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# **An Investigation into Facilitating Learning via the Whole Brain Model in the Study Unit of Toothmorphology**

by

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SUMMARY

**An Investigation into Facilitating Learning via the Whole Brain  
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In the future, the educational approach favoured by dental schools will play an important role in stimulating the full development of the dentists of the future. The demands of the workplace are becoming more and more diverse and should academic programmes in dentistry integrate the necessary knowledge, skills and attitudes learners will need to be a successful oral health practitioner.

Currently new legislation is reforming and restructuring education and training in South Africa. These changes are being implemented with a view to raising the quality of education in the country and enabling it to become a bigger international economic role-player. In accordance with the new demands on education and training the School of Dentistry at the University of Pretoria has developed a new curriculum that integrates and includes the new paradigm of teaching and learning in higher education. Key concepts in the new curriculum include critical thinking, problem-solving, co-operative learning (small group learning), learner-centred and outcomes-based learning. In the new paradigm the role of the student changes from a receiver of new information to an active, independent and self-motivated learner, while the lecturer becomes a facilitator of learning that plans, implements and develops learning interventions in order to manage the learning processes of the learners.

During the twentieth century a considerable amount of research concerning learning styles, which emphasizes the fact that individual learners have different approaches to learning. This phenomenon must be taken into consideration when planning meaningful learning interventions for groups of learners with diverse approaches to learning.

The aim of this research is to identify a suitable teaching and learning model that integrates the principles of learning styles while at the same time accommodating the new teaching and learning paradigm in South Africa. The Whole Brain Model of Herrmann that integrates the research of Sperry (Split Brain Theory) and MacLean (Triune Brain Theory) and divides the human brain into four modes of thinking or thinking styles was selected for the purpose of this study.

The study was conducted with a third year group of learners in dentistry. For the purpose of this study the thinking style preferences of the individuals and the group were measured with the HBDI instrument. The facilitator of learning implemented the principles of the model to accommodate the thinking style

diversity of the group as well as to stimulate development of the full potential of the learners. The results of this study indicate a significant improvement in learners' retention, participation and attitudes towards the content, towards learning as well as towards group interaction and problem solving.

This study proposes enhancement of the quality of the learning outcome when integrating the Whole Brain Teaching and Learning Model as part of the educational strategy in facilitating learning in the study-unit of Toothmorphology.

**Key terms:** Toothmorphology; dentistry; whole brain thinking; outcomes-based education; diversity; left brain and right brain; limbic system; Whole Brain Teaching and Learning Model; Whole Brain Model; facilitating learning.

## **CHAPTER 1**

### **1. ORIENTATION TO THE STUDY**

#### **1.1 Introduction**

South Africa is currently in the middle of educational reform. The National Qualifications Framework (NQF) and the South African Qualification Authority (SAQA) are the two governing bodies restructuring education and training in South Africa. The objective of the educational reform is to raise the quality of education in the country, thus enabling it to become a bigger international economic role-player.

The SAQA act which promulgates the concept of outcomes-based education (OBE) and lifelong learning was introduced in 1995. This act underscores change, reform and restructuring of the entire educational system in South Africa. In the new democratic South Africa all citizens have an equal right to education on all levels. More learners of diverse ethnic, cultural, socio-economic and racial backgrounds are now studying at higher educational institutions in South Africa than ever before.

The School of Dentistry at the University of Pretoria has implemented a new curriculum to meet the demands of the new system. The new curriculum now spans a period of five years instead of the previous five and a half-years of study. Dentistry, like most sciences in the twenty-first century, is expanding rapidly with new knowledge, concepts and technologies. This growth in what the learners have to learn (knowledge, skills and attitudes) in a reduced time-span necessitates educational strategies that will enhance the quality of learning.

The new educational paradigm's foundation and focus are the learner and learning. Educators are encouraged to adopt strategies that will foster the development of the critical outcomes set by SAQA (1997:24). The critical outcomes determine the specific outcomes envisaged in each field of specialization. The following critical outcomes have been adopted for the

study unit of Toothmorphology as part of the Module of Odontology. The learner should be able to demonstrate the following:

1. *Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made.*

As a professional a dentist needs to make responsible decisions in everyday practice, which includes the diagnosis and treatment of diseases of the oral environment. Being critical and creative thinkers when dealing with people and solving their health problems as well as managing a practice is becoming all the more important for professionals in all walks of life because of the demands made by modern society.

2. *Work effectively with others as a member of a team, group, organization, and the community.*

It is inevitable for a dentist to work as part of a team and it is of paramount importance to learn how to function effectively with others in this particular professional context.

3. *Organize and manage himself/herself and his/her activities responsibly and effectively.*

Healthcare professionals like a dentist need to be responsible and organized when dealing with appointments, patient information and administrative duties.

4. *Collect, analyze, organize and critically evaluate information.*

A dentist must have the ability to collect information regarding a specific problem and to analyze, organize and critically evaluate the information with a view to making a diagnosis and deciding on a treatment plan for the problem. A dentist should also be able to collect relevant information regarding different aspects of everyday practice, e.g. a health problem of a patient, a business problem, an employee problem, and information on new technologies, skills and knowledge.

5. *Communicate effectively using visual, mathematical and/ or language skills in the modes of oral and/ or written presentation.*

Dentists must be able to communicate with patients, colleagues, oral hygienists, dental assistants and other employees about relevant issues in dentistry by using different media as well as oral and written presentations.

The following developmental outcomes that were adopted by SAQA (1997:25) are also included as important critical outcomes for learning in the study unit of Toothmorphology. These outcomes state that it must be the intention of any learning programme to make the learner aware of the importance of the following:

1. *Exploring and thinking about a variety of learning strategies in order to learn effectively.*

Currently learning theory underscores the importance of learners' understanding their own thinking preferences and getting the opportunity of exploring and developing diverse thinking and learning strategies. This will empower learners and help them to learn more effectively and to become lifelong learners.

2. *Responsible participation in the community.*

As a healthcare provider in the community the dentist needs to be a responsible person that other people can trust.

3. *Being culturally and aesthetically sensitive across a range of social contexts, which includes race, religion and language.*

Dentists must be aware of the diversity in the community and be able to show the necessary and equal respect for every patient.

The ultimate vision embodied in the critical outcomes is to help develop literate, creative and critical citizens in South Africa who will lead a productive and self-fulfilled life (Van der Horst & McDonald, 1997:7).

## **1.2 Motivation for this study**

The new SAQA Act (1995) promulgates outcomes-based education (OBE) and lifelong learning that supports a learning-centred approach in which

learners take responsibility to learn while lecturers act as facilitators of learning. This move from the traditionally lecturer-centred to a learning-centred approach implies a vital paradigm shift from being a lecturer to a facilitator of learning. Research in education and psychology in the previous two decades emphasized the diverse preferences or styles of learning of individual learners. To help learners maximize their potential when learning new knowledge, skills and attitudes these preferred modes must be accommodated during learning interventions. The motivation for this study is to investigate the use of a model that will comply with the principles of OBE, enhance the process and quality of learning, cater for the individual needs of each learner and promote learning style flexibility.

### **1.3 Role of the study unit of Toothmorphology in the BChD curriculum**

Dentists prevent and heal diseases in and around the human oral cavity. Most work in this regard requires dentists to repair and replace broken or diseased toothstructure. They need to have the necessary knowledge, skills and attitudes to practice their profession effectively. In the science of dentistry dentists strive after restoring form and function in the oral cavity in the most effective way for every situation. In the third year of the BChD curriculum the study unit of Toothmorphology familiarizes learners with the anatomy and structure of healthy toothstructure in the human oral cavity. Knowledge of each individual tooth's morphology helps dentists to restore lost structure to the best functional and aesthetical level possible.

### **1.4 Problem statement**

The SAQA Act (1995) requires facilitators of learning to use innovative and creative learning-centred strategies to complement OBE and lifelong learning to maximize the potential of all learners. Lecturers in dental education should focus their attention on a few scenarios and problems before employing a specific model to facilitate learning:

1. Less than twenty-five percent of the permanent full-time lecturers in the School for Dentistry at the University of Pretoria had formal training in the science of education (Faculty of Health Sciences, 2001:1).
2. Traditionally, educational practices in the dental curriculum at the University of Pretoria were lecture-based. Content was mainly delivered via lectures using notes and textbooks. This practice caters mostly for strong left-brain learners and focuses on the knowledge of the lecturer and delivery of that knowledge to the learners.
3. Currently there is no inclusion of whole brain learning (thinking style diversity) in the dental education curriculum.

Lecturers in dentistry are faced with the problem of selecting and using an educational model that will assist the facilitation of learning in such a way that learners will successfully achieve the critical and the specific outcomes of the curriculum.

### **1.5 Rationale for this study**

The future of the dental profession rests on two important academic processes. Academics, on the one hand, have to facilitate the process of learning of novice learners who have to become competent professionals. Learners on the other hand enter the learning environment to acquire and develop the necessary knowledge, skills and attitudes to become professionals that will be lifelong learners maximizing their potential. The rationale for conducting this study is the investigation and implementation of an educational model that can foster learning facilitation and learning per se in the study unit of Toothmorphology while accommodating the paradigm of OBE.

### **1.6 Formulation of the research hypotheses**

The following research hypotheses have been formulated for this study:

- ◆ A whole brain approach enables the facilitator of learning to create a learning environment that empowers learners to maximize their potential.



- ◆ Whole brain learning accommodates and develops the expectations learners have about learning and thus makes learning more enjoyable, effective and productive.

The hypotheses will be investigated by means of a literature study, qualitative observation, statistical analysis of learner performances and qualitative assessment via questionnaires.

## **1.7 Research methodology**

The research for this study includes a literature study, empirical research and action research.

1.7.1. The literature study will investigate the following:

- ◆ The SAQA Act (1995) and outcomes-based education (OBE).
- ◆ Different strategies for effective learning facilitation.
- ◆ Available learning style models.
- ◆ The research by Sperry and MacLean.
- ◆ The Metaphoric Four Quadrant Whole Brain Model.

1.7.2. An empirical research study will be done on the use of the Herrmann Brain Dominance Instrument (HBDI) and the Metaphoric Four Quadrant Whole Brain Model to facilitate learning of a BChD III group of learners in the study unit of Toothmorphology. This research will include the following:

- ◆ Qualitative observation (directly and indirectly through the use of personal notes, video-recordings and photography).
- ◆ Determining and describing the learners' preferred modes of learning (quantitative research).
- ◆ Comparing the learners' M-scores (matriculation results) with their preferred modes of thinking via the HBDI (quantitative research).
- ◆ Statistical analysis and description of the results of questionnaires learners have completed on the quality of their own learning and the process of facilitating learning that is used during learning opportunities (quantitative research).

- ◆ Statistical analysis and description of the learners' scores in three tests (quantitative research).

1.7.3. Action research is used as part of this study to evaluate the educational strategy of the study unit of Toothmorphology critically in order to identify problems and to improve its teaching practice on an ongoing basis.

## **1.8 Terminology**

### ***Action research***

A collaborative, critical inquiry by the academics themselves (rather than expert educational researchers) into their own teaching practice, into problems of students learning and into curriculum problems (Zuber-Skerritt, 1992:1-2).

### ***Assessment***

Assessment is a strategy for measuring knowledge, behaviour or performance, values or attitudes (Van der Horst and McDonald, 1997:169).

### ***Cognition***

Cognition is the mechanism by which the brain acquires, processes, and uses knowledge.

### ***Cognitive domain***

The cognitive domain includes learning outcomes that relate to the head or intellect, such as memory, understanding and reasoning (Van der Horst and McDonald, 1997:37).

### ***Commisurotomy***

Commisurotomy is a procedure whereby the corpus callosum, a structure in the brain that connects the left and right hemispheres of the brain, is surgically split in two.

### ***Competency***

Competency is the term that comprises knowledge, skill and ability, and relates to the application of that knowledge and skill within an occupation or industry level to the standard of performance required in employment (SAQA, 1997).

### ***Co-operative learning***

Co-operative learning manifests when learners in small groups cooperate to learn with a deliberate attempt to maximize their human potential (Slabbert, 1997:175).

Co-operative learning involves working together to accomplish shared goals, using skills that benefit each group member (Singhanayok and Hooper, 1998:18).

For the purpose of this dissertation co-operative learning implies that learners use group work to maximize their potential.

### ***Corpus callosum***

The corpus callosum is a thick band of nerve fibers that connects the left and right sides of the brain (Herrmann, 1995:10).

### ***Creativity***

Creativity is a personal interaction with an idea, with material, or with a problem. It is a process that requires sequences and activities unique to the individual and that results in a product, an acquired skill, or a modified behaviour (Steinaker and Bell, 1979:91).

For the purpose of this dissertation creativity implies that a learner uses unusually innovative thinking and understanding to solve problems or perform tasks.

### ***Critical thinking***

Critical thinking refers to thinking at a high level of complexity where thought processes such as understanding, analysis, synthesis, application and evaluation are involved. Critical thinking includes more than just the intellectual domain of human functioning as it is supported by other domains, such as the emotional domain (SAQA, 1997:217).

Critical thinking is a logical process of interaction and of making choices with given sets of variables and manifests itself taxonomically as the process of interaction and of making choices develops (Steinaker and Bell, 1979:96).

### ***Curriculum***

The curriculum is the total structure of ideas and educational experiences making up any one educational system or its component parts. It includes the following:

- ◆ Decisions on the structure of the entire learning programme.
- ◆ The formulation of outcomes.
- ◆ Decisions on the content to be included.
- ◆ The strategies for facilitating learning and methods to be used.
- ◆ Choice of media.
- ◆ Assessment techniques.
- ◆ Evaluation (adapted from SAQA, 1997:36).

### ***Deep learning***

The deep approach to learning involves an active attempt by the student to understand the instructor's intended meaning and to relate the ideas presented in the classroom to the student's prior experiences and knowledge (Hendricson, Berlocher and Herbert, 1987:175).

For the purpose of this study deep learning occurs when a learner is actively using existing knowledge to create meaning of new information thereby altering his or her knowledge of the content.

### ***Evaluate***

To evaluate means to give one's own opinion about a topic, using certain standards as a basis (Van der Horst and McDonald, 1997:180).

### ***Evaluation***

Evaluation is the process of making a decision about the learning of the learner, using information gained from formal and informal assessment (Van der Horst and McDonald, 1997:169).

### ***Facilitator of learning***

For the purpose of this study the facilitator of learning is the lecturer that is responsible for guiding the instructional and learning processes.

### ***Facilitating learning***

Facilitating learning is a deliberate, conscious intervention in the life of a human being caused by activating learning through challenging obstacles which necessitate exploration into the unknown and by ensuring the continuation of that learning which results in maximizing the potential of the human through conquering the obstacles (Slabbert, 1997:31).

### ***Formative assessment***

Formative assessment helps learners to improve their performance, maximize their learning and reflect on and improve their own learning – it forms and shapes learning (Van der Horst and McDonald, 1997:168).

### ***Hemispheric dominance***

Hemispheric dominance refers to the degree to which each brain hemisphere tends to assume control of information processing and behaviour when given a chance to do so (Hellige, 1993:15).

### ***Learning***

Learning is the acquisition of new memories (Bridgeman, 1988:365).

Learning is the relative permanent change in an individual's attitude or behaviour that occurs as a result of repeated experience (Simms and Simms, 1995:2).

Learning is defined by the APA Division 15 Committee on Learner-centred Teacher Education for the 21st Century (1995), adapted from Gourgey (1998:81), as a process of creating meaningful representations of knowledge through internally mediated processes including self-awareness, self-questioning, self-monitoring, and self-regulation.

For the purpose of this dissertation learning is a lifelong process of change that is driven by the continuous integrated input and practice of knowledge, skills and attitudes to satisfy the demands of the future.

### ***Learning programme***

A learning programme consists of courses or units of learning, learning materials combined with a methodology, by which learners can achieve agreed-upon learning outcomes (SAQA, 1997:37).

### ***Learning style***

Learning style refers to an individual's characteristic mode of gaining, processing, and storing information during an educational experience (Carrier, Newell and Lange, 1982:652).

### ***Learning theory***

For the purpose of this dissertation learning theory is described as the effort by researchers to explain the process of learning and the learner.

### ***Lifelong learning***

Lifelong learning is a term that is associated with the continuous process of continually discovering one's own potential to fulfil our purpose in life as long as we live (Slabbert, 1997:29).

### ***Meaningful learning***

Meaningful learning is learning which can be related to existing aspects of the learner's conceptual structure (Lovell, 1980:161).

### ***Memory***

Memory is the human ability to access information in the brain that was experienced or stored previously; memory has been described as a link to the past (Beitz, 1996:164).

### ***Metacognition***

Metacognition is the intra-personal communication process by which individuals know their personal cognitive processes and the use of critical thinking (Beitz, 1996:164).

### ***Metacognitive knowledge***

This comprises three types of knowledge, namely *self-knowledge*, *task knowledge* and *strategy knowledge* and refers to a learner's cognitive ability and skill to use these during learning.

### ***Metalearning***

Metalearning is the process of knowing one's personal learning behaviours (Beitz, 1996:159).

### ***M-Score***

The M-Score comprises the allocation of different numerical values to the symbols attained in matriculation subjects, depending on whether the subject was passed at Higher Grade or at Standard Grade by the candidate (Van Dyk, 1992).

### ***Outcomes***

Outcomes are the results of learning processes. It may include formal or informal learning activities and refers to knowledge, skills, attitudes and values that are learnt within particular contexts. The outcomes are what the

learners should be able to demonstrate to show that they understand and are able to apply the content (SAQA, 1997:4).

### ***Paradigm***

A paradigm is a basic way of perceiving, thinking, and doing - associated with a particular vision of reality. It can be classified as a framework of thought (SAQA, 1997:217).

### ***Problem solving***

Problem solving is the process through which the learner draws upon his repertoire of previously learned responses to find a solution to a new problem (Lovell, 1980:162).

### ***Rote-learning***

Rote learning occurs when material is learned by heart in a parrot fashion without it being related in any meaningful way to the learner's existing conceptual structures (Lovell, 1980:163).

### ***Surface learning***

The surface approach to learning is characterized by a tendency to memorize discreet facts, to be anxiously aware of the need to reproduce this information during a test, and to view any particular learning tasks in isolation from all other course work and from other events in the student's academic life (Hendricson et al., 1987:175).

## **1.9 Outlining of chapters**

*Chapter 1:* Chapter 1 introduces and justifies the study describing the role of the study unit of Toothmorphology in the BChD curriculum of the School of Dentistry at the University of Pretoria, stating the problem it investigates, formulating a research hypothesis and outlining the research methodology of the study.



*Chapter 2:* This chapter discusses outcomes-based education and describes the roles of the learner and the facilitator of learning. Effective strategies to facilitate learning including co-operative learning, meta-learning, theories of learning and learning styles are discussed. It includes an evaluation of different learning style models and outlines the reasons for using the Whole Brain Teaching and Learning Model as part of this dissertation.

*Chapter 3:* This chapter discusses traditional instruction in the study unit of Toothmorphology as well as facilitating learning using the Whole Brain Teaching and Learning Model. Diverse teaching interventions that were planned and implemented during learning sessions to accommodate and develop the learners in the group are discussed. This study also includes the use of action research as part of this study.

*Chapter 4:* In this chapter the results and statistics of the empirical research of this study are described and discussed. This includes the HBDI profile of the group, test scores during the study and the learners' M-Score. The chapter also describes the feedback from the learners after receiving instruction via the Whole Brain Teaching and Learning Model. Finally it reports on learner assignments and projects that were completed as part of the learning outcomes for this study.

*Chapter 5:* In this chapter the results and findings of the study are summarized and the importance of diversity during the facilitation of learning is illuminated. In this chapter the implementation of the Whole Brain Teaching and Learning Model in facilitating learning in dentistry is justified. The chapter also discusses the relevance of this model in the development of the critical and developmental outcomes of the learners, thus accommodating the new paradigm of learning in South Africa. This chapter concludes with the findings of this study and recommends further areas of research.

## CHAPTER 2

### 2. LEARNING IN HIGHER EDUCATION

#### 2.1 Learning in South Africa

##### 2.1.1 Introduction

This section describes the new paradigm for education and training in South Africa that propagates outcomes-based education (OBE) and lifelong learning. The focus is on what OBE entails and the new roles of the lecturer as facilitator of learning and the student as learner.

##### 2.1.2 A new education and training act

A new act for education in South Africa was promulgated on 4 October, 1995: the South African Qualifications Authority (SAQA) act. According to the SAQA document (1997:11) on Outcomes-Based Education (OBE) in South Africa, the vision of this new National Education Policy is to enable people “*to value, have access to and succeed in lifelong education and training of good quality*”. This is in line with the goal to re-engineer a system that will structure education and training to enable South Africa to become an international economic role-player.

The decision was taken to move from a content-based curriculum to an outcomes-based learning programme in order to accommodate and develop the needs of the people of South Africa with a view to keeping up with international trends in learning. The aim is to develop literate, creative and critical citizens in South Africa who will lead a productive and self-fulfilled life (Van der Horst & McDonald, 1997:7), also confirmed by Olivier (1998:21) with the following statement:

*The purpose of education and training is to prepare learners for life in society and for performing a job.*



### 2.1.3 A new paradigm for learning

The SAQA act (1995) and OBE pave the way for a *new paradigm* in education and training in South Africa where all learners have equal access to all learning institutions responsible for upgrading the nation through learning. This new paradigm for education and training in South Africa aims to make education more relevant, accessible and transparent to non-educators (learners, and the wider public). In the old paradigm education was demarcated by a fixed curriculum that was prescriptive and detailed; it restricted teacher-initiative. In the old paradigm the curriculum, being central to the education process, was a non-participative activity for lecturers or the public (SAQA, 1997:6-12).

**Table 1: Comparison between the old and the new paradigm of learning**  
- a synthesis of Van der Horst and McDonald (1997:27) and Olivier (1998:39)

| Old Paradigm  | New Paradigm   |
|---|--|
| ♦ passive learners  | ♦ Active learners  |
| ♦ Examination-driven learning                             | ♦ Critical thinking, reasoning, reflection   |
| ♦ Rote-learning of content                                | ♦ An integration of knowledge; learning is process and outcomes driven and real-life problems are used to drive learning |
| ♦ Syllabus is content-based and broken down into subjects | ♦ Learning programmes are outcomes-based   |
| ♦ Content placed in rigid time frames                     | ♦ Flexible time-frames   |
| ♦ Syllabus is rigid                                       | ♦ Learning programmes seen as guides that allow lecturers to be innovative and creative in designing programmes          |
| ♦ Lecturer-centred  | ♦ Lecturer is a facilitator of the learning process; learner is the centre of attention                                  |
| ♦ Emphasis on what the lecturer hopes to achieve          | ♦ Emphasis on outcomes – what the learner achieves   |
| ♦ Lecturers responsible for learning                      | ♦ Learners responsible for own learning  |
| ♦ Curriculum development process not open to the public   | ♦ Wider community involvement is encouraged  |
| ♦ Assessment via tests and exam                           | ♦ Continuous assessment, peer-   |

assessment, self-assessment

According to Table 1 learners in the new paradigm are actively engaged in aspects such as critical thinking, reasoning and reflecting on what they are learning and are made responsible for their own learning. The lecturer is merely the facilitator of learning that guides learning through creative and innovative learning programme design in order to assist, manage, coach and direct learners to acquire the set learning outcomes.

#### **2.1.4 Defining outcomes-based education**

Outcomes-based education (OBE) is an approach to learning in which learning facilitators and learners focus their attention and effort during the learning process on the stated end result of learning. In an effort to describe this approach to learning Van Schalkwyk (1999:1) states that:

*OBE - Focuses curriculum, instruction, and measurement/ assessment on the desired student outcomes; the knowledge, competencies, and qualities students should be able to demonstrate when they finish.*

Olivier (1998:20) describes OBE in the following words:

*Outcomes-based learning reflects the notion that the best way to get where you want to be, is to first determine what you want to achieve. Once the end goal (product, outcome, etc.) has been determined, strategies, techniques and other ways and means will be put into place to achieve the goal.*

It is concluded for the purpose of this dissertation that OBE focuses the total educational strategy (curriculum development, facilitation of learning and assessment practice) on what learners should be able to demonstrate after completion of a learning programme.

### **2.1.5 Characteristics of outcomes-based education**

Boschee and Baron, adapted from SAQA (1997:17), give the following summary of the characteristics of OBE:

- ◆ What learners are to learn is clearly identified
- ◆ Each learner's progress is based on demonstrated achievement
- ◆ Each learner is provided the time and assistance to realize his/her potential
- ◆ Each learner's needs are accommodated through multiple teaching and learning strategies and assessment tools

Meeting the learning needs of each individual learner is an important aspect within the new paradigm for learning. The design of learner-centered educational strategies is an ongoing process based on meeting these needs during learning (Olivier, 1998:51).

