contains 50 items. Students are required to indicate to what extent they engage in the activity concerned while studying. They rate each item on a five-point Likert-type scale: 1 (“I do this seldom or never”); 2 (“I do this sometimes”); 3 (“I do this regularly”); 4 (“I do this often”), and 5 (I do this almost always”).

Part B of the ILS instrument is subdivided into two parts each consisting of 25 items. One part focuses on students’ study motives and the other on students’ views on studying. The part on study motives is concerned with the motives, objectives and attitudes students have regarding their studies. They rate each item on a five-point Likert-type scale: 1 (“Disagree entirely”); 2 (“Disagree for the most part”); 3 (“Undecided or do not know”); 4 (“Agree for the most part”), and 5 (Agree entirely”). The part focussing on students’ views on studying is concerned with students’ views on learning, good education, cooperation with others, teacher’s tasks, the role of their peers and their own tasks as students. They rate each item on a five-point Likert-type scale as described for the rating of study motives.

3.5 Students' perceptions of blended learning

I constructed an 86-item Online Experience Questionnaire (OEQ) to measure students' perceptions of blended learning focusing specifically on online learning. The items were distributed across 10 scales of the OEQ. The scales were adapted from other questionnaires measuring online learning (Cheung and Huang 2005; Lee and Tsai 2005; Kerr *et al.* 2006; Tsai 2008) and previous literature on blended learning (see Chapter 2). The scales were (1) Relevance; (2) Multiple sources; (3) Challenge; (4) Collaborative learning; (5) Cognitive apprenticeship; (6) Epistemological awareness; (7) Learning goals; (8) Internet experience; (9) Self regulation, and (10) Technical aspects. Seventy-nine closed-ended questions were rated on a five-point Likert-type scale: 1 ("Strongly disagree"); 2 ("Disagree"); 3 ("Neutral"); 4 ("Agree"), and 5 (Strongly agree"). Seven other questions were open-ended or focused on students' demographic information and use of information and communication technologies (Appendix B).

3.6 Data analyses

3.6.1 Students' learning styles

Descriptive statistics for the 16 scales and their subscales used in the ILS were computed. These were the mean and the standard deviation.

3.6.2 Students' perceptions of blended learning

Descriptive statistics were computed for the 10 scales of the OEQ that were constructed *a priori* (see section 3.5).

The mean and standard deviation were computed for each scale. Since a high number of scales were used for the OEQ, it was important to determine whether a smaller number of underlying factors (scales) might explain the variability in students' responses to individual items of the OEQ. I used exploratory factor analysis to assess the dimensionality of students' responses to the initial 84 items of the OEQ using Statistica (StatSoft 2007). The reliability of the scales was assessed using Cronbach's (1951) alpha. The aim of the exploratory factor analysis was to identify a coherent set of scales with minimal cross loadings between latent factors. Principal components were extracted to simplify factor structure. Items with low loadings (<0.65) were eliminated.

Content analysis was used to analyse open-ended questions (Babbie and Mouton 2006). This involved reading students' comments and identifying the major themes. These were coded manually. The number of students who gave similar comments was then tallied.

3.6.3 Relations between learning styles, perceptions of blended learning and course marks

The relationships among learning styles, perceptions of blended learning and final course marks were analysed using correlation analysis. Pearson's product-moment correlation coefficients were calculated between scale scores for the ILS, scale scores of perceptions of blended learning factors identified through exploratory factor analysis, and students' final course marks.

3.6.4 Cluster analysis based on students' learning styles, perceptions of blended learning and final course marks

Cluster analysis was used to identify subgroups of students who varied systematically according to their perceptions of blended learning, learning styles and final course marks. Scores were converted to percentages and a hierarchical cluster analysis was done using Ward's minimum variance method (StatSoft 2007).

Chapter 4. The *Moodle* Learning Management System

4.1 Introduction

This chapter describes how I used the *Moodle* LMS in one of the courses that I teach in the Department of Environmental Science at Rhodes University. I begin by giving an overview of the theoretical framework supporting the design of the Environment Management course for 2006. A description of the course and how I used the *Moodle* LMS concludes the chapter.

4.2 Theoretical framework supporting the learning design I used

The learner is central in teaching and learning practices (Biggs 1999). The specific role of learners in the learning process has been underpinned by three main theories of learning namely behaviourism, cognitivism and constructivism (Bednar *et al.* 1992; Harre, 2006). The behaviourist theory argues that objective knowledge exists outside the learner's mind and thus learning focuses on how objective knowledge can be transferred to the learner. In contrast, the cognitivist theory emphasises the mental processing of information during the learning process. Constructivism differs from these two theories by emphasizing the complex interaction among a learner's existing knowledge, social context and the problem to be solved (Tam 2000). Delgarno (2001) has argued that shifts in psychological and pedagogical theory have resulted in moves towards a constructivist view of learning in recent years.

Despite the increased recognition of the importance of constructivism in learning (McInerney and McInerney 2006), there have been major difficulties in translating this epistemological philosophy into learning design (Tam, 2000; Moallem 2001; Karagiorgi and Symeou 2005). Jonassen *et al.* (1993 cited by Moallem, 2001) and Dalgarno's (2001) models can be used for learning designs that embrace a constructivist epistemological theory.

Jonassen *et al.*'s (1993) continuum of knowledge acquisition model argues for a combination of objectivist and constructivist epistemological views in learning design. Briefly, the model recognises that knowledge ranges from ignorance to expertise. This continuum of knowledge is associated with three learning phases namely introductory, advanced and expert. The phases are in turn associated with the traditional learning design model based on the simple objectivist model of learning for the introductory learning phase and the complex constructivist model of learning for the expert learning phase.

Dalgarno's (2001) typologies of constructivism can be associated with a learning design that focuses on the active participation of the learner in the learning process (Figure 4.1). Briefly, he argues that

constructivism is based on three key principles. First, each person forms their own representation of knowledge by building on individual experiences and thus there is no single correct representation of knowledge. Second, people learn through active exploration and learning occurs when a learner's exploration uncovers inconsistencies between their current knowledge representation and their experience. And third, learning occurs within a social context that requires interaction between learners and their peers during the learning process.

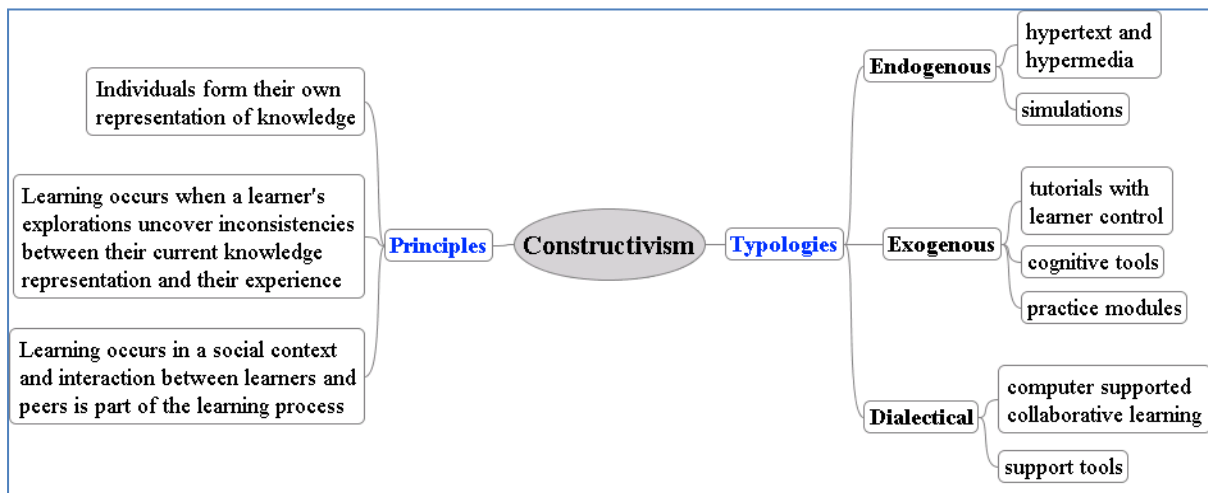


Figure 4.1 Typologies of constructivism (Adapted from Dalgarno 2001)

Dalgarno (2001) uses Moshman's (1982) types of constructivism to highlight its implications for learning design. The endogenous view of constructivism stresses the key role of the learner in knowledge construction as highlighted by the first and second principles of constructivism. He states that use of hypermedia and simulations support this view of constructivism. The exogenous view of constructivism acknowledges the importance of direct instruction but focuses on student-centred learning with learners having some choice of the sequence and choice of learning content. Learning materials that support the exogenous view include tutorials with learner control, cognitive tools (e.g., concept maps, modelling software) and practice modules (e.g., multiple choice questions, quizzes). The dialectical view of constructivism emphasises the importance of social interaction in knowledge construction. Cooperative and collaborative learning strategies are therefore crucial for dialectical constructivism. Computer assisted collaborative learning using tools such as forum discussions and email can be used to promote this view of constructivism (Schellens and Valcke 2006; Moreno *et al.* 2007; Woo and Reeves 2007).

I used a mixed instruction design model for the Environmental Management 302 course in 2006. The model was based on both the objectivist and constructivist epistemological theories. The model was informed by the continuum of knowledge acquisition model (Jonassen *et al.* 1993) and Dalgarno's

(2001) typologies of constructivism that discuss a practical way of applying the constructivist epistemological theory.

4.3 Course description

4.3.1 Overview of the course

The overview of the course is given in Chapter 3. Here I will give an overview of the learning outcomes of the course.

4.3.2 Learning outcomes

The course was expected to contribute to eight critical cross-field outcomes that graduates were expected to be able to accomplish (Boughey 2004). By the end of their degree, learners were expected to be able to:

1. identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made;
2. work effectively with others as a member of a team, group, organisation, community;
3. organize and manage oneself and one's activities responsibly and effectively;
4. collect, analyze, organize and critically evaluate information;
5. communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written persuasion;
6. use science and technology effectively and critically, showing responsibility towards the environment and health of others;
7. demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation, and
8. reflect on and explore effective learning strategies.

The Environmental Management course also had specific learning outcomes. By the end of the course learners were expected to be able to demonstrate:

1. a critical understanding of a range of environmental management approaches;
2. an ability to differentiate between various environmental management tools;

3. an understanding of the application of environmental management approaches;
4. an appreciation of the spatial and temporal complexity of each management issue;
5. a comprehension of the discipline terminology associated with each issue;
6. an appreciation of the role of different disciplines in addressing environmental issues;
7. a critical approach that appraises current dogma and popularist projections;
8. an ability to conduct self study and synthesis of relevant information, and
9. an ability to communicate (verbally and in writing) results and understanding related to issues of environmental management.

4.3.3 Teaching and learning methods

The teaching and learning methods consisted of formal lectures, problem-based learning and practicals. Learners were expected to interact with each other using the discussion forum in the *Moodle* LMS.

An attendance register was circulated at each lecture. Whilst lectures were not compulsory, students were strongly encouraged to attend lectures in order to obtain the maximum benefits from the course, and to meet the course outcomes. Students were informed that records of attendance would be consulted in situations where students were borderline cases or in instances where appeals and value judgements needed to be made.

4.3.4 Assessment of learning

Individual and group assignments were used for the summative assessment of student learning as described in Chapter 3. Students were also required to: (a) keep journals in *Moodle* and (b) contribute to online discussions in *Moodle*. Journal entries consisted of reflections on a student's learning. The journal entries and contributions to discussions were assessed. Students assessed the contribution of their peers to online discussions (Appendix A).

4.4 The learning design I used for my course

As stated above, a mixed learning design informed by objectivist and constructivist epistemological models was used. The traditional learning design model is based on an objectivist ontology and epistemology. It requires an analysis of the conditions that influence instruction such as content, the

learner's prior knowledge, expected learning outcomes, learning strategies, assessment strategies and techniques, and evaluation (Moallem 2001). The key design principles in the constructivist model include (Moallem 2001):

1. creating real world environments that provide a relevant context for learning;
2. focussing on realistic approaches to solving real-world problems;
3. an instructor acting as a mentor when solving problems;
4. stressing conceptual interrelatedness, providing multiple representations or perspectives on the content;
5. learning goals and objectives should be negotiated and not imposed;
6. evaluation should serve as a self-analysis tool;
7. providing tools and environments that help learners interpret the multiple perspectives of the world, and
8. learning should be internally controlled and mediated by the learner.

It is clear that there are some tensions between the objectivist and constructivist models. For example, the pre-specification of learning outcomes in the traditional learning design model is incompatible with the constructivist model because learning is constructed by the learner based on personal experience and negotiations with other learners. Nevertheless, both models can be applied within a course as explained by Jonassen *et al.*'s (1993) continuum of knowledge acquisition model.

4.5 The Moodle learning management system

4.5.1 Definition and philosophy underlying Moodle

Moodle is an acronym for 'Modular Object-Oriented Dynamic Learning Environment' (Cole, 2005: <http://moodle.org/>). It is an open-source e-learning software that is increasingly used in many countries as evidenced by the more than 50 language packs that have been developed. It is stated that *Moodle* is guided by social constructivist pedagogy (Cole, 2005). The sections below give a brief overview of the screen shots and some of the learning tools that are available in *Moodle*.

4.5.2 Moodle login screen

When a user logs on to the *Moodle* website, a username name and password are required to access a given course (Figure 4.2). First-time users will be required to type in an “enrolment key”. This is a security measure that restricts access to a course to only registered users.



Figure 4.2 Login screen shot in Moodle

This screen page is where a user selects a course category. The number after the course category indicates the number of courses in that category. For example, there are five courses under Botany and 19 courses under Environmental Science. Clicking on the relevant course category displays a list of courses in that category. Users can then select a course of their interest.

4.5.3 Course screen in Moodle

4.5.3.1 Lecturer view

Clicking on a course if one is registered as a lecturer will provide a screen shot as shown in Figure 4.3. The left part of the screen shows the course settings. These include the list of all registered participants, learning activities, and administrative controls. The central part of the screen shows the course content. This shows that the course has been set up in topic format. The alternative is a weekly format. I used the topic format to enable learners to see at a glance the themes that would be covered in the course. This would assist learners in constructing their own learning. A summary of the course and the various topics and learning resources are also shown. The controls for editing, deleting, moving and hiding topics are also shown. The right side of the screen highlights the latest news, upcoming events, recent activities and a calendar. I used these features to remind students about the deliverables and news about the course.

