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-

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 inter-dependence.

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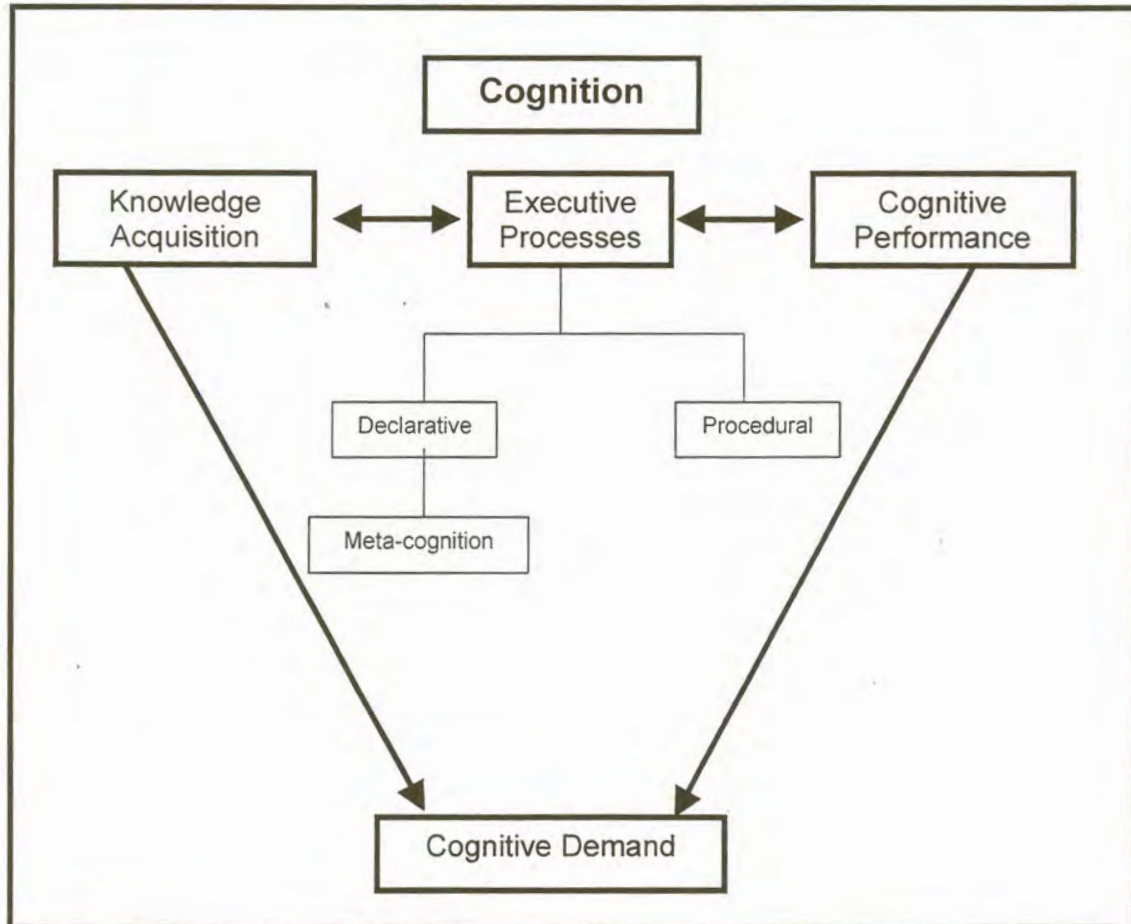
Worral (1990:174) states *"meta-cognition is a thinking activity and involves learner control and self-regulation"*. Duell, quoted by Worrel (1990:171), defines meta-cognition as *"the knowledge and regulation of one's own learning system"*. According to Gourgey (1998:82) meta-cognition can be seen as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