The new paradigm focuses on a learner-centred results-orientated approach instead of the outdated teacher-centred content-driven approach. The learner is an active participant during the learning process and the focus shifts from teaching to learning (SAQA, 1997:17).

### **2.1.6 Role of the learner in outcomes-based education**

In OBE the learners are provided with the necessary guidelines, assistance and time in order to maximize their potential. According to Van der Horst and McDonald (1997:14) (1997:211) all learners have to:

- ◆ Be responsible, self-directed, independent and productive learners
- ◆ Think purposefully and critically
- ◆ Be problem-solvers
- ◆ Communicate effectively
- ◆ Work hard
- ◆ Take responsibility for their own learning
- ◆ Be more independent in their learning and thinking

- ◆ Assess own progress apart from the facilitator's assessment

Rather than just acquiring knowledge, learners have to develop the ability to criticize, reason, solve problems, think and apply knowledge within the applicable context. The emphasis for the learner is on what is to be mastered, to acquire the specific outcomes of a learning programme successfully through learning and developing the necessary skills (psycho-motor), knowledge (cognitive), and attitude (affective).

Olivier (1998:60) reasons that the goal of learning via OBE prepares learners for the opportunities in the real world. He states that:

*The objective of OBE training is to enable each learner to accomplish knowledge and skills as well as mastering processes necessary to accept the challenges and opportunities of the world of the future.*

### **2.1.7 Role of the facilitator of learning in outcomes-based education**

In OBE the lecturer directs learners to acquire, integrate and find meaning in knowledge and help them implement new knowledge, skills and attitudes. The lecturer functions as a facilitator of learning that has the responsibility of planning, managing, and implementing learning programmes by using creative and innovative instructional design strategies and processes (SAQA, 1997:19).

The facilitator and learner are engaged in a "partnership" of learning where both have a responsibility for learning to take place. Van der Horst and McDonald (1997:93) refer to the fact that effective facilitators of learning hold themselves and the learners accountable for the learning process. Olivier (1998:61) explains that OBE requires facilitators to:

- ◆ Provide guidance to how and where information can be found.
- ◆ Provide information that is inaccessible, or needs to be explained to the learner.

- ◆ Demonstrate aspects of a learning programme that need demonstration.
- ◆ Help learners to build on acquired knowledge.
- ◆ Confirm the progress of a learner on a continuous basis.
- ◆ Guide the process and progress of achieving the outcomes.
- ◆ Match the learning context with learning styles.
- ◆ Make learning relevant of the workplace.
- ◆ Stimulate creativity in the learners by self-learning, self-development, and higher order thinking.

The Department of Education printed in the Government Gazette (South Africa, 2000) the norms and standards for educators in higher education as a national policy. These norms and standards are summarized into seven roles and associated competencies, which exemplify the competent facilitator of learning or educator. The seven roles of a competent educator are as follows:

#### **2.1.7.1 Learning mediator**

The facilitator mediates learning in a manner that accommodates the diverse needs of learners. The learning mediator demonstrates the following practical competencies:

- ◆ The use of problem-based tasks and projects.
- ◆ Appropriate use of group-work.
- ◆ Adjustment of teaching strategies to cater for different learning styles and preferences for learning.
- ◆ The creation of a learning environment in which learners develop strong internal discipline.
- ◆ The creation a learning environment in which critical and creative (whole brain) thinking by learners is encouraged.
- ◆ The effective use of common teaching resources like charts, textbooks and whiteboards appropriately.
- ◆ The effective use of popular media and everyday resources like newspapers, magazines and other artifacts from everyday life.

- ◆ The effective use of media like overhead projectors, video and computers.

#### **2.1.7.2 Interpreter and designer of learning programmes and materials**

This role of the facilitator requires the understanding and interpretation of provided learning programmes, the design of original learning programmes and the identification of the requirements for a specific context of learning. As a designer the learning facilitator selects and prepares suitable textual and visual resources for learning. The practical competencies include the following:

- ◆ Interpreting and adapting learning programmes so that they are appropriate for the context in which learning will occur.
- ◆ Designing original learning resources including charts, models and worksheets.
- ◆ Evaluating and adapting learning programmes and resources through the use of learner assessment and feedback.

#### **2.1.7.3 Leader, administrator and manager**

As a leader and manager of the learning process the facilitator takes control, makes appropriate decisions and implements new strategies or controls. As administrator the learning facilitator keeps a record of learning progression, planning of learning, feedback from learning and learners as well as his or her continuous development of the curriculum. The following are the practical competencies for this role of the facilitator:

- ◆ Constructing a classroom atmosphere, which is democratic but disciplined.
- ◆ Managing learning in various situations (group-work, individualized learning contents) and in different educational contexts.
- ◆ Keeping good records of learning.

#### **2.1.7.4 Community, citizenship and pastoral role**

This role puts an emphasis on the responsibility of the facilitator to have respect for and act responsibly towards others and to develop an environment that



supports and empowers learners during learning. This role includes the following practical competencies:

- ◆ Developing life-skills.
- ◆ Demonstrating caring, committed and ethical professional behaviour.
- ◆ Developing the whole person.

#### **2.1.7.5 Scholar, researcher and lifelong learner**

This role requires the facilitator to take the responsibility for his or her own ongoing personal, academic, occupational and professional growth by doing reflective study and research in his or her field of specialization. The practical competencies for this role include:

- ◆ Upholding the principles of academic integrity and the pursuit of excellence in the field of education.
- ◆ Being numerically, technologically and media literate.
- ◆ Applying research meaningfully to educational problems.

#### **2.1.7.6 Assessor**

This role requires the facilitator to use assessment as an integral part of the learning process. It requires the facilitator to understand the purposes, methods and effects of assessment. The practical competencies of this role include the following:

- ◆ Making appropriate use of different assessment practices.
- ◆ Assessing in a manner appropriate to the field of specialization.
- ◆ Providing feedback to learners in sensitive and educationally helpful ways.

#### **2.1.7.7 Learning area specialist**

This role requires the facilitator to be well grounded in the knowledge, skills, values, principles, methods and procedures relevant to the field of specialization or occupational practice. The practical competencies of this role include the following:

- ◆ Adapting general educational principles to the field of specialization.

- ◆ Selecting methodologies appropriate to learners and contexts of learning.
- ◆ Facilitating learning in a manner, which allows learners to transfer knowledge and use it in different contexts.

The facilitation of learning puts a responsibility on the lecturer to incorporate these roles into his or her educational practice. Ultimately the role of the facilitator is to assist learners to be successful during learning by introducing necessary educational strategies that will maximize the potential of all learners.

### **2.1.8 Facilitating learning in outcomes-based education**

To achieve the goals of the new paradigm SAQA (1997:43) has proposed some new strategies for teaching and learning:

1. A culture of learning or learner-centred culture should be developed in educators and learners.
2. Progression should occur on a learning continuum at the cognitive, affective and psychomotor levels.
3. A climate reflecting a friendly atmosphere should be developed and motivating learners with a view to optimizing learning should be given priority.
4. Balance should be maintained between individual, group and class work.
5. The following could be implemented:
  - ◆ Applying the holistic approach by facilitating learning through role-play, music, simulation and games, using multimedia and a variety of resources e.g. magazines, journals, newspapers, videotapes, etc.
  - ◆ Teaching through a variety of ways: e.g. discovery, investigation or using the problem-solving inquiry approach.
  - ◆ Relating outcomes to real-life situations.
  - ◆ Allowing for different creative thinking strategies.
  - ◆ Encouraging communication at all levels.
  - ◆ Using effective classroom management.

Alignment is a central component of the educational system in OBE, where the curriculum, instruction and assessment practices are matched to the outcomes of learning. The goal of the educational process is to promote meaningful learning. Meaningful learning develops new skills, knowledge, and attitudes that will help to develop new capabilities (Van der Horst & McDonald, 1997:27).

### **2.1.9 Assessment in outcomes-based education**

Assessment, as part of the total educational strategy (curriculum development, teaching/ facilitating of learning and assessment), is used to measure knowledge, skill and behaviour during the learning process. The assessment practice in OBE should not only take into account *what* learners have to learn and *why* they have to learn it but also *how* they should learn.

For each specific learning programme assessment should be aligned with the outcomes learners must achieve. It should therefore not focus on single opportunities using outdated assessment strategies but rather be comprehensive and holistic including variety and continuous assessment (Van der Horst & McDonald, 1997:168).

Assessment in the new paradigm is an ongoing process assisting the learner and learning facilitator to monitor the learning progress continuously against the critical and specific outcomes for the learning programme. The following strategies for assessment in OBE are proposed by SAQA (1997:33), and adapted to the context of higher education:

#### **◆ Portfolio assessment**

The portfolio must have a clear intent. A portfolio can be evidence of student work, or a deliberate strategic and specific collection of student work.

#### **◆ Performance assessment**

Learners have to demonstrate specific skills.

◆ **Lecturer-made tests**

Tests are a valuable tool in the teaching and learning process that provides the learning facilitator and the learner with feedback concerning previous learning. The information provided to the learning facilitator also helps with the planning and development of instruction.

◆ **Self-assessment**

During self-assessment the learner measures his own knowledge, skill and attitude. Self-assessment helps the learner to focus on what is to be learnt and to be self-responsible.

◆ **Peer-assessment**

During peer-assessment the learner measures the knowledge, skills and attitudes of his peers in the same learning programme. Peer-assessment is valuable to use in conjunction with self-assessment and performance-assessment.

◆ **Other assessment strategies**

Another assessment strategy could include direct observation and the use of a journal by the facilitator to collect data from learning interventions for assessment purposes.

Not all assessment strategies are suitable for the assessment of learning in the different learning programmes or different contexts of learning. The learning facilitator selects the best assessment strategy for the specific outcomes that he or she wants to assess. The best assessment strategy helps the learning, thus facilitator and learner to gather data or feedback about previous learning enabling them to adapt the facilitating of learning or learning strategy to enhance or improve learning (SAQA, 1997:33).

## **2.2 Tools and strategies for facilitating learning in the context of outcomes-based education**

### **2.2.1 Introduction**

In the new paradigm of OBE the facilitator of learning has the responsibility of designing and implementing an educational strategy that will enhance learning so that the learner will be actively involved, motivated and challenged to acquire the knowledge, skills and attitudes necessary for reaching the outcomes.

The facilitator should therefore be familiar with utilizing a variety of educational tools or interventions that are available for effective facilitating of learning. In this section research on co-operative learning, meta-cognition, meta-learning, learning theory and learning style will be discussed as tools or interventions for effective facilitating of the learning process.

### **2.2.2 Co-operative learning**

#### **□ Defining co-operative learning**

Slabbert (1997:175) warns that learning facilitators must not mistake co-operative learning for group work although it does involve learners to work in groups. He says that utilizing co-operative learning assists learners to co-operate to learn and thus learn more efficiently.

Singhanayok and Hooper (1998:18) explain co-operative learning as follows:

*Co-operative learning involves working together to accomplish shared goals, using skills that benefit each group member. Co-operative learning encourages students to discuss, debate, disagree, and ultimately to teach one another.*

These definitions describe co-operative learning as a strategy learning facilitators can utilize to facilitate learning by organizing learners in groups to co-operate while learning. During co-operative learning the facilitator uses problems or tasks

to challenge each learner in each group to construct meaning. The learner constructs new meaning, using the group members' existing knowledge and understanding of the content.

For the purpose of this study co-operative learning manifests itself when learners in a group work together to maximize their potential.

□ **Reasons for implementing co-operative learning**

Davidson, adapted from Slabbert (1997:189), gives the following reasons for implementing co-operative learning:

- ◆ It provides a social support system for learning.
- ◆ In the group learners can help and support each member with everyday personal problems. This will help to build strong relationships and facilitate an atmosphere of understanding and caring in the group.
- ◆ It offers opportunities for success to all learners by helping one another to achieve a common goal.
- ◆ Learners help one another to understand and have better insight into that which is learned. By encouragement and support all learners can come to a common understanding of the content.
- ◆ It provides opportunities for learners to challenge one another's ideas, which in turn improves the quality of learning.
- ◆ Exchange of different insights, understanding and information between learners in a group helps the group to have a better perspective and more possible options to choose a solution from.
- ◆ Different approaches of solving problems are being experienced.
- ◆ More possibilities are generated within a group.
- ◆ Through explaining to one another, concepts become clearer to one.
- ◆ Learners construct a new and better understanding of the content while communicating about it.
- ◆ One learns by talking, listening, explaining and thinking with others.

- ◆ Talking, listening and explaining requires processes of thinking and by implementing these into learning activities makes the learner active during the learning process.
- ◆ It creates the opportunity to practise and refine the ability to grow in communication within the norms of a learning programme.
- ◆ A safe and comfortable environment helps the learner to be more spontaneous and confident to give his or her insight and opinion about the content.
- ◆ It offers opportunities for creative thinking and solving problems.
- ◆ All learners have a creative ability within them that can be used to do, create or solve problems (Steinaker & Bell, 1979:91). The earth is evidence of a creative Creator. As humans we are all part of this creative work and were made to be creative in thinking or doing. Co-operative learning assists the facilitator in putting the responsibility of learning in the hands of the learners. This gives learners the opportunity to be creative in their thinking and actions and to become meaningful learners.
- ◆ Groups can handle difficult situations that are well beyond the capabilities of an individual learner.
- ◆ A group has more options, possible answers, variety and strengths to use during a difficult situation than only one individual learner.
- ◆ It supplies the scope to maximize social skills, which are the essence of interdependence.
- ◆ Life is about relationships - with the Lord, spouse, children, family, colleagues, friends and neighbours. Using co-operative learning helps to facilitate relationships.

□ **Experience with co-operative learning**

Extrovert and active learners lead and speak more easily in a group, helping the others to understand new context at a higher cognitive level. Speaking and reasoning in a group stimulates learners to higher cognitive levels and enables them to reflect on what they have learnt.

Introvert and less active learners also benefit from co-operative learning by getting a chance to share thoughts and also having responsibility to help solve problems or construct meaning within the group. It assists the development of the less active learner's self-respect and confidence by being more actively involved and responsible during learning (Lord, 1998:587).

□ **Benefits of using co-operative learning**

Previous work by Kleffner and Dadian (1997:66), Olivier (1998:17) and Sobral (1998:118) describes a variety of benefits that co-operative learning helps to develop during learning:

- ◆ Collecting, analyzing, organizing and critically evaluating information.
- ◆ Communicating more effectively.
- ◆ Identifying and solving problems.
- ◆ Using critical and creative thinking.
- ◆ Contributing to the full personal development of each learner and the social and economic development of the society at large.
- ◆ Taking responsibility for own learning.
- ◆ Developing a more positive attitude towards the learning programme.
- ◆ Validating and measuring their own opinions against those of their peers.
- ◆ Recalling and applying the necessary information more often in the clinical setting.
- ◆ Developing skills to be a lifelong learner.
- ◆ Professional behaviour skills.

Co-operative learning assists the mastering of some of the critical outcomes in OBE. This is very significant since the goal of facilitating learning in the new paradigm is to facilitate the development of these outcomes by the learners.

□ **Using co-operative learning in OBE**

OBE paves the way for the integration of diverse learning strategies; therefore learning facilitators should implement a variety of educational tools and



techniques to enhance the quality of learning. In OBE learners are actively involved in managing their own process of learning: in literature this is referred to as meta-learning. During a co-operative learning intervention, the focus is on activities that involve learners to speak, discuss and think as opposed to a formal lecture where learners only look and listen.

Co-operative learning therefore assists learners in being actively involved, in using critical thinking processes and problem solving skills during learning, and thus assisting the learners to take responsibility for their own learning (Mattana, Shepherd & Knight, 1997:480).

Lord (1998:580) highlights the importance of the learner's active involvement during learning with the following statement:

*For lasting learning to take place, students must be actively involved in thinking about what is being heard, seen or done.*

The ultimate goal of co-operative learning is to work as a team: to share in the process of learning, to share ideas, to voice different opinions and to learn from one another. In other words, co-operative learning helps learners to be active participants during their own learning experience.

### **2.2.3 Meta-cognition and meta-learning**

#### **□ Defining meta-cognition**

Meta-cognition is a term that describes *self-awareness* (meta) of *thinking or cognitive processes* (cognition) and forms an integral part of brain functioning. Learners use reflection techniques during meta-cognitive processing when they think and deliberate concepts among themselves on the learning material which helps them to construct meaning from newly acquired knowledge (Slabbert, 1997:193).

Co-operative learning enhances meta-cognition and evokes a realization within the learner for the necessity of reflecting on what he or she is learning. Literature reveals that learners engaged in co-operative learning use meta-cognitive processing and achieve higher levels of learning and therefore co-operative learning and meta-cognition are interconnected components of effective learning (Singhanayok & Hooper, 1998:18). Both develop the other during the learning process but each has a specific purpose in maximizing the potential of the learner.

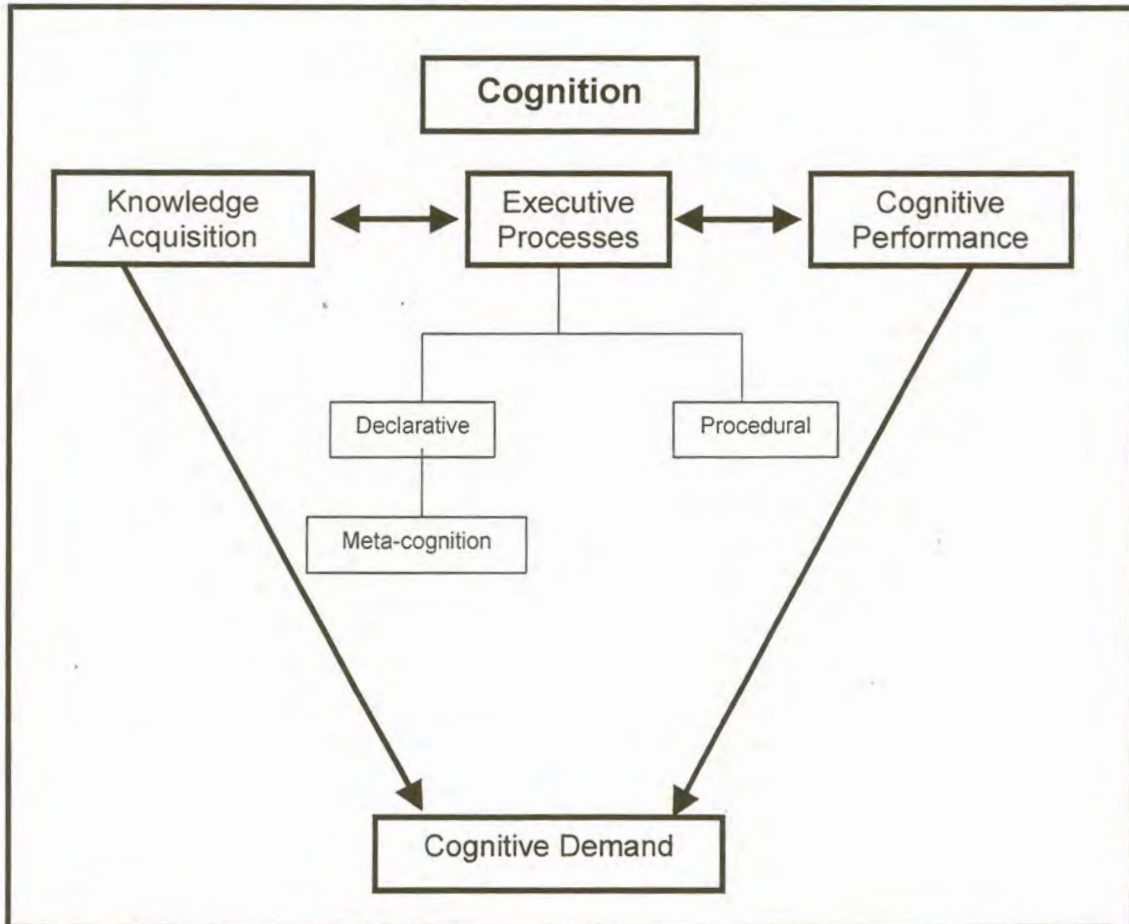
Worral (1990:174) states *“meta-cognition is a thinking activity and involves learner control and self-regulation”*. Duell, quoted by Worrel (1990:171), defines meta-cognition as *“the knowledge and regulation of one’s own learning system”*. According to Gourgey (1998:82) meta-cognition can be seen as *“a supervisor for thinking processes”*.

Meta-cognition, for the purpose of this study, is defined as the ability, activity and process of the human brain to regulate, coordinate and supervise thinking processes during learning.

#### □ **Cognitive processing**

The mental processes of the brain are usually referred to as cognition or cognitive processing (Worrel, 1990:171). According to Figure 1 (p.32) cognition consists of three components: knowledge-acquisition, executive processes and performance. Meta-cognition is a component of the executive processes that coordinate and regulate cognitive processes in the human brain.

Figure 1: Cognitive processing



(Adapted from Worrel 1990:171)

□ **Defining meta-learning**

As part of the executive processes meta-cognition indicates only a cognitive function of the brain. This study focuses on (whole brain) learning, thus including the cognitive, affective and psychomotor domains of learning. The undergraduate programme in dentistry includes learning new knowledge (cognitive), skills (psycho-motor) and attitudes (affective) in order to reach the specific outcomes for each study unit successfully. A definition by Slabbert, adapted from Slabbert (1997:99), states that:

*Meta-learning is the control activities of learning which consist of:*

- *Planning to execute a learning task;*
- *Monitoring the execution of a learning task, and*
- *Evaluating the outcome of the learning task.*

Slabbert (1997:99) defines a meta-learner as "*an active, effective, autonomous, independent, lifelong learner - the trade mark of one who is becoming a fully versatile maximized human being*".

For the purpose of this study the control, coordination and supervision of learning in the cognitive, psychomotor and affective domains with the purpose of maximizing one's own potential is referred to as meta-learning.

#### □ **Meta-learning strategies**

During learning the learner analyses learning tasks. Through understanding the learning task the learner discovers what is expected as outcomes. The learner executes what is required by the outcome. The following questions adapted from Slabbert (1997:101) serve as a guide and could be used by the learner during meta-learning.

#### ◆ *Planning*

##### a. Learning task factors

1. Topic - Do I know anything about this topic?
2. Detail - Do I know enough about this?
3. Task - What do I think am I required to do?
4. Outcome - What end product or task should I produce?

##### b. Personal factors

1. Preferred mode of learning - How do I prefer learning or doing this?
2. Learning approach - What is my motive for doing this?



3. Learning strategy - How should I do this?
  
- ◆ *Monitoring*
  1. New knowledge - How does this new knowledge compare under what I already know?
  2. Understanding - Do I understand what I should be doing?
  3. Progress - Is this the best and only way of doing it?
  4. Completion - Did I complete this to the best of my ability?
  
- ◆ *Assessment*
  1. Product/ task - How do I feel about my end product?  
- How do I feel about my peers' products?
  2. Quality - How could I have done this even better?
  3. Future - How can I use this in the future?

□ **Components of meta-learning**

The Meta-learning Model by Slabbert (1997:105) gives a schematic representation of what meta-learning entails. This integrated model (refer to p. 35) identifies three components of the meta-learning process:

*Meta-learning experience* - The learner receives a learning task that challenges him or her. The learner experiences a feeling of not knowing what is expected or how to solve the problem. This creates a need to find solutions to successfully solve the problem and relieve the tension caused by not knowing.

*Meta-learning knowledge* - To solve the problem by themselves the learners need to use meta-learning knowledge. This includes knowledge of the components of the learning task, knowledge of themselves and knowledge of meta-learning strategies.

*Meta-learning strategies* - Solving of the problem or doing of the learning task is done through meta-learning strategies.

All three these components are necessary for effective control and supervision of meta-learning processes during learning.