4.5.3.2 Student view

The screen shot of what a student sees (Figure 4.4) is similar to that of a lecturer. However, the major difference is that students cannot change course settings and content. The important point about this screen is that major course events can be displayed on the calendar. The calendar and the list of upcoming events remind students about key course events and deadlines for assignments.

The screenshot displays the Moodle interface for a lecturer. At the top, the course title is "Env 302: Management Concepts and Methods (2006)". The user is logged in as James Gambiza. The interface is divided into several sections:

- Left Sidebar:** Contains navigation menus for "People" (Participants), "Activities" (Assignments, Forums, Glossaries, Questionnaires, Resources), "Search Forums" (Advanced search), "Administration" (Turn editing off, Settings, Edit profile, Teachers, Students, Groups, Backup, Restore, Import, Reset, Reports, Questions, Scales, Grades, Files, Help, Teacher forum), and "My courses".
- Topic outline:** The main content area, titled "Course Summary", describes the course structure. It lists three topics:
 - 1 Introduction**: Includes "Env 302 Course Outline 2006" and "Env 302 Class List 2006.xls".
 - 2 Integrated Pollution and Waste Management**: Includes lectures from "Lecture 1_IPWM Introduction" to "Lecture 9_J Bay case study".
 - 3 Environmental Policies**
- Right Sidebar:** Contains "Latest News" (Add a new topic..., 21 Jul, 16:27, James Gambiza, Welcome more..., Older topics...), "Upcoming Events" (There are no upcoming events, Go to calendar..., New Event...), "Recent Activity", "Calendar", and "Blocks".

Callout boxes highlight "Course content" pointing to the Topic outline and "Course news and events" pointing to the Latest News section.

Figure 4.3 Lecturer view screen in Moodle

4.5.3.3 Participant screen

The screen view for participants indicates the list of students who were enrolled for the course. For example 32 students were enrolled for the Environmental Management Concepts and Methods course in 2006 (Figure 4.5). The screen can be made “alive” if students upload their photos on the course web-page.

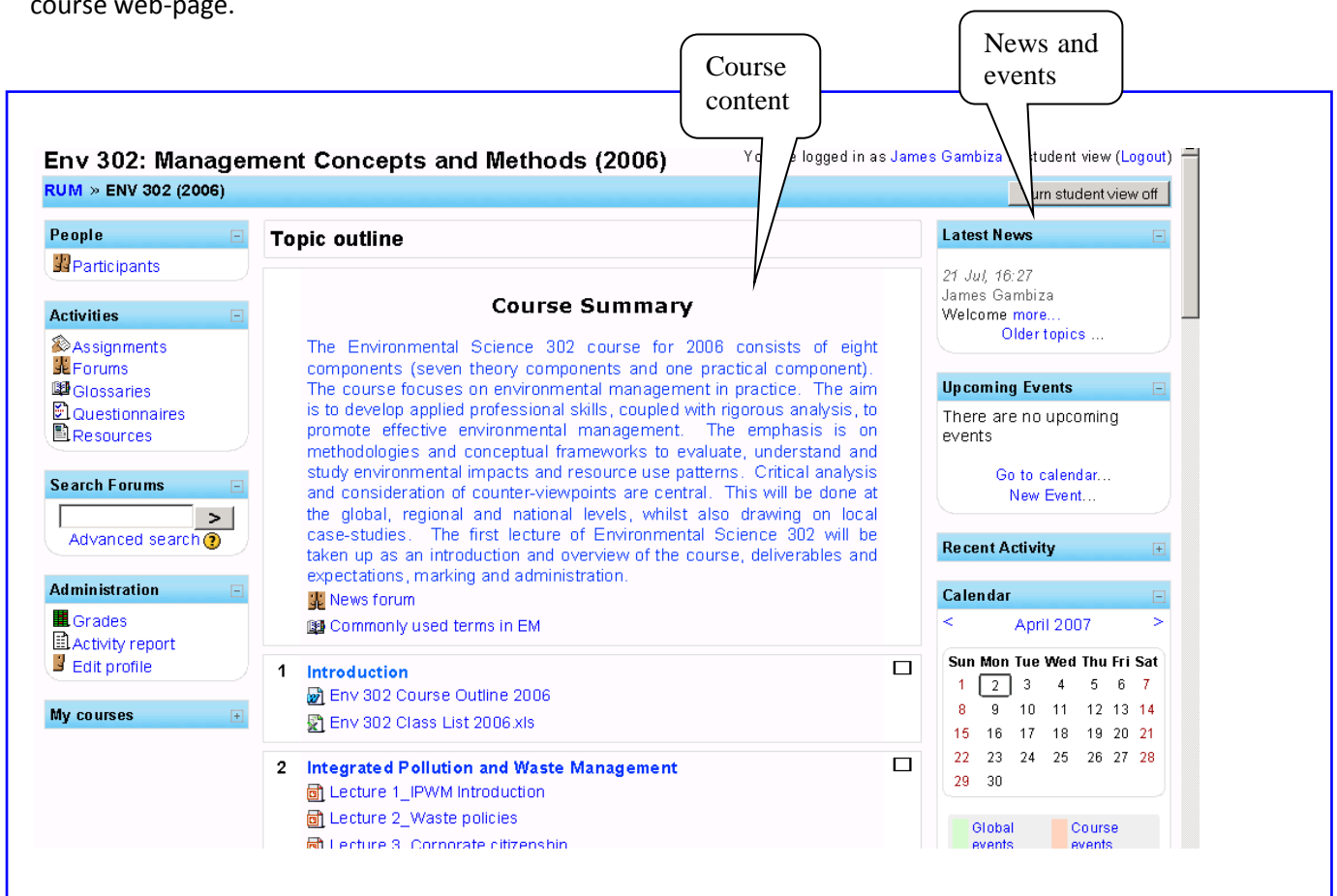


Figure 4.4 Student view screen

The participant screen is also crucial for monitoring students’ visits to the course web-page. It can show at a glance when students last visited the course website. Furthermore, by clicking on a student’s name, the lecturer can find out the number of times a student visited the website. Information about the topics that a student viewed and the time a student spent viewing a particular topic or resource is also given. This screen therefore provides vital information about a student’s actions. It provides the lecturer with an insight into how the student learns in a given course. The ability of *Moodle* to track students’ actions can help lecturers understand how students learn.

RUM » ENV 302 (2006) » Participants

Env 302: Management Concepts and Methods (2006)

Participants | Blogs

My courses: ENV 302 (2006) | Visible groups: All participants | Show users who have been inactive for more than: Select period | User list: Less detailed

Teachers

First name / Surname	City/town	Country	Last access ↑	Select
James Gambiza	Grahamstown	South Africa	now	<input type="checkbox"/>
	Grahamstown	South Africa	142 days 20 hours	<input type="checkbox"/>

32 Students

(Accounts unused for more than 365 days are automatically unenrolled)

First name / Surname	City/town	Country	Last access ↑	Select
	Grahamstown	South Africa	25 days 22 hours	<input type="checkbox"/>
	Grahamstown	South Africa	47 days 4 hours	<input type="checkbox"/>

Figure 4.5 Participant screen view

4.6 Learning management features that I used

A key tool for managing a course in *Moodle* is “adding a resource” (Figure 4.6). I used mostly “compose a text page” and “link to a file or web-site” features. Linking the course web page to important websites supports the principle of autonomous learning as espoused in the constructivist epistemology. Figure 4.7 shows some of the resources that were available for learners.

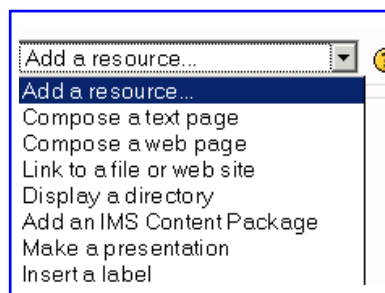


Figure 4.6 Screen view of course management features

Topic	Name	Summary
1	Env 302 Course Outline 2006	Outlines the modules and assessment tasks.
	Env 302 Class List 2006.xls	Class list
2	Lecture 1_IPWM Introduction	Introduction to module on integrated pollution and waste management.
	Lecture 2_Waste policies	Waste policies
	Lecture 3_Corporate citizenship	.
	Lecture 4_EMS Introduction	.
	Lecture 5_Waste minimisation	.
	Lecture 6_TA Intro	.
	Lecture 7_TA 2	.
	Lecture 9_J Bay case study	.
3	Overseas Development Institute	Rich source of policy briefs related to the environments.
	Institute of Development Studies	Rich source of policy briefs focusing on development.
	Global Environmental Outlook	Gives information on environment focus on the global scale.
	Sustainable Livelihoods Approach	Important papers on concept of sustainable livelihoods its implications for policy-making and development.
	Lecture 1_Introduction to policy analysis.ppt	Introduces concept of policy, institutions and processes.
	Lecture 2 Key players and issues.ppt	Discusses the different stakeholders and issues to consider

Figure 4.7 Screen view of some of the resources that were available to learners

The “add activity” tool in *Moodle* is crucial for learning (Figure 4.8). I used the “assignment”, “forum”, “glossary”, “journal” and “survey” features. These activities are important for active learning, interacting with peers, reflecting on learning, and for course evaluation. For example, the journal, assignment and forum activities are crucial for endogenous, exogenous and dialectical types of constructivist learning, respectively (Dalgarno, 2001).

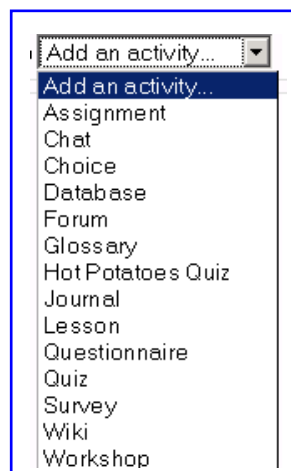


Figure 4.8 Screen view of activities in Moodle

Examples of screen shots for the assignment, forum discussion, glossary and survey features are shown in Figures 4.9 – 4. 12. At a glance, the lecturer can see how many students have submitted assignments. There is also an option to grade assignments online or to provide formative feedback that is crucial for learning.

Forums are an important component of *Moodle*. The news forum is for communicating with students. The discussion forums allow students to interact with their peers either individually or as groups. One of the key principles of constructivism stresses that learning occurs in a social context and requires interaction among learners (Dalgarno 2001).

Surveys are important tools that can be used for evaluating a course or for research purposes. I used the survey tool in *Moodle* to gather data about students’ perceptions of blended learning.

Topic	Name	Assignment type	Due date	Submitted	Grade
3	Reflecting on group work and peer evaluation	Online text	Thursday, 17 August 2006, 03:05 PM	View 28 submitted assignments	-
4	Reflections on Big Corporations and PNRM	Online text	Friday, 1 September 2006, 02:00 PM	View 25 submitted assignments	-

Figure 4.9 Screen view of assignments

Env 302: Management Concepts and Methods (2006) Jump to...

RUM » ENV 302 (2006) » Forums Search forums ?

Subscribe to all forums
Unsubscribe from all forums

General forums

Forum	Description	Discussions	Subscribed
News forum	General news and announcements	1	Yes
Teacher forum	A forum for teacher-only notes and discussion	0	No

Learning forums

Forum	Description	Discussions	Subscribed
3 Forum Discussion 1: Global Environmental Policies	Discuss the effectiveness of global environmental policies in addressing environmental problems. Support your arguments using at least three scientific articles. [Maximum length: 500 words excluding references.]	6	Yes
7 Ethics	Is it ethical to produce genetically modified crops for human consumption? Support your arguments using at least three scientific references. Your written	7	Yes

Figure 4.10 Screen view of discussion forums

Env 302: Management Concepts and Methods (2006) Jump to...

RUM » ENV 302 (2006) » Glossaries

Topic	Name	Entries
	Commonly used terms in EM	1

Figure 4.11 Screen view of a glossary

Env 302: Management Concepts and Methods (2006) Jump to...

RUM » ENV 302 (2006) » Questionnaires

Name	Summary	Type
Inventory of Learning Styles	To add background stuff	template
MEd Questionnaire Template	Investigates students' experiences of online learning.	template
Inventory of Learning Styles_MEd study	The inventory of learning styles was developed to gain clearer insight into how students go about their studies and how they perceive their own learning. The inventory consists of a list of statements on study strategies, motives and attitudes. The survey forms part of my Masters in Education (MEd) degree study. Participation in the survey is OPTIONAL. Any information obtained during the study will be treated in strict confidence. I sincerely thank you for assisting me in my study.	private
Survey of Moodle and Internet_MEd study	This is a survey of students' experiences in using Moodle and the Internet for learning. The survey will help me gain a clearer insight into students' experiences of online learning and forms part of my Masters in Education	private

Figure 4.12 Screen view of surveys

4.7 Challenges in using the *Moodle* learning management system

There were important challenges in using the *Moodle* LMS to promote blended learning. These will be addressed in the next chapter on findings of the study.

4.8 Conclusions

The *Moodle* LMS is a useful tool that can be used to offer students opportunities for learning, based on the socio-constructivist learning theory. It is also useful for reaching students who for one reason or another tend to skip lectures.

Chapter 5. Findings

5.1 Use of information and communication technologies for learning

About 91% of students owned computers. They had been using computers for about 10 years (standard deviation = 2.8). Fifty per cent of the students had access to Internet at home or in their residences. Internet and email were the most used tools for learning (Table 5.1). Students also used the short message service about four times a week for learning. There was wide variation in the use of a given tool. Use of the Internet had the lowest coefficient of variation (67%) while telephones had the highest variation (102%).

Table 5.1 Descriptive statistics of weekly use of information and communication technologies for learning purposes

Tool	Mean number of times used	Standard deviation	Coefficient of variation (%)
Internet	6.6	4.49	67.6
Email	6.0	4.25	70.3
Short message service	4.2	3.07	72.6
Telephone	2.4	2.40	101.6

Students used the *Moodle* learning management tool for learning. Perceptions of their use of Moodle differed widely from their actual use of the tool - which was automatically recorded whenever learners logged-in. All but two learners under-estimated their frequency of use of *Moodle* (Figure 5.1). Two learners over-estimated the number of times they had used *Moodle*.