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│                          │    Cognition     │                         │
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│   │ Acquisition │        │  Processes  │        │ Performance │      │
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│                      │  Declarative │    │ Procedural │              │
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│                      ┌───────────────┐                                │
│                      │ Meta-cognition │                               │
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│                      │  Cognitive Demand │                            │
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(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 under-graduate 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.
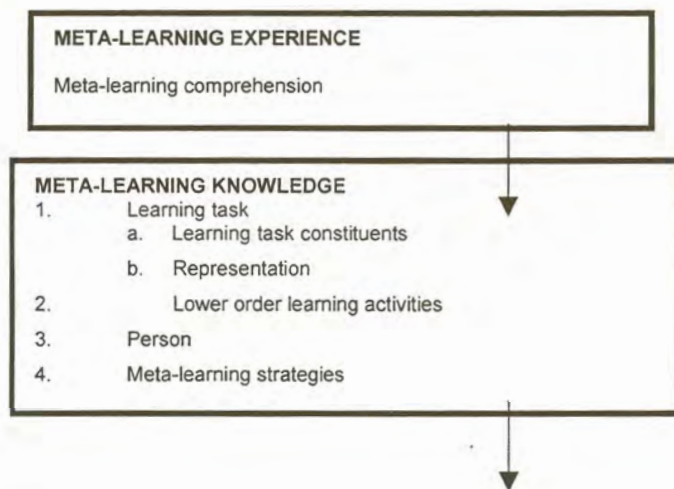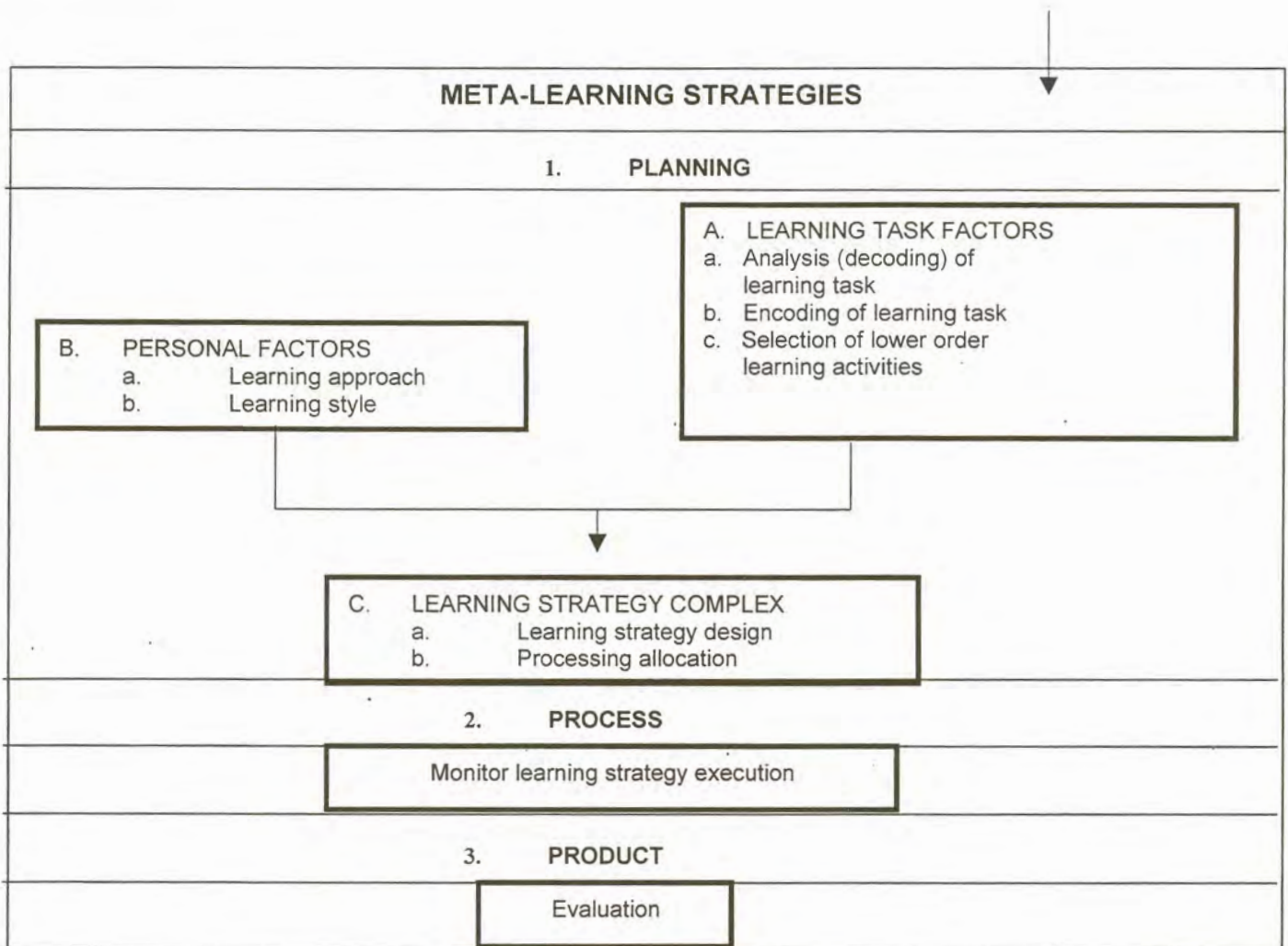
❑ **Meta-learning in OBE**

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

| META-LEARNING EXPERIENCE |
| Meta-learning comprehension |

| META-LEARNING KNOWLEDGE |
| 1. Learning task |
| a. Learning task constituents |
| b. Representation |
| 2. Lower order learning activities |
| 3. Person |
| 4. Meta-learning strategies |

META-LEARNING STRATEGIES

1. PLANNING

A. LEARNING TASK FACTORS
a. Analysis (decoding) of learning task
b. Encoding of learning task
c. Selection of lower order learning activities