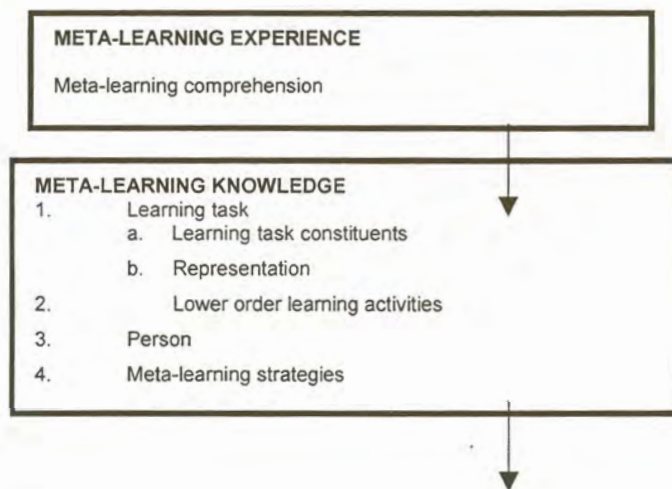
□ **Meta-learning in OBE**

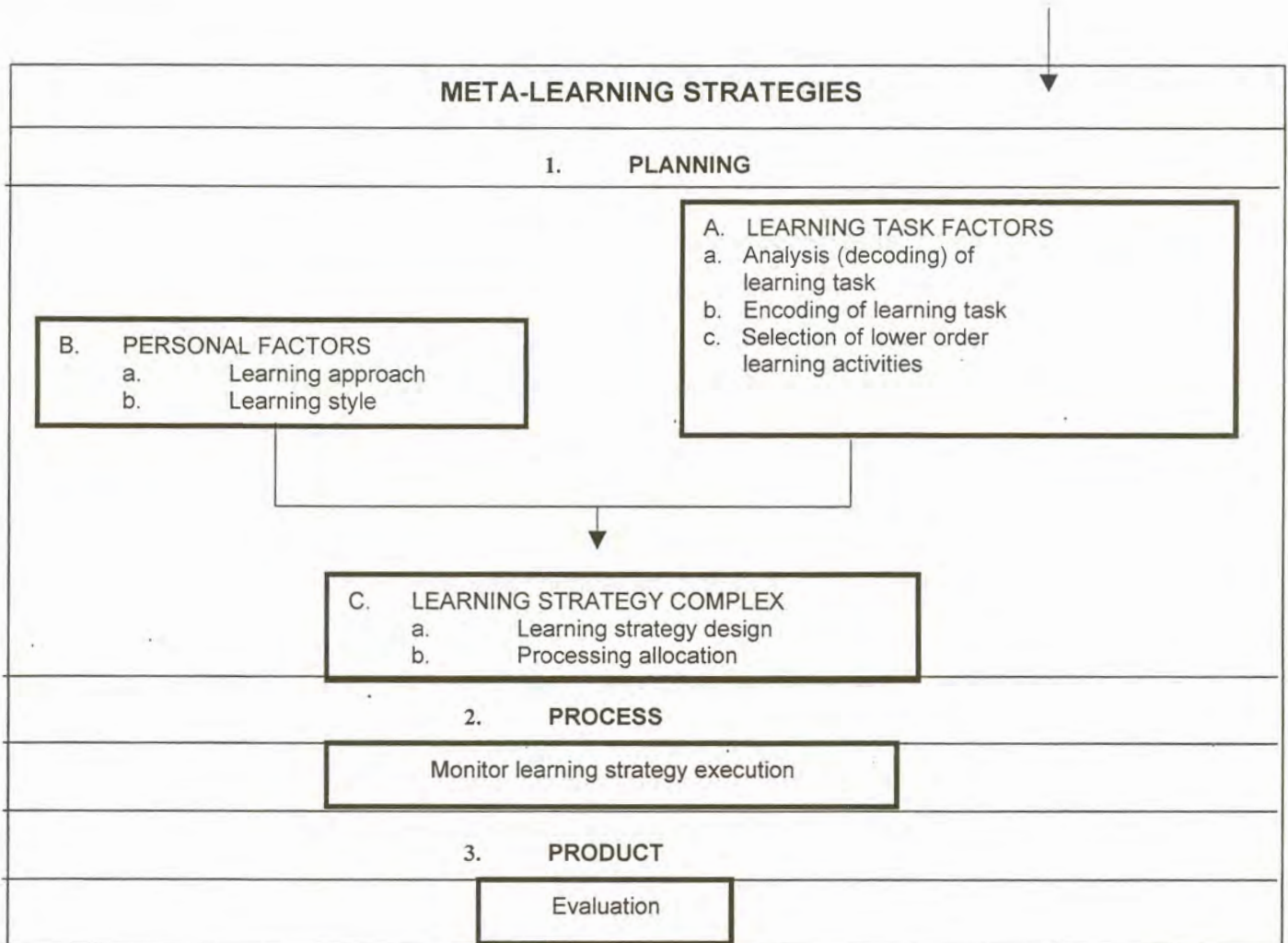
In OBE the learner takes responsibility for his or her own learning and should therefore be in control and more independent of his or her own learning processes. The focus in the new paradigm is on maximizing one's own potential and becoming a lifelong learner. Meta-learning assists learners to be in control of their own learning process and to become lifelong learners. The focus of learners in OBE is therefore the following:

- ◆ Being independent and autonomous in learning.
- ◆ Becoming active participants during the learning process.
- ◆ Being effective in their learning.
- ◆ Becoming lifelong learners (Slabbert, 1997:106).

Inclusion of tools in the educational strategy that enhance meta-learning will help to maximize the learners' potential through meaningful learning in the cognitive, psychomotor and affective domains.

**Figure 2: Meta-learning Model**





(Adapted from Slabbert, 1997:100)

## 2.2.4 Learning theory

### 2.2.4.1 Defining learning theory

Snelbecker (1974:31) states that one of the major research questions in education is how and why people learn. Learning theories are about the process of learning and how that process causes a change in behaviour. The construction of theory in educational practice usually attempts to explain the process of learning. Theories of learning are therefore attempts of researchers to organize ideas of the current understanding of learning into unified patterns or models in

order to guide learning facilitators in their educational practice (Bolles, 1979:1). As Hill (1990:20) states:

*A theory of learning is a creative attempt to explain what learning is and why it works as it does.*

For the purpose of this dissertation learning theory is described as the effort by researchers to explain the process of learning and the learner.

#### **2.2.4.2 Types of learning theories**

Learning theory has its origin in the science of psychology. The classical learning theories by researchers such as Thorndike (connectionism theory), Pavlov (classical conditioning), Hull (hypothetico-deductive behaviour) and Skinner (operant conditioning) were developed during the first half of the twentieth century (Bolles, 1979:iii).

The classical theorists developed theories that were aimed at trying to understand and describe the learning process. These theories attempted to objectify the study of behaviour and are still known as the early Behaviourism theories (Lefrancois, 1982:11). Bolles (1979:190) points to the fact that the classic learning theories are too limited and do not allow for the greater measure of generalization that researchers are looking for.

Because of a revival of interest in the cognitive processes during the second half of the twentieth century the information processing theories and the instructional theories (cognitive constructivism) were developed (Snelbecker, 1974:137).

Scheurman (1998:7) argues that the four major learning theories that examine the different approaches to learning are behaviourism, cognitive constructivism, social constructivism and information processing.



### □ **Behaviourism**

The belief of the behaviourists is that knowledge exists outside and independent of people and the goal of education is to instill into learners, knowledge and skills that were previously developed by others.

According to the behaviourists, knowledge is received through the senses and the role of the lecturer is that of a transmitter of knowledge. The primary function of learning activities is to break down the learning content in smaller increments and to present the content in an organized manner. The behaviour is then reinforced by a reward. This work by the behaviourists highlights two very important notes for facilitators of learning:

- ◆ If a learner does not practise a newly learned skill it can be lost.
- ◆ The rewarding of success influences learning.

This illuminates the behaviourist theory which implies that the greater the input or stimulus from the learning facilitator the greater the output or response from the learner.

### □ **Cognitive constructivism**

Constructivists believe that knowledge is created by people and influenced by their culture and values. The constructivism theories are categorized into two basic views: cognitive and social constructivism. The role of the lecturer in cognitive constructivism is to function as a facilitator that challenges the learners. The way learners are challenged is by problems posed that stretch the learners into a position of intellectual disequilibrium. Learners then build understanding of reality through problem solving.

### □ **Social constructivism**

In social constructivism the lecturer functions as a collaborator. This role causes the lecturer to monitor the learning activities of the learners in the classroom and to be an active participant with the learners during the learning process.

#### □ Information processing theory

This theory describes learning as a flow of information from the external environment to the internal human environment and back again to the external environment. The information received from the external environment can be stored as either short-term or long-term memory through meaningful encoding. The brain searches and retrieves information from the short-term or long-term memory and then organizes the information and response when needed (Gagnè, 1985:75).

The information processing theory includes three elements: activation of prior knowledge, encoding of information and knowledge elaboration. All three these elements are a part of problem-based learning.

#### **2.2.4.3 Learning theories and outcomes-based education**

Theories of learning give only a unilateral approach of how the learning process works whereas OBE promulgates a multi-dimensional approach to learning and to facilitating learning.

Learning is focused on what the learner must actually *be doing* and not what the facilitator of learning can *tell* or *do*. Facilitators of learning have the responsibility to construct or establish the environment that will enhance, accommodate, and maximize learning for all learners in a group. They also have the responsibility of accommodating all learners during learning and should be aware of the diversity of learners that can influence learning. This study concurs with Snelbecker (1974:111) and Scott (1978:334) who argue that theories do not make provision for "individual differences" because they only formulate general laws of behaviour.

In OBE facilitators are to demonstrate procedures, challenge learners, promote meta-learning, use problem-solving, foster critical thinking, develop

communication skills, and guide learners to resources during the facilitating of learning. Currently no theory of learning is complete enough to help facilitators accommodate or develop all the aspects required by the new paradigm of OBE.

Hill (1990:20) concludes that learning theories are attempts by researchers to summarize knowledge about learning into a single theory that will give an explanation of how and why people learn. According to Norman (1999:888), Scheurman (1998:9) and McKenna (1995:31) there is currently no theory of learning that can be interpreted literally and used on its own for an effective educational strategy. This illuminates the fact that learning theories are incomplete for practical use by facilitators and thus not suited to facilitating learning in the new paradigm of OBE.

## **2.2.5 Learning style technology**

### **2.2.5.1 Defining learning style**

Facilitators of learning are aware of the diverse methods and strategies learners use to accumulate, organize and structure new information. A learner does this in order to accommodate new knowledge in a manner that is best suited to him or her. This individually preferred manner of learning is referred to as a learner's learning style (Cross & Tilson, 1998:89). A definition by Dunn (Shaughnessy, 1998:141) states that:

*A person's learning style is the way that he or she concentrates on, processes, internalizes, and remembers new and difficult academic information or skills.*

For the purpose of this study learning style is defined as the preferred manner in which a learner best processes, internalizes, stores and consequently learns new knowledge, skills and attitudes during a learning experience.

□ **Learning style and learning**

The concept *learning style* underscores the fact that every learner is unique in how he or she acts and cognitively interacts with new information and skills. During learning some learners prefer to read textbooks and handouts, others prefer to ask questions and discuss the content, others prefer to have new information in visual format such as diagrams and schematic representations, others prefer to work in a group while others prefer to work individually. This illustrates why only utilizing a formal lecture or only using group work during learning opportunities makes learning effective for some and ineffective for other learners, because not all learners prefer the same learning activities.

Learning style technology is available to facilitators to use as part of their educational strategy for the facilitating of learning. It helps facilitators to accommodate diverse learning styles, optimize learning activities and maximize the potential of each learner during learning opportunities thus providing each learner with a more satisfying and optimal learning experience as stated by Morse, Oberer, Dobbins and Mitchell (1998:91):

*Using a learning style model facilitates success for each learner.*

Herrmann (1996:26,31) warns that not utilizing the knowledge and understanding that learning style technology offers may cause learning avoidances during learning opportunities. According to him this is important to note because learning avoidances are more significant than learning preferences since avoidances can be a “turn-off” for learning. He explains that a “turn-off” during learning is highly demotivating to learners while a “turn-on” activity is highly motivational for learning. Highly motivational or “turn-on” activities are interesting, stimulating, satisfying and have a strong alignment with the learners' preferences for learning.

It thus seems important to accommodate learners' preferred learning styles during learning to facilitate a more satisfying learning experience. Currently there are a number of different learning style models available for use by facilitators of learning. For the purpose of this study a few of the major learning style models are investigated.

#### **2.2.5.2 Kolb's Learning Style Model**

##### **□ A theory of experiential learning**

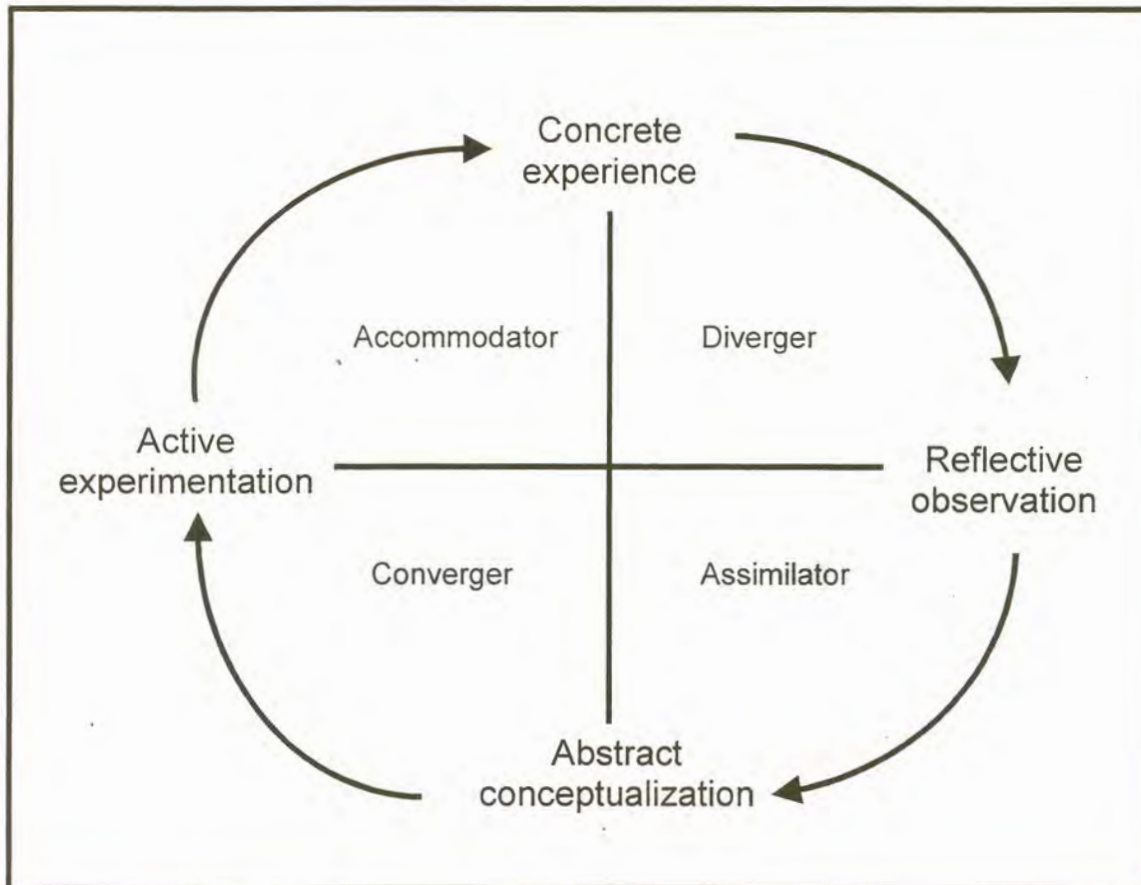
The Kolb Learning Style Model is based on the concept of how people prefer to process information. Kolb (1984:38) states that:

*Learning is the process whereby knowledge is created through the transformation of experience.*

The model includes learning style as well as the process of learning through experience and attempts to identify the learning preferences of an individual learner (Cross & Tilson, 1998:90).

Kolb's model of experiential learning describes the process of learning as a four-stage cycle consisting of four learning modes – concrete experience, reflective observation, abstract conceptualization and active experimentation. This model sees learning as a holistic process that involves the integration of four human functions: thinking (cognitive), feeling (affective), perceiving (perceptual) and behaving (behavioural) (Pickworth, 1997:62; Simms & Simms, 1995:131).

Figure 3: Kolb's Model of experiential learning



(Adapted from Pickworth, 1997:62)

The model identifies four types of learner classified according to preferences for the four learning processes. The styles of learners are characterized as follows:

- ◆ Doing or active experimentation (AE).
- ◆ Watching or reflective observation (RO).
- ◆ Feeling or concrete experiences (CE).
- ◆ Thinking or abstract conceptualization (AC).

Two dimensions of the learning process are characterized during the interplay of these four processes. Prehension is the first dimension that represents knowledge gained through concrete experience (apprehension) and abstract

conceptualization (comprehension). Transformation, the second dimension, represents knowledge gained through reflective observation (perceptual) and active experimentation (behavioural). Kolb's theory suggests that integration of all four learning modes is needed for higher levels of learning and the development of a learner. Furthermore, the theory suggests that experiences of a learner play the most important role in the process of learning (Simms & Simms, 1995:130).

□ **Kolb's Learning Styles Inventory (LSI)**

Kolb developed a diagnostic tool to identify an individual's learning style and the relative emphasis placed on the four learning processes (Highfield, 1988:30; Pickworth, 1997:62). The assessment tool is called The Learning Styles Inventory (LSI). The four learning styles identified by the LSI are listed in the following table:

**Table 2: The four learning styles identified by the LSI**

| Learning style | Learning takes place through   |   |
|----------------|--|---|
| Accommodator   | <ul style="list-style-type: none"> <li>- Concrete experience</li> <li>- Active experimentation</li> </ul>        | Concrete experience is transformed into learning by active experimentation or doing things                            |
| Diverger       | <ul style="list-style-type: none"> <li>- Concrete experience</li> <li>- Reflective observation</li> </ul>        | Concrete experiences are transformed into learning by reflective observation by using their imaginative abilities     |
| Assimilator    | <ul style="list-style-type: none"> <li>- Reflective observation</li> <li>- Abstract conceptualization</li> </ul> | Abstract conceptualizations are transformed into learning by creating theoretical models using reflective observation |
| Converger      | <ul style="list-style-type: none"> <li>- Abstract conceptualization</li> </ul>                                   | Abstract conceptualization is   |



|  |                                  |  |
|--|----------------------------------|--|
|  | tion<br>- Active experimentation | transformed into learning through active experimentation or practical application of ideas |
|--|----------------------------------|--|

□ **Evaluation of the model**

- ◆ According to Riding and Rayner (1998:55) the model reflects a set of less stable individual differences, which can change over time.
- ◆ Simms, according to Riding and Rayner (1998:57), criticize the LSI for a lack of reliability and validity.
- ◆ Curry, according to De Bello (1990:215), reported strong reliability but fair validity of the LSI.
- ◆ Tennant, according to Riding and Rayner (1998:57), argues that Kolb's learning style is misleading because of its focus on the learning process rather than on "individual differences" of a learner.
- ◆ The LSI does not quantify measurements.

**2.2.5.2 Myers-Briggs Model**

□ **A theory of personalities**

The Myers-Briggs Model is based on Carl Jung's theory of personalities and classifies people according to preferences for a specific learning style. The model uses the traits of an individual's personality to form a specific learning style for a learner. These traits include the following (Felder, 1996:19):

- **Is the learner an extrovert or an introvert?**

Extroverts focus on the outer world and people and want to try things out. They like to talk and also prefer to use psychomotor skills. Introverts are focused on the inner world and like to think things through. They like to read and to work alone.



- **Is the learner sensing (likes to learn through senses) or prefers to learn through intuition?**

Learners that prefer to learn through their senses like to focus on the facts, specifics, and step-by-step processes and are detail-orientated. A learner that prefers learning through intuition focuses on meanings and possibilities and prefers tasks that rely on quick insight and seeing relationships. These learners also like to use their own imagination and want to find their own way.

- **Is the learner a thinker or a feeler?**

Thinkers prefer logical organization and rules and are sceptical. Feelers like relationships and are very appreciative. When they make a decision they take others and themselves into consideration.

- **Is the learner a judge or a perceiver?**

Judgers prefer to plan and control events. They like to follow agendas and want formalized instruction. They tend to drive toward closure without all the necessary data. Perceivers resist closing before they have all the data. They are flexible, can adapt to changing circumstances and like discovery and informal training.

#### □ **Myers-Briggs Type Instrument (MBTI)**

The model uses the Myers-Briggs Type Instrument to measure sixteen different types of learning style (Felder, 1996:19).

#### □ **Evaluation of the model**

- ◆ It is a psychological model used only by practitioners with a psychological background who are registered to use the model.
- ◆ The MBTI instrument gives only a non-specific quantified measurement.
- ◆ This model gives too little variations of different types of learning style.
- ◆ It is non-specific.

### 2.2.5.3 Dunn and Dunn's Learning Styles Model

#### □ Theory of the model

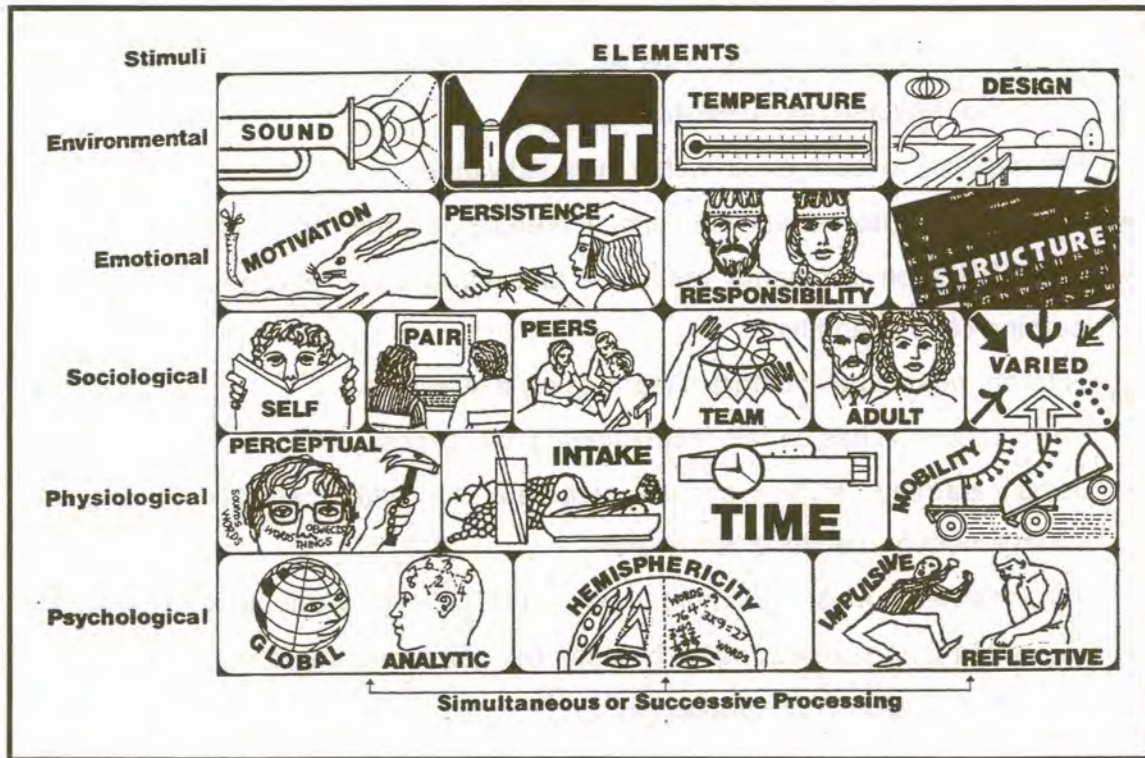
The Dunn and Dunn Learning Style Model is based on the following theoretical assumptions (Morse et al., 1998:43):

- ◆ The capacity to learn exists within most individuals.
- ◆ Every learner has certain instructional preferences that can be measured.
- ◆ Instructional environments, resources and approaches respond to diversified learning style strengths.
- ◆ Different people have different learning style strengths.
- ◆ Every individual has certain instructional preferences.
- ◆ Using learning styles enables learners to attain statistically higher achievement and attitude test scores.
- ◆ It is possible for most facilitators to apply this tool in their educational practice.
- ◆ Use of learning style strengths by a learner can make the learning of new or difficult information more successful.
- ◆ The less academically successful the learner is the more important it is to accommodate and develop his or her learning style preference.

This model describes learning style as a learner's reactions to twenty elements derived from five different stimuli (Cross & Tilson, 1998:89):

- a) *Environmental concerns*: sound, light, temperature and seating design.
- b) *Emotional dimensions*: motivation, persistence, responsibility, structure.
- c) *Social interaction preferences*: working alone, in a group, with authoritative adults, or in several ways.
- d) *Physiological preferences*: perceptual modalities (Auditory, kinesthetic, tactile, visual), learning during different times of the day, the need for moving around or intake of food during learning.
- e) *Psychological preferences*: global or analytical, left-brain or right brain, impulsive or reflective preferences.