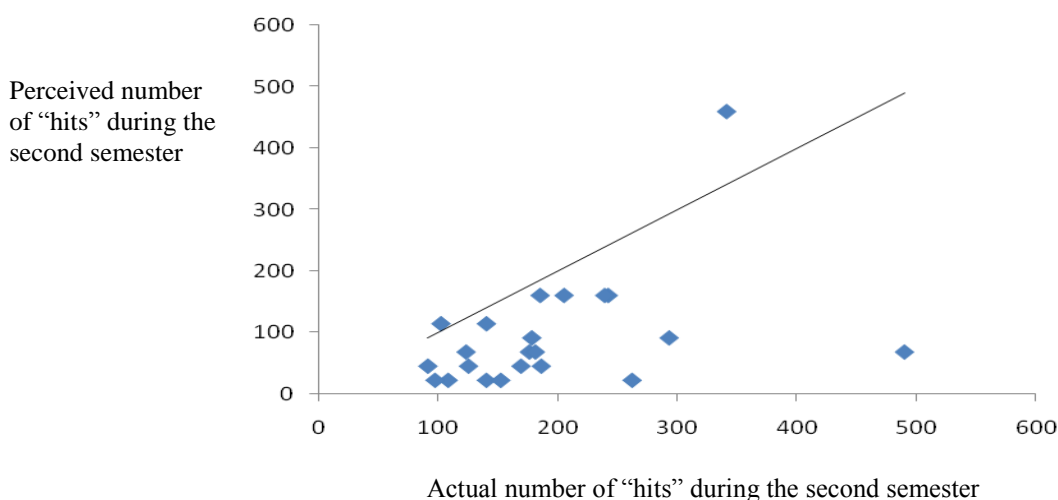


Figure 5.1 The relation between the actual and perceived numbers of times (“hits”) students logged into the Moodle learning management system during the second semester in 2006. The diagonal is the equality line. Points above the diagonal are over-estimates while those below are under-estimates. Sample size was 22

Estimates of the proportion of lectures that should be offered online rather than face-to-face varied widely among students (Table 5.2). Fifty per cent of the students wanted more than 75% of their lectures to be offered online. In contrast, about 32% of the students wanted the proportion of online lectures not to exceed 10%.

Table 5.2 Estimated proportions of lectures that should be offered online rather than face-to-face in a blended learning environment

Proportion of lectures that should be offered online (%)	Frequency (count)	Frequency (%)
0	3	13.6
1 – 10	4	18.2
11 – 25	1	4.5
26 – 50	1	4.5
51 – 75	2	9.1
>75	11	50.0

5.2 Students' learning styles

Students scored lowest on analytic and deep processing strategies (Table 5.3). They scored highest on concrete processing cognitive strategies (67%). The score for the memorising and rehearsing processing strategy was slightly lower. Students varied widely in their cognitive processing strategies. The coefficient of variation of the scores ranged from about 19% for concrete processing to 27% for memorising and rehearsing strategies.

Table 5.3 Descriptive statistics of students' cognitive processing strategies. Sample size was 26

Scale	Subscale ¹	Mean score	SD	Mean as a proportion of maximum score (%)	CV (%)
Deep processing	Relating and structuring	17.8	4.41	59.3	24.8
	Critical processing	11.7	3.02	58.5	25.8
Stepwise processing	Memorising and rehearsing	16.5	4.39	66.0	26.6
	Analysing	13.7	3.41	54.8	24.9
Concrete processing		16.7	3.20	66.8	19.2

¹A blank in this column indicates that there are no subscales. SD = standard deviation; CV = coefficient of variation

Scores for the regulation strategies varied widely both among and within the strategies (Table 5.4). External regulation of learning processes had the lowest score (52%) and external regulation of learning results had the highest (63%). The score for lack of regulation was 53%. The coefficient of variation of scores ranged between about 19% for self regulation of learning content and 29% for external regulation of learning processes.

Table 5.4 Descriptive statistics of students' regulation strategies. Sample size was 26

Scale	Subscale ¹	Mean score	SD	Mean as a proportion of maximum score (%)	CV (%)
Self regulation	Self regulation of learning processes and results	17.0	4.20	56.7	24.7
	Self regulation of learning content	12.0	2.27	60.0	18.9
External regulation	External regulation of learning processes	13.0	3.71	52.0	28.5
	External regulation of learning results	15.7	3.41	62.8	21.7
Lack of regulation		13.3	3.68	53.2	27.7

¹A blank in this column indicates that there are no subscales. SD and CV are as defined for Table 5.3

Scores varied widely both among and within learning orientations (Table 5.5). Learning for a vocation had the highest score (86%) while the score for ambivalence was lowest (46%). Scores for certificate-directed and personally interested goals were intermediate. The coefficient of variation of scores ranged from 11% for the vocation-directed to 27% for the ambivalent learning goals.

Table 5.5 Descriptive statistics of students' learning goals. Sample size was 26

Scale	Mean score	SD	Mean as a proportion of maximum score (%)	CV (%)
Vocation-directed	21.5	2.42	86.0	11.3
Self-test-directed	18.8	4.54	75.2	24.2
Certificate-directed	16.2	3.81	64.8	23.5
Personally interested	15.5	2.52	62.0	16.3
Ambivalent	11.5	3.12	46.0	27.1

SD and CV are as defined for Table 5.3

The scores varied greatly both among and within mental models of learning (Table 5.6). Use of knowledge had the highest score (83%) while cooperative learning had the lowest score (56%). The scores for the other scales of models of learning were generally similar (72-76%). The coefficient of variation of scores ranged between about 13% and 35%.

Table 5.6 Descriptive statistics of students' mental models of learning. Sample size was 26

Scale	Mean score	SD	Mean as a proportion of maximum score (%)	CV (%)
Use of knowledge	20.8	2.66	83.2	12.8
Intake of knowledge	19.0	2.85	76.0	15.0
Construction of knowledge	18.6	2.58	74.4	13.9
Stimulating education	17.9	4.06	71.6	22.7
Cooperation	14.0	4.87	56.0	34.8

SD and CV are as defined for Table 5.3

Three clusters of students were identified based on the scales of learning styles (Figure 5.2). The clusters differed significantly in all scales except for seven scales and course marks (Table 5.7). The non-significant scales were lack of regulation, personal interest, certificate-directed, vocation-directed, ambivalent, construction of knowledge, and intake of knowledge scales.

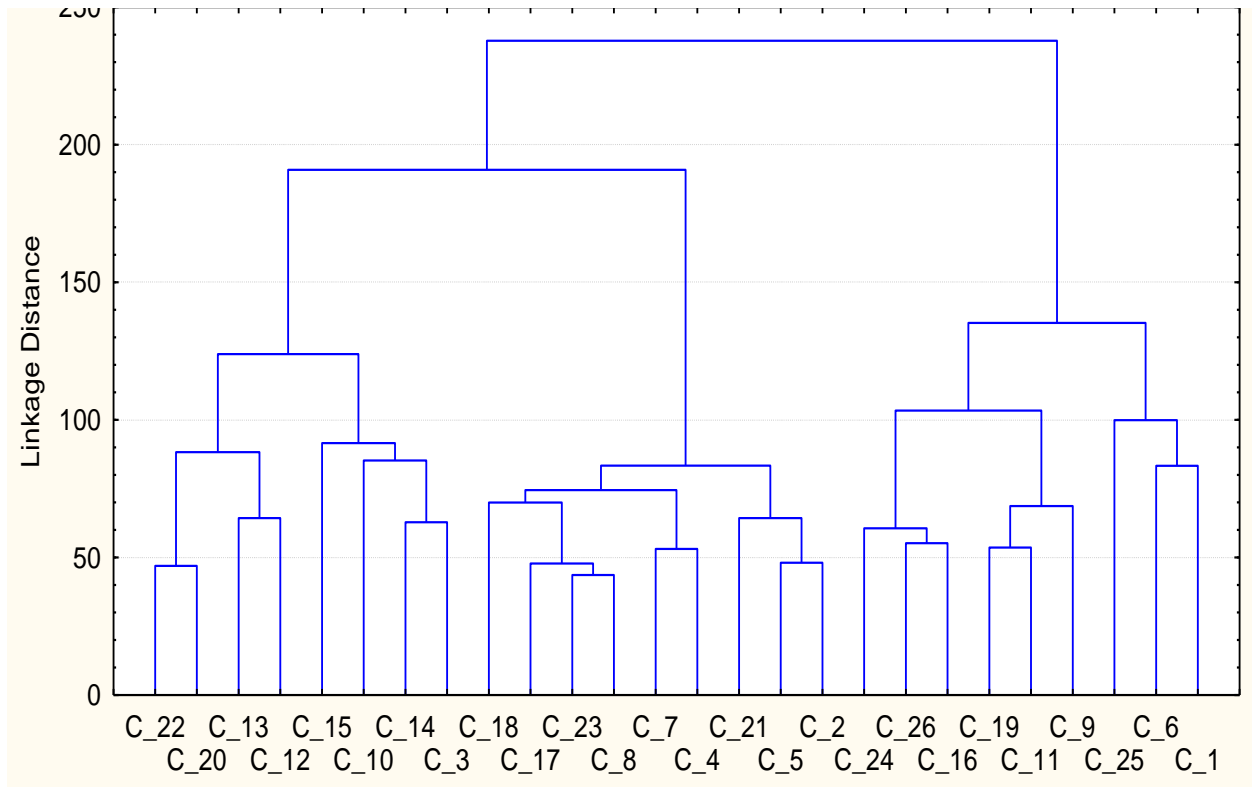


Figure 5.2 Dendrogram showing clusters of students based on 20 scales of Vermunt's (1996) Inventory of Learning Styles. The x-axis labels (C_1 to C_26) refer to codes for the students. The linkage distances are Euclidean

Students in cluster 1 scored highest in all scales except for the self-directed, stimulating education and cooperative learning scales that had intermediate scores. About 35% of the students were placed in cluster 1. In contrast, students in cluster 2 had intermediate scores for all scales except for two that were lowest (memorising and rehearsing, and analysing) and another two that were highest (stimulating education and cooperative learning). Most students (46%) were in cluster 2. Cluster 3 consisted of students who scored lowest in all variables except for the memorising and rehearsing, and analysing scales that were intermediate.

Table 5.7 Descriptive statistics of clusters of students based on Vermunt's (1996) scales of learning styles

	Mean	SD	Mean	SD	Mean	SD
Relating and structuring**	72.2	10.80	53.3	11.89	50.7	9.83
Critical processing**	72.8	11.49	52.9	13.22	50.0	10.00
Memorising and rehearsing**	78.2	12.67	58.0	8.27	60.8	28.34
Analysing**	67.1	12.13	47.3	9.62	50.4	6.07
Concrete processing**	76.4	7.86	64.3	11.50	56.8	12.13
Self regulation of learning processes**	64.4	14.24	56.9	9.79	42.7	11.16
Self regulation of learning content**	68.3	9.35	59.6	8.11	47.0	7.58
External regulation of learning processes**	67.1	12.45	44.3	7.71	42.4	6.69
External regulation of learning results**	74.2	11.33	56.7	10.90	57.6	10.04
Lack of regulation	56.4	19.02	56.3	7.90	40.0	11.66
Personal interest	61.8	8.97	60.7	12.97	63.2	5.22
Certificate-directed	69.3	18.22	67.3	12.40	53.6	10.81
Self-test-directed**	80.0	14.28	81.0	14.38	53.6	16.40
Vocation-directed	86.7	10.20	86.0	8.94	85.6	11.52
Ambivalent	42.7	15.75	51.3	7.40	39.2	11.10
Construction of knowledge	75.1	7.69	75.3	10.35	68.0	14.14
Intake of knowledge	77.3	14.42	76.3	8.94	71.2	12.13
Use of knowledge*	87.1	7.94	84.7	9.16	72.0	11.66
Stimulating education*	69.8	20.41	78.3	8.61	58.4	13.45
Cooperative learning**	53.8	21.83	66.7	13.47	37.6	10.81
Course marks	64.2	5.04	61.6	8.96	70.6	7.80

Marked scales differ significantly among clusters (* = $p < 0.05$; ** = $p < 0.01$).

5.3 Students' perceptions of the online learning component of blended learning

Students' perceptions of the online learning environment varied among scales (Table 5.8). Students perceived the online learning environment as not challenging with a score of only 46%. In contrast, most students felt they had adequate Internet experience (84%). Most learners also felt the Internet supported their goals for learning (82%), provided multiple sources of information (79%), and was relevant for their learning (75%). Furthermore, the scores for the other scales were also high.

Table 5.8 Descriptive statistics of students' perceptions of the online component of blended learning based on a priori scales. Sample size was 22

Scale	Mean score	SD	Mean as a proportion of maximum score (%)	CV (%)
Internet experience	21.0	2.89	84.0	13.8
Learning goals	24.6	2.68	82.0	10.9
Multiple sources	43.3	4.74	78.7	10.9
Relevance	41.1	4.44	74.7	10.8
Epistemological judgements	46.4	6.53	71.4	14.1
Cognitive apprenticeship	10.5	1.29	70.0	12.3
Technical aspects	13.7	2.67	68.5	19.5
Self regulation of learning	19.7	2.94	65.7	14.9
Cooperative learning	44.8	8.98	64.0	20.0
Challenging	16.2	4.11	46.3	25.4

Despite the generally high scores for the scales measuring students' perceptions of the online learning environment, there was high variability in students' scores within a given scale. The coefficient of variation ranged from about 11% for the scales measuring learning goals, multiple sources and relevance to about 25% for the challenging scale.

Students also highlighted what they liked and disliked with both online learning and group work (Table 5.9). Most learners liked using the Internet because of: a wide range of topics and information (55%), ease of accessibility (45%), and convenience (36%), ease of use (18%), up-to-date course information (18%) and student interaction (14%). In contrast, most learners disliked using Internet for learning due to the poor quality of some of the information (45%). Some learners also felt lack of access (18%) and technical issues were also problems they faced when using Internet. Fifty per cent of learners did not answer the question whether they disliked Internet for learning (i.e., left it blank). Only 18% of the learners left the question on whether they liked Internet for learning blank.