B. PERSONAL FACTORS
a. Learning approach
b. Learning style

C. LEARNING STRATEGY COMPLEX
a. Learning strategy design
b. Processing allocation

2. PROCESS

Monitor learning strategy execution

3. PRODUCT

Evaluation

(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
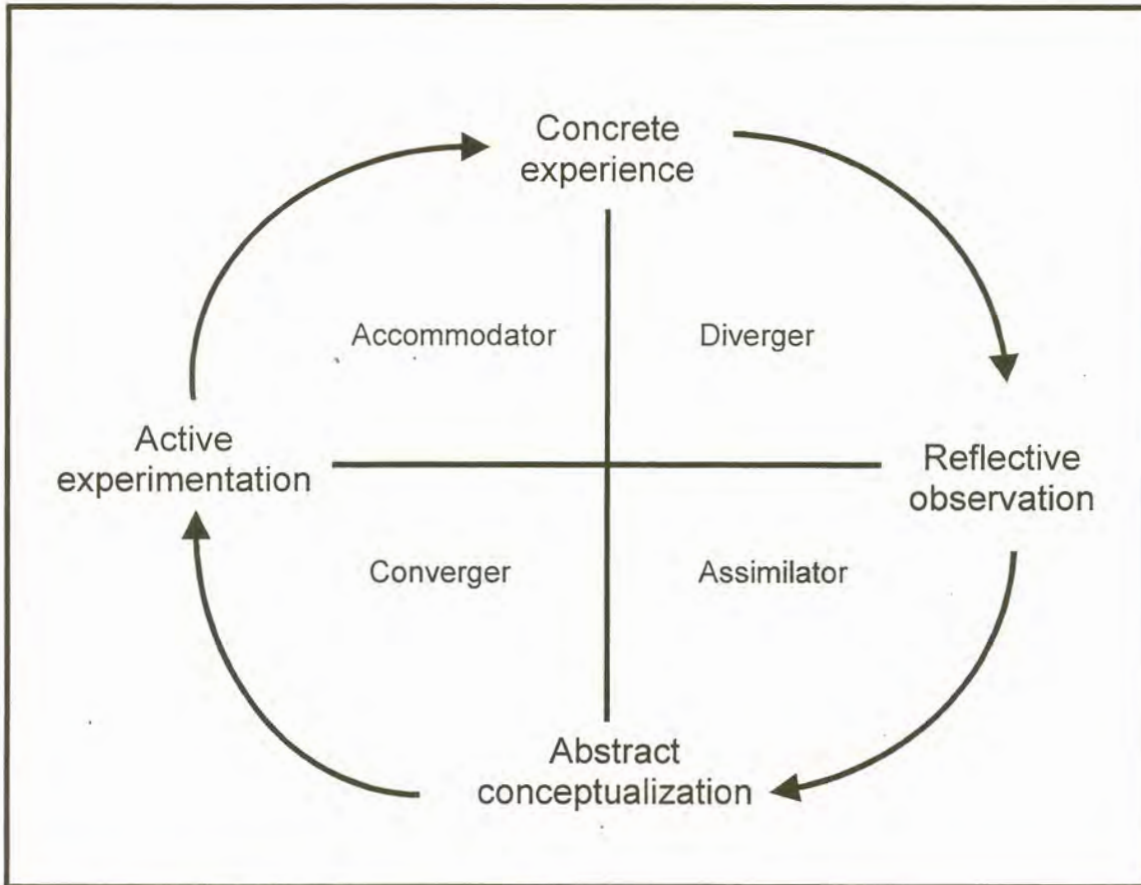
(Adapted from Pickworth, 1997:62)

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	- Concrete experience - Active experimentation	Concrete experience is transformed into learning by active experimentation or doing things
Diverger	- Concrete experience - Reflective observation	Concrete experiences are transformed into learning by reflective observation by using their imaginative abilities
Assimilator	- Reflective observation - Abstract conceptualization	Abstract conceptualizations are transformed into learning by creating theoretical models using reflective observation
Converger	- Abstract conceptualiza-	Abstract conceptualization is

	tion	transformed into learning through
	- Active experimentation	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
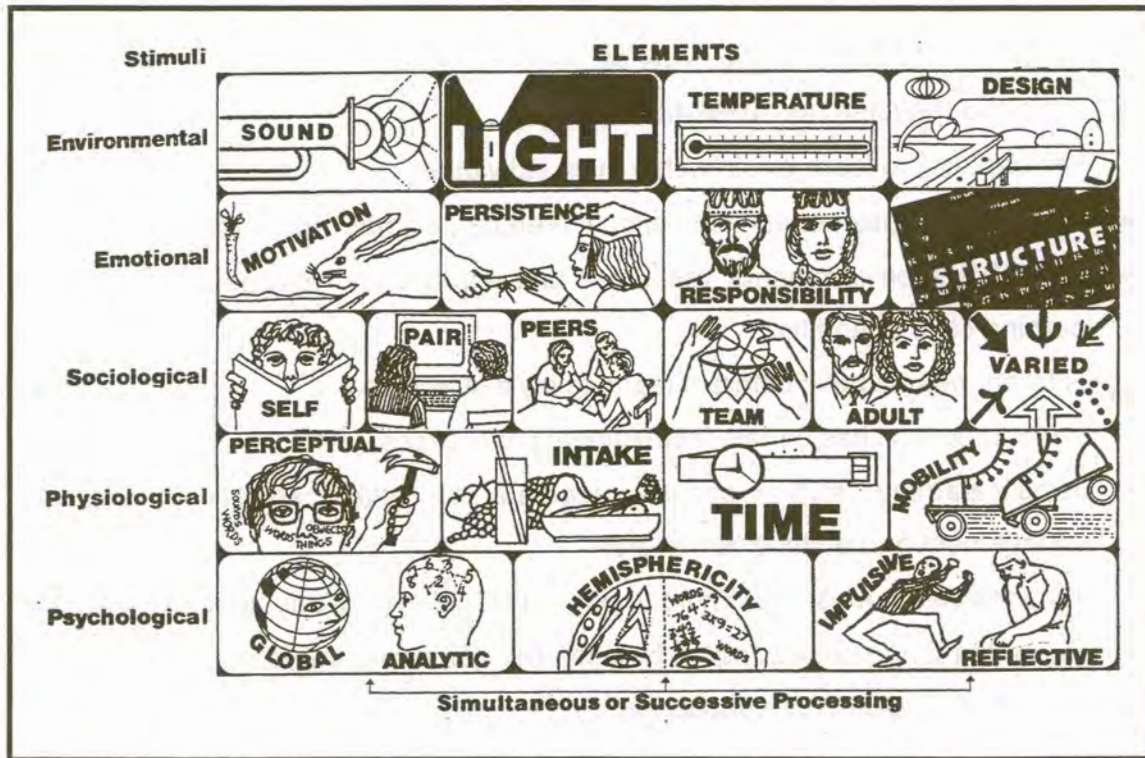
(Morse et al., 1998:43)