Figure 4: Dunn and Dunn's Learning Styles Model



(Morse et al., 1998:43)

□ **Productivity Environmental Preference Survey (PEPS)**

In higher education the Model of Dunn and Dunn uses the PEPS (Productivity Environmental Preference Survey) instrument to identify an adult learner's preferences for learning. The PEPS consists of 100 dichotomous questions relating to the twenty factors or variables referred to as elements of learning-style. After administering the self-report inventory (paper- or computer-based) a summary of each learner's preferred learning style is given (Morse et al., 1998:43-4).

□ **Evaluation of the model**

- ◆ Research by Murray-Harvey (1994a:385) indicates that many of the PEPS' elements have poor test/re-test reliability and according to her this is of critical

importance because it is claimed that the PEPS measures stable, inherent characteristics of individual learners.

- ◆ Murray-Harvey (1994b:1006) also reports on the problem of limited amount of data available on the construct of the PEPS instrument. The instrument thus lacks construct validity.

#### 2.2.5.4 McCarthy's 4MAT System

##### □ Theory of the 4MAT system

McCarthy developed a teaching strategy model called the 4MAT system that incorporates brain dominance, creativity and learning styles. The system is based on the research of Kolb on experiential learning and learning styles. It proposes that during learning a learner continually moves between abstract conceptualization and concrete experience (De Bello, 1990:216).

The system based on brain dominance processing preferences and individual learning styles raises the awareness to facilitators why certain aspects work for some learners and not for others. According to McCarthy there are four learning style clusters, which have led to the development of a four-step model: the 4MAT system.

This system assists facilitators to organize learning activities according to the various ways different learners prefer to learn. It is an eight-step cycle of instruction that responds to the learning needs of four types of learners (McCarthy, 1990:31; De Bello, 1990:216):

- a) *Dynamic learners:* Risk-takers, adaptive, inventive and enthusiastic.  
*Explain the **why***
- b) *Innovative learners:* Curious, aware and perceptive.  
*Ask **what if***
- c.) *Analytic learners:* Critical, fact seeking and philosophizing.  
*Present the **what***

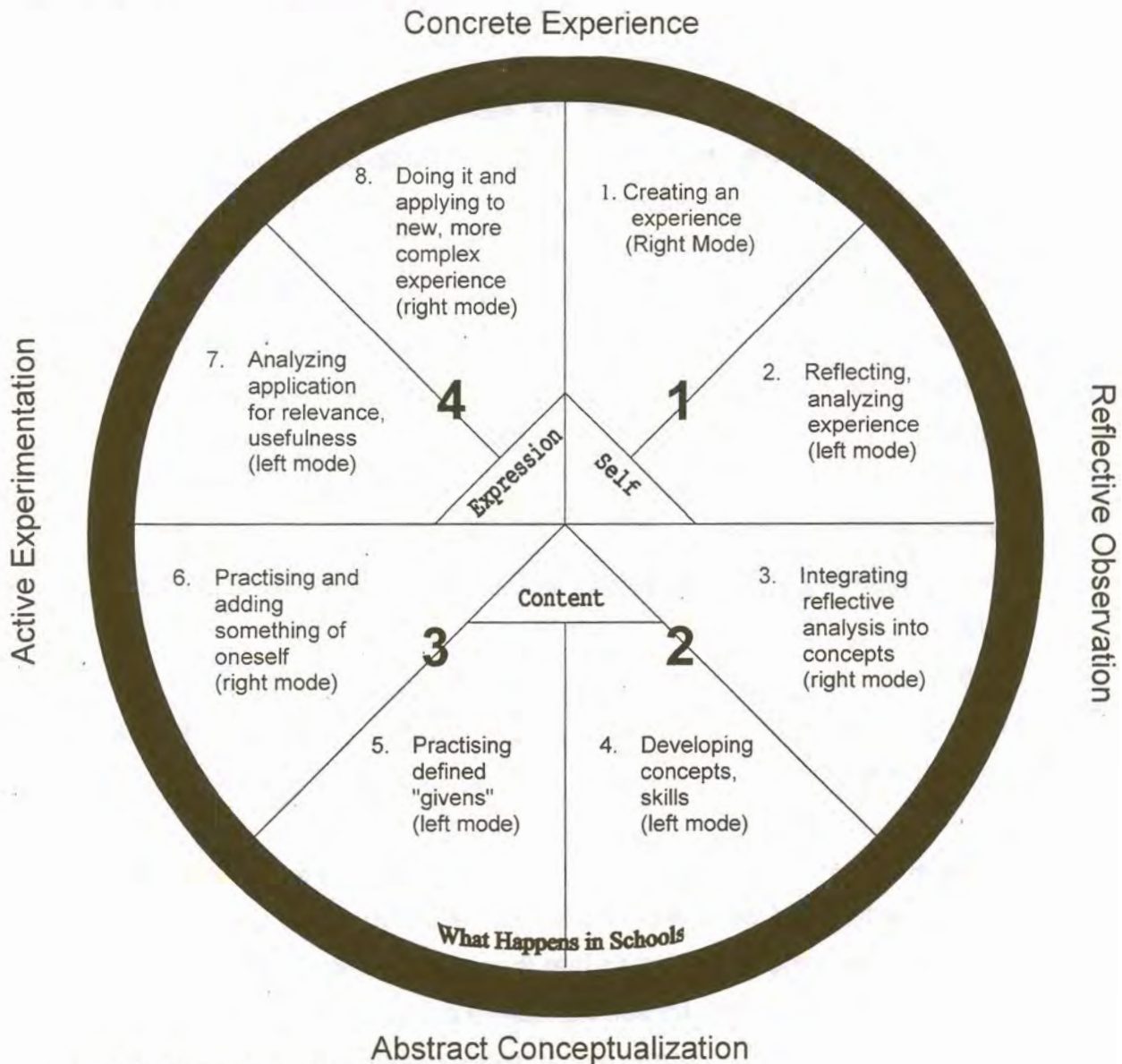


- c) *Common sense learners*: Hands-on, practical and orientated towards the present.  
*Demonstrate the **how***

This four-quadrant model illustrates the two major differences in how learners prefer to learn: how they perceive or process information. Perceiving is manifested through sensing, feeling or thinking and processing is manifested through watching or doing. McCarthy added knowledge on left-brain/right-brain functioning to this construct, identifying that verbal, field-independent activities are associated with the left-brain and visuo or spatial, field-dependent activities are associated with right-brain functions. The system by McCarthy proposes a spiral process of learning (De Bello, 1990:216).

Progression of learning occurs as the learning activity moves around the cycle (Figure 5, p. 51). The learner first experiences something (right-brain, motivational arousal), then he or she watches, reflects, thinks and a theory is developed (left-brain, analytical activity). The theory is experimented, practised and evaluated (left-brain, mastery of concept activity). Finally the learner has to think of alternatives and apply them to different real-world problems or situations (right-brain, many ideas and brain storming activities).

Figure 5: The 4MAT System



(McCarthy, 1990:33)

The learner then synthesizes (right-brain activity) what was learnt so that it will be possible to use it during a next similar situation or experience. According to McCarthy this causes the learners to get smarter because they apply experience to experience. The system gives the facilitator the benefit of organizing learning opportunities according to a systematic framework. It gives the benefit of working 25% of the cycle in the learner's preferred style and to challenge the learner 75%

of the time to work in less preferred styles. Thus learning activities appeal to each learner's most preferred style during the learning process but also stretches the learner to learn and think while not working in his or her preferred learning style. Facilitators of learning can use the 4MAT System to improve learning activities by using diverse strategies during the cycle of learning (McCarthy, 1990:33; De Bello, 1990:216). According to McCarthy (1990:31):

*4MAT offers a way to accommodate, as well as challenge, all types of learners, by appealing to their accustomed learning styles while stretching them to function in less comfortable modes.*

□ **Evaluation of the model**

- ◆ The model provides only guidelines on how to prepare for, and facilitate learning.
- ◆ There is only limited research available on this model.
- ◆ It does not give a quantified measurement of thinking or learning preferences of individual learners.

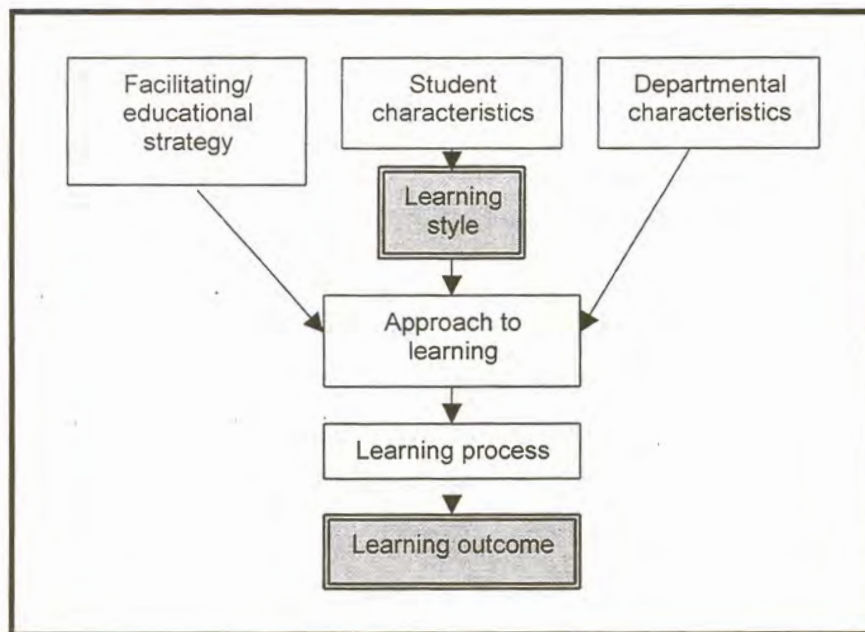
□ **The value of learning styles in outcomes-based education**

In the new paradigm of OBE learner's needs are accommodated and developed through multiple learning strategies so that they will maximize their potential by developing the necessary skills for solving real-life problems. This causes a need for learners to develop less preferred learning styles in order to develop their full potential. Learning style technology assists facilitators to be more effective and efficient during learning activities through utilizing different strategies for the same learning outcome in order to accommodate and develop the diversity learners have (Cross & Tilson, 1998:91).

Facilitators of learning are responsible for accommodating and developing learners during learning by aligning the learning context with the diverse learning

style preferences that exist within a group of learners. Although it may not be always possible to accommodate or develop every learner, it should still be the aim of the educator to incorporate this technology into his or her teaching practice. According to Olivier (1998:61) the knowledge and use of learning style technology is of the utmost importance during the facilitating of learning.

**Figure 6: The learning process**



(Adapted from Newble & Entwistle, 1986:163)

Figure 6 suggests that the learner's learning style, the facilitating strategy and the characteristics of individual departments in the learning environment influence the learner's approach to learning, the learning process and ultimately the outcome of learning. Different approaches, learning environments and learning contexts by different departments or learning facilitators put pressure on learners to adapt their approach to learning for every different situation. Facilitators should note the importance of aligning the facilitating strategy with the preferred style of learning to ensure success in achieving the outcomes of learning (Newble & Entwistle, 1986:163).



#### □ **Summary**

OBE assists facilitators of learning to prepare learners for living and working in society (Olivier, 1998:21). Learners should be learning life-skills that can be used in real-life contexts outside of the formal learning environment. Learning style technology gives an excellent opportunity for learners to be confronted and made aware of the diversity that exists within themselves and others. In the clinical wards, learners confronted with real-life problems are more aware and appreciative of the knowledge and understanding they got from the learning processes that include the use of learning style technology.

### **2.2.6 Development of brain specialization**

#### □ **Introduction**

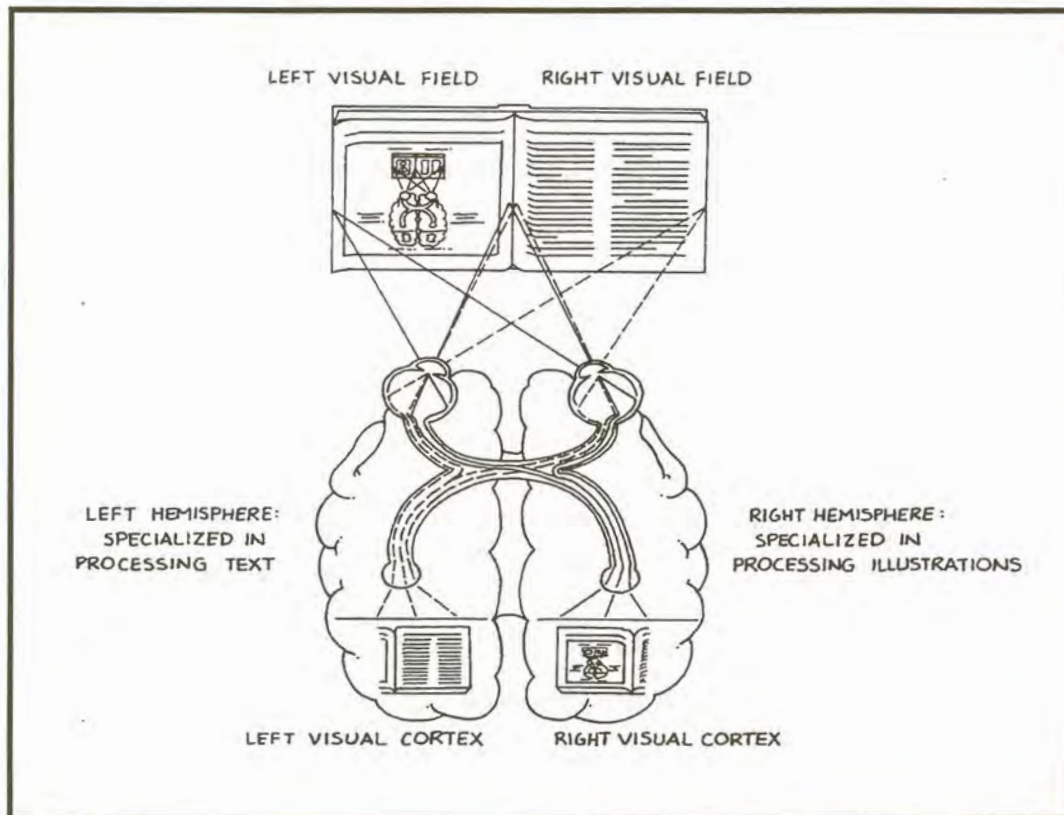
The responsibility of higher education institutions is to create an environment that is conducive to productive learning and facilitators of learning should be aware of factors that cause learners to learn productively. Knowledge on how the brain or "thinking organ" functions with regard to learning is important as a basis for those who have to facilitate learning activities. The following section describes the "Split Brain Theory" and "Triune Brain Theory" in order to give a better understanding of brain functioning and specialization of the human brain.

#### **2.2.6.1 Split Brain Theory**

Roger Sperry received the Nobel Prize in 1981 for his research on the working of the human brain. This research combines the biological as well as the physiological world of medicine and illuminates the principle of hemisphere specialization (Levy, 1990:232). He also observes that there is no change in behaviour or temperament of split-brain patients. These patients received a commissurotomy procedure that causes disconnection of the right from the left hemisphere by incision through the corpus callosum. The corpus callosum is a structure in the midline of the brain consisting of specialized nerve fibers that connect the left and right brain hemispheres.

Sperry and his colleagues developed tests to reveal why there is no change in behaviour and temperament of split-brain patients and what the function of the corpus callosum and the two hemispheres is. This research unveiled functioning differences between the left and right hemispheres of the human brain (Jensen, 1994:4). Figure 7 indicates that split-brain patients can only verbally describe an object or figure that is projected to the right visual field or left-brain.

**Figure 7: Visual fields of a split brain**



(Herrmann, 1995:14)

They are able to solve only pattern-matching problems that are projected to the left visual area (or right-brain). Because language is mainly centred in the left hemisphere the patients that only receive information to the right hemisphere can



solve the problems but are unable to describe verbally what they see (Bridgeman, 1988:65).

Testing of the hemispheres' functioning suggests that the world of inner experience is divided into a separate left and right system. It is demonstrated when the same commissurotomy patient performs the same task by using either the left or right brain, depending on which hemisphere receives the information. The research indicates that a patient using two different strategies, as if two different people are performing the same task, reaches the same outcome indicating that the two hemispheres are different in their functioning of the same task. The two hemispheres are unaware of the other's perceptual, learning and related memory experiences and further tests have revealed that each hemisphere uses a different mode of cognitive and perceptual processing (Sperry, 1976:17).

Sperry (1976:18) points out that if the two halves of the brain are completely disconnected, not only are two separate hemispheres the result but also two separate mentalities in one human. Each hemisphere has its own conscious awareness, its own ability, its own functioning of sense and learning and its own specialized form of intellect (Gazzaniga, 1998:51).

**Table 3: Specialization of the brain**

| <b>Left Hemisphere</b>      | <b>Right Hemisphere</b>      |
|-----------------------------|------------------------------|
| Dominance for:              | Dominance for:               |
| - Speech; verbal processing | - Music,                     |
| - Writing                   | - Spatial movements          |
| - Calculation               | - Holistic thinking          |
| - Logic                     | - Symbolic thinking          |
| - Intellect                 | - Artistic ability           |
| - Analytic thinking         | - Being the minor hemisphere |
|                             | - Receptive thinking         |

- Reading
- Detail
- Control
- Sequential ordering
- Being active
- Writing
- Synthesized thinking
- Emotions
- Spirituality
- Recognition of complex figures
- Simultaneous comprehension
- Perception of abstract patterns

(Adapted from Trotter, 1976:219)

The research by Sperry concludes that each of the two halves of the brain has specific areas of specialization (Hamilton, 1990:181).

The left hemisphere is the language-dominant hemisphere and is more aggressive, linguistic, verbal, logical and leads more easily. It performs tasks in a logical, symbolic, analytic computer-like manner. The right hemisphere performs with a synthetic, spatio-perceptual and mechanical kind of information processing not yet simulatable in computers. The right hemisphere also does not naturally lead the left hemisphere and is regarded as the “minor” hemisphere (Hamilton, 1990:182).

Although the right hemisphere is generally inferior in all performances involving linguistic, mathematical or sequential reasoning it is superior in the performance of certain tasks. These tasks are non-mathematical and non-linguistic and involve the apprehension and processing of spatial patterns, relations and transformations (Sperry, 1976:18).

The research of Sperry highlights the functioning and ability of the right hemisphere and is summarized as follows (Herrmann, 1995:9):

*The non-vocal hemisphere is indeed a conscious system in it's own right, perceiving, thinking, remembering, reasoning, evaluating,*

*willing, and emoting, all at a characteristically human level (Sperry, 1976:18).*

Sperry's findings illuminate the significant role and functioning of the right hemisphere that was previously neglected. This research indicates that the right hemisphere of the human brain is specialized and has the capacity for advanced mental functioning. A normal human brain has a physical and functional right and left hemisphere that each has clearly different specialized functions although the two halves normally function as an integral unit. Facilitators of learning should take note of the following statement by Sperry (adapted from Trotter, 1976:223):

*Our educational system and modern society generally discriminate against one whole half of the brain.*

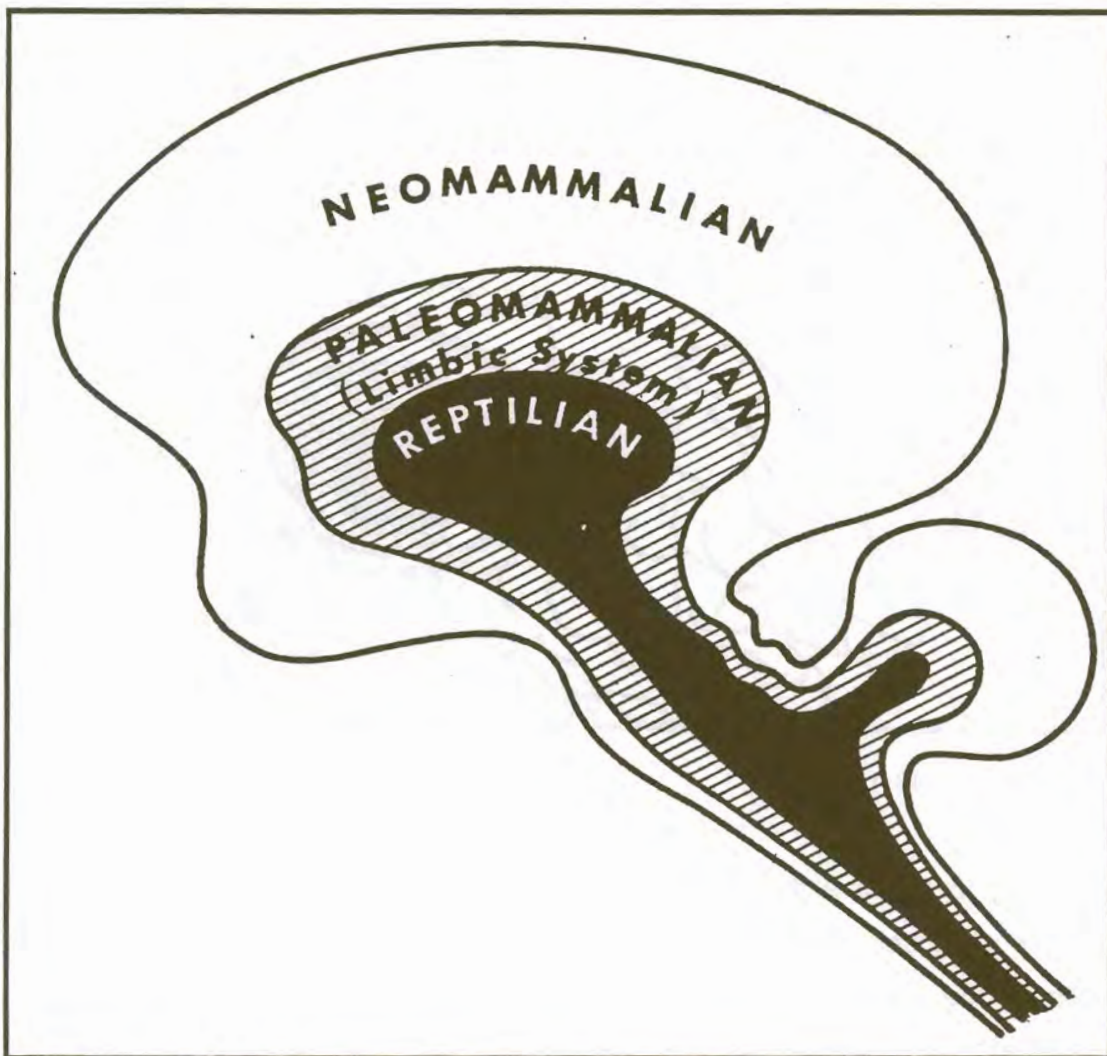
#### **2.2.6.2 Triune Brain Theory**

Research by MacLean led to the development of the "Triune Brain Theory". "Triune" refers to three sub-entities or three-in-one. MacLean uses this term when describing the human brain according to its function and ability. This research concludes that the brain consists of three sub-entities, each unique in function and structure (Hand, 1984:146).

The sub-entities include the brainstem (reptilian brain) also called the R-complex, the limbic system (paleomammalian or mammalian brain) and the massive neocortex (neomammalian brain). The triune brain theory explains the human brain as three brains superimposed (figure 8, p. 59) on one another amalgamated as one brain. Each of the three "brains" has its own mentality, special abilities, view of the outside world, and sense of space, sense of time, motor functions and memories. Any one of the three brains, depending on past experiences, mechanisms of survival and circumstances, can determine behaviour (MacLean, 1977:208). MacLean (1977:208) suggests that the human brain looks at the outside world through three mentalities. One of the differences

between the three "brains" is the fact that the two primitive brains do not have the ability to communicate verbally with the outside world. This fact is important to note because communication is usually seen as an important indication of intelligence to the world. The two primitive brains include the R-complex (reptilian brain) and limbic system (mammalian brain).