Most learners liked group work for three main reasons. These were: gaining different perspectives of an issue (45%); sharing work (27%) and developing their interpersonal skills (18%). In contrast, 23% percent did not answer the question why they liked group work. Students also gave three reasons why they disliked group work. These were: high transaction costs (36%), "passengers" (23%) and the course being ruined if one was in a bad group (5%). However, 45% of the students did not answer the question why they do not like group work (i.e., left it blank).

Table 5.9 What students liked and disliked with online learning and group work. Sample size was 22. freq = frequency. Frequencies add to more than 22 because each respondent was allowed to provide multiple responses

What I liked	freq	Example statement	What I disliked	freq	Example statement
Online learning					
Wide range of topics and information	12	“Online academic databases – journals!”	Quality of information	10	“The amount of junk to sort through.”
Easily accessible	10	“Easily accessible”	Lack of access	4	“Not all have internet → labs often full!! Enviro ¹ has no computers of their own!”
Convenience	8	“You can read and learn at your own pace”	Technical issues	3	“Sometimes it is difficult to get in – because it’s a computer.”
Ease of use	4	“Ease of use”	Fixed discussion topics and long-winded discussions	2	“Fixed discussion topics”
Up-to-date course information	4	“One gets to know about what needs to be done at any time of the day”	Daily access	1	“Need to access Internet daily”
Student interaction	3	“Discursive learning”	Over reliance of some departments on online learning	1	“Over reliance of some departments on online learning (i.e., replacing lecturers with online readings.”
Interesting	1	“Interesting”	Being monitored	1	Lecturers can monitor what we look at
Lecture notes	1	“Lecture notes”	Email	1	“Time-wasting email”
Independence	1	“Independence”	Plagiarism	1	“Potential for plagiarism is high.”
Submitting assignments online	1	“Being able to submit assignments online”	Use of quota	1	“Due to Rhodes use of quotas (which is due to the unreasonable cost of Internet in South Africa) the availability of multimedia learning tools can be greatly diminished, at times the slow speed of the connection can also inhibit the use of multimedia for coursework but this is due to government incompetence (sic) in the field of telecommunications.”
Community of inquiry	1	“Communication with peers and experts is enabled.”	Blank	11	
Blank	4				
Group work					
Gain different perspectives	10	“There are more ideas which result in a better product.”	Transaction costs	10	“Sometimes it takes long to do simple things.”
Shared work	6	“Work can be shared”	Passengers	5	“If the group is composed of slackers then it doesn’t work as inevitably either one person gets left with the work or one person who wants to achieve is held back by the group.”
Interpersonal skills developed	4	“Being placed outside my comfort zone; getting to know other people.”	Group can ruin one’s work	1	“If stuck with a bad group it can ruin the course.”
Blanks	5		Blanks	10	

¹Enviro is the acronym students use when referring to the Department of Environmental Science

5.4 Factor structure for the online experience questionnaire items

A set of 30 items was identified from the initial set of 79 items that were used in the Online Experience Questionnaire (OEQ). These items were spread across seven factors (Table 5.10). The factors were: (1) epistemological judgements; (2) multiple sources; (3) learning goals; (4) relevance;

(5) Internet experience; (6) appropriate tool, and (7) student interaction. The first five factors were identified *a priori* while the last two were new scales.

Five scales that had been identified *a priori* were eliminated since they had items with low loadings (< 0.65) on the factors that were extracted. The scales that were eliminated were cognitive apprenticeship; technical aspects; self-regulation of learning; cooperative learning, and challenging.

Table 5.10 Factor structure for the Online Experience Questionnaire items

Item	Factor						
	Student interaction	Learning goals	Relevance	Internet experience	Multiple sources	Appropriate tool	Epistemological judgements
Q50	0.872						
Q75	0.871						
Q45	0.820						
Q74	0.796						
Q12	0.794						
Q43	0.780						
Q27	0.757						
Q77	0.747						
Q39		0.785					
Q29		0.758					
Q30		0.704					
Q60			0.798				
Q64			0.788				
Q26			0.749				
Q58			0.671				
Q81				0.820			
Q16				0.718			
Q01					0.838		
Q82					0.826		
Q25					0.751		
Q49					0.729		
Q35					0.697		
Q02					0.671		
Q28						0.884	
Q61						0.762	
Q40						0.675	
Q08							0.814
Q09							0.753
Q19							0.710
Q80							0.663

The description of each item is given in Appendix B. Items 25 and 58 were reverse scored.

5.5 Relationship between learning styles and perceptions of online learning component of blended learning

The reliability of the scales for the OEQ was high and Cronbach's alpha ranged between 0.712 for the Internet experience scale and 0.934 for the student interaction scale (Table 5.11). The reliability of the remaining scales had alpha values generally around 0.8.

There were positive correlations among scales measuring perceptions of online learning. The scale of learning goals was positively correlated with the Internet experience ($r = 0.46$) and multiple sources of information ($r = 0.53$) scales. Internet experience was also positively correlated with the perception of Internet enabling learners to make epistemological judgements ($r = 0.48$).

There were significant correlations between scales measuring perceptions of online learning and those measuring learning styles. The perception of the Internet as supporting learning goals was correlated with cognitive processing strategies (analysing ($r = 0.62$) and concrete processing ($r = 0.56$)), external regulation of learning results ($r = 0.45$), self-test-directed learning orientation ($r = 0.57$), and the use of knowledge ($r = 0.45$) conception of learning. The perception of the relevance of online learning scale was negatively correlated with the vocation-directed learning orientation ($r = -0.48$). The perception of multiple sources of information scale was positively correlated with construction of knowledge ($r = 0.48$) and negatively correlated with cooperative learning ($r = -0.46$) conceptions of learning. The perception of the Internet as an appropriate tool was correlated with the personal interest learning goal ($r = 0.48$) and intake of knowledge ($r = 0.56$). The perception of the Internet as supporting epistemological judgements was positively correlated with the relating and structuring ($r = 0.58$), and memorising and rehearsing ($r = 0.46$) cognitive processing strategies, external regulation of learning results ($r = 0.68$) and intake of knowledge ($r = 0.44$). There were nearly significant correlations between epistemological judgement and analysis ($r = 0.43$) and external regulation of learning processes scales ($r = 0.42$).

Final course marks were negatively correlated with lack of regulation (-0.48) and cooperative learning ($r = -0.46$). Final course marks were significantly positively correlated with the Internet experience scale only ($r = 0.47$).

Table 5.11 Pearson product-moment correlations between scale scores for students' perceptions of online learning, scores for learning styles and final course mark

Scale ¹	StuInt	LeaGoa	Relevance	IntExp	MulSou	AppToo	EpiJud	Marks
StuInt ($\alpha = 0.934$)	1.00							
LeaGoa ($\alpha = 0.790$)	0.128	1.00						
Relevance ($\alpha = 0.771$)	0.211	0.082	1.00					
IntExp ($\alpha = 0.712$)	-0.026	0.458*	0.271	1.00				
MulSou ($\alpha = 0.873$)	0.116	0.525*	0.156	0.415	1.00			
AppToo ($\alpha = 0.811$)	0.392	0.102	-0.003	0.063	0.066	1.00		
EpiJud ($\alpha = 0.804$)	0.293	0.240	0.310	0.482*	0.346	0.191	1.00	
Marks	-0.099	0.221	0.029	0.468*	0.377	-0.119	-0.129	1.00
RelStr	0.237	0.182	0.328	0.020	0.174	0.037	0.577**	-0.086
CritPro	-0.190	0.148	0.019	0.010	0.063	-0.356	0.290	-0.053
Memreh	0.088	0.139	0.117	0.025	-0.069	0.085	0.466*	-0.333
Analysing	0.197	0.615**	0.053	0.169	0.360	0.224	0.426	-0.266
ConcPro	-0.136	0.559**	-0.322	0.042	0.114	-0.169	0.033	0.037
SrLpro	-0.091	0.398	0.166	-0.184	-0.021	-0.100	-0.026	-0.120
SrLcon	0.148	0.119	0.106	0.005	-0.019	-0.204	0.360	-0.044
ErLpro	0.034	0.401	0.159	0.291	-0.115	0.253	0.422	-0.167
ErLres	0.240	0.449*	0.326	0.172	0.175	0.107	0.684**	-0.310
LacReg	0.256	0.010	-0.0416	0.031	-0.095	0.312	0.296	-0.484*
PerInt	0.097	0.393	-0.006	0.314	0.086	0.476*	0.102	0.146
CerDir	-0.433	0.145	-0.137	0.196	-0.226	-0.028	0.395	-0.151
SelDir	-0.228	0.568**	-0.115	0.214	0.204	-0.115	0.056	-0.097
VocDir	0.048	0.311	-0.481*	0.174	0.058	0.272	0.303	-0.255
Ambiv	-0.051	0.097	0.198	0.419	0.159	0.266	0.272	-0.063
ConKno	0.324	0.355	0.263	0.036	0.481*	0.120	0.316	0.099
IntKno	0.323	0.152	0.163	0.076	0.008	0.559**	0.443*	-0.272
UseKno	-0.166	0.445*	-0.340	0.225	0.211	-0.172	0.214	0.098
StiEdu	-0.076	-0.211	-0.045	0.327	-0.374	0.186	0.199	-0.134
CooLea	-0.045	-0.325	0.144	0.071	-0.455*	0.135	0.361	-0.473*

¹Codes for the scales are: StuInt = Student interaction; LeaGoa = Learning goal; IntExp = Internet experience; MulSou = Multiple sources; AppToo = Appropriate tool; EpiJud = Epistemological judgements; Marks = Final course marks; RelStr = Relating and structuring; CritPro = Critical processing; Memreh = Memorising and rehearsing; ConcPro = Concrete processing; SrLpro = Self-regulation of learning processes; SrLcon = Self-regulation of learning content; ErLpro = External regulation of learning processes; ErLres = External regulation of learning results; LacReg = Lack of regulation; PerInt = Personally interested; CerDir = Certificate-directed; SelDir = Self-test-directed; VocDir = Vocation-directed; Ambiv = Ambivalent; ConKno = Construction of knowledge; IntKno = Intake of knowledge; UseKno = Use of knowledge; StiEdu = Stimulating education; CooLea = Cooperative learning. Sample size was 20. Marked correlations are significantly different (* = $p < 0.05$; ** = $p < 0.01$). An alpha value after a scale is Cronbach's alpha for testing the reliability of the scales.

5.6 Cluster analysis of students' learning styles and perceptions of blended learning

Three distinct clusters of students were identified (Figure 5.3; Table 5.12). Cluster 1 consisted of five students. Students in this cluster scored highest in 18 scales. The scores for the remaining ten scales (student interaction, critical processing, concrete processing, self-regulation of learning processes, self-test-directed, vocation-directed, construction of knowledge, stimulating education, cooperative learning and) were intermediate.

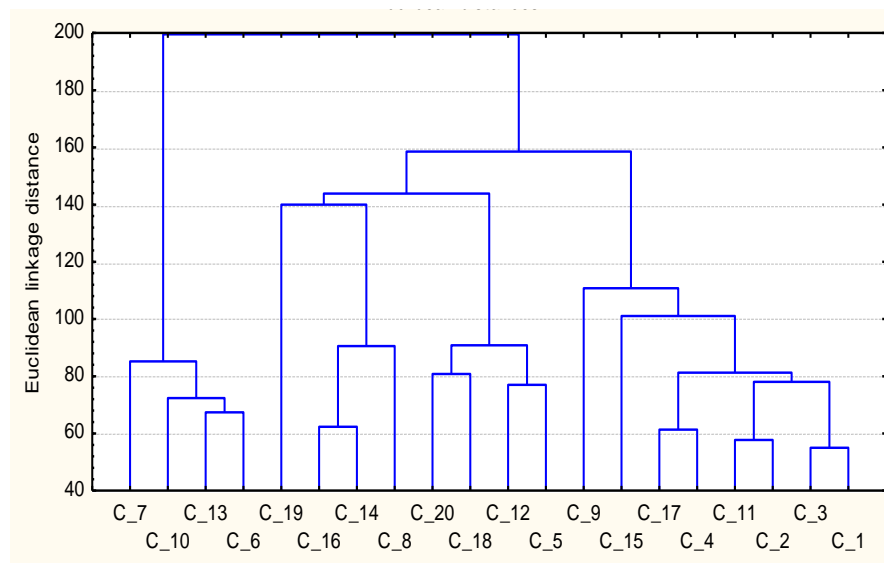


Figure 5.3 Dendrogram showing clusters of students based on course final marks, seven scales of the OEQ, 20 scales of Vermunt's (1996) Inventory of Learning Styles. The x-axis labels (C_1 to C_20) refer to codes for the students. The linkage distances are Euclidean

In contrast, cluster 2 consisted of eight students who scored highest in five scales (student interaction, vocation-directed, construction of knowledge, stimulating education and cooperative learning) and lowest in 15. These were learning goals, multiple sources, relating and structuring, critical processing, memorising and rehearsing, analysing, concrete processing, self regulation of learning processes, self regulation of learning content, external regulation of learning processes, external regulation of learning results, certificate-directed, self test-directed, use of knowledge and final course marks.

Cluster 3 consisted of seven students who scored highest in five scales (critical processing, concrete processing, self-regulation of learning processes, self-test-directed and final course marks) and lowest in 13. These were student interaction, relevance, Internet experience, appropriate tool, epistemological judgement, lack of regulation, personal interest, vocation-directed, ambivalent, construction of knowledge, intake of knowledge, stimulating education and cooperative learning.