□ **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.
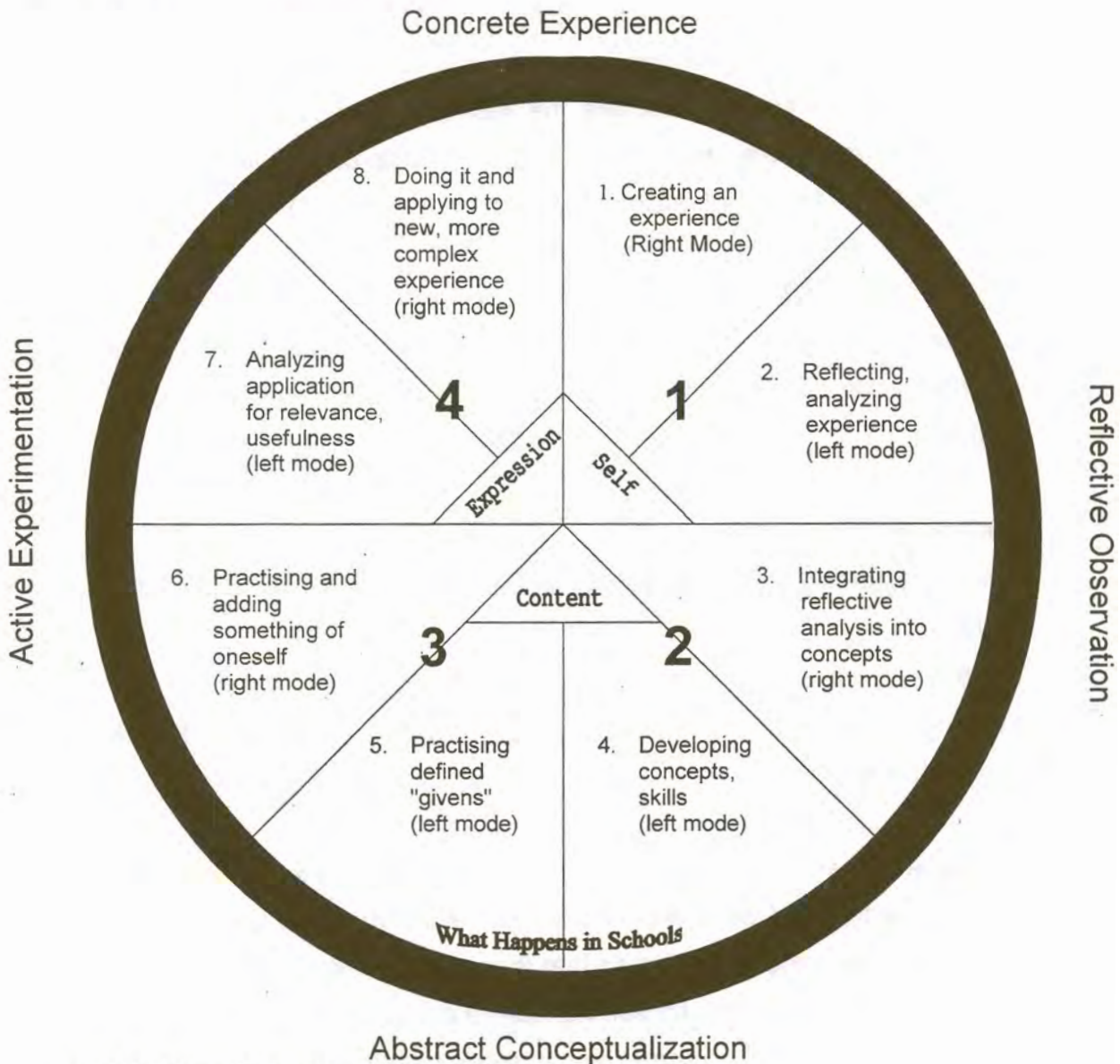*Present the **what***