**Figure 8: Triune brain**



(MacLean, 1967:377)

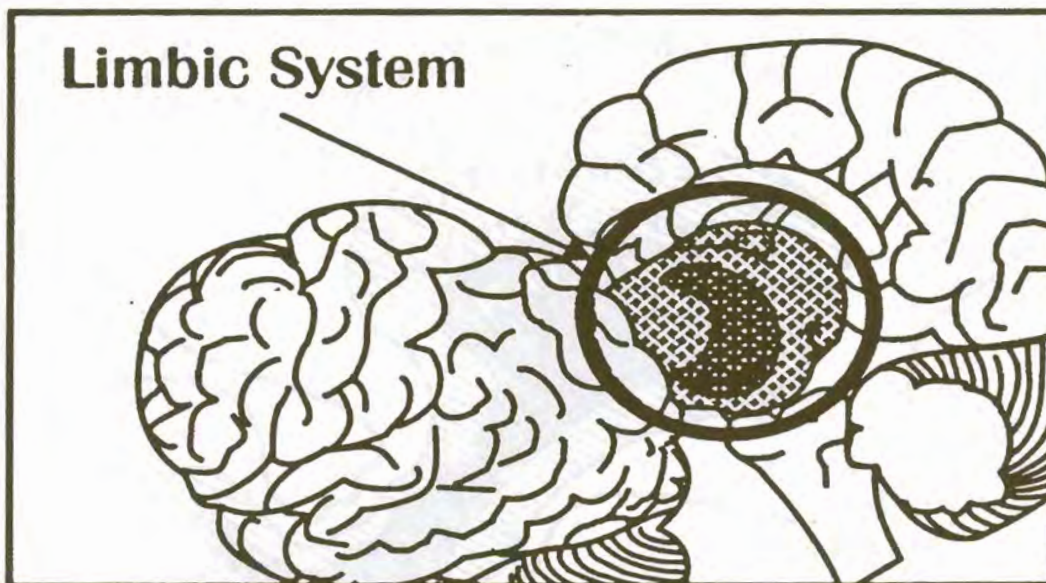
□ **R-complex**

The R-complex includes the brainstem (reptilian brain) and deals with only the most basic of needs. It reacts and takes control of the body in situations of immediate threat and is not associated with any memory.

□ **Limbic system**

The limbic system is situated in the middle of the three brains. It surrounds the R-complex and is surrounded by the neocortex.

**Figure 9: Limbic system**

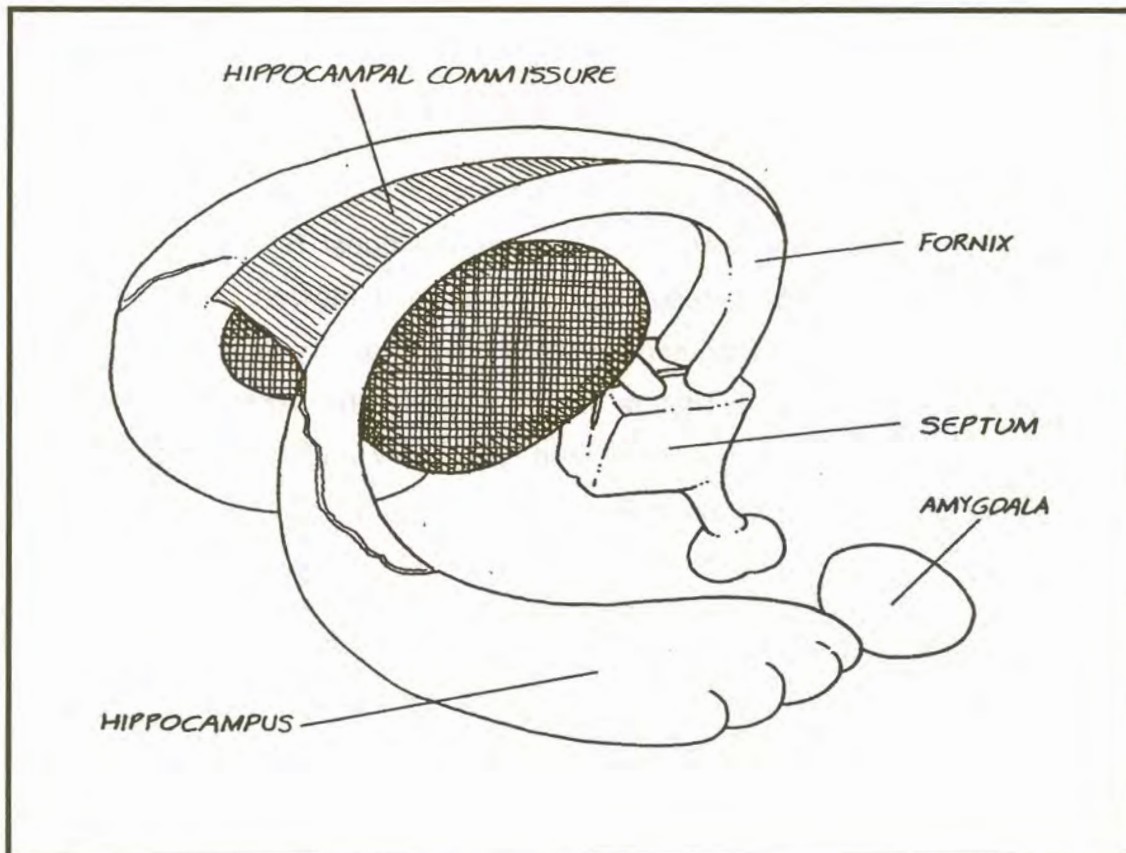


(Herrmann, 1996:14)

According to figure 9 the limbic system is “hidden” within the neocortex and consists of closely related structures surrounding the corpus callosum in the midline of the brain. These structures that form the limbic system contain a much smaller area than the surrounding neocortex. The limbic system consists of two separate halves that are interconnected and are nestled within each of the left and right hemispheres. It appears to be anatomically hidden within the two

halves of the brain and is only visible when the brain is dissected (Herrmann, 1996:13).

**Figure 10: Structures forming the limbic system**



(Herrmann, 1995:32)

The primary functions of the limbic system include the storage of short-term memory as well as the triggering and storage of long-term memory. The limbic system plays an important role in the functioning of the neocortex in that it is involved with three very important systems of human memory, which are main functions of the neocortex (Herrmann, 1995:33):



- ◆ Information is processed by the limbic system into appropriate modes for processing.
- ◆ The brain stores different kinds of information in areas that are suited for that kind of information through the work of the limbic system.
- ◆ The storing of information from short term to long-term memory is also influenced by the limbic system.

□ **Neocortex**

The limbic system is surrounded by the neocortex (Figure 9, p. 60). Human intellectual functions, which include logic and the quest for knowledge, are controlled by the neocortex. According to Forget and Morgan (1997:165) the neocortex is the ultimate computer and does it have a very important function during learning. Therefore facilitators should minimize the existence of threats that will trigger the limbic system and negatively influence the optimal performance of the neocortex in the learning environment.

It is the belief of MacLean that to refer to a left-brain (rationale, analytic) and right brain (emotional, holistic and interpersonal) only is incorrect and behaviours commonly referred to as right brain functions should be attributed to the limbic system. MacLean underlines this by the following statement adapted from Holden (1979:1068):

*Something doesn't exist unless it's tied up with an emotion.*

This statement by MacLean is very bold and suggests that no learning of new knowledge, skills or attitudes has occurred if an emotional experience is not associated with it. This we know is not absolutely true in our own experiences of learning. Learning new mathematical formulas, or what debit and credit means does not really require having an emotional experience about it. But we also know that when we encounter a real-life experience that includes emotions, like receiving a painful injection, the learner in dentistry can use this information in

order to learn skills to be able to deliver painless anesthesia. In other words, to maximize learning the limbic system and the neocortex must be included and accommodated during the learning process.

MacLean concurs with Sperry that the speed of the educational process outruns the process of learning in the following statement (MacLean, 1977:208):

*It may not be assumed that the student can keep up with the accelerated speed and pace of medical education through indoctrination with speed-reading and the help of computers. Man's new brain may be able to travel at such speeds, but his two animal brains, which forever tag along, must be presumed to move at their own pace. They have their own biological clocks and their own sequential idealistic way of doing things, which cannot be hurried.*

Reports on brain functioning almost exclusively focuses on the left and right hemispheres functions. This usually excludes the role of the limbic system during thinking and learning. Facilitators of learning should consider these important aspects of brain functioning to accommodate and develop the whole brain during learning activities. The following section describes the Metaphoric Four Quadrant Whole Brain Model that combines thinking style preference and brain dominance.

### **2.2.7 The Metaphoric Four Quadrant Whole Brain Model**

#### **□ Introduction**

In 400 BC Hippocrates concluded that the brain in man was double or consisted of two “brains” (Lumsdaine & Lumsdaine, 1997:76). This concurs with the research of Sperry whose work resulted in most of the knowledge of the specialization of the human brain, as it is known today. According to the work of Sperry on hemisphere specialization the left hemisphere is better in solving logical, analytic and mathematical problems and is good at language, planning, scheduling and organizing. The right brain, in contrast, is better in performing holistic and synthesizing activities, is non-verbal, intuitive and prefers visual,

spatial and simultaneous processing while showing a greater preference for music and being artistic (Trotter, 1976:219). The research of Sperry forms the basis of Herrmann's philosophy on the functioning and specialization of the human brain (Herrmann, 1982:84).

#### □ **Development of the model**

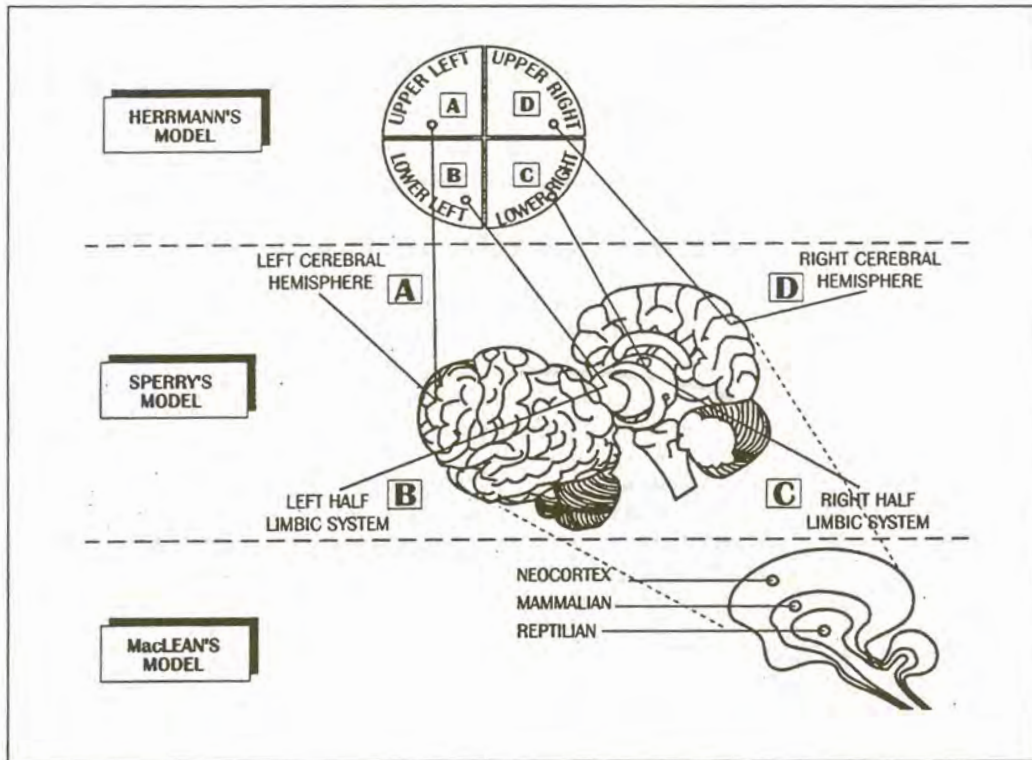
Herrmann's contribution to the research on the functioning of the brain is the fact that previous researchers overlooked the essential role the limbic system plays in brain function. He integrated the findings from the research of MacLean about the role of the limbic system, and the findings of Sperry on the physiology of the functioning of the brain, and designed a metaphoric four-quadrant model. He postulated that individuals develop a preference to use certain "quadrants" of the brain when learning. This has led to the development of a unique pattern of preference for using the brain to learn, understand, and express something. He calls these cognitive preferences or modes of knowing thus acknowledging that learners have different thinking and learning preferences.

The discovery that individuals do not use their brains in the same manner or with the same frequency led Herrmann to the conclusion that people develop brain dominances. These dominances are developed through nature (thirty percent) and nurture (seventy percent) (Herrmann, 1995:19). The use of brain dominance or thinking preferences when solving problems and learning causes a quicker response time and a higher skill level (Herrmann, 1995:17).

Herrmann's Model was developed from the knowledge acquired of the duality of the right and left-brain theory (Sperry, 1976:18) (Trotter, 1976:219) as well as the triune brain theory (MacLean, 1977:208) and is a merger between the two theories (Figure 11, p. 65). The Whole Brain Model anatomically also includes the structures below the cerebral cortex previously denied in the "left-brain/right-brain model" of Sperry. The most valuable contribution by Herrmann is the

inclusion of the limbic system as the second set of “hemispheres” in the Whole Brain Model.

**Figure 11: Relationship between the Whole Brain Model and the theories of Sperry and MacLean**



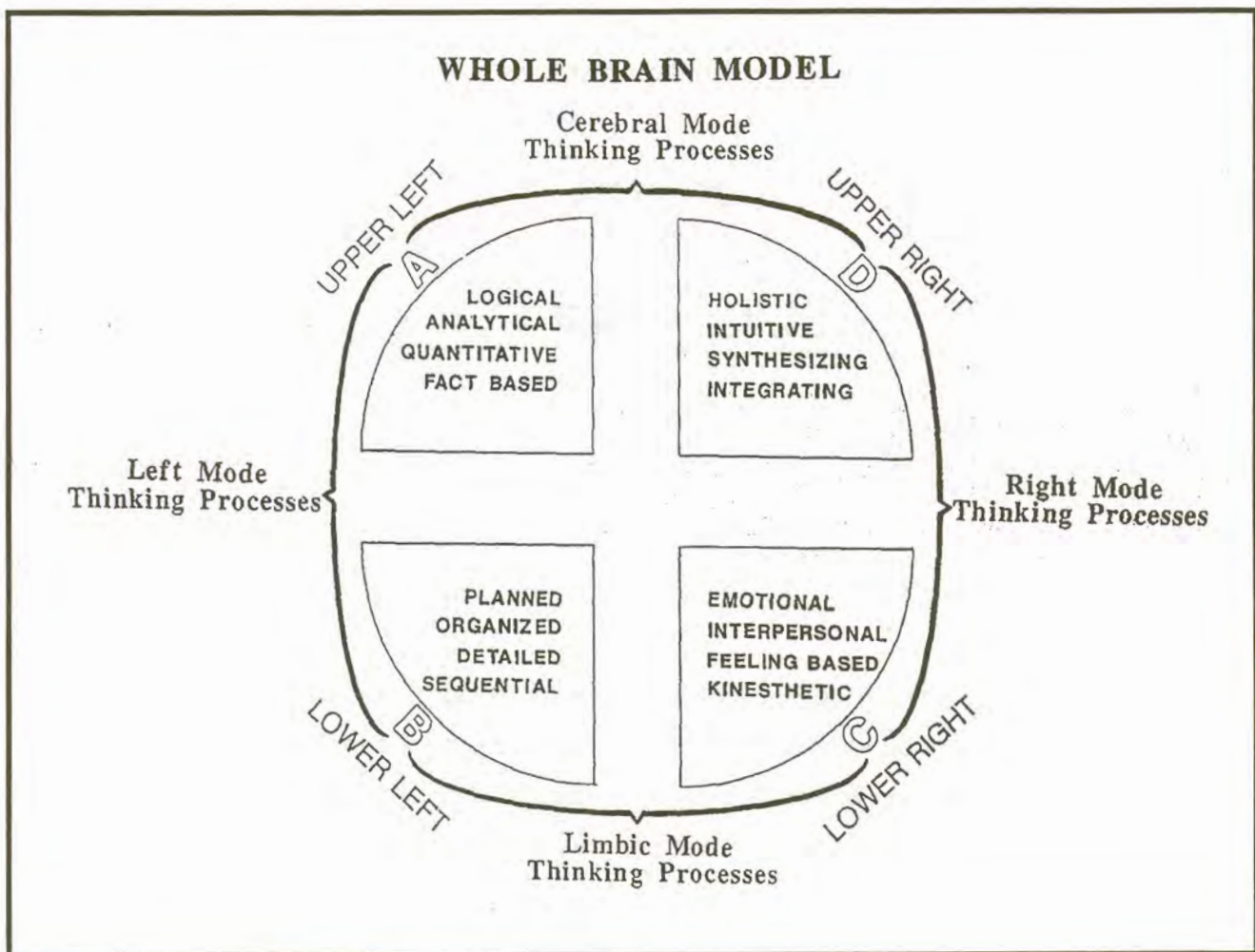
(Herrmann, 1996:14)

The four specialized modes of thinking and learning are organized into four distinct quarters or quadrants of the brain. The model reveals the four parts of the specialized brain and is founded on the research and observable evidence of four different thinking and learning preferences (Herrmann, 1996:6,63).

Researchers with the likes of Sperry, Bogen, Gazzanaga and Ornstein referred to the left and the right hemispheres when talking of brain dominances or specialization (Herrmann, 1996:12). Herrmann's Model integrated it to the cerebral hemispheres (left and right) and limbic hemispheres (left and right).

Although Herrmann's research is based on the physiology of the brain his model is a metaphoric model as the four-quadrant circular display represents a whole brain. The whole brain is divided into four quarters indicating the four preferred modes of thinking. The four quadrants are identified with an A for the left upper quadrant, a B for the left lower quadrant, a C for the right lower quadrant and a D for the right upper quadrant (Figure 12).

**Figure 12: The Whole Brain Model**



(Herrmann, 1995:411)

□ **The characteristics of the four thinking modes**

The following characteristics of the four thinking modes indicate the diversity of thinking preferences learners with different dominant modes have during learning.

**Quadrant A thinking preferences:**

- The A-quadrant in the model includes the upper left cerebral hemisphere associated with *analytical, factual, quantitative, technical, mathematical, problem solving, and critical* and *rational* preferences of thinking.
- Learners with a preference for this mode of thinking prefer learning by using facts to build cases and theories. They respond to formal lectures, applicable case discussions, textbooks and programmed learning. They like collecting data and information, doing research, organizing information in a logical manner and prefer problem solving. They are also performance-driven, task-driven and achievement-orientated.

**Quadrant B thinking preferences:**

- The B-quadrant in the model includes the lower left limbic hemisphere associated with *organization, controlled, detailed, conservative, disciplined, persistent, sequential, structured* and *planned* preferences of thinking.
- Learners with a preference for this mode of thinking prefer learning that is structured and contains processes. They prefer testing theories and practising skills before doing and respond to structured and sequential formats. These learners are very organized, keep to the rules, take detailed notes, and prefer using a diary to keep a schedule and do planning for the future. They prefer following specific directions and like to work according to a design and time schedule.

**Quadrant C thinking preferences:**

- The C-quadrant in the model includes the lower right limbic hemisphere associated with *interpersonal, sensory, emotional, kinesthetic, music, intuitive (gut-feeling)* and *symbolic* preferences of thinking.
- Learners with a preference for this mode of thinking prefer learning that includes listening and the sharing of ideas and are known to express their thoughts verbally. They value intuitive (gut-feeling) thinking and prefer to learn in an environment that is harmonious. They also learn by integrating personal experiences with content. These learners respond to people-orientated case studies and prefer working in groups and with music rather than individually. They also respond to experiential and sensory involving activities, i.e. touching, smelling, tasting and enjoy moving around during learning.

**Quadrant D thinking preferences:**

- The D-quadrant in the model includes the upper right cerebral hemisphere associated with *conceptual, spatial, flexible, intuitive (concept), visual, holistic, innovative* and *imaginative* preferences of thinking.
- Learners with a preference for this mode of thinking prefer learning through self-discovery and experimenting. They learn by constructing their own concepts, use their intuition and explore hidden possibilities. These learners respond to learning designs that include self-discovery, are visual and aesthetically pleasing. They prefer the "big picture" and do not focus on the detail during learning.

According to Herrmann (1995:324) typical tests of intelligence only measure the left-brain thinking modes (A and B quadrants) and almost completely disregard the limbic thinking modes (C and D quadrants). Herrmann is also concerned that most learning in higher education appears to be in left-brain (A and B quadrant) terms and according to the Metaphoric Whole Brain Model intelligence comes in at least four different forms.

This notion is shared by the research of Gardner on intelligence (Armstrong, 1994:1). Gardner challenges the validity and use of a single score from an “IQ” test that is taken outside of reality to determine a learner’s intelligence. He proposes a theory of multiple intelligences (MI theory) which groups the wide range of human capabilities into seven comprehensive categories or seven intelligences (Logical-Mathematical, Spatial, Linguistic, Bodily-Kinesthetic, Musical, Interpersonal and Intra-personal). Later work by Gardner includes the Naturalistic Intelligence (Berk, 2001). According to the MI theory everybody possesses all eight intelligences, but in each individual the eight different intelligences function together in a unique manner, making the possibilities of intelligence much broader than only a single “IQ” score (Armstrong: 1994:2).

Gardner’s work on human intelligence concurs with Herrmann that individual learners have unique ways of thinking, which cause learners to have diverse preferences when learning. It is important for facilitators of learning to consider this fact in order to have a teaching practice that is geared towards accommodating and developing any group of learners that will have diverse capabilities and thinking preferences within the group. The preferences for the four thinking modes of the Whole Brain Model are measured by the Herrmann Brain Dominance Instrument (HBDI) that gives a quantified measurement indicating the strength of preference in each mode of thinking for a learner.

□ **Herrmann Brain Dominance Instrument (HBDI)**

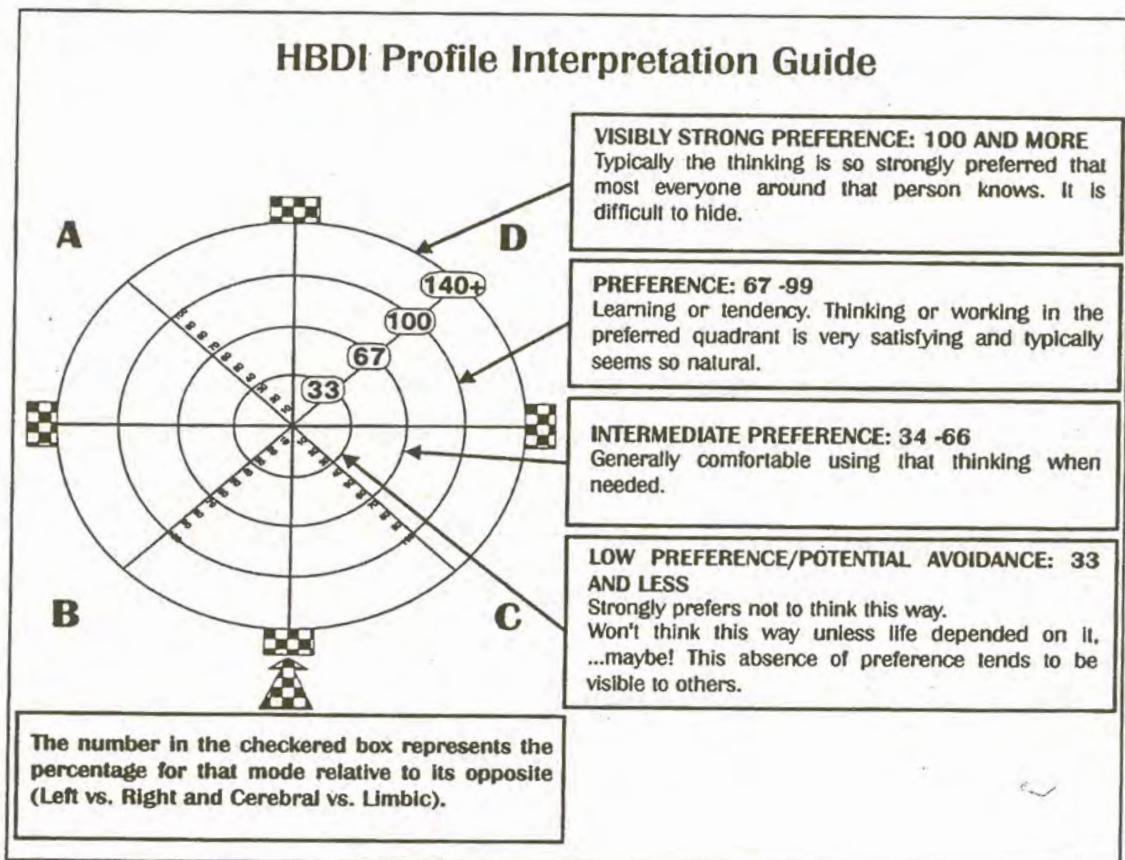
The HBDI, an instrument consisting of 120 questions, measures learners’ brain dominances or thinking preferences. The instrument reveals to learners what they pay attention to, what turns them on or off, and how they prefer to learn.