Table 5.12 Descriptive statistics of clusters of students based on scales of perceptions of online learning, learning styles and final course marks

	Scale ¹	Cluster 1 (n = 5)		Cluster 2 (n = 8)		Cluster 3 (n = 7)	
		Mean	SD	Mean	SD	Mean	SD
1	StuInt	76.0	8.40	76.9	6.65	56.1	23.84
2	LeaGoa	92.0	5.58	81.7	14.58	86.7	12.17
3	Relevance	75.0	12.75	70.0	10.35	67.9	10.75
4	IntExp	96.0	8.94	83.7	5.18	81.4	14.64
5	MulSou	83.3	10.27	73.7	14.95	80.0	12.17
6	AppToo	85.3	14.45	85.0	8.54	63.8	14.33
7	EpiJud	94.0	10.84	70.0	13.09	62.9	11.85
8	RelStr	72.0	6.06	48.7	13.21	59.5	15.21
9	CritPro	63.0	9.08	46.2	9.91	65.7	11.70
10	Memreh	72.0	15.23	55.5	14.41	56.6	11.87
11	Analysing	59.2	10.35	49.0	10.20	51.4	10.69
12	ConcPro	74.4	10.81	59.0	12.05	74.9	6.41
13	SrLpro	55.3	7.67	52.9	15.27	61.0	14.10
14	SrLcon	69.0	8.94	56.2	8.35	60.0	5.00
15	ErLpro	67.2	19.47	43.5	8.93	47.4	10.69
16	ErLres	77.6	7.80	54.0	11.52	58.3	10.03
17	LacReg	67.2	16.34	57.0	11.06	52.6	4.86
18	PerInt	64.8	5.22	64.0	11.52	56.0	12.65
19	CerDir	73.6	9.63	63.0	11.26	64.6	17.50
20	SelDir	82.4	7.80	77.0	16.66	82.9	11.25
21	VocDir	87.2	5.22	89.5	7.07	82.3	12.83
22	Ambiv	58.4	8.29	50.0	7.71	44.6	12.53
23	ConKno	74.4	9.63	76.5	11.20	72.0	6.53
24	IntKno	84.0	10.20	79.0	8.49	67.4	7.46
25	UseKno	86.4	6.07	83.5	9.90	84.6	8.77
26	StiEdu	80.0	5.66	80.5	8.93	62.3	19.30
27	CooLea	67.2	12.13	69.0	12.96	46.3	20.89
28	Marks	62.4	4.77	61.4	8.19	65.4	10.47

¹Codes for scales are as defined for Table 5.11

Chapter 6. Discussion and Conclusions

6.1 Use of information and communication technologies for learning

The nature of students entering higher education has changed. The students who did my course had extensive experience in using information and communication technologies. Indeed there was clear evidence that my students used Internet and email to support their learning (Table 5.1). These findings support recent assertions by some authors (Bonk *et al.* 2006; Graham 2006; Mayadas *et al.* 2009) that students now expect to use information and communication technologies to support their learning. This shows the need to use blended learning to promote teaching and learning (Garrison and Kanuka 2004; Ginns and Ellis 2007).

The extremely high proportion of students who owned computers in this class (91%) is atypical of students who enter university in developing countries (Teferra and Altbach 2004). I attributed this high proportion to the fact that the majority of students who enrol at Rhodes are from historically advantaged backgrounds (personal observation). Most of the students had been using computers for almost ten years. Given their average age of 22 years, it is clear that they started using computers at primary school. The exceptionally high experience of Rhodes students in using computers augurs well for the use of blended learning to support teaching and learning (Garrison and Kanuka 2004; Tsai 2007; Mayadas 2009).

Students requested that learning resources be put online to complement face-to-face learning (Table 5.2). This demonstrates the need to understand students' perceptions of blended learning. Only 14% of the respondents wanted all their lectures to be offered face-to-face. These findings support the suggestion that the question is no longer whether one should use blended learning or not, but rather it is how to incorporate blended learning to promote teaching and learning (Ellis *et al.* 2006; Ross and Gage 2006; Mayadas *et al.* 2009).

Students underestimated their use of the LMS (Figure 5.1). I attributed this to the fact that students logged into the system more than once per given day and yet in their answers they stated that they logged into the system daily. Each time a student logged in, however, a "hit" was recorded leading to the discrepancy between the actual hits recorded by the LMS and the students' perceived frequency of logging into the system. The question I asked students should have been more explicit.

6.2 Students' learning styles

Three of Vermunt's (1996) learning styles were demonstrated in this study. These were the meaning-directed, application-directed and reproduction styles. The undirected learning style was not demonstrated. Cluster 1 consisted of students who scored highest in self regulation and deep processing strategies (Table 5.7). This group of students therefore showed the meaning-directed style. Cluster 2 consisted of students who could be characterised as showing the application-directed style. These students scored high (about 85%) on both use of knowledge and vocation-directed scales while scores for the concrete processing and regulation strategies scales were intermediate. Cluster 3 fitted Vermunt's (1996) typology of the reproduction-directed learning style. Students in this group had high scores for the scales measuring intake of knowledge and intermediate scores for memorising and rehearsing. I attributed the lack of a cluster depicting students with an undirected learning style to two reasons. First, there is a rigorous selection process of students who enrol at Rhodes University due to the high competition for places (Academic registrar, pers. com). Rhodes University is one of a few South African universities demonstrating high efficiency in student outputs (Taylor and Harris 2004). Second, the study was conducted on third year students. Advanced undergraduates have been shown to have more sophisticated views of epistemology and learning than first year students (Perry 1970; Entwistle and Peterson 2004).

A key finding from this study was the phenomenon of dissonance between learning conceptions, learning motives and learning processes as reported by several authors (Lindblom-Ylance 2003; Meyer and Shanahan 2003; Vermunt and Minnaert 2003; Cano 2005). For example, students showing a meaning-directed learning style (Cluster 1, Table 5.7) generally scored highest in scales measuring deep processing cognitive strategies (i.e., relating and structuring, critical processing), memorising and rehearsing, intake of knowledge, construction of knowledge and use of knowledge. This is clear evidence of conceptually conflicting learning intentions and processes (Meyer and Shanahan 2003).

The phenomenon of dissonance has been attributed to many reasons (Boulton-Lewis *et al.* 2003; Boulton-Lewis *et al.*, 2004; Vermunt and Vermetten 2004). For example, dissonance may be attributed to a learning environment that forces students to study in ways that do not match their conceptions of learning (Lindblom-Ylance and Lonka 2000; Meyer and Shanahan 2003). Assessment methods such as multiple choice questions may promote rote learning (Rust 2002; 2007) leading to dissonance. Students may adopt a "shotgun" learning strategy to increase their chances of success in examination questions that require low order learning skills (Bloom *et al.* 1956). Alignment of

teaching/learning methods, learning outcomes and assessment (Biggs 1999) could be crucial in promoting consonance in learning concepts and processes.

6.3 Students' perceptions of the online learning component of blended learning

I developed seven scales that described students' perceptions of online learning (Table 5.10). The scales were supported by students' qualitative responses about the Internet learning environment and group work (Table 5.9). The scales generally agreed with those developed by other authors (Kerr *et al.* 2006; Lee and Tsai 2005; Tsai 2008). However, there was no evidence to support the validity of the *a priori* scales measuring cognitive apprenticeship; technical aspects; self-regulation of learning; cooperative learning, and challenging dimensions of online learning contrary to other authors' findings (Kerr *et al.* 2006 and Tsai 2008). I attributed these differences to two reasons. First, the items of the online experience questionnaire that I developed did not explicitly ask questions about some scales such as cognitive apprenticeship. It is now generally agreed that the potential to develop communities of inquiry is one of the major advantages of online learning (Garrison and Kanuka 2004; Graham 2006; Tsai 2008).

Second, lack of evidence for the challenging scale (Tsai 2008) and technical aspects (Kerr *et al.* 2006) was attributed to the students' high computer skills and experience, and technical support at Rhodes University. As stated in Chapter 5, about 91% of the students in my class owned computers and about 50% had access to Internet either at home or in their residences. Furthermore, the students had been using computers for about 10 years on average.

There was evidence of high within scale variability in students' perceptions of online learning (Table 5.8). This is in agreement with other authors' findings that highlight individual students' differences in many aspects that affect their learning and perceptions of the learning environment (Felder and Brent 2005; see also Chapter 2: section 2.4). These differences show the need to use a diversity of teaching and learning methods to promote teaching and learning (McInerney and McInerney 2006).

6.4 Relationship between students' learning styles and perceptions of blended learning

According to Ginns and Ellis (2007), perceptions of the learning environment influence study behaviour and ultimately students' learning outcomes and performance. Both expected and unexpected patterns in the relations between perceptions of blended learning and learning styles were demonstrated (Table 5.11). Learning goals were positively correlated with some elements of cognitive processing strategies (analysis and concrete processing) and external regulation of learning

strategies. Similarly, the perception that the Internet provides multiple sources of information was positively associated with advanced models of epistemology that support construction of knowledge (Perry 1970; Schommer 1990; Entwistle and Peterson 2004).

There was dissonance (Vermunt and Verloop 2000; Meyer and Shanahan 2003; Cano 2005) in the relationships between perceptions of the Internet as enhancing epistemological judgements and some components of learning style. The perception of epistemological judgements was both positively correlated with deep processing cognitive strategies (relating and structuring information) and surface processing cognitive strategies (memorising and rehearsing information). The phenomenon of dissonance has been attributed to several factors such as the culture, context of type of course and assessment strategies (Boulton-Lewis *et al.* 2004; Vermunt and Vermetten 2004; Duarte 2007).

Although cooperative learning has been shown to be important in supporting studying and learning (Garrison and Kanuka 2004; McInerney and McInerney 2006; Tsai 2008), there was a negative relationship between cooperative learning and some scales measuring students' perception of their learning environment (i.e., student interaction, learning goals and multiple sources of information). I attribute these findings to the generally negative feelings among students about group work in this cohort of students. Students were placed into groups rather than being allowed to choose their own groups. The tensions became so severe that students sent each other death threats and as course coordinator I had to intervene to diffuse the tensions. Although cooperative learning is important in achieving the learning outcomes that students should be able to work as a team, the process of creating teams is extremely important in promoting harmony within a group.

There was no relationship between final course marks and deep processing cognitive strategies, and advanced conceptions of epistemology, contrary to other authors' findings (Entwistle and Peterson 2004; Vermunt and Vermetten 2004; Schommer-Aikins and Easter 2006). I attribute this major finding to the nature of assessment in this course (Chapter 3). For example, individual assignments and the examination contributed 67% to the final course mark while group assignments contributed the remainder. The negative relationships among students within their groups affected their learning. This is supported by the significant negative relationship between cooperative learning and final course marks (Table 5.11). Lack of regulation of learning strategies was negatively correlated with final course marks. This finding is in agreement with other authors' findings (Vermunt 1996; Busato *et al.* 1998; Vermunt and Vermetten 2004).

6.5 Cluster analysis of students' learning styles and perceptions of blended learning

Three general groups of students were identified with profiles supporting the meaning-directed, application-directed and reproduction learning styles (Vermunt 1996; Vermunt and Vermetten 2004). The cluster analysis results based on students learning styles, perceptions of their learning environment and final course marks again demonstrate the phenomenon of dissonance (Long 2003; Lindblom-Ylane 2003). Theory attributes this phenomenon to the learning context (e.g., nature of the course) and assessment practices. The ultimate goal of higher education is to produce learners who demonstrate higher order learning skills (Bloom *et al.* 1956; McInerney and McInerney 2006).

More studies investigating the phenomenon of dissonance are required. Both longitudinal and cross-sectional studies would be useful in this regard (Lindblom-Ylanne 2003; Boulton-Lewis *et al.* 2004).

6.6 Conclusions

The study identified three broad learning styles of students. These were the meaning-directed, application-directed and reproduction-directed learning styles. The undirected learning style was not identified. This was attributed to the generally high entry requirements for students who enrol at Rhodes University (Academic registrar, pers. com.). Furthermore, Rhodes University is one of the smallest universities in South Africa. The students to staff ratio is one of the most favourable and leads to high student lecturer interaction. Indeed Rhodes has one of the highest pass rates in South Africa.

Seven scales describing students' perceptions of the online learning component of blended learning were identified. These were epistemological judgements, multiple sources of information, learning goals, relevance, Internet experience, appropriate tool and student interaction. A 30-item online experience questionnaire was designed to measure these scales.

The relationship between students' learning styles and their perceptions of the learning environment showed both expected and unexpected patterns. Students demonstrated dissonance in their cognitive strategies, mental models of learning, regulation of their learning strategies and learning orientations.

6.7 Recommendations

Blended learning is here to stay. The millennial generation (Mayadas *et al.* 2009) expects to use information and communication technologies to support their learning. There is evidence that the question in higher education is now on how to use blended learning to support high quality learning rather than whether one should use blended learning or not. Furthermore, there is an increase in student exchanges among universities (personal observation). International students are generally switched on regarding the use of information and communication technologies to support their learning.

The following broad recommendations arise from my study:

1. There is a need to assess students' learning styles because it is important in promoting effective teaching and learning (Felder 2008, pers. com.). I have introduced this practice in my department.
2. There is a need to investigate the phenomenon of dissonance in students' learning styles. The hallmark of a university education is the demonstration of high order learning skills and sophisticated epistemological understanding.
3. The negative association between cooperative learning and academic performance needs further study. Real world problems require students who are able to work in teams. The discipline of environmental science, in particular, requires students who can work in teams. This is why my department places such high importance on group work. Furthermore, the ability to work as a team is one of the critical cross-field outcomes in the National Qualifications Framework.

Institutional support for innovation in teaching and learning is crucial. Fortunately, Rhodes University's Centre for Higher Research, Teaching and Learning is playing an important role in this regard. The support for the centre should continue to promote the development of a community of practice that supports teaching and learning.

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Appendices

Appendix A: Environmental Science 302 Course Outline 2006



RHODES UNIVERSITY

COURSE TITLE: ENVIRONMENTAL MANAGEMENT CONCEPTS AND METHODS: ENV 302 (2006)

1. INTRODUCTION

1.1 Purpose of course

The Environmental Science 302 course for 2006 consists of eight components (seven theory components and one practical component). The course focuses on environmental management in practice. The aim is to develop applied professional skills, coupled with rigorous analysis, to promote effective environmental management. The emphasis is on methodologies and conceptual frameworks to evaluate, understand and study environmental impacts and resource use patterns. Critical analysis and consideration of counter-viewpoints are central. This will be done at the global, regional and national level, whilst also drawing on local case-studies. The first lecture of Environmental Science 302 will be taken up as an introduction and overview of the course, deliverables and expectations, marking, and administration.

1.2 Credit Value

The course has a credit value of about 15. It is assumed that the 'average' learner would need approximately 10 hours to complete one credit's worth of learning. The 10 hours would include lecture attendance, practicals, self study and work on assignments.

Assumptions of Prior Learning (or Learning assumed to be in place)

The skills covered in Environmental Science 201 and 202 are particularly relevant, especially those relating to systems analysis, team work, and interdisciplinarity.