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

Concrete Experience

Active Experimentation

Reflective Observation

8. Doing it and applying to new, more complex experience (right mode)

1. Creating an experience (Right Mode)

7. Analyzing application for relevance, usefulness (left mode)

2. Reflecting, analyzing experience (left mode)

4

1

Expression

Self

6. Practising and adding something of oneself (right mode)

Content

3. Integrating reflective analysis into concepts (right mode)

3

2

5. Practising defined "givens" (left mode)

4. Developing concepts, skills (left mode)

What Happens in Schools

Abstract Conceptualization

(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%

51

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
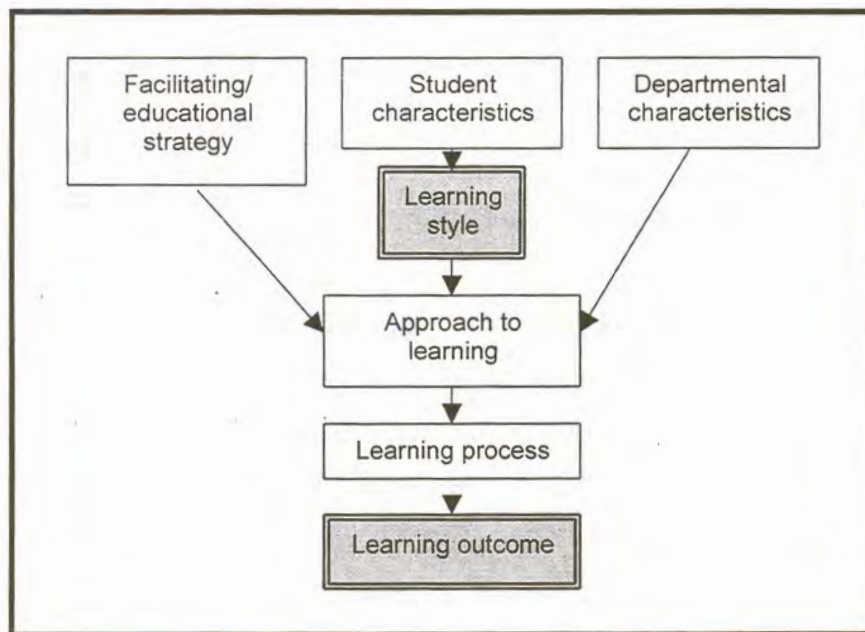
(Adapted from Newble & Entwistle, 1986:163)

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 commisurotomy 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
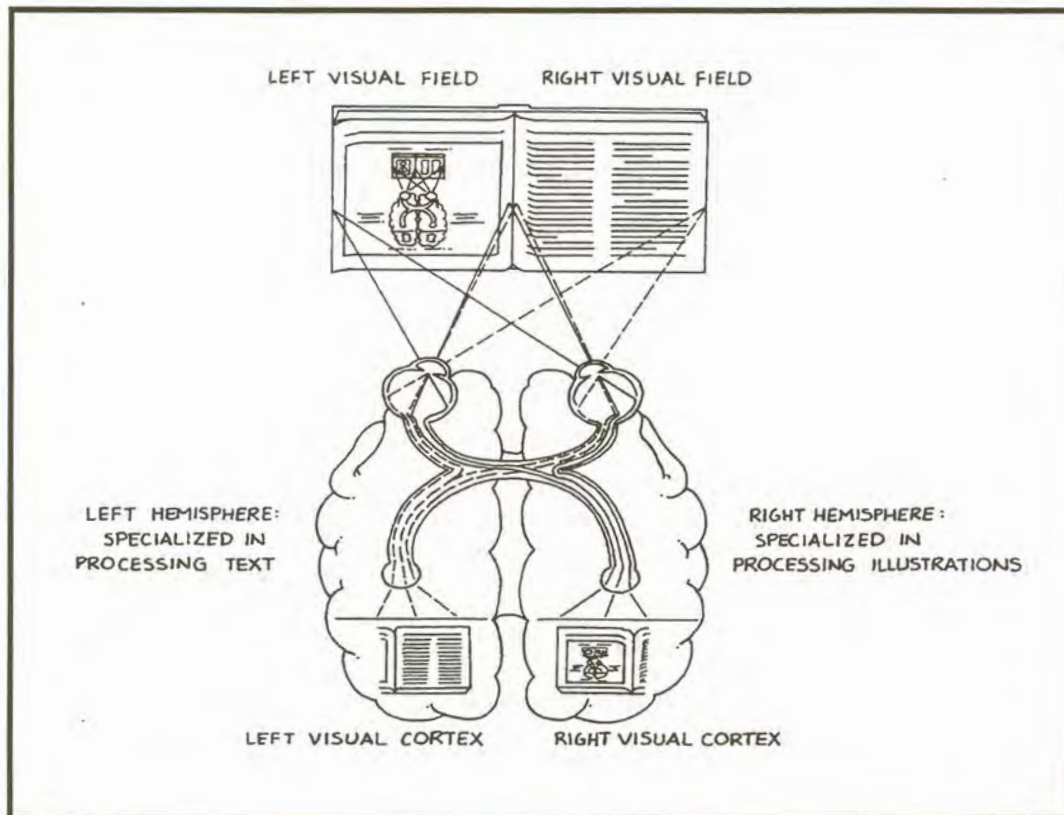
(Herrmann, 1995:14)

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 commisurotomy 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