*When thinking preferences are assessed with the HBDI, the output is a brain dominance profile (Lumsdaine & Lumsdaine, 1997:81).*



The quantified measurement in each quadrant or profile score (A, B, C, D) makes up the brain dominance profile. The score in each of the four quadrants is quantified and is marked on axes bisecting these four quadrants. A score of zero starts in the middle of the circular display and moves to more than one hundred and forty on the most outward circle area. The scores of a learner's profile, drawn on this grid as a four sided figure, represent an individualized visual metaphor of thinking preference for that specific learner as presented in Appendix A.

**Figure 13: HBDI-interpretation**



(Herrmann, 1996:32)

The circular display indicates intensity of brain dominance and consists of three regions indicated by Figure 13. Preference for a specific quadrant is quantitatively indicated by a 1, 2 or 3: one (1) equals a score of more than 67,

two (2) equals a score between 34 and 66 and three (3) equals a score between 0 and 33. A score of one (1) indicates a strong to very strong preference for that quadrant or mode of thinking. A score of two (2) indicates a thinking mode that is neither preferred nor avoided, intermediate preference, and can be used when needed. A score of three (3) indicates a mode of potential avoidance and low preference being very demanding and even enervating for a learner to work in, but does not mean that it is impossible for a learner to use this thinking mode (Herrmann, 1995:70; Lumsdaine & Lumsdaine, 1997:81)

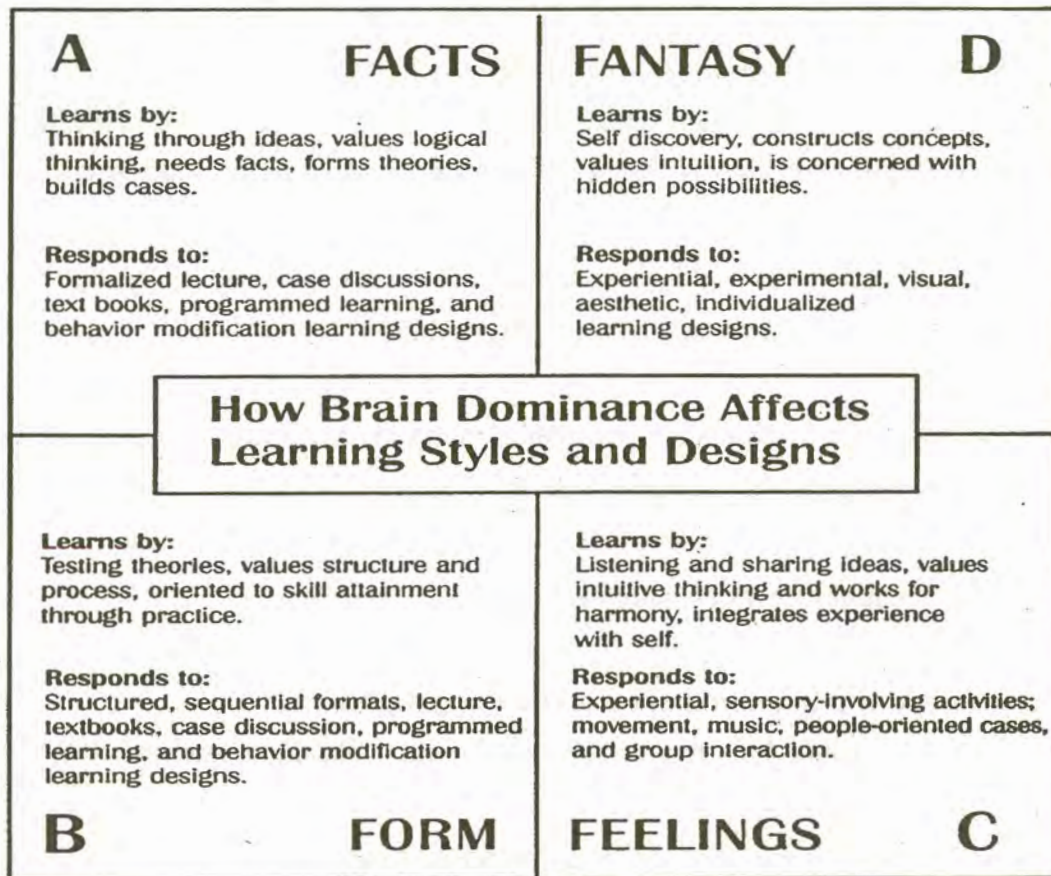
The adjective pairs are a second quantified measurement included in the profile. This measurement (from 0 to more than 10) indicates which quadrants are most preferred (highest score) for learning under a stress situation and could change although it is usually very consistent with a learner's profile.

□ **The effect of brain dominance on learning styles**

This model indicates that the preferred thinking style of a learner causes a learner to have a preference for certain activities usually in alignment with his or her thinking preference and learning materials during learning. The following diagram supplies an overview of the four brain quadrants and the activities a learner with a preference for a specific quadrant responds to and prefers to learn by.

Figure 14 (refer to p. 72) indicates how brain dominance affects learning styles and summarizes learning styles in each of the four quadrants of the Whole Brain Model and suggests different learning activities that would stimulate each learning style to make learning more meaningful.

Figure 14: How brain dominance affects learning styles and designs



(Herrmann, 1996:154)

□ **Evaluation of the Metaphoric Four Quadrant Whole Brain Model**

The model has the following advantages for the learning situation:

- ◆ It accommodates the new paradigm in the South African educational context of OBE. The model focuses on learners' needs and preferences during learning and accommodates the development of most of the critical cross-field outcomes set by SAQA (1995).
- ◆ It assists facilitators in accommodating uniqueness of each learner and to develop learners to be whole-brain thinkers. The model suggests that learning activities should include all four preferred modes of thinking. This supports the idea that learning should be aligned with the brain as a whole and not only be confined to accommodating and developing one area or way of thinking.

Jensen (1998:1) supporting the concept of whole brain learning refers to it as brain-compatible learning.

- ◆ It serves as a vehicle to be more creative and innovative in designing and delivering learning activities.
- ◆ The model creates an awareness amongst facilitator and learner of their preferred modes of thinking (brain dominance) and thus enables them to discover what turns them on and what turns them off and consequently what they pay attention to. This awareness by the facilitator and learner helps them to understand their less preferred mode of thinking and poses challenges to develop it.
- ◆ It serves as a tool that facilitators of learning can use, as part of their educational practice, to minimize learning avoidances and maximize learners' potential.
- ◆ A major advantage of using the HBDI is that it gives a quantified measurement of individual learner's brain dominance or preferred modes of thinking. Bunderson (Herrmann, 1988:65) performed three different studies with four different forms of validity on the HBDI – content-based, construct-based, criterion-based and face validity were done. He found only positive conclusions on the validity of the HBDI. Validity has also been tested by more than sixty doctoral dissertations that were based on the HBDI. According to a study by Bunderson (1995), adapted from De Boer, Steyn and Du Toit (2001), the HBDI provides a reliable and valid measurement of thinking preferences when applied professionally and interpreted in conformity with the Whole Brain Model.
- ◆ The instrument (HBDI) is easy to administer via pencil and paper or computer medium.
- ◆ The instrument is also available in different languages i.e. German, Spanish, Greek and French etc. including the African language Zulu.

The Metaphoric Whole Brain Model of Herrmann demonstrates that learners have different thinking style preferences that influence their learning. The new

paradigm of OBE challenges facilitators to accommodate and develop learners' diversities during learning activities. The model's greatest advantage is that it measures thinking style preferences of individual learners and thereby supplies facilitators of learning with information to plan learning activities that will accommodate and develop all learners.

## **2.2.8 Models available for the facilitation of learning in this study**

### **□ Introduction**

Brain research during the previous three decades has led to the development of the concepts of "thinking preference " and "learning style". This work highlighted to researchers and facilitators of learning the fact that learners have diverse preferred modes of assimilating and processing information. Facilitators of learning in dentistry should also consider incorporating this knowledge on thinking and learning into their teaching practice.

### **□ Learning style models available for learning**

There are various thinking or learning style models available that facilitators can utilize to help optimize learning. Decision on the suitability of a model should be based on the answers to the following questions (Cross & Tilson, 1998:89; De Bello, 1990:218; Curry, 1999:409):

- ◆ Is the model scientifically validated?
- ◆ Is there widespread use of the model by practitioners?
- ◆ Is there extensive research available on the model?
- ◆ Are visits to practitioners that are using the model possible?
- ◆ Is training on the use of the model possible?

For the purpose of this study the following criteria were also considered:

- ◆ Is the model aligned with the critical outcomes of OBE in the South African educational environment?
- ◆ Is the model understandable and easy to use by professional academics (medical sciences) with no or little educational background?



- ◆ Is it easy to administer the measuring instrument?
- ◆ Is the facilitator prepared to adapt his style/educational practice during learning to accommodate all learners?

□ **Evaluation of learning/thinking style models**

In the previous section learning style models including the Herrmann Model are discussed. All these models propose a tool for facilitators to make learning more meaningful to learners. In Table 4 five such models are summarized.

**Table 4: Learning/ thinking style models**

| Model                              | Instrument | Summary of Evaluation  |
|------------------------------------|------------|--|
| Kolb's Learning Style Model        | LSI        | <ul style="list-style-type: none"> <li>- focus on learning process</li> <li>- does not quantify measurement</li> <li>- lacks reliability and validity</li> </ul>                                   |
| Myers-Briggs Model                 | MBTI       | <ul style="list-style-type: none"> <li>- psychometric instrument</li> <li>- non-specific for educational purposes</li> </ul>   |
| Dunn & Dunn's Learning Style Model | PEPS       | <ul style="list-style-type: none"> <li>- poor test/re-test reliability</li> <li>- lacks construct validity</li> </ul>  |
| McCarthy's 4MAT System             | -          | <ul style="list-style-type: none"> <li>- limited research</li> <li>- provides only guidelines to facilitator</li> <li>- does not quantify measurement of individual preferences</li> </ul>         |
| Herrmann's Whole Brain Model       | HBDI       | <ul style="list-style-type: none"> <li>- combines brain dominance (the whole brain) and thinking style preference</li> <li>- gives an individualized quantified measurement of thinking</li> </ul> |

- preference
- proven to be a valid and reliable instrument

From Table 4 it can be deduced that the Whole Brain Model complies with criteria set by Cross and Tilson, De Bello and Curry (refer to p. 74).

◆ *Is the model scientifically validated?*

The comprehensive studies of Bunderson, vice-president for Management Research at Education Testing Services in the USA, have validated the instrument (HBDI). The University of Texas (Schkade & Potvin) performed separate validation studies and provided proof of validity. There are also ongoing validation processes throughout the world as part of the research and development effort of Herrmann International.

◆ *Is there widespread use of the model by practitioners?*

Universities around the world are using the instrument in undergraduate training, postgraduate training or both, i.e. University of: Texas, North Carolina, Toledo and Pretoria to name but a few. Wofford College, Warton School of Business, Queens' University and Franklin University also use the instrument.

◆ *Is there extensive research available on the model?*

There are more than sixty doctoral theses and numerous published articles in scientific journals covering diverse educational fields available.

◆ *Are visits to practitioners that are using the model possible?*

Yes, it is possible to visit practitioners that are using the model.

◆ *Is training on the use of the model possible?*

Yes there is training and accreditation.

### **2.2.9 A model selected for this study**

In the study unit of Toothmorphology the lecturer-centred model was traditionally used during learning causing the problem that learners do not develop critical thinking, problem-solving skills and creativity. Dental educators are concerned

about and frequently complain that learners are often not able to solve the problems they are confronted with in the clinic with the knowledge they obtained from the classroom setting.

The new learning-centred paradigm of OBE promulgated in the South African learning environment attempts to pave the way for active learning and learners to maximize their potential through lifelong learning. This chapter illuminates the fact that learning is influenced by facilitators' and learners' preferred thinking styles and learning activities should accommodate and develop all preferred styles, thus facilitating whole brain learning. This should be done without losing the intent of the learning programme or curriculum.

The Whole Brain Model of Herrmann is selected for the purpose of this study because of the various advantages it brings to learning in the new paradigm of OBE. These advantages include accommodating and developing the way learners prefer to think and learn and help them to achieve the critical and specific outcomes of the study unit of Toothmorphology. This model gives facilitators the advantage of using a tool that is based on the physiological characteristics of the brain combined with the different preferences for thinking learners have when learning.



## **CHAPTER 3**

### **3. LEARNING FACILITATION VIA THE WHOLE BRAIN TEACHING AND LEARNING MODEL**

#### **3.1 The Whole Brain Teaching and Learning Model**

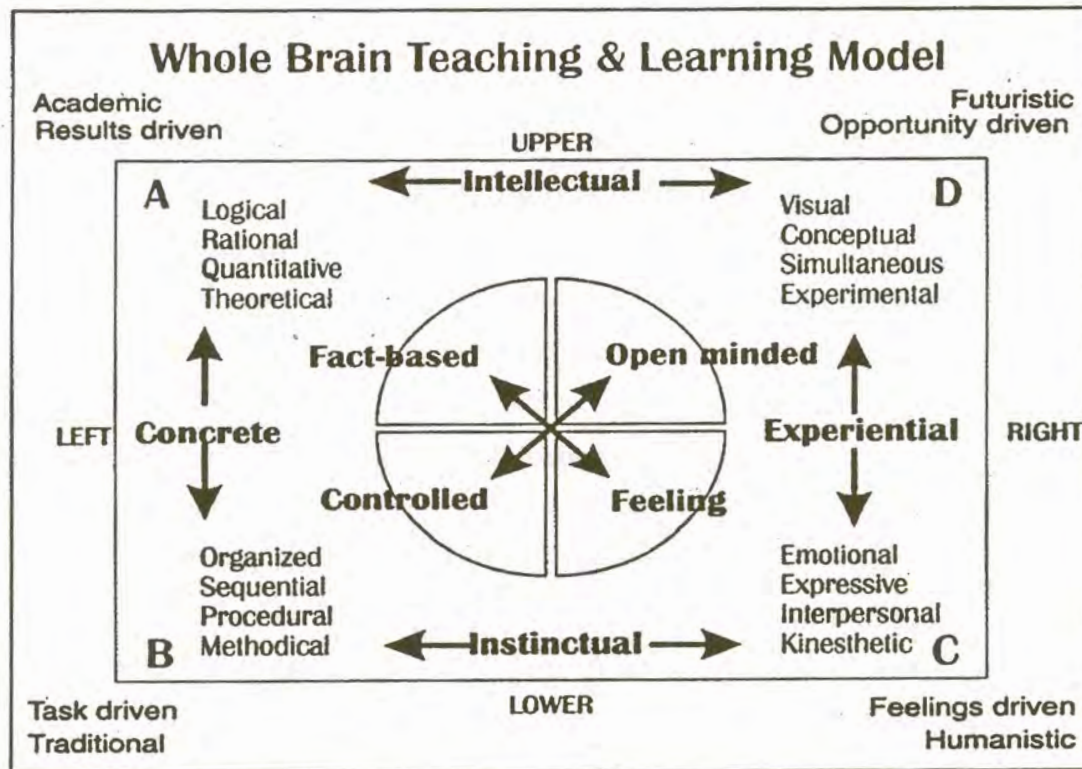
##### **3.1.1 Introduction**

Whole brain technology is a concept that is easy to use, valid and reliable, supplying a quantified measurement of individual learner's thinking style preference. According to the research by Herrmann (1996:151) a group consisting of eighteen or more learners will represent a diverse spectrum of thinking style preferences thus, representing a composite whole brain group. Herrmann designed a "Teaching and Learning Model" (Figure 15, p. 79) based on the whole brain concept. This model assists facilitators of learning in accommodating and developing diverse thinking styles and in making learning more meaningful for all learners. It describes the conditions under which learners with strong preferences in the four different quadrants learn best.

Learners with strong thinking style preferences for the A-quadrant prefer a cognitive and rational approach. When in this mode the learner is likely to approach problem solving in a logical manner and to take account of facts, figures, statistics and other tangibles. The learner will prefer conclusions that are backed up by supporting data or by examples of precedent. Learners expect the facilitator to reduce the complex content to the simple, the unclear to the clear and the cumbersome to the efficient. This mode prefers structure in a practical and procedural sense (Herrmann International, 1999:6)

Learners with strong preferences in the B-quadrant have a natural inclination towards organization, reliability, efficiency, order and discipline. Tasks might frequently be prioritized and tackled in a systematic and sequential manner. This quadrant is methodical and attentive to detail (Herrmann International, 1999:6).

Figure 15: Whole Brain Teaching and Learning Model



(Herrmann, 1996:155; 1995:417)

Learners with strong thinking style preferences for the C-quadrant are naturally in tune with and sensitive to others' needs, attitudes and atmosphere. There is usually an attraction to people plus an ability to relate to others and express themselves easily. Characteristics may include good interpersonal skills with an awareness of the feelings of others and ease of communication (Herrmann, 1999:7).

With a D-quadrant preference the learner can usually handle several mental inputs simultaneously, make rapid connections and feel comfortable with abstract concepts. An initially holistic approach to problem solving may be preferred and conclusions are reached in a spontaneous rather than a studied manner. Lateral thinking takes place in this mode and inspires imaginative, innovative and original

ideas. According to Herrmann this quadrant could be described as the catalyst for the creative process. Learners may have an inclination towards adventure, experimenting and risk taking (Herrmann, 1999:7).

### **3.1.2 Facilitation of learning in the study unit of Toothmorphology via the Whole Brain Teaching and Learning Model**

Traditionally the content in the study unit of Toothmorphology is delivered using the lecture-based method of instruction in a series of lectures during the third year of study in dentistry. The lecturers deliver the content (knowledge) of Toothmorphology via formal lectures to the learners who have to sit and listen passively, take notes and learn (memorize) the content in order to pass tests and examinations (summative assessment). There are however, opportunities for learners to make drawings of the content to represent the work visually. Sometimes relevant content is presented by using video material or a slide show to make learning more stimulating and visual. This kind of teaching practice gives the impression that there is not enough planning or purpose to include educational technology and good teaching practice during learning opportunities. It seems that the main intention of most learning opportunities is the delivery of knowledge by lecturers to learners.

In the new paradigm of OBE a study unit (e.g. Toothmorphology) has key learning points that include knowledge, skills and attitudes that represent the essence of the content that the learners must achieve. These key learning points, or specific outcomes, are what the curriculum intends for learners to master.

The following are the specific and sub outcomes for the study unit of Toothmorphology (Janse van Vuuren, 2000:21-35):

#### **a. Specific outcomes**

- ◆ A dentist should be able to identify any tooth of the human dentition correctly.
- ◆ A dentist should be able to restore pathology of the hard tissues (tooth) to the correct form and function.

- ◆ b. Sub-outcomes
- ◆ The learners should be able to describe (in oral and written format and by using drawings) the following:
  - ◆ Form, arrangement and terminology of the different teeth in the dentition.
  - ◆ Anatomy of the human tooth.
  - ◆ Differences of the maxillary and mandibular central incisors.
  - ◆ Differences of the maxillary and mandibular lateral incisors.
  - ◆ Differences of the maxillary and mandibular canines.
  - ◆ Differences of the maxillary and mandibular first premolars.
  - ◆ Differences of the maxillary and mandibular second premolars.
  - ◆ Differences of the maxillary and mandibular first molars.
  - ◆ Differences of the maxillary and mandibular second molars.
  - ◆ Differences of the maxillary and mandibular third molars.

These specific outcomes should be planned and facilitated in ways that accommodate and develop the diverse thinking style preferences in a group. According to Herrmann (1996:153) each key learning point should be incorporated in the learning activities using three or four of the different thinking style preferences. Using learning activities that accommodate the diverse thinking styles of the four brain “hemispheres” helps to stimulate or *turn* learners *on*.

This method of learning facilitation not only accommodates diversity but also helps development of learners’ lesser-preferred thinking styles. By aligning educational tools and techniques during learning with strategic precision to each key learning point optimizes learning activities and minimizes learning avoidances.

## **3.2 Planning, implementing and facilitating 'whole brain' learning**

### **3.2.1 Action Research as part of this study**

As part of this study, the researcher as facilitator of learning implemented the principles of action research. The use of action research during the teaching and learning process has two major benefits: improvement of teaching practice and contributing to current knowledge in education (Hodgkinson & Maree 1998:51).

#### **3.2.1.1 Definition of action research**

Hodgkinson and Maree (1998:52) emphasize the fact that there is no universally accepted definition of action research in literature, but for the purposes of this study a definition by Zuber-Skerritt (1992:1-2) defines action research as

*collaborative, critical inquiry by the academics themselves (rather than expert educational researchers) into their own teaching practice, into problems of students learning and learning into to curriculum problems.*

This definition highlights the three areas that are 'researched' during the process of action research: teaching practice, student learning and the curriculum. Action research includes a critical inquiry into these three aspects in collaboration with other people (other academics or the students). It can be concluded from this definition that a lecturer uses action research during teaching and learning to evaluate the educational process as a whole critically in order to identify problems. When the 'researcher' diagnoses a problem, he or she uses this information to improve his or her teaching practice and thus improves student learning.

#### **3.2.1.2 Action research models**

There are currently a wide variety of action research models available. Hodgkinson and Maree (1998:54-58) summarize the following examples of action research models in three categories:

1. Stage models - Elliot's stage action research model  
- Ebbutt's stage action research model
2. Cyclical models - McLean's cyclical action research model
3. Spiral models - Stringer's interacting spiral action research model  
- Zuber-Skerritt's four-moment action research model  
- Kemmis's spiral action research model

### **3.2.1.3 Action research steps during this study**

Every model displays a certain pattern of specific steps that is followed during action research. For the purpose of this study the researcher adapted and used the activity plan proposed by Hodgkinson and Maree (1998:61), that includes four steps during the action research process:

#### **1. Planning**

- ◆ The facilitator identified a general idea of what he wanted to achieve with the study.
- ◆ In the context of this study three problems were formulated (refer to p. 4).
- ◆ Research hypotheses were stated for this study (refer to p. 5).
- ◆ The literature was reviewed (refer to Chapter 2) concerning the new paradigm of OBE in South Africa. Different tools and strategies for facilitating learning in the context of OBE were reviewed. This review included a search into different learning style models available that included the Metaphoric Four Quadrant Whole Brain Model. For the purpose of this study the Whole Brain Teaching and Learning Model that was developed from the Whole Brain concept (p.85) was selected for the purpose of this study. The formulated problems and hypotheses were modified and refined to accommodate the use of this model as part of the study.
- ◆ A teaching and learning strategy was planned and learning activities prioritized.

#### **2. Implementation**

- ◆ The facilitator identified performance criteria for measuring the

effectiveness of the teaching and learning strategy that had been planned.

The following questions tested the achievement of the criteria:

- Do the activities capture learner attention?
- Are learners stimulated by the various activities?
- Are the learners actively busy during group work?
- Are the learning activities appropriate for the specific content?
- Are learners motivated to attend the learning sessions?
- Do learners enjoy learning the study unit?
- Do the learning activities accommodate diverse thinking style preferences?
- Are the learning activities appropriate to develop thinking style diversity?
- ◆ Diverse learning interventions or activities were implemented.

### 3. Observation

- ◆ Evidence was gathered via questionnaires, field notes, direct observation and by using indirect observation through video recordings of learning sessions.
- ◆ The data was analyzed.
- ◆ Problems were noted and used for reflecting upon the teaching practice.

### 4. Evaluation

- ◆ The outcomes of the teaching practice and learning performances were reviewed by the facilitator and learners.
- ◆ The effectiveness of the teaching practice was evaluated by the facilitator and learners.
- ◆ The learners and facilitator made recommendations.
- ◆ By taking into consideration the outcomes of the evaluation process the facilitator modified teaching practice.

Action research facilitated other changes to the educational practice of the facilitator, which included:

- ◆ Adapting his own preferred thinking style to incorporate whole brain thinking while using the Whole Brain Concept during learning activities.

- ◆ Having a positive attitude during learning activities towards learners with diverse thinking preferences, especially towards learners with style preferences that do not match the style preference of the facilitator.
- ◆ Developing different creative and innovative learning materials and learning activities to accommodate and develop diversity in the group.

The use of action research helped the facilitator of learning to gather information continuously in a planned manner in order to construct and implement meaningful learning activities. One of the first steps before planning meaningful activities was to profile the individual learners and the group.

### **3.2.2 HBDI scores of the individuals and the group**

The learners and facilitator completed the HBDI survey one week prior to the onset of the first learning intervention. The purpose was to:

- ◆ Create awareness by the facilitator for diverse thinking preferences of learners;
- ◆ Challenge the lecturer to innovate teaching strategies and learning activities in order to accommodate and develop learners during learning opportunities;
- ◆ Influence the attitudes of the learners (and facilitator) to meaningful learning positively, and
- ◆ To make learning more meaningful by using the Whole Brain Teaching and Learning Model.