2. OUTCOMES

2.1 Critical Cross-Field Outcomes

Learners will be able to:

- 2.1.1 identify and solve problems
- 2.1.2 work in a team
- 2.1.3 organize and manage themselves
- 2.1.4 collect, analyse and evaluate information
- 2.1.5 communicate effectively
- 2.1.6 use science and technology
- 2.1.7 recognize problem solving contexts
- 2.1.8 reflect on and explore effective learning strategies

2.2 Specific Intended Outcomes

By the end of the course learners should be able to demonstrate:

- 2.2.1 A critical understanding of a range of environmental management issues and approaches
- 2.2.2 An ability to differentiate between various environmental management tools
- 2.2.3 An understanding of the practical application of various environmental management approaches

- 2.2.4 An appreciation of the spatial and temporal complexity of each issue
- 2.2.5 A comprehension of the discipline terminology associated with each issue
- 2.2.6 An appreciation of the role of different disciplines in understanding and addressing environmental issues
- 2.2.7 A questioning approach that objectively appraises current dogma and popularist projections
- 2.2.8 An ability to conduct self study and synthesis of relevant information
- 2.2.9 An ability to communicate (verbally and in writing) results and understanding related to issues of environmental management

More specific and complementary outcomes are provided for each theory component and the practical component.

3. TEACHING METHODS

Lecturers will provide specific details for each theory component. The teaching and learning methods will consist of formal lectures, problem-based learning and practicals. Where possible, guest lecturers will be invited to give individual lecture contributions with case studies and real-life experiences. Guest lectures will be scheduled at times convenient to the guest/s. Learners are expected to interact with each other using the discussion forum in the Moodle LMS.

An attendance register will be circulated at each lecture. Whilst lectures are not compulsory, students are strongly encouraged to attend lectures in order to obtain the maximum benefits from the course, and meet the course outcomes. Records of attendance will be consulted in situations where students are borderline cases or in instances where appeals and value judgements need to be made. Students should also be familiar with the Departmental policy on leave of absence (Appendix 1) and the requirements for DP (Appendix 2).

4. COURSE CONTENT

The theory components that will be covered in this course are shown in the table below. Lecturers will provide detailed contents for each component.

Theory component	No. of lectures	Lecturer	Date
Introduction	1	James Gambiza	24 Jul
Integrated Pollution and Waste Management	9	K. Whittington Jones	25 Jul – 04 Aug
Environmental Policies	10	James Gambiza	07 Aug – 21 Aug
Environmental Ethics	9	James Gambiza	22 Aug – 01 Sep
Integrated Environmental Management Tools (EIA)	5	CES	04 Sep – 08 Sep
Break			09 Sep – 17 Sep
Integrated Environmental Management Tools (EIA & EMPR) continued	5	CES	18 Sep – 22 Sep
Integrated Environmental Management Tools (SEA) Integrated Environmental Planning Tools (LEAP/IDP/SDF/Agenda 21)	10	CES	26 Sep – 09 Oct
Participatory Natural Resource Management	9	James Gambiza	10 Oct – 20 Oct
Synthesis	5	Christo Fabricius	23 Oct – 27 Oct

The practical project component has already been set and planning activities commenced during the second term. Students need to refer to the relevant documentation regarding the number and nature of the different deliverables for the practical component.

5. RESOURCES

Lecturers will provide notes and a list of key readings for their theory components. In some instances learning resources will be posted on Moodle.

6. STUDENT ASSESSMENT

Individual and group assignments will be used for the summative assessment of student learning. Assignments will consist of one essay (see Appendix 3), a review of a scientific paper (Appendix 3), verbal presentations of the research proposal and results, written reports of practicals, a journal of reflective learning and online discussions. The essay, review of the scientific paper and reflective journal are individual assignments while practicals and online discussions will be done in groups. Consult the general writing guidelines (Appendix 4) and the marking criteria for the essay (Appendix 5) and the four deliverables for the practical (Appendices 6 – 9). Students will be required to assess their peers for group assignments (Appendix 10).

Students will be required to: (a) keep weekly journals in Moodle and (b) contribute (at least twice for a given topic) to online discussions in Moodle. Journal entries will consist of reflections on one's learning during the week. The journal entries and contributions to discussions **will be assessed**. Students will assess the contribution of their peers to online discussions.

Students are reminded to avoid any form of plagiarism in assignments. A mark of **zero** is usually assigned for plagiarised submissions, without an opportunity to rewrite that assignment. Please ensure you are familiar with the University policy and definitions regarding plagiarism, and the departmental penalties associated with plagiarism (Appendix 11).

The due dates for the assignments are provided below. Please note that without **ANY EXCEPTIONS** a penalty of **10% per day**, or part thereof, will be levied against late submission of assignments and peer evaluation forms. Submission of assignments and peer evaluation forms by E-mail is not allowed; hard copies of the assignments should be submitted in the appropriate box.

Assignment	Due date	Time
Review of scientific paper	25 Aug	16:30
Essay	22 Sep	16:30
A critical summary of online discussions	20 Oct	16:30

Allocation of marks

Exams

Theory paper 1	22%	
Theory paper 2	22%	
Practical	33%	(All deliverables combined as per mark sheet already circulated)

Year mark

Reflective journal	1%
Online discussions	4%
Review of scientific paper	6%
Essay	12%

The assessment of the specific learning outcomes (highlighted in section 2) is summarized below.

Specific Outcomes	Assessment Criteria	Assessment Tasks
2.2.1 – 2.2.6.	Demonstrate a critical understanding of environmental management issues	Exams, practical, essay, online discussions
2.2.7 – 2.2.9	Critical analysis and synthesis of relevant information	Practical, review of scientific paper, online discussions

7. EVALUATION

The course will be evaluated using either questionnaires or small group instructional diagnosis (SGID).

Trouble shooting

In the event of individual or group problems, please contact the relevant lecturer dealing with that part of the course with which the problems are associated. For more general issues, or unsatisfactory resolution of the problem, please contact the course coordinator, James Gambiza (Office 104 Bangor House; tel. 6037010; email: j.gambiza@ru.ac.za).

Appendix 1: Leave of absence policy in the Department of Environmental Science

1. To achieve its core learning outcomes, the Department aims to promote ‘active learning’ by students through discussion, debate and practical activities. To achieve this, the Department stimulates lecture attendance by offering interesting and relevant lectures and practicals, and showing passion for teaching and for Environmental Science as a subject. It also expects students to respond by participating in all lectures and practicals.
 2. The Department understands, however, that this might not always be possible, and has therefore formulated this leave of absence policy.
 3. Environmental Science students must attend:
 - a) 100% of all practical activities
 - b) 100% of student presentations
 4. Students not complying with this will not be allowed to write end of term examinations, i.e. will be refused ‘Duly Performed’ certificates, unless complying with this leave of absence policy.
 5. Students are expected to attend all lectures. Lecture attendance data will be used in the allocation of a mark for student participation, and to assist staff decisions on ‘borderline’ cases.
 6. Students may be granted leave of absence on the basis of:
 - a) Illness;
 - b) Bereavement;
 - c) Participation in an official match of a recognised competitive sporting code as a member of a national, provincial or Rhodes 1st team.
 7. A student requesting leave of absence should submit:
 - (a) An official leave of absence form. This must first be signed by the lecturer concerned (i.e. the one whose part of the course you will be missing/have missed), and then the HoD);
 - (b) Proof that the absence was justified:
 - i. In the case of illness: a medical certificate;
 - ii. In the case of bereavement: a letter from a responsible individual (pastor or parent);
 - iii. In the case of sport: a letter from a Rhodes sport administrator *at least one week in advance of the match*;
 8. Students who have been granted leave of absence must nevertheless submit all assignments, including those set, or due, during the period when they were granted leave of absence. The submission dates for such assignments will be extended by the number of days absent. The onus is also on the student to familiarise him/herself with any practical techniques that had been displayed or taught during the period of their absence.
 9. The Department has the right to verify the authenticity of leave of absence requests, but undertakes not to infringe on students’ right to privacy while doing so.
-

Appendix 2: Requirements for DP

The following DP requirements are applied within the Department of Environmental Science. It is the responsibility of each student to be familiar with them, and make every effort to comply.

- To attend **ALL** practicals – see **Leave of Absence Policy**.
- To hand in all assignments for marking on the due date. Any assignments handed in late without prior permission from the lecturer concerned will be penalised by a deduction of 10% per day or part therefore.
- A sub-minimum of at least 35% in the year mark. Students failing to obtain 35% for their year mark will not be permitted to write exams.
- A sub-minimum of 35% will also be applied in each exam. Thus, a student failing any exam with less than 35% will be deemed to have failed the course irrespective of their final aggregated mark for that semester course (i.e. year mark, plus exam 1 mark, plus exam 2 mark).
- Whilst lectures are not compulsory, students are expected to attend lectures so as to meet all the outcomes of the course. An attendance register will be circulated at each lecture. This will be consulted when value judgments are to be made on borderline cases.

Appendix 3: Assignments for ENV 302 course (2005)

Essay

Write an essay not exceeding **3 000** words, excluding references, on **ONE** of the four topics provided below. Please comply with the standing guide-lines for essays in the Department of Environmental Science, with special attention to those relating to the number, format and use of references.

Impacts of policies on natural resource management.

or

Discuss the weaknesses of EIA.

or

The integrated application of environmental management tools in the development and operation of eco-industrial parks.

or

Issues to consider when implementing systematic conservation plans.

Review of a scientific paper

Provide a critical review of the format, content and arguments in the article listed below. The review should not exceed **2 000 words**, excluding references.

Pimm, S., Raven, P., Peterson, A., Sekercioglu, C.H. & Ehrlich, P. 2006. Human impacts on the rates of recent, present, and future bird extinctions. *Proceedings of the National Academy of Sciences*, **103 (29)**: 10941-10946.

Appendix 4: Guidelines for written work and reviews of scientific papers

General guides in written work

- Provide a clear statement of the purpose and objective of the report or essay.
- A clearly structured and logical flow and argument must be developed.
- Papers should begin with a clear introduction, followed by a discussion (which should, ideally, be further divided into sections), conclusion and reference list. Research reports have a similar logical structure such as: introduction, literature review, methods, results, discussion, conclusion and reference list.
- Justify and substantiate statements and views/theories by providing original data or by referring to other sources.
- Phrases such as “*it has been shown*”, or “*it has been stated*”, or “*it has been argued*” must be followed by a reference, i.e. who has shown it, stated it, or argued it.
- Avoid excessive use of the phrase “In order to...”. In most cases the words “in order” are superfluous.
- If supporting a particular viewpoint, substantiated with reference to other work, make sure there is evidence that one is aware of any counter viewpoints and that they are acknowledged.
- All ideas and words borrowed from other authors/papers must be acknowledged in the text and in the reference list at the end of the paper. You are permitted to use material from other sources and even to use direct quotes, but the original source must **always** be acknowledged.
- Plagiarism, the theft of one author’s work by another, is considered unethical and unacceptable. Rhodes students caught plagiarising will be given a zero mark. Students who are consistently caught plagiarising risk losing their DP (ensure you are familiar with University policy and definition).
- The reference list must provide full details of the sources that you cited in the paper, so that the reader can locate these sources for themselves if needs be. Refer to Environmental Science 2 guides on how to cite and reference work. Refresh your memory, particularly re the section on Common Mistakes in Referencing.
- At third year level, Environmental Science essays must draw upon and cite **at least** 15 references, of which **at least** 70% must be from journal articles. The balance (30%) can be between books and Internet web sources. The number of references for practical reports and reviews is less, but the same ratio of journals to other sources is applied.
- Look at the guides for review of scientific papers, which can also act as a useful checklist for preparing and editing your own work.

Formatting

- All documents must have page numbers. Do not number the title page/front cover. Page one corresponds to the page with the Introduction. Any pages occurring before the Introduction (e.g. table of Contents, Executive Summary), except the Title page, should be numbered with small Roman numerals.
- A major title or heading should not end with punctuation. For example there should be no full stop after a heading or title.
- When using a number in text (e.g. 6 years; 15 people), it should be written out in full if ten or less, but left as a numeric if greater than ten (e.g. six years; 15 people).
- Always leave a space between a numeric and its accompanying units. For example, 27 m, as opposed to 27m; 16 kg instead of 16kg.
- Do not use footnotes. If the statement is worth saying, and needed for clarity, then put it within the text directly, not a footnote. If it is not central to your argument or point, exclude it.
- Tables should not run over from one page to the next except where it is a very long table. Therefore, position the Table within the page so that it does not flow over to the next page.
- The headings for Tables should be above the Table.
- The captions for Figures should be below the Figures.
- Ensure all parts of the document have consistent formatting. In terms of striving for consistency, it is not a case of one format is correct and another incorrect, it is simply that whichever format you use must be *consistent throughout the document*. Common inconsistencies include:
 - Left and right hand justification of the text throughout most of the document, but one or two paragraphs (usually merged in from some other document) are only left justified.
 - Different formatting of headings even though in the same level of heading hierarchy (for example underlined in some places, not others; bold or italic in some places, not others, etc.).
 - Changes in spacing before and after headings, or between paragraphs. For example, in one section there is only one line between a heading and the subsequent text, in another section there are two lines.
 - Inconsistent application of capital letters. For example, Rhodes University on one page, and then Rhodes university on another.

- Inconsistent use of hyphens for the same word, e.g. on one page the word is hyphenated (over-exploited), and on the next page it is not (overexploited).
- Inconsistent punctuation or styles between references in the reference list.
- On one page a full stop after an abbreviation (e.g. Fig. 2) and on other pages not (Fig 2).

General marking criteria for written reports

The following criteria are taken into account in marking general written reports in the Department of Environmental Science.

Understanding of the question/problem	Is the question/problem directly addressed, is the answer to the point?
Presentation of the facts	Are all the relevant facts provided? Are key facts, elements or views absent?
Structure and flow	Does the content have a logical, well-defined structure, broken up into component parts that lead on from one to the next?
Logic	Are the arguments clear and logical? Are the conclusions valid in relation to the facts presented and arguments posed? Are arguments, view points and conclusions substantiated?
Critical thinking	Have contrary views to the conventional dogma been considered and appraised, have assumptions been considered, is there evidence of the student trying to critique ideas based on their own views and thinking? Have they balanced and considered contradictory views on the issue and then come to a defensible conclusion of why one is better than the other, or that some new position is required?
Use of references	Has a wide range of references been consulted, are most of them reasonably recent (< 5 years), is the ratio of journal to non-journal sources satisfactory; is the reference list without errors?
Editorial detail	Is it clear that the document has been proof-read, with minimal spelling, typo, syntax errors and layout inconsistencies?
Overall effort	Does the extent and detail of the work demonstrate that significant effort has gone into it?