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

- Reading	-	Synthesized thinking
- Detail	-	Emotions
- Control	-	Spirituality
- Sequential ordering	-	Recognition of complex figures
- Being active	-	Simultaneous comprehension
- Writing	-	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
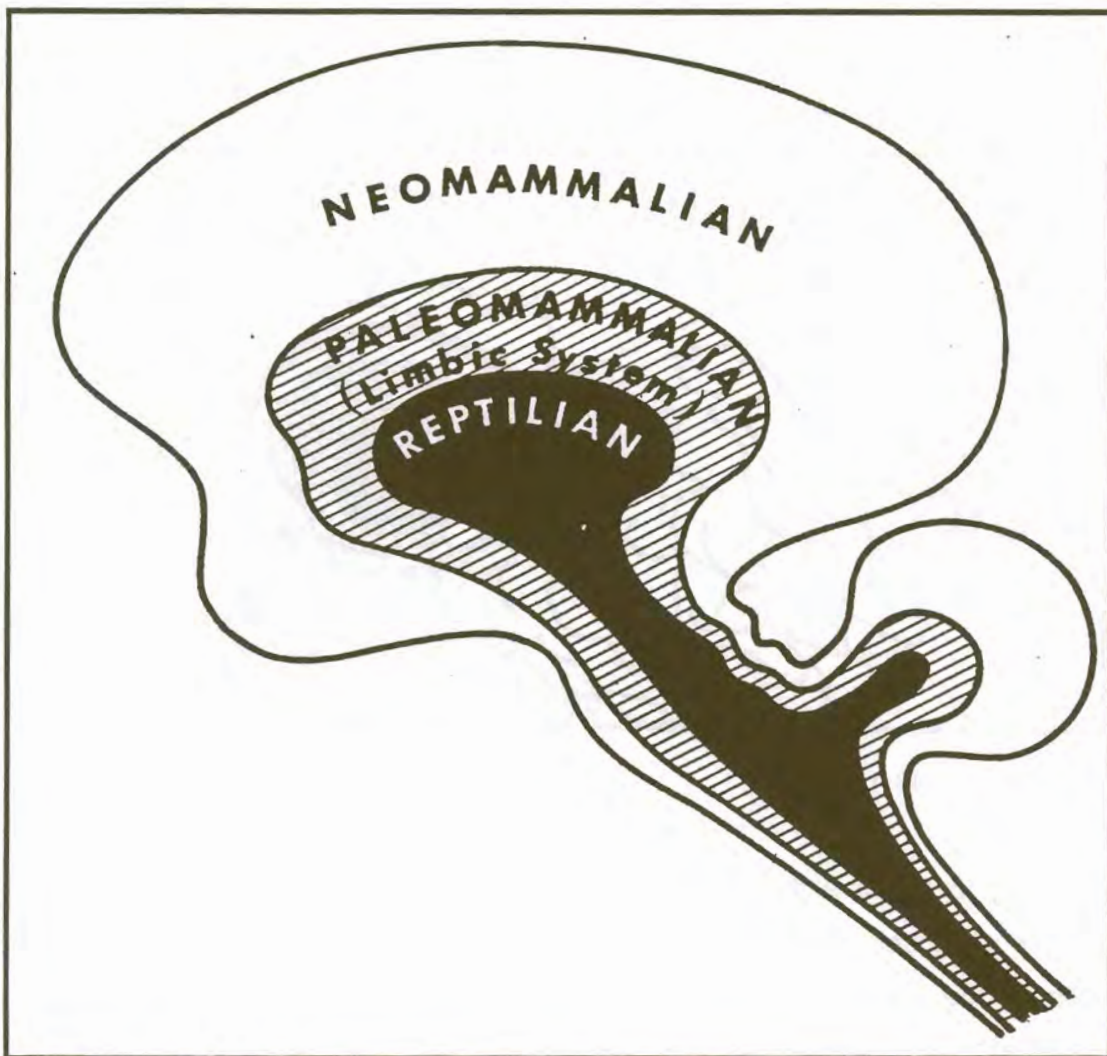
(MacLean, 1967:377)

❏ **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
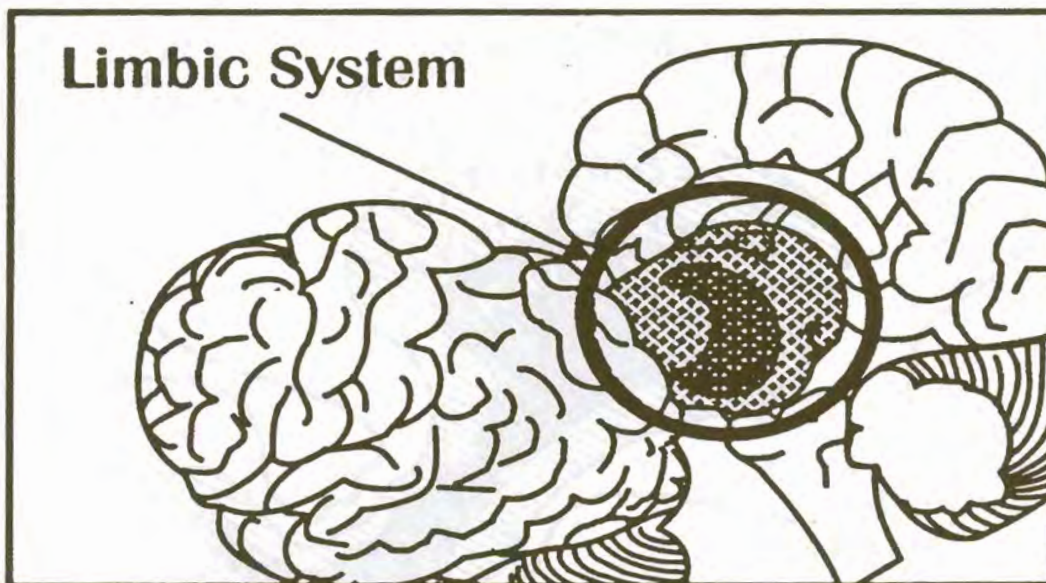
Limbic System