After completing the HBDI survey each learner received a personal profile and accompanying booklet from Herrmann International (1999) that gave him or her more information about the Whole Brain Model and helped him/her to understand his/her personal profile better. In Table 5 the profiles were statistically analyzed.





Table 5: HBDI scores of the group

| Learners  | Profile code | Quadrant Score |     |     |     | Adjective Pairs |    |    |    |
|-----------|--------------|----------------|-----|-----|-----|-----------------|----|----|----|
|           |              | A              | B   | C   | D   | A               | B  | C  | D  |
| Female 1  | 1122         | 89             | 111 | 50  | 44  | 8               | 10 | 4  | 2  |
| Female 2  | 3211         | 32             | 47  | 113 | 116 | 4               | 0  | 10 | 10 |
| Female 3  | 3211         | 21             | 54  | 80  | 128 | 2               | 4  | 9  | 9  |
| Female 4  | 2121         | 56             | 74  | 60  | 114 | 1               | 6  | 8  | 9  |
| Female 5  | 2121         | 48             | 89  | 66  | 84  | 4               | 9  | 6  | 5  |
| Female 6  | 1122         | 98             | 104 | 45  | 45  | 8               | 11 | 2  | 3  |
| Female 7  | 1122         | 71             | 119 | 54  | 35  | 5               | 12 | 3  | 4  |
| Female 8  | 3111         | 32             | 84  | 129 | 74  | 0               | 6  | 12 | 6  |
| Female 9  | 1122         | 72             | 99  | 56  | 62  | 5               | 9  | 5  | 5  |
| Female 10 | 2111         | 45             | 80  | 95  | 75  | 2               | 5  | 11 | 6  |
| Female 11 | 2121         | 47             | 74  | 62  | 99  | 4               | 8  | 4  | 8  |
| Female 12 | 2111         | 36             | 68  | 83  | 120 | 2               | 7  | 5  | 10 |
| Female 13 | 3111         | 32             | 83  | 90  | 113 | 2               | 6  | 9  | 7  |
| Female 14 | 1221         | 93             | 53  | 53  | 68  | 7               | 8  | 6  | 3  |
| Female 15 | 2121         | 57             | 84  | 66  | 89  | 6               | 8  | 3  | 7  |
| Female 16 | 2111         | 60             | 68  | 71  | 96  | 8               | 2  | 7  | 7  |
| Female 17 | 2111         | 50             | 95  | 83  | 75  | 5               | 7  | 6  | 6  |
| Female 18 | 2221         | 51             | 63  | 60  | 101 | 2               | 4  | 9  | 9  |
| Female 19 | 2112         | 54             | 69  | 89  | 54  | 3               | 6  | 12 | 3  |
| Female 20 | 1112         | 68             | 83  | 89  | 57  | 6               | 7  | 6  | 5  |
| Female 21 | 2111         | 53             | 68  | 69  | 107 | 4               | 10 | 3  | 7  |
| Female 22 | 1121         | 86             | 90  | 44  | 75  | 9               | 8  | 2  | 5  |
| Female 23 | 2211         | 66             | 53  | 68  | 102 | 5               | 5  | 7  | 7  |
| Male 1    | 1221         | 92             | 71  | 51  | 75  | 7               | 7  | 2  | 8  |
| Male 2    | 1122         | 77             | 111 | 62  | 54  | 4               | 9  | 8  | 3  |
| Male 3    | 1112         | 86             | 72  | 75  | 57  | 7               | 4  | 9  | 4  |
| Male 4    | 1122         | 84             | 75  | 66  | 53  | 6               | 9  | 5  | 4  |
| Male 5    | 1221         | 77             | 62  | 56  | 102 | 7               | 4  | 3  | 10 |
| Male 6    | 1121         | 71             | 90  | 56  | 81  | 3               | 5  | 5  | 11 |
| Male 7    | 1121         | 87             | 78  | 56  | 69  | 8               | 4  | 5  | 7  |
| Male 8    | 1122         | 89             | 75  | 66  | 53  | 5               | 4  | 9  | 6  |
| Male 9    | 2121         | 62             | 102 | 66  | 71  | 5               | 9  | 3  | 7  |
| Male 10   | 1221         | 95             | 66  | 51  | 93  | 7               | 3  | 7  | 7  |
| Male 11   | 2121         | 45             | 93  | 59  | 105 | 5               | 6  | 8  | 5  |
| Male 12   | 2211         | 63             | 45  | 98  | 86  | 3               | 2  | 10 | 9  |
| Male 13   | 1211         | 92             | 45  | 71  | 78  | 8               | 3  | 8  | 5  |
| Male 14   | 1212         | 78             | 62  | 69  | 60  | 5               | 5  | 10 | 4  |
| Male 15   | 1122         | 96             | 102 | 50  | 51  | 6               | 7  | 6  | 5  |
| Male 16   | 1121         | 83             | 89  | 45  | 80  | 6               | 8  | 4  | 6  |
| Male 17   | 1122         | 105            | 89  | 41  | 59  | 8               | 6  | 3  | 7  |
| Male 18   | 1222         | 92             | 66  | 60  | 54  | 11              | 8  | 1  | 4  |
| Male 19   | 1132         | 113            | 93  | 32  | 53  | 10              | 6  | 3  | 5  |



|         |      |    |     |    |    |   |   |    |   |
|---------|------|----|-----|----|----|---|---|----|---|
| Male 20 | 1122 | 83 | 107 | 65 | 36 | 7 | 8 | 6  | 3 |
| Male 21 | 2111 | 39 | 84  | 75 | 84 | 1 | 7 | 11 | 5 |
| Male 22 | 1111 | 75 | 68  | 72 | 84 | 5 | 8 | 7  | 4 |
| Mean    | 1111 | 69 | 79  | 67 | 77 | 5 | 6 | 6  | 6 |

The following relates to Table 5:

### 1. Learners

- N = 45
- Female = 23 (51%)
- Male = 22 (49%)

### 2. Profile code

Every profile will have at least one primary score, but could have as many as four. This consists of four numbers placed in order of the quadrants: A B C D. The terms primary (1), secondary (2) and tertiary (3) are used to designate the zones of the profile grid.

**Primary (code 1)** = total over 66. In a given quadrant a primary indicates a distinct preference for the type of activities relevant to that quadrant.

**Secondary (code 2)** = total 34-66. A secondary in the profile indicates a comfort zone in types of activities of that quadrant. It is still a preference, but clearly secondary to the primary (ies).

**Tertiary (code 3)** = total 0-33. A tertiary indicates a lack of preference and thus an avoidance of activities representative of the quadrant. In a profile, a tertiary reinforces the preferences of the primary situated diagonally opposite it.

### 3. Quadrant score

The quadrant score indicates the strength of preference a specific learner has for the four brain dominances or thinking modes (A B C D).

#### 4. Adjective pairs

The four numbers appearing on the line 'Adjective Pairs' are the result of 24 forced choice pairings on the survey. This section pairs each descriptor with the other three quadrants.

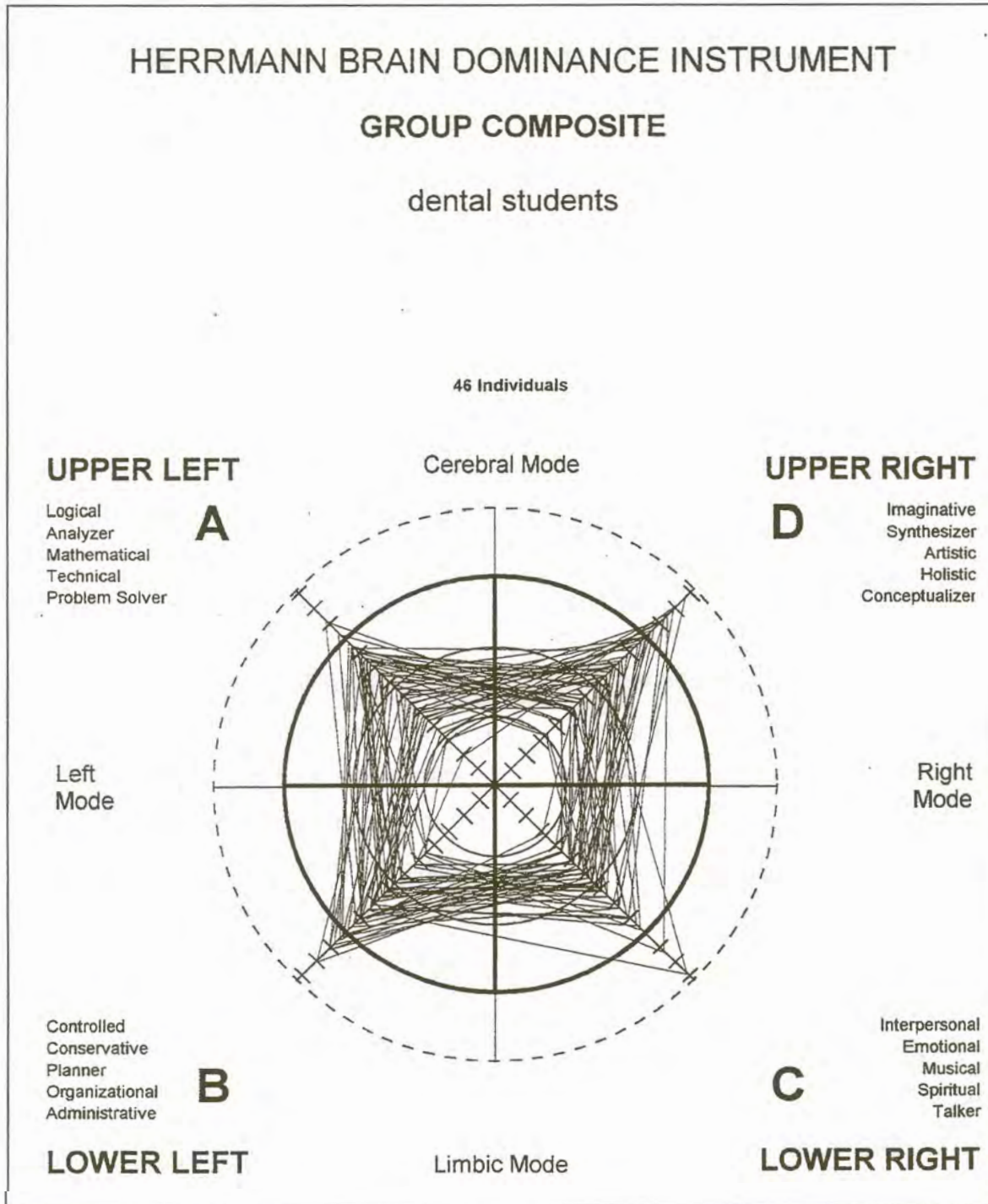
Experts in instrument design feel a balanced array of force-choice pairing like this adds to the accuracy of the personal profile. If the spread of these scores is in approximate correlation to the profile score, it shows entire consistency. If the score is significantly different, it indicates that the individual was somewhat inconsistent when completing the questionnaire.

From Table 5 it is concluded that group N represents a composite whole brain group, also revealed by the group composite profile in Figure 16 (p. 87). Data from a study of 5000 profiles done by Herrmann indicate that the aggregate total of all profiles gives a 1-1-1-1 (whole brain) profile. This is also evident of this group of learners with N = 1-1-1-1. Herrmann postulated that this would be true of most statistically significant groups of profiles.

Lumsdaine and Lumsdaine (1997:200) point out the advantages and usefulness of the HBDI:

- ◆ Students gain insight into their thinking preferences, which makes it easier for them to initiate successful learning strategies.
- ◆ The results are useful to facilitators of learning who can appreciate and understand student questions, comments and answers well in the light of their preferred style of thinking.
- ◆ The HBDI is useful in the construction of whole-brain groups during learning opportunities. Students develop easier understanding for those who are "different" and problems are solved more easily and more creatively in a whole brain group.

Figure 16: Composite map of the group





- ◆ The influences of curriculum changes on student thinking skills can be measured.
- ◆ Faculty members gain insight into their own cognitive and mental preferences, especially the members that feel isolated or left out.

### 3.2.3 Whole brain teaching strategies to facilitate learning

Different strategies and activities were used during this study to accommodate and develop diverse thinking styles of learners during learning interventions. The aim was to accommodate learners, preferred modes of thinking, but also to develop learning in all four quadrants. In Tables 6-9 the learners' expectations in each of the four quadrants or brain dominances during learning are described as well as the teaching strategies the facilitator of learning used to facilitate learning in the study unit of Toothmorphology.

**Table 6: Teaching strategies to facilitate learning for A-quadrant thinking style preferences**

| <i>Expectations of Learner</i>   | <i>Strategies of Facilitator</i>   |
|--|--|
| <ul style="list-style-type: none"> <li>◆ Precise to the point information.</li> <li>◆ Listening to informal lectures.</li> <li>◆ Theory and logical rationales</li> <li>◆ Proof of validity.</li> <li>◆ Research references.</li> <li>◆ Textbook reading.</li> <li>◆ Quantifiable numbers and data sets.</li> <li>◆ Problems.</li> <li>◆ Subject matter expertise.</li> <li>◆ Opportunity to ask challenging questions.</li> </ul> | <ul style="list-style-type: none"> <li>◆ Various textbooks on the study unit were made available to learners during learning interventions.</li> <li>◆ Clinically orientated articles on the subject were collected from scientific and other journals and made available to learners during learning interventions.</li> <li>◆ Real-life case studies were constructed and used by the facilitator to present learning activities in a problem-based format.</li> </ul> |



- ◆ Short informal lectures were used as part of introductions, orientation, conclusions and summaries during learning sessions.
- ◆ The facilitator was available as an expert on the content for advice and guidance during learning.

During learning the facilitator did make use of only short informal lectures during the introduction, orientation and summary of learning material. Various textbooks on Dental Anatomy including Toothmorphology as well as appropriate articles in dental journals were available to learners. Learning included solving real-life problems while the facilitator acted as an expert who gave learners advice during learning. Learners had to analyze problems (see example: Appendix D), collect information on the problem by using textbooks and clinical articles and produce possible answers.

**Table 7: Teaching strategies to facilitate learning for B- quadrant thinking style preferences**

| <i>Expectations of Learners</i>  | <i>Strategies of Facilitator</i>   |
|--|--|
| <ul style="list-style-type: none"> <li>◆ Organized consisted approach.</li> <li>◆ Listening to detailed lectures.</li> <li>◆ Taking detailed notes.</li> <li>◆ Staying on track and on time, making time management schedules.</li> <li>◆ Complete subject chunks.</li> <li>◆ Beginning, middle and end.</li> <li>◆ Opportunity to practise and evaluate.</li> </ul> | <ul style="list-style-type: none"> <li>◆ A separate study manual for the study unit of Toothmorphology was handed out that included ground rules for learning opportunities as well as the assessment (whole brain) practice.</li> <li>◆ Information on the Whole Brain Concept was delivered to learners via an introductory learning session and handouts.</li> <li>◆ Every learner received a detailed</li> </ul> |



- ◆ Practical applications.
  - ◆ Examples.
  - ◆ Clear instructions and expectations.
  - ◆ Frequent repetition.
  - ◆ Want to follow directions and do not want to try something in a different way.
  - ◆ Testing theories.
  - ◆ Writing a sequential report on results of experiments.
- ◆ analysis and description of his or her brain dominance profile.
  - ◆ Every learning session was organized on the whiteboard by using visual time frames for each activity during learning.
  - ◆ At the end of each learning session the facilitator summarized the learning that took place during that session and related it to the specific outcomes of the study unit.
  - ◆ The learners had to keep record of all their previous learning and learning material
  - ◆ Learners were regularly informed how and when they will be assessed
  - ◆ The facilitator acted as co-manager, co-organizer and co-administrator during learning.

Together with the individual profile each learner received an interpretation and explanation of their own profile. During the first learning opportunity the learners were instructed on the Whole Brain Model to make sure everybody understood the reasons for and conditions of learning via the Whole Brain Concept. During this session the facilitator also outlined the rules that were to be followed during learning to make sure that everybody was more secure. The following are the ground rules and conditions that were set during learning via the Whole Brain Teaching and Learning Model:

- ◆ Everything that happens during learning in the classroom is confidential.



- ◆ No discrimination between peers is allowed during learning.
- ◆ Everybody has an equal chance to ask questions and speak his or her mind.
- ◆ No fun or jokes are allowed when somebody has done something wrong or stupid.
- ◆ Respect for one another is imperative.
- ◆ Learners must be spontaneous and enjoy learning.

A separate study manual, organizing the specific outcomes of learning in this study unit, was supplied to the learners. The facilitator adapted the study-manual (micro-structure level of the curriculum) for the study unit of Toothmorphology to include the principles of the Whole Brain concept. Learning sessions were presented using a time schedule that clearly outlined the intended activities that would take place during a session. At the start and the end of each learning session the facilitator orientated the learners' learning according to the specific outcomes and related it to the critical outcomes.

**Table 8: Teaching strategies to facilitate learning for C-quadrant thinking style preferences**

| <i>Expectations of learner</i>  | <i>Strategies of Facilitator</i>   |
|---|--|
| <ul style="list-style-type: none"><li>◆ Group discussion and involvement.</li><li>◆ Meeting new people.</li><li>◆ Sharing ideas.</li><li>◆ Expressing feelings.</li><li>◆ Doing role-play or physical acting out.</li><li>◆ People orientated case studies.</li><li>◆ Learning by teaching others.</li><li>◆ <i>Prefer video to audio learning material.</i></li><li>◆ Moving around (kinesthetic).</li></ul> | <ul style="list-style-type: none"><li>◆ The learners had to work in groups of three.</li><li>◆ Music was played during learning sessions at selected times.</li><li>◆ The facilitator used stories from personal experiences in private practice to give better meaning to important aspects of the content.</li><li>◆ <i>Sessions included physical activities, e.g. walking around to collect data, presenting a short</i></li></ul> |





- ◆ Hands-on learning.
  - ◆ Respect for and from others.
  - ◆ Personal connection with lecturer.
  - ◆ Emotional involvement.
  - ◆ User-friendly learning experience.
  - Use of all the senses.
- ◆ drama, scenario or role-play as a group in front of the class.
  - ◆ Learners were encouraged to move around and speak to their peers in other groups when necessary.
  - ◆ The facilitator provided personal help to learners with learning or personal problems.
  - ◆ Mutual respect and appreciation were shown to all learners for their contributions during learning activities.
  - ◆ A warm and friendly mood or atmosphere was maintained during learning.
  - ◆ The facilitator acted as a mentor, motivator and friend during learning.

During learning sessions the facilitator played music softly in the background while group work was commencing. The learners were invited to supply the music they prefer for learning opportunities. The learners were divided into heterogeneous, whole brain groups during the first learning opportunity. The brain dominance profiles of the three learners in a group had to include dominances for all four quadrants. The heterogeneous groups were used during the whole study. There was freedom and motivation to move around during learning and activities such as drama, scenarios and role-play were used to activate learners' thinking and moving around during learning activities. Learners had to interpret cartoons about an "intervention in the dental chair" or advertise a "new toothbrush" to the class. The facilitator used stories from his own professional experience to present real-life problems. The facilitator was



available on a continuous basis to help learners with personal, learning and other problems.

**Table 9: Teaching strategies to facilitate learning for D-quadrant thinking style preferences**

| <i>Expectations of Learner</i>   | <i>Strategies of Facilitator</i>   |
|--|--|
| <ul style="list-style-type: none"><li>◆ Fun and spontaneity.</li><li>◆ Surprising and playful approaches.</li><li>◆ Pictures, metaphors and overviews.</li><li>◆ Discovering of the content.</li><li>◆ Freedom to explore.</li><li>◆ Quick pace and variety.</li><li>◆ Opportunity to experiment.</li><li>◆ New ideas and concepts.</li><li>◆ Looking at the big picture, not the facts or detail.</li><li>◆ Taking initiative and getting involved.</li><li>◆ Brainstorming.</li><li>◆ Problems with many possible answers.</li><li>◆ Playing with new ideas.</li><li>◆ Exploring hidden possibilities.</li><li>◆ Thinking about the future.</li><li>◆ Future-orientated case discussions.</li><li>◆ Come up with something new.</li><li>◆ Thinking about trends.</li><li>◆ Relying on intuition.</li></ul> | <ul style="list-style-type: none"><li>◆ Learners had to introduce themselves to the class by using a metaphor.</li><li>◆ The learners and facilitator had much fun during the drama-like presentations of scenarios and role-play.</li><li>◆ Colourful innovative learning materials made learning fun and interesting.</li><li>◆ A variety of drawings and sketches to illustrate content were used.</li><li>◆ The various textbooks available to learners brought variety into the classroom.</li><li>◆ Movie-clips on video and cartoon pictures from magazines were used as icebreakers or during a learning session to stimulate learners.</li><li>◆ Futuristic design activities were used as introductions, e.g. designing the toothbrush of the future.</li><li>◆ Future-orientated discussions were</li></ul> |



used to show the relevance of the content in a clinical working situation on a real patient.

- ◆ Real-life pictures from magazines and clinical journals were used to bring life to the content
- ◆ Videos that were previously made by a colleague for the study unit of Toothmorphology were shown to learners during learning sessions
- ◆ The learners had the freedom to construct and deliver their own project that would incorporate what they had learnt during the learning sessions in a whole brain manner

Interesting learning designs and learning materials were used during learning opportunities, which helped to construct an element of intrigue, surprise and excitement throughout the course of learning. A lot of different colours, patterns and designs were used for learning materials. Role-play, scenarios and metaphors set the scene for fun and spontaneity during learning, and were used as icebreakers at the start of a session or as an energizer in the middle of a learning session.

A short clip from a movie and some cartoon pictures, all about dentistry, were used to stimulate learners, create an atmosphere of fun and spontaneity and to help learners to be active and overcome boredom during learning activities. The content was illustrated using real-life pictures and videos on Toothmorphology. As a final outcome of learning the learners were given a task to construct their

own whole brain model on Toothmorphology giving them the freedom to demonstrate in the format of their choice what they had learnt in this study unit.

The facilitator attempted with innovative and creative learning design and activities to accommodate the diverse preferences of the whole group that represented an equal distribution of all four thinking modes.

### **3.3 Assessment**

#### **3.3.1 Traditional assessment in the study unit of Toothmorphology**

The total educational strategy includes three important aspects: *curriculum development*, *teaching practice* and *assessment*. Assessment is that part of the educational process where what the learner has learnt is measured against set criteria or outcomes. This can be done during learning or at the end of learning. There are two types of assessment that are used to measure the learning performance of learners (Malan & du Toit, 1991:153) - assessment with a formative function and assessment with a summative function.

- a. Formative assessment
  - takes place during instruction
  - ideal to be used continuously during learning
  - learner gets continuous feedback of performance that helps to manage learning
  - more informal and low stress to learners
  - used for learner's benefit
- b. Summative assessment
  - takes place after instruction in the form of an examination or semester test
  - more formal and high stress to learners
  - used for certification purposes or society's benefit

Traditionally in the study unit of Toothmorphology, as with most other study units in the curriculum, the learners' performance is assessed by using mostly summative assessment and only a few formative assessment interventions.

### **3.3.2 Assessment in the new paradigm of outcomes-based education**

Assessment plays an important role in the new paradigm of OBE. It is used to collect evidence of learner development and achievement. This helps the facilitator of learning to manage the learning process in order to make learning more meaningful.

Assessment forms an integral part of the teaching strategy and learning activities in OBE. Assessment is multidimensional, aiming to measure different aspects of learning, including skills and processes as well as knowledge and attitudes. A practice of Continuous Assessment (CASS) that places the emphasis on formative assessment of learners' work over a period of time by using different assessment strategies is proposed by SAQA (1997:25). This assessment practice can include the following strategies:

- ◆ Self-assessment
- ◆ Peer-assessment
- ◆ Portfolio-assessment
- ◆ Performance assessment
- ◆ Observation sheets
- ◆ Journals
- ◆ Teacher-made tests
- ◆ Assessment of prior learning
- ◆ Diagnostic assessment
- ◆ Achievement-based assessment

### **3.3.3 Assessment as part of this study**

Facilitators of learning in higher education agree that assessment drives learning. This illuminates the fact that when developing the curriculum, assessment must be incorporated and used to drive meaningful learning.