Guides on review of scientific papers

In appraising scientific papers there are a number of attributes the reader can consider. These have been listed below. Because scientific papers are written in different formats (e.g. journal articles reporting on empirical studies, synthesis papers providing a meta-analysis of previous work, review papers in journals, chapters in books, theoretical reviews, and more), not all evaluation criteria are applicable to every paper. For example, chapters in books rarely follow the same format as empirical papers along the style of Introduction, Study Area, Methods, Results, and Discussion. Things to consider (which is also a useful checklist for your own work) are:

Writing style

- Language and sentence structure are easy to read
- It is error free
- Uses appropriate terminology, but is not a litany of jargon
- All acronyms are defined in full at first presentation

Structure

- The overall structure and flow of thinking is logical and clear
- The objectives and justification for the paper are clear
- Hypotheses are introduced and clearly stated
- The paper is not full of generalisations, i.e. arguments and points are supported by data within the paper or citations of other relevant work
- If a review paper, it considers both/more sides of current thinking before drawing conclusion, i.e. unbiased

Relevant and up-to-date

- The paper is dealing with current, topical issues
- Most, but not necessarily all, of the cited references are recent (< 5 years old)

Study Area

- Details of the area are provided so the reader can judge if the site was atypical in some regard

Methods

- The methods are appropriate to address the objectives or key questions
- Sample size seems valid (check the magnitude of the standard deviation relative to the mean; if no standard deviation given, why not?)
- The most recent methods are used, not out-dated or discredited methods
- The assumptions and/or short-comings of the methods are mentioned (if there are any)
- The methods are clear, so that the reader could repeat the study exactly if they so wished
- Units are clear and all symbols in equations are defined

Analyses/Results

- The data are subjected to appropriate statistical analyses (did not invalidate any of the required assumptions for specific tests)
- The authors do not read or discuss non-significant results or outliers without justification
- If outliers are evident, they have not been given undue importance, but nor have they been ignored
- Units are clear and consistent
- Confidence limits are provided for the means, if means have been reported

Discussion

- The conclusions or arguments are clear
- They are substantiated and logical relative to the data and arguments presented
- The authors make clear comparisons between their results and other work in the same field. Similarities and differences are considered. Possible reasons for differences are offered, or hypothesised. Comparisons are not obviously biased
- Comparisons are valid, i.e. across similar vegetation types, socio-economic profiles, climates, etc.
- The implications of the results for policy, management, users, further research are made clear, but are not blown out of proportion (for example extrapolating from one site or one model, to challenge continental or global understanding of the issue)

Tables

- Do not duplicate information in the figures
- Column/row totals add up
- Units are provided
- The heading accurately reflects the contents of the table
- There are not too many tables
- Would more tables have been a useful way of summarising the findings
- Individual tables are not too large and crammed with so much data it is arduous to read

Figures

- They do not duplicate information in the tables
- Units are provided
- The heading accurately reflects the contents of the figure
- There are not too many figures
- Would more figures have been a useful way of summarising the findings
- Individual figures are not too large and crammed with so much information that it is arduous to read
- The text provides a summary of the main points evident from the figure

References

- All the references cited in the text appear in the reference list and vice versa
- All the references are in the correct order (usually alphabetical)
- The punctuation format is consistent between the references
- Details of each reference are provided, i.e. no missing page numbers, or volumes, or dates, publisher, etc.

Appendix 5: Essay marking grid

Criteria	Excellent (9-10)	Very Good (7-8)	Satisfactory (5-6)	Poor (3-4)	Very Poor (0-2)	Weight
Format	Conforms to writing guidelines of the Department; Good use of headings / sub-headings to guide flow	Minor deviations from Departmental guidelines; use of headings & sub-headings	Some errors in format; limited use of headings / sub-headings	Frequent errors in format; occasional use of headings / sub-headings	No adherence to Departmental guidelines or use of headings	1.0
Introduction	Logically constructed, positions essay accurately without unnecessary information; excellent insight into topic	Logical and gives good idea of the background to the topic and demonstrates insight	Reasonably logical description of current thinking on the topic	Limited logic, limited evidence of clear purpose for the essay	Poor logic, limited evidence of a clear purpose for the essay	1.0
Presentation & style	Polished, imaginative approach, fluent writing, accurate grammar & spelling; no repetition	Carefully & logically presented, fluent writing & accurate grammar & spelling, minor repetition	Coherent & organised, mainly fluent, some spelling & grammatical errors	Some attempt to organise, not always fluent, contains spelling & grammatical errors	Disorganised, frequent spelling & grammatical errors; significant repetition	1.0
Originality	Many creative ideas and / or examples; explores a variety of perspectives	Uses imagination to go beyond standard requirements; uses original examples	Some evidence of imaginative thought; some original examples	Shows little imagination; originality is marginal	No evidence of creativity or use of original examples	1.5
Content & Knowledge	Comprehensive knowledge; in depth specialisation	Reasonable knowledge of chosen topic	Provides factual / conceptual knowledge base & appropriate terminology	Limited knowledge of topic & some appropriate terminology	Lacks evidence of knowledge relevant to topic and / or misuses terminology	1.5
Use of Literature & Referencing	Has developed & justified own ideas based on a wide range of resources, thorough analysis and discussion; citations are accurate and formatted correctly	Good integration of theory from a range of resources – used to support own ideas on the topic; very few citation errors	Clear evidence of application of readings relevant to the subject; uses some resources; frequent citation errors	Literature is presented uncritically & in a purely descriptive way; indicates limitation of understanding; significant errors in citation	Little evidence of use of literature or irrelevant information; frequent citation errors	1.5
Critical Reasoning	Consistently demonstrates critical analysis; well integrated into the text	Demonstrates critical analysis of the topic	Some critical analysis of the topic with reasonable integration	Some evidence of critical thought	No evidence of critical analysis	1.5
Conclusions	Analytical and clear, well grounded in theory and shows development of new concepts or ideas	Good development shown in summary of arguments based on theory or literature	Evidence of findings and conclusions based in theory or literature	Limited evidence of findings and conclusions supported by theory or literature	Unsubstantiated conclusions with little foundation / no relevant conclusions	1.0

Appendix 6: Marking criteria for verbal presentations on project proposal

GROUP:	EXAMINER:	Mark allocation	Mark given
INTRODUCTION Title of project is clear. The project should be introduced in a logical and interesting manner, essentially explaining why the project needs to be done. Reference to other work is desirable, and the hypothesis to be tested relative to that work.		5	
OBJECTIVE & KEY QUESTIONS The student provides a concise statement of what the project is addressing and the specific questions that will be answered to address the overall objective		10	
STRUCTURE AND CONTENT <ul style="list-style-type: none"> · Knowledge of literature (is the student aware of, and has drawn upon, the most recent, and relevant literature) · Structure of talk (outline is provided, the talk well structured, follows a logical sequence and is balanced between the different components; participation of all group members) · Conclusion/finishing off (does the talk end off well, or just comes to an abrupt or hanging halt) 		10	
METHODOLOGY <ul style="list-style-type: none"> · Data collection (sample size is adequate; variables measured and tools/approach used match the key question to be answered; project is not overboard in terms of number of treatments) · Data analysis (student has given appropriate thought to how the data will be analysed) · Assumptions and possible pitfalls (all assumptions underlying the project approach have been identified and a contingency plan in place should they be revealed to be invalid) · Timing of activities (is the schedule of project activities compatible with the requirements of the project) 		30	
PRESENTATION <ul style="list-style-type: none"> · Language (use of technically and grammatically correct English; not garbled or rushed, or stunted with ‘ums’ ‘ers’ etc.; not peppered with slang) · Projection of voice & eye contact (student does not mumble into the overhead or notes, looks up frequently, speaks loudly enough, and projects voice towards the audience) · Fluidity (the presentation is fluid without interrupting stops and starts; it is not simply read from the overhead or slide) · Use of visual aids (suitable use of visual aids to support the understanding of the project by the audience. Could include overheads, slides, Power point slides, pieces of novel equipment, specimens, etc. Not too many, not too few) · Nature of the visual aids (suitable in terms of use of colour, legible font size, appropriate spacing, headings, amount of information/text on each one, etc.) · Timing (is the talk significantly under or over the allotted time) 		33	

<p>QUESTIONS The student is able to defend his/her approach, backed up with reference to other research, preliminary data. They could elaborate confidently and concisely when requested.</p>	12	
TOTAL	100	

Appendix 7: Marking criteria for written project proposal

GROUP:	EXAMINER:	Mark allocation
<p>INTRODUCTION Title of project is clear, unambiguous and not too long. The project should be introduced in a logical and interesting manner, explaining why the project needs to be done. Contextualisation should include a world perspective of the issue, followed by an African or developing nation perspective and finally South Africa and the particular study region. There should be evidence of a <i>critical</i> review/analysis of previous work making a logical lead into the objectives and questions for the study. Reference to other work is necessary, and should be mainly recent and relevant journal articles.</p>		25
<p>OBJECTIVE & KEY QUESTIONS The proposal should have a concise statement of what the project is addressing/hypothesis and the specific questions that will be answered to address the overall objective.</p>		10
<p>STUDY AREA/S Pertinent details of the Study Area are provided to allow the reader to evaluate whether or not it is suitable for the proposed work, or that it is atypical in some way. What details are relevant depends upon the nature of the project, but could include location (latitude & longitude; altitude; proximity to regional centres or features of influence), environmental data (abiotic & biotic), social data (population and hh sizes, gender distribution, employment status institutions, language) and economic (mean incomes, GDP).</p>		5
<p>METHODS</p> <ul style="list-style-type: none"> · Data collection (sample size is adequate; variables measured and tools/approach used match the key question to be answered; units of measurements are clear; project is not overboard in terms of number of treatments or sample sites). · Data analysis (details of proposed analyses are provided, and they match the format of the proposed raw data). · Assumptions & possible pitfalls (relevant assumptions underlying the project approach have been identified and a contingency plan is in place should they be revealed to be invalid). 		25
<p>TIMING & BUDGET</p> <ul style="list-style-type: none"> · Timing of activities & budget (schedule of project activities is clear, & is compatible with the requirements of the project, seasonality. The budget is realistic, all items included, calculations & totals correct). 		5
<p>REFERENCE LIST <i>Full details</i> for each reference are provided, as per examples in the Department of Environmental Science writing guidelines. Refs are in alphabetical order. All refs cited in the text are in the list and vice versa. Most (> 70%) are from recent journal articles. No inconsistencies in style or punctuation from one reference to the next.</p>		15
<p>PRESENTATION & STYLE</p> <ul style="list-style-type: none"> · Language (use of technically and grammatically correct English; wording should be clear, unambiguous and without colloquialisms; abbreviations/acronyms are defined upon first presentation; no repetition). · Accuracy (no typographical errors, limited grammatical errors, no inconsistencies in styles, punctuation, hyphenations, etc., it is clear the document has been proof-read). · Layout & length (the proposal should be neatly presented, headings clear and in logical sequence, tables and figures do not spill over from one page to another, spacing not irregular nor cramped up). 		15
TOTAL		100

Appendix 8: Marking criteria for verbal presentations on project results

GROUP:	EXAMINER:	Mark allocation	Mark given
INTRODUCTION Title of project was clear. The project was introduced in a logical and interesting manner, essentially explaining why the project needed to be done. Reference to other work is desirable, and the hypothesis to be tested relative to that work if necessary. The student provided a summary of the structure of the talk to follow.		5	
OBJECTIVE & KEY QUESTIONS The student provided a concise statement of what the project set out to address and the specific questions that were to be answered to meet the overall objective		5	
METHODOLOGY <ul style="list-style-type: none"> · Data collection (sample size was adequate; variables measured and tools/approach used matched the key questions; project was not overboard in terms of number of treatments) · Data analysis (data were subjected to appropriate analytical techniques) · Assumptions and possible pitfalls (assumptions were identified and considered) 		10	
RESULTS & CONCLUSIONS <ul style="list-style-type: none"> · Format of results (the presentation of the results were clear and easy to understand through use of figures and tables; there was not too much information crammed into individual figures or tables; the key findings were highlighted; statistically significant results were highlighted) · Conclusions (the student distilled a set of logical conclusions from the study, supported by the data they collected) · Knowledge of literature (the student was aware of, and drew upon the most recent and relevant literature, s/he made comparison of key findings to other studies) 		25	
PRESENTATION <ul style="list-style-type: none"> · Structure of talk (the talk was well structured, followed a logical sequence and was balanced between the different components (e.g. did not spend 10 minutes on introduction and only three minutes on results and conclusions; participation of group members) · Language (used technically and grammatically correct English; not garbled or rushed, nor stunted with ‘ums’ ‘ers’ etc.; not peppered with slang) · Projection of voice & eye contact (student did not mumble into the overhead or notes, looked up frequently, spoke loudly enough, and projected voice towards the audience) · Fluidity (the presentation was fluid without interrupting stops and starts; it was not simply read from the overhead or slide) · Use of visual aids (suitable use of visual aids to support the understanding of the project by the audience. Included overheads or slides, or PowerPoint slides or pieces of novel equipment, specimens, etc. Not too many, not too few) · Nature of the visual aids (suitable in terms of use of colour, legible font size, appropriate spacing, headings, amount of information/text on each one, etc.) · Timing & finishing off (the talk ended off well, did not just come to an abrupt or hanging halt; was not significantly under or over the allotted time) 		40	

<p>QUESTIONS The student was able to defend his/her approach, results and conclusions, backed up with reference to other research if necessary. They could elaborate confidently and concisely when requested. Did not repeatedly misunderstand questions, nor ramble on for ages in response to a single question; did not contradict themselves between or within answers</p>	15	
TOTAL	100	