(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
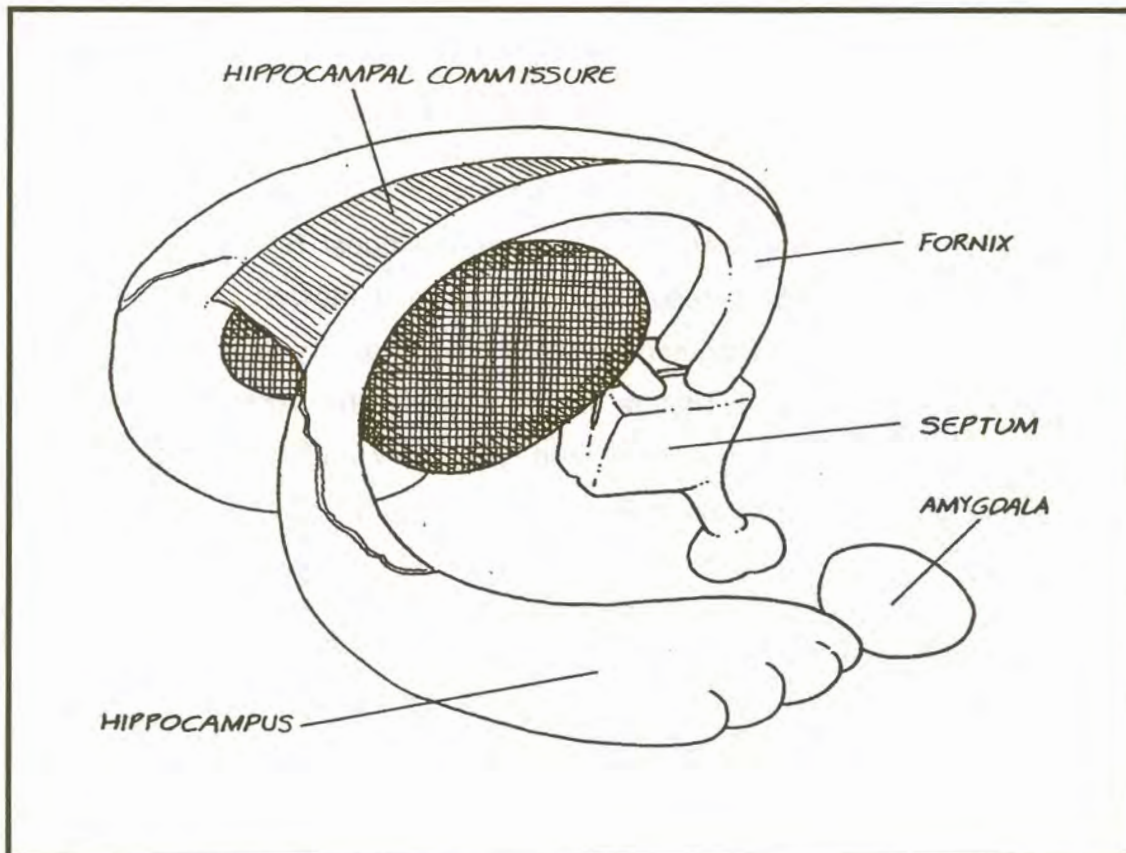
(Herrmann, 1995:32)

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,

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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**
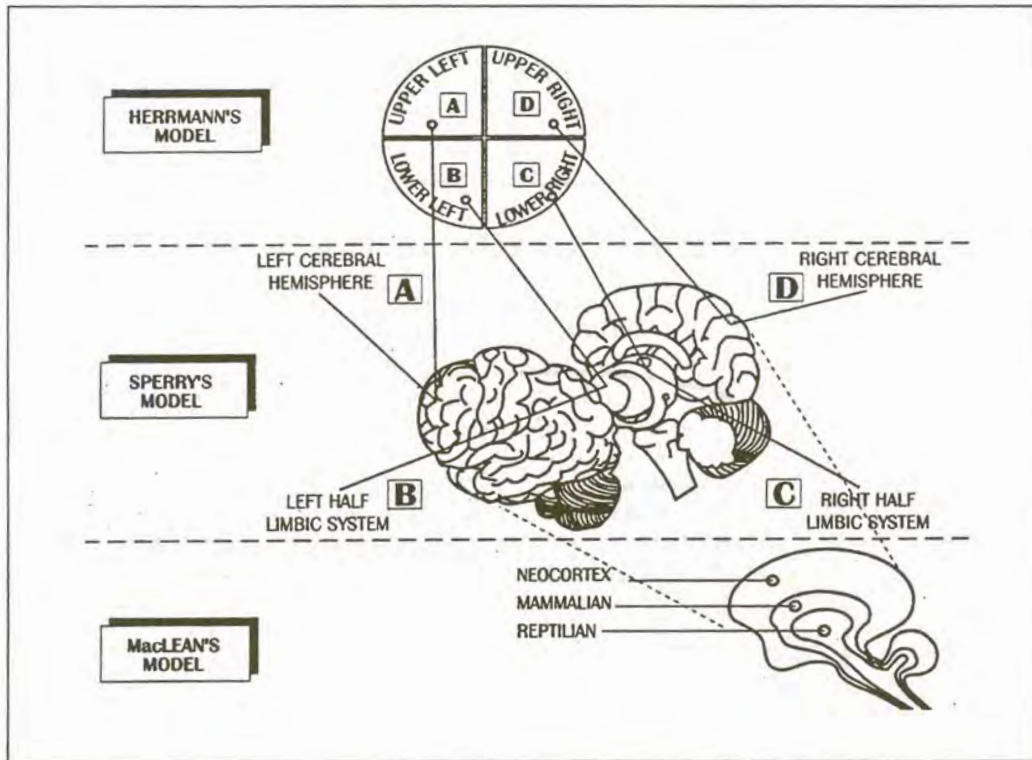
(Herrmann, 1996:14)

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 left upper quadrant (Figure 12).