During this study assessment was incorporated as a necessary and important aspect of the total educational strategy (curriculum design, learning and

assessment) geared towards meaningful learning and maximizing human potential. Assessment was not only used to measure *what* (content) the learners should learn but also *why* they have to learn it (to become competent and skilled) *and how* they should learn (outcomes-based learning, whole brain learning).

Diverse assessment strategies were planned and aligned with the teaching practice according to the Whole Brain Teaching and Learning Model as well as to the specific outcomes of the study unit of Toothmorphology. The following strategies for assessment were implemented:

- ◆ *Facilitator-made tests*: Tests were given during learning sessions and included questions about the facts and detail of the study unit. It also included (holistic) questions on the relevance of Toothmorphology in a clinical situation, placing responsibility on the learners to incorporate what they have learnt into one answer. Learners also had the opportunity of assessing one another's answers (peer-assessment) to these tests.
- ◆ *Self-assessment*: Learners assessed their own knowledge, skills and attitudes during learning as part of the weekly feedback via a questionnaire (Appendix B).
- ◆ *Peer-assessment*: Learners measured the knowledge, skills and attitudes of their peers in their own group as part of the weekly feedback via a questionnaire (C quadrant).
- ◆ *Other assessment*: Learners received an assignment where they had to produce something that would demonstrate what they had learnt in the study unit of Toothmorphology in a whole brain format (Appendix A).

Assessment assisted the facilitator of learning and learners to monitor learning performance continuously against the specific outcomes. The use of "whole-brain" assessment during this study also helped accommodating and developing diversity in thinking and learning.



Formative assessments consisted of tests written during learning sessions; a final test at the end of the series of learning sessions constituted the summative assessment. Summative assessment was done for the sole purpose of promotion.



## Chapter 4

### 4. Empirical study

#### 4.1 Introduction

The purpose of this study was to implement an educational model that enhances the quality of learning while accommodating the new paradigm of OBE. The Herrmann Whole Brain Model was selected and implemented in the study unit of Toothmorphology. During the study the following data was compiled and summarized:

- ◆ HBDI profile scores of the group of learners.
- ◆ Test scores by learners for the study unit of Toothmorphology.
- ◆ Mean M-Score of the group.
- ◆ Learners' feedback of learning via the Whole Brain Model.

The data was statistically analyzed and is described in this chapter.

#### 4.2 Interpretation of HBDI scores

##### 4.2.1 Thinking preferences of the group

As part of this study the learners and facilitator had to complete the HBDI survey. This was done before the commencement of the learning opportunities. The facilitator used the data from the profile score of the group as well as the individual scores to plan learning opportunities.

**Table 10: Preferred modes of thinking of the group**

| Quadrant | Mean  | Std. Dev. | Min.<br>Score | Max.<br>Score | Median |
|----------|-------|-----------|---------------|---------------|--------|
| A        | 69.48 | 22.62     | 21            | 113           | 71.50  |
| B        | 79.26 | 18.36     | 45            | 119           | 79.00  |
| C        | 67.09 | 18.82     | 32            | 129           | 67.50  |
| D        | 76.63 | 23.83     | 35            | 128           | 75.00  |



Table 10 (refer to p. 101) indicates that this is a heterogeneous group of learners having a strong or very strong preference (profile score equal or more than 67) for thinking in all four quadrants of the whole brain. This data strongly supports Herrmann's statement (Herrmann, 1996:150) that:

*The only safe assumption is that every learning group represents a corporate whole brain.*

The learning facilitator used the data to structure learning activities according to learners' thinking preferences. For the purpose of this study the facilitator planned his educational practice to accommodate and develop whole brain thinking in order to maximize the full potential of all learners and minimize learning avoidances during learning.

#### **4.3 Comparison between the profile-score and M-Score**

Traditionally, the School for Dentistry at the University of Pretoria uses the M-Score, which is based on learners' performances in grade twelve (Van Dyk, 1992), as an indicator to select learners to study dentistry. The higher the M-Score, the better chance a learner has to be selected to study dentistry. Currently there are only sixty selected learners in the first year of study for the BChD degree. For the purpose of this study it is concluded that the M-Score is used as an indication of a learner's ability, indicating the learners that are more intelligent and will be able to deliver the learning performances that are needed to be successful during their studies. Table 11 (refer to p. 103), which summarizes the M-Scores of this group of learners, indicates a minimum M-Score of 10 and a maximum M-Score of 30 for this group of learners. Pearson Correlation Coefficients were done between the group of learners' M-Scores and their preferred thinking styles.

Table 11: Summary of M-Scores

| Mean score | Std. Dev. | Min. Score | Max. Score | Median |
|------------|-----------|------------|------------|--------|
| 23.73      | 4.63      | 10         | 30         | 23     |

No statistically significant correlation was found between individual learner's M-Scores and their preferred modes of thinking. For this group of learners, the data indicates that the ability to perform well in school is not linked to a specific thinking style preference or HBDI pattern. It is suggested that human intelligence cannot be limited to only one, two or three of the brain dominant modes but to any combination (HBDI profile) of all four the modes. This coincides with the work of Gardner on multiple intelligences that was described previously in Chapter 2 (refer to p. 69).

#### 4.4 Test scores for Toothmorphology

The learners wrote three lecturer-made tests during this study. The mean scores for the three tests are summarized in Table 12. The results from the three written tests in Table 12 show a significant high mean score for this group of learners. The minimum score for these tests by a learner was eighty percent and the highest score was one hundred percent with a mean score of ninety six percent for the group. Pearson Correlation Coefficients found no correlation between a learner's preferred modes of thinking and tests scores obtained during the study.

Table 12: Summary of test scores during this study

| Test | Min. | Max. | Mean | Std Dev. | Median | Variation |
|------|------|------|------|----------|--------|-----------|
| 1    | 86   | 100  | 97   | 1.737    | 98     | 3.019     |
| 2    | 82   | 100  | 95   | 1.949    | 96     | 3.802     |
| 3    | 80   | 100  | 95   | 2,636    | 96     | 6.951     |

Test performances of groups in previous years in the study unit of Toothmorphology delivered mean scores between sixty and seventy percent. It can be argued that the significant increase in the mean score of this group

measured against previous groups is due to the fact that the tests were too easy. This fact cannot be argued as valid since the questions in the previous tests were of the same kind. No test papers of previous years (1998 and 1999) were available to learners.

It could be argued that the learning facilitator who marked the tests was very lenient with marks. Since this study unit is about exact facts of anatomy the answers to all questions could be only right or wrong. The learners also had the first opportunity to mark their peers' tests. They could also contest the marks received from peer assessment. At the end the facilitator double-checked the allocation of marks.

The feedback from the questionnaires at the end of each week is described in section 4.5. The fact that this group of learners performed very well in this study unit seems to correspond with their positive experience of learning via the Whole Brain Model.

#### 4.5 Evaluation of learning via the Whole Brain Teaching and Learning Model

The learners completed a questionnaire (Appendix B) after the first and again after a second set of four learning opportunities. Each learning session lasted for two hours and was presented to accommodate and develop the Whole Brain Concept. The questionnaire consisted of various kinds of questions about the learning experiences of the learners with the Whole Brain Model. The feedback received from the questionnaires was statistically analyzed.

**Table 13: Summary of scores from learner feedback**

| Question | Mean          | Min. Score | Max. Score | Std. Dev.     |
|----------|---------------|------------|------------|---------------|
|          | Week1 / week2 |            |            | Week1 – week2 |
| 1        | 4.04 / 4.17   | 3          | 5          | .638 / .716   |
| 2        | 3.95 / 4.17   | 2          | 5          | .638 / .936   |



|             |                    |   |   |              |
|-------------|--------------------|---|---|--------------|
| 3           | 4.04 / 3.91        | 2 | 5 | .767 / .900  |
| 4           | 4.13 / 4.04        | 2 | 5 | .868 / .824  |
| 5a          | 4.39 / 4.47        | 3 | 5 | .891 / .790  |
| b           | 4.34 / 4.26        | 3 | 5 | .572 / .810  |
| c           | 4.47 / 4.47        | 3 | 5 | .665 / .730  |
| d           | 3.78 / 3.95        | 2 | 5 | .902 / .824  |
| e           | 3.65 / 3.82        | 1 | 5 | 1.070 / .936 |
| 6a          | 4.13 / 4.04        | 3 | 5 | .694 / .767  |
| b           | 4.17 / 4.26        | 3 | 5 | .834 / .810  |
| c           | 4.47 / 4.43        | 3 | 5 | .593 / .787  |
| d           | 4.34 / 4.21        | 3 | 5 | .647 / .735  |
| 7           | 3.69 / 3.91        | 2 | 5 | .926 / .848  |
| 8           | 4.17 / 4.34        | 3 | 5 | .716 / .647  |
| 9           | 4.34 / 4.39        | 3 | 5 | .589 / .782  |
| <b>Mean</b> | <b>4.13 / 4.16</b> |   |   |              |

Pearson Correlation Coefficients were done for the feedback received from the learners via the questionnaires for question one to nine. All the answers for the same question had a statistically significant high correlation (coefficients = -1 or 1). There was a statistically significant low correlation between all the different questions for both the two sets of answers from the different weeks.

The mean score for all questions for the first (4.13) and second (4.16) set of learning sessions indicates a better learning experience (equal or above a score of four) by the learners than what they had experienced previously in their studies. It is concluded that for this study learning via the Whole Brain Model caused more meaningful learning than what they had previously experienced.

The learners also had the opportunity to respond freely via the open questions (question ten and eleven) in the evaluation form. The feedback from all the

questions was very significant and positive. This feedback helped the learning facilitator with action research during the study.

#### **4.6 Learner assignment**

The learners had to produce, manufacture or construct something to illustrate the knowledge they had acquired in the study unit of Toothmorphology in a Whole Brain manner. The learners received this assignment after the first week of learning activities had been completed. They had to submit the finished assignment one week after the completion of the learning activities for the study unit.

The response from the learners exceeded all expectations. The learners responded by handing in products and artifacts that demonstrated knowledge of the content, order of content, working together or individually, creativity, artistic ability, diversity, excitement, commitment, as well as the willingness to dare and be different. The products ranged from different games, puzzles, magazines, traveller's journal, doctor's jacket, family album to a selection of four different flavours of pizzas in one model demonstrating the content of Toothmorphology in the four different modes of thinking.

#### **4.7 Learners' experiences during learning**

The different outcomes, data and feedback from this study indicate that the learners had a positive and meaningful learning experience. Learners' answers to the open questions, question ten and twelve, of the weekly questionnaire indicated the following as very positive aspects experienced during learning via the Whole Brain Model:

- ◆ Nineteen learners stated that they enjoyed the responsibility to research and discover information actively and solve problems on their own.
- ◆ Nineteen learners stated that learning via the Whole Brain Model was very enjoyable, exciting and they had fun while learning. These learners stated that they were looking forward to coming to a learning session.

- ◆ Twenty-two learners stated that they were learning faster, more easily and more effectively during these learning sessions than what they were used to in other lecturers' learning sessions. These learners also indicated that the Whole Brain Concept made new information more understandable and easier to learn and that they spent much less time at home to understand and get to know the work than in any other study unit previously experienced.
- ◆ Thirty-eight learners of the group indicated that co-operating in a group made the learning of the content much easier and more enjoyable. The learners enjoyed getting to know one another and having the opportunity of listening to and respect different opinions and views from different people. They also indicated that the Whole Brain Model helped them to know and understand themselves and others better.
- ◆ Nine learners indicated that they enjoyed the variety and various methods and activities during learning.

There was, however, a negative learning experience by one of the learners during the study.

- ◆ This learner indicated a negative and less meaningful learning experience for this study unit than in previous study units. This learner indicated frustration and a need for more lectures, concrete information and self-study (A-quadrant preferences) during learning.
- ◆ This learner's profile score (profile score=1222) indicated a strong to very strong preference for learning in the A-quadrant or left cerebral thinking mode. This is a less preferred thinking mode for the facilitator of learning as indicated by the facilitator's profile score (profile score=2112). The facilitator used this information to adapt learning activities to accommodate and develop this learner.
- ◆ After completion of the learning in the study unit of Toothmorphology this learner personally reported a positive and meaningful learning experience to the facilitator. This learner also performed above the group's mean score for this study unit.



Overall all learners reported a very positive and meaningful learning experience during this study. The facilitator also experienced the opportunity to be a part of the learning process via the Whole Brain Model as very enriching, stimulating, exciting and very positive.

## **CHAPTER 5**

### **5. SUMMARY, CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Summary**

In the paradigm of OBE the role of the lecturer has changed from a deliverer of content (lecturer-centred) to a facilitator of learning that helps the learners (learner-centred) to master the critical and specific outcomes in this study unit for Toothmorphology. This new role of the lecturer in dentistry includes a variety of functions (Chapter 2, p. 19) during the teaching and learning process to help the learners to be successful during learning of new knowledge, skills and attitudes.

This study has implemented the principles of the Whole Brain Teaching and Learning Model to propagate meaningful learning by accommodating and developing thinking style diversity. Profiling this group of learners stimulated awareness of diverse thinking styles to the learning facilitator. The mean profile score of the group indicates that there is a statistically significant strong to a very strong preference for all four brain dominant modes of the Whole Brain Model, and consequently preferences for learning activities that include all four thinking modes.

These findings have challenged the facilitator to adapt his own thinking style preference during learning in order to accommodate and develop a group of learners with diverse thinking styles. Creative and innovative learning materials and activities, planned and implemented via the Whole Brain Model, were used to facilitate learners to master the critical and specific outcomes of learning in the study unit for Toothmorphology. Different learning materials, methods and techniques were not only used for the purpose of diversity but were planned and delivered with a specific strategy to minimize learning avoidances and to develop whole brain thinking.

During the study the facilitator of learning made use of action research to evaluate and adapt implemented learning activities continuously and to minimize



learning avoidances with a view to fostering meaningful learning by a diverse group of learners.

The results of this study indicate a significant improvement of learners' retention, participation and attitudes toward the content and learning as well as to group interaction and problem solving.

## **5.2 Conclusion**

In the new paradigm of education and training in South Africa learning facilitators help learners to maximize their potential through well planned, specifically intended and flexible learning activities where the focus is on learning rather than delivery of knowledge. To learn learners need to think, and thinking is facilitated by the learning activities that are used to engage learners with the content. The Whole Brain Model helps facilitators of learning to understand the concept of thinking diversity and how to accommodate and develop whole brain thinking during learning. Studies by Bunderson (adapted from De Boer et al., 2001) of the model have proved it to be reliable and valid when analyzing thinking style preferences, thus delivering accurate quantitative information for use when planning learning activities. Herrmann (1996) states that:

*The whole brain concept, once understood, becomes irresistible.*

In the new paradigm it cannot be assumed that all learners' potential will be maximized when learning facilitators use single educational technologies, such as problem solving or cooperative learning as a basis for all learning activities. It is the responsibility of the educator and trainer to be innovative and creative in his or her educational practice in order to accommodate and develop diverse thinking and thereby enhancing the quality of learning. The Whole Brain Teaching and Learning Model helps to plan and deliver diverse learning activities with the specific intention of facilitating meaningful learning with all learners in a group. Having a strong preference for a specific style of thinking is no indication

of competence for that style and the facilitator should use learning opportunities to train, motivate and let learners practise whole brain thinking to develop all thinking styles fully.

This dissertation underscores awareness of thinking style diversity of learners in the learning environment and introduces the positive results of using the Whole Brain Model to accommodate and develop learners' learning for enhancing the quality of learning.

### **5.3 Recommendations of this study**

#### **5.3.1 Recommendations for teaching and learning in Dentistry**

- ◆ Facilitators of learning in dentistry can use the principles of the Whole Brain Concept to enhance the awareness of thinking style diversity in the learning environment.
- ◆ Lecturers facilitating learning in different modules of the dentistry curriculum can integrate and use the principles of the Whole Brain Teaching and Learning Model into their teaching practice.
- ◆ The Whole Brain Teaching and Learning Model can be used to accommodate and develop whole brain thinking and learning in order to stimulate the full development of the individual learners' potential.
- ◆ This study recommends the use of the Whole Brain Teaching and Learning Model by facilitators of learning in dentistry to help them deliver learning interventions with a more strategic educational purpose.

#### **5.3.2 Recommendations for further research**

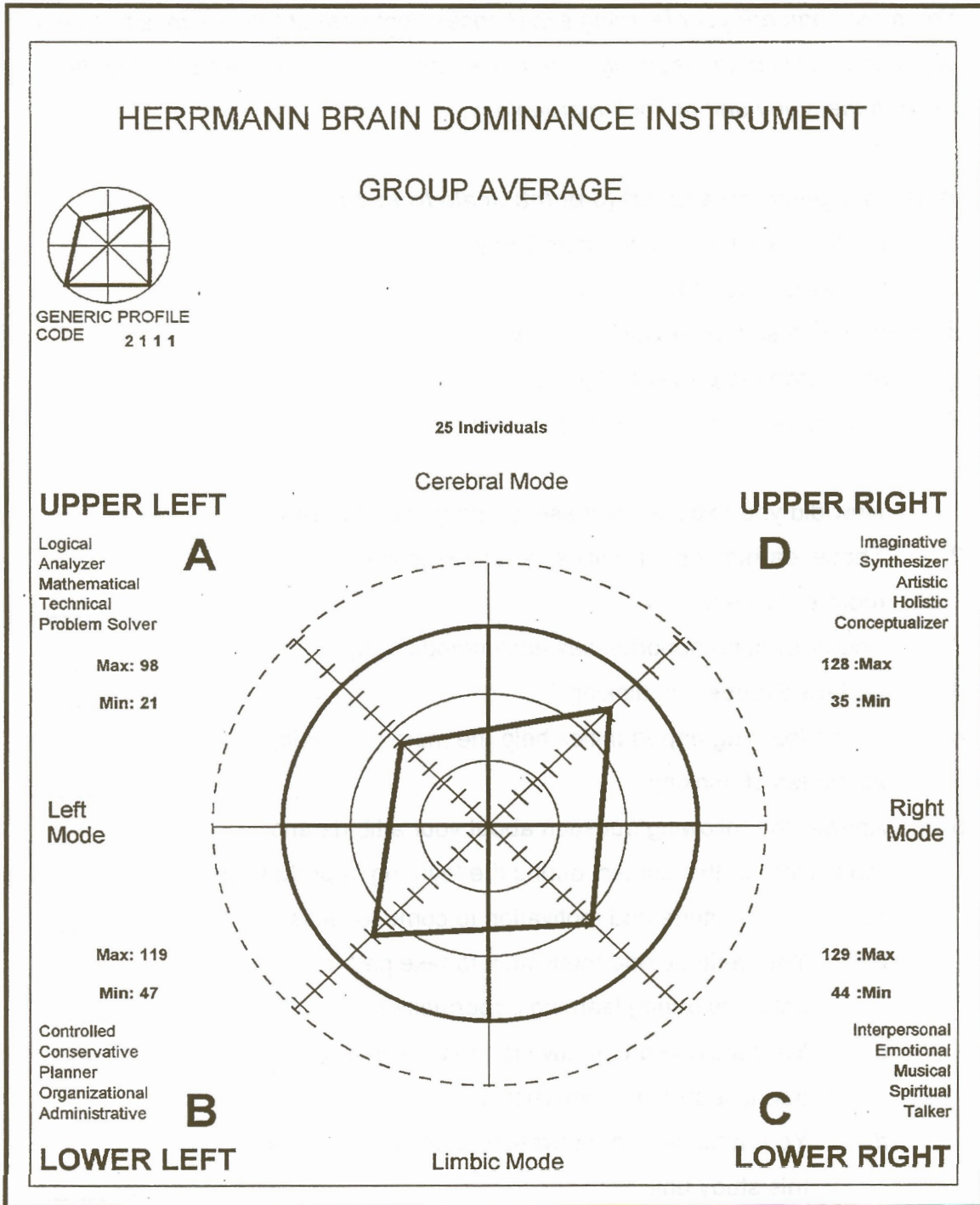
- ◆ It is recommended that this group of learners are re-tested after a period of time to determine the retention of learning in this study unit.
- ◆ Further research is recommended to determine if this group of learners' thinking styles will have changed over time during their studies.



- ◆ Further research is proposed to correlate the learners' thinking style preferences with their performances in different modules of dentistry as well as their final examination results results appears twice.
- ◆ This study proposes measurement of thinking style preferences of all academic staff in the dental school to raise the awareness of diversity and to investigate a group profile of dental academics.
- ◆ A study is proposed to investigate the thinking style diversity of dentists in private practice as well as dentists working in the public sector (oral health clinics). Group profiles and correlation of the two groups could be investigated.



APPENDIX A: HBDI Profile



**APPENDIX B: Questionnaire learners completed**

*You must compare your learning experiences (lectures) of the previous two years of you studies with the learning experiences that you have received during this week in the study unit of Toothmorphology.*

**Marks are given on a Likert (5 point) scale from 1 to 5:**

- 1** = much worse than the previous 2 years
- 2** = worse than the previous 2 years
- 3** = the same as the previous 2 years
- 4** = better than the previous 2 years
- 5** = much better than the previous 2 years

- |    |  |       |
|----|--|-------|
| 1. | How did you experience these learning opportunities?   | _____ |
| 2. | These learning opportunities cause me to learn more effectively  | _____ |
| 3. | These learning opportunities accommodate my preferred modes of thinking  | _____ |
| 4. | These learning opportunities help me more to develop all modes of thinking   | _____ |
| 5. | Answer the following question about your attitude and motivation for this subject during the learning opportunities: |       |
| a. | Your attitude and motivation to come to class  | _____ |
| b. | Your attitude and motivation to take part in activities during learning opportunities                                | _____ |
| c. | Your attitude and motivation to work in a group during learning opportunities  | _____ |
| d. | Your attitude and motivation to do self-study for this study unit  | _____ |
| e. | Your attitude and motivation to make use of the study-guide for this subject   | _____ |



6. How well do I keep to the class rules that were spelled out before the start of the lectures:
- a. What is your degree of spontaneity during the learning Opportunities? \_\_\_\_\_
  - b. Are you on time for the learning opportunities? \_\_\_\_\_
  - c. Your participation in group work \_\_\_\_\_
  - d. Are you creative and original in doing tasks and problems? \_\_\_\_\_
7. How does the study-guide compare to the study-guides you received in the previous years? \_\_\_\_\_
8. How was your experience of the learning aids that were used (textbooks, models, pictures, scenarios, problems, icebreakers, metaphors) \_\_\_\_\_
9. How did you experience the different methods of assessment (self-evaluation, peer-evaluation, written tests, group-evaluation) that were used during the learning opportunities? \_\_\_\_\_
10. What did you experience as very positive during the learning opportunities of this week? \_\_\_\_\_  
\_\_\_\_\_
11. What can be changed or done differently to make your learning experience better? \_\_\_\_\_  
\_\_\_\_\_
12. Are there anything else that you would like to comment on? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## APPENDIX C: Learner assignment

### **Learner Assignment for Toothmorphology**

You must design and construct a whole brain model that will show or illustrate the knowledge that you acquired in this study unit of Toothmorphology for the module of Odontology. The model must be something that you can use to remember the embedded knowledge of this subject. You can work individually on this project.

**There is no restriction on what you can do and it is entirely up to you what type of model it is, but you must incorporate the four aspects of the whole brain model, including the following:**

- ◆ **A-quadrant** - prefers the facts, detail, reading textbooks, logic, problem solving, opportunity to ask challenging questions and quantitative data.
- ◆ **B-quadrant** - prefers organization, summaries, a time-schedule, opportunity to practise, clear instructions, examples, an organized consistent approach and a beginning, middle and end.
- ◆ **C-quadrant** - prefers group discussion, drama, music, stories, physical activities and sharing personal experiences.
- ◆ **D-quadrant** - prefers brainstorming, metaphors, pictures, drawings, designs, active imagination, innovations and thinking about the future.

**Assignments should be handed in before or during the last learning session for this study unit. Enjoy the challenge!**



## APPENDIX D: A problem during learning

Module: Odontology  
Study-unit: Toothmorphology

### **Problem 2** 03/04/2000

You are visiting your grandmother in Cape Town during the summer holidays. You are having tea on the veranda, which is overlooking the False Bay area. She recently received a new set of full removable dentures (maxilla and mandible). She wants to know from you how many teeth are there in a healthy permanent dentition, and what the different teeth with different sizes and shapes.

- ◆ You are allowed to ask the facilitator of learning questions regarding this problem. You can also make use of the different clinical journals and textbooks to solve this problem.
- ◆ You have to make a written report as a group, and be ready to deliver your answers to the questions your grandmother is asking.
- ◆ This problem should be solved as a group. You have 25 minutes before the discussion starts.

Learning facilitator: Dr Marius Oosthuizen



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