Appendix 9: Marking criteria for written practical report

GROUP:	EXAMINER:	Mark allocation	Mark given
INTRODUCTION Title of project is clear. The project is introduced in a logical manner, essentially explaining why the project needed to be done. Refers to other work, and the hypothesis to be tested relative to that work is given		5	
OBJECTIVE & KEY QUESTIONS The student provides a concise statement of what the project set out to address and the specific questions that were to be answered to meet the overall objective		5	
METHODOLOGY <ul style="list-style-type: none"> · Data collection (sample size was adequate; variables measured and tools/approach used matched the key questions; project was not overboard in terms of number of treatments) · Units are clear and all symbols in equations are defined · Data analysis (data were subjected to appropriate analytical techniques) · Assumptions and possible pitfalls (assumptions were identified and considered) 		10	
RESULTS <ul style="list-style-type: none"> · Format of results: presentation of results is clear and easy to understand through use of figures and tables; there is not too much information crammed into individual figures or tables · Findings: the key findings are described; statistically significant results are highlighted · Tables and figures follow the Departmental guidelines 		30	
DISCUSSION AND CONCLUSIONS <ul style="list-style-type: none"> · Arguments: clear and logical; student is aware of, and draws upon the most recent and relevant literature; makes clear comparisons between his/her results and other work in the same field; similarities and differences are considered; possible reasons for differences are offered or hypothesised; comparisons are not obviously biased; comparisons are valid (i.e. across similar vegetation types, socio-economic profiles, climates, etc.) · Implications of results for policy, management, users, further research are made clear, but are not blown out of proportion (e.g., extrapolating from one site to challenge continental or global understanding of the issue) · Conclusions (the student distilled a set of logical conclusions from the study, supported by the data s/he collected) 		40	
PRESENTATION <ul style="list-style-type: none"> · Writing style: language and sentence structure are easy to read; error free; uses appropriate terminology, but is not a litany of jargon; all acronyms are defined in full at first presentation · Structure: overall structure and flow of thinking is logical and clear; follows Departmental guidelines on scientific writing. 		10	
TOTAL		100	

Appendix 10: Environmental Science: Group Assignment: Peer Review

Please complete a review for each member of your group. All ratings will be kept strictly confidential. No group member will see the rating sheets. They will be used only by the lecturer to assess the individual's contribution to the overall group effort.

Student Name: **Student No.** **Group #:** ...

Course:

Assignment: **Date due:**

In the table below there are four criteria according to which each group member should be assessed. These criteria include attendance, reliability, academic contribution, quality of work, behaviour, and share of workload. Against each one of the criteria you are asked to give each student a rating out of five on the following basis:

1. Little or no input or contribution (behaviour = disruptive and uncooperative)
2. Some input but inadequate and below expectations (behaviour = uncooperative)
3. Adequate or average contribution at expected level (behaviour = co-operative)
4. Good, above average contribution (behaviour = co-operative and provided some direction)
5. Excellent contribution (behaviour = provided considerable direction and leadership)

**Please use the following table to rate each member of your group against the four assessment criteria.
Do not evaluate yourself.**

Assessment Criteria	Student Name	Student Name	Student Name	Student Name	Student Name	Student Name
1. Attendance, punctuality and reliability (1-5)						
2. Academic contribution (1-5)						
3. Quality of work produced (1-5)						
4. Share of the workload (1-5)						
Total marks						

Some questions about group dynamics:

1. Did the group decide how to divide up responsibilities and tasks, and delegate tasks?

.....

2. If yes, was the division of responsibilities fair and relatively equally divided?

.....

3. If responsibilities were not equally shared account for why this occurred.

.....

Appendix 11: General guides for the Department of Environmental Science regarding penalties to be imposed in substantiated instances of plagiarism

Note:

These are only a guide to ensure some degree of consistency, and the final penalty imposed can be increased or decreased depending upon extenuating or mitigating circumstances for each case.

Category C offences are automatically referred to the University Plagiarism Committee, chaired by the Vice-Chancellor.

Category A	Suggested penalty	Category B	Suggested penalty
Copying of text from another student: first offence and extent of copying is <10%.	Assignment is marked as normal. The assigned mark is reduced by 15%. Then it is divided by two and assigned to each participant. If the copier owns up s/he will get zero and the lender will get the assigned mark less 15%.	First repeat offence and/or copying >10% of text from another student.	Assignment is marked as normal. The assigned mark is reduced by 30%. Then it is divided by two and assigned to each participant. If the copier owns up s/he will get zero and the lender will get the assigned mark less 30%.
Direct lifting of one or more segments or blocks of text without quotation marks and/or due acknowledgement. First offence and confined to <10% of text.	Mark as normal. Then deduct an absolute 50% from the mark.	Direct lifting of one or more segments or blocks of text without quotation marks and due acknowledgement. First repeat offence and/or >10% of text.	A mark of zero is assigned.
Direct lifting of sentences or phrases scattered throughout other text, without using quotation marks and/or due acknowledgement. First offence and confined to less than 10% of text.	Mark as normal. Then deduct an absolute 40% from the mark.	Direct lifting of sentences or phrases scattered throughout other text, without using quotation marks or due acknowledgement. First repeat offence and/or >10% of text.	A mark of zero is assigned.
Paraphrasing/rewording of a block of text without due acknowledgement and essentially lifting the idea and flow of thought/logic/text from the original source. First offence and confined to <10% of the assignment.	Mark as normal. Then deduct an absolute 30% from the mark.	Paraphrasing/rewording of a block of text without due acknowledgement and essentially lifting the idea and flow of thought/logic/text from the original source. First repeat offence and confined to >10% of the assignment.	A mark of zero is assigned.
Negligent referencing, first offence.	Mark as normal. Then deduct an absolute 15% from the mark.	Negligent referencing, first repeat offence.	A mark of zero is assigned.

Appendix B. Online Experience Questionnaire

Directions: Thank you for your time. There are no right or wrong answers so your first reaction is usually best. Please do not omit any items. Your efforts will help us to identify tasks that are most important for student success. Using the following scale, rate how well each item describes you, by circling your response to the right of each item.

Your participation in this survey is voluntary. Confidentiality of information will be maintained at all times.

Scale: **Strongly Disagree (1)** **Disagree (2)** **Neutral (3)** **Agree (4)** **Strongly Agree (5)**

When navigating Moodle and internet-based learning environments, I prefer that they can ...

1. provide a variety of relevant web links. 1 2 3 4 5
 2. discuss a learning topic through various perspectives. 1 2 3 4 5

In Moodle and internet-based learning environments, I prefer that ...

3. students can discuss each other's ideas 1 2 3 4 5
 4. When contributing to a forum discussion I analyse the successive steps in an argument one by one 1 2 3 4 5

In Moodle and internet-based learning environments, I think deeply about ...

5. how I learn. 1 2 3 4 5
 6. how to become a better learner. 1 2 3 4 5
 7. my own understanding. 1 2 3 4 5

In Moodle and internet-based learning environments, I critically ...

8. evaluate web content. 1 2 3 4 5
 9. judge the value of different perspectives. 1 2 3 4 5

When navigating Moodle and internet-based learning environments, I prefer that they ...

10. display the source of knowledge. 1 2 3 4 5
 11. enable deep exploration about the nature of knowledge. 1 2 3 4 5
 12. Moodle helps me to develop my critical thinking skills when I contribute to the discussion forum. 1 2 3 4 5
 13. A person is available for assistance with Moodle difficulties. 1 2 3 4 5
 14. I doubt whether learning in Moodle is worth all the effort. 1 2 3 4 5
 15. I prefer learning individually rather than being compelled to work with my peers. 1 2 3 4 5
 16. I am capable of attaching files to an e-mail message. 1 2 3 4 5
 17. For the kind of work I would like to do, I need to have skills in using the internet. 1 2 3 4 5
 18. I am a competent internet browser. 1 2 3 4 5
 19. I can download new software when necessary. 1 2 3 4 5
 20. Moodle enabled me to take responsibility for my own learning. 1 2 3 4 5
 21. What **I like** and **dislike** about using Moodle to support my learning:

Things that I like	Things that I dislike
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>

22. I need to interact with my peers and the lecturer in class to learn. 1 2 3 4 5
 23. Overall I would rate my internet skills high. 1 2 3 4 5
 24. Internet makes learning more interesting. 1 2 3 4 5
 25. I doubt whether online learning using Moodle facilitated my learning. 1 2 3 4 5
 26. Moodle created a comfortable learning space. 1 2 3 4 5
 27. In addition to the learning resources in Moodle, I study other literature related to the content of the course. 1 2 3 4 5
 28. Most of my close classmates think that I should be using the internet regularly in my studies. 1 2 3 4 5

Scale:	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
29. All university students are expected to be computer literate.	1	2	3	4	5
30. Overall, the use of the internet will assist my job opportunity and job performance.	1	2	3	4	5
31. My lecturers are very supportive of internet use for class assignments.	1	2	3	4	5
32. The internet is available to me when I need to use it.	1	2	3	4	5
33. My university has supported the use of the internet.	1	2	3	4	5
34. A person is available for assistance with internet difficulties.	1	2	3	4	5
35. I use a diversity of tools on the internet for my studies (e-mail, Explorer, Google search engine, online discussion groups, etc.).	1	2	3	4	5
36. Working with the internet is complicated, it is difficult to understand what is going on.	1	2	3	4	5
37. It takes too long to learn how to use internet to make it worth the effort.	1	2	3	4	5
38. Use of the internet can decrease the time needed for my coursework.	1	2	3	4	5
39. Use of the internet helps improve my learning.	1	2	3	4	5
40. Internet motivates me to explore many topics I may not have seen before.	1	2	3	4	5
41. I use the internet for a variety of tasks (reports, team projects, individual assignment, study collaboration, etc.).	1	2	3	4	5
42. Internet is an effective learning tool because of the multimedia capabilities.	1	2	3	4	5
43. Discussion forums in Moodle can provide stimulating thoughts and enhance my creative thinking skills.	1	2	3	4	5
44. Using Moodle forces me to become an expert in internet technology instead of increasing expertise in my subject.	1	2	3	4	5
45. Use of the discussion forum enhanced my communication skills in collaborative learning.	1	2	3	4	5
46. The internet enabled me to construct my own knowledge.	1	2	3	4	5
47. Use of the internet can significantly increase the quality of output of my coursework.	1	2	3	4	5
48. I will be at an advantage in the job market with my internet skills.	1	2	3	4	5
49. Moodle helps me to combine different modules that are dealt with separately a course into one whole.	1	2	3	4	5
50. I draw my own conclusions on the basis of the data that are presented by other students in the discussion forum.	1	2	3	4	5
51. In Moodle, I do not proceed to a subsequent topic until I have mastered the current topic in detail.	1	2	3	4	5
52. What I like and dislike about using the internet for my learning:					

Things that I like	Things that I dislike
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>

53. Quizzes (multiple choice, true and false, and short answer questions) in Moodle would help me-assess my learning	1	2	3	4	5
54. When I am studying in Moodle, I also pursue learning goals that have not been set by the lecturer but by myself	1	2	3	4	5
55. In general, the internet is very complex to use.	1	2	3	4	5
56. I would test my learning progress by completing questions, tasks and exercises if these were made available in Moodle.	1	2	3	4	5
57. Moodle encouraged students to interact with one another.	1	2	3	4	5
58. Moodle does not add value to my learning.	1	2	3	4	5
59. I have trouble processing large amounts of learning resources in Moodle.	1	2	3	4	5
60. I am interested in using Moodle to facilitate my learning.	1	2	3	4	5
61. More departments should use Moodle to facilitate learning.	1	2	3	4	5
62. I use Moodle to satisfy course requirements and to pass exams.	1	2	3	4	5
63. Using Moodle improved my communication skills.	1	2	3	4	5
64. Moodle helps me to construct an overall picture of a course for myself.	1	2	3	4	5
65. Using Moodle to display the best answers for assignments by my peers would help my learning.	1	2	3	4	5

- Scale:** **Strongly Disagree (1)** **Disagree (2)** **Neutral (3)** **Agree (4)** **Strongly Agree (5)**
66. When learning in Moodle, I add something to the subject matter from other sources from the internet. **1** **2** **3** **4** **5**
67. Moodle enabled me to approach learning from many different angles, including aspects that were previously unknown to me. **1** **2** **3** **4** **5**
68. Working with other students to prepare for our forum discussion improved my learning. **1** **2** **3** **4** **5**
69. Contributing to the discussion forum in Moodle enabled me to work together with my peers for our mutual benefit. **1** **2** **3** **4** **5**
70. I am afraid using Moodle for learning is too demanding for me. **1** **2** **3** **4** **5**
71. Assessing each other's assignments in Moodle will result in timely feedback. **1** **2** **3** **4** **5**
72. Moodle promoted cooperative learning activities. **1** **2** **3** **4** **5**
73. Use of the internet may enhance my interpersonal skills in collaborative learning. **1** **2** **3** **4** **5**
74. Moodle facilitated thoughtful discussions among students. **1** **2** **3** **4** **5**
75. Forum discussions help me to be critical of experts and my peers. **1** **2** **3** **4** **5**
76. What **I like** and **dislike** about group work for my learning:

Things that I like	Things that I dislike
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>

77. Moodle enabled me to reflect on my learning. **1** **2** **3** **4** **5**
78. There were prompt responses to my questions about the use of Moodle. **1** **2** **3** **4** **5**
79. Moodle was used to create an efficient learning environment. **1** **2** **3** **4** **5**
80. Assessing my peers' assignments in Moodle will improve my learning. **1** **2** **3** **4** **5**
81. I can install new software when necessary. **1** **2** **3** **4** **5**
82. Moodle catered for different ways of learning. **1** **2** **3** **4** **5**
83. What proportion of your lectures should be offered online? [0%] [1-10%] [11-25%] [25-50%] [51-75%] [>75%]
84. On average, how many times **per week** do you use the following for learning purposes:
- a. Internet?:
- b. email?:
- c. Moodle?:
- d. sms?:
- e. telephone calls?:
85. Any other comments about using Moodle and the internet for learning purposes:

Comments about Moodle	Comments about internet
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>

86. Demographic information:
- a. Registration number:
- b. State the year you started using a computer:
- c. Do you own a personal computer? [Yes] [No].
- d. Do you have access to internet at your residence? [Yes] [No].

Thank you for your assistance