Figure 12:   The Whole Brain Model

WHOLE BRAIN MODEL

Cerebral Mode
Thinking Processes

UPPER LEFT

UPPER RIGHT

(A) LOGICAL
ANALYTICAL
QUANTITATIVE
FACT BASED

(D) HOLISTIC
INTUITIVE
SYNTHESIZING
INTEGRATING

Left Mode
Thinking Processes

Right Mode
Thinking Processes

(B) PLANNED
ORGANIZED
DETAILED
SEQUENTIAL

(C) EMOTIONAL
INTERPERSONAL
FEELING BASED
KINESTHETIC

LOWER LEFT

LOWER RIGHT

Limbic Mode
Thinking Processes

(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.

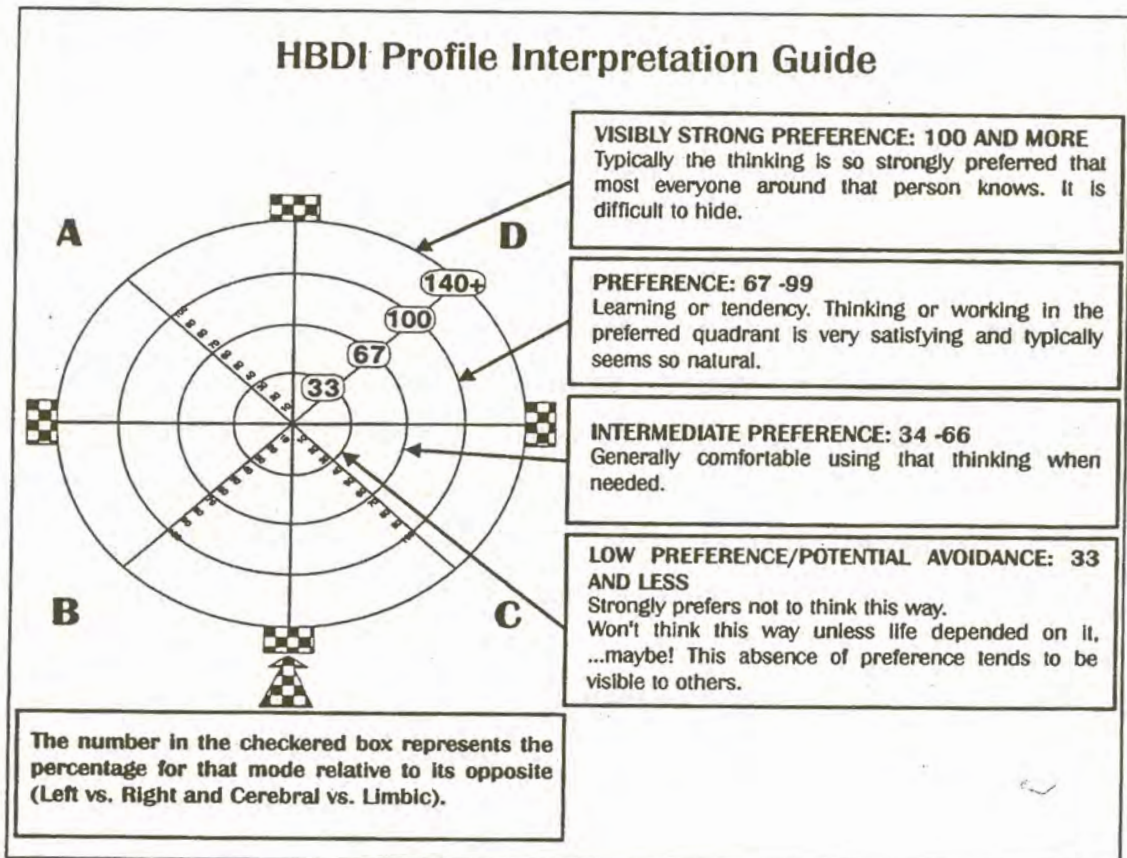❑ **Herrmann Brain Dominance Instrument (HBDI)**

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

HBDI Profile Interpretation Guide

- **VISIBLY STRONG PREFERENCE: 100 AND MORE** Typically the thinking is so strongly preferred that most everyone around that person knows. It is difficult to hide.
- **PREFERENCE: 67 -99** Learning or tendency. Thinking or working in the preferred quadrant is very satisfying and typically seems so natural.
- **INTERMEDIATE PREFERENCE: 34 -66** Generally comfortable using that thinking when needed.
- **LOW PREFERENCE/POTENTIAL AVOIDANCE: 33 AND LESS** Strongly prefers not to think this way. Won't think this way unless life depended on it, ...maybe! This absence of preference tends to be visible to others.

The number in the checkered box represents the percentage for that mode relative to its opposite (Left vs. Right and Cerebral vs. Limbic).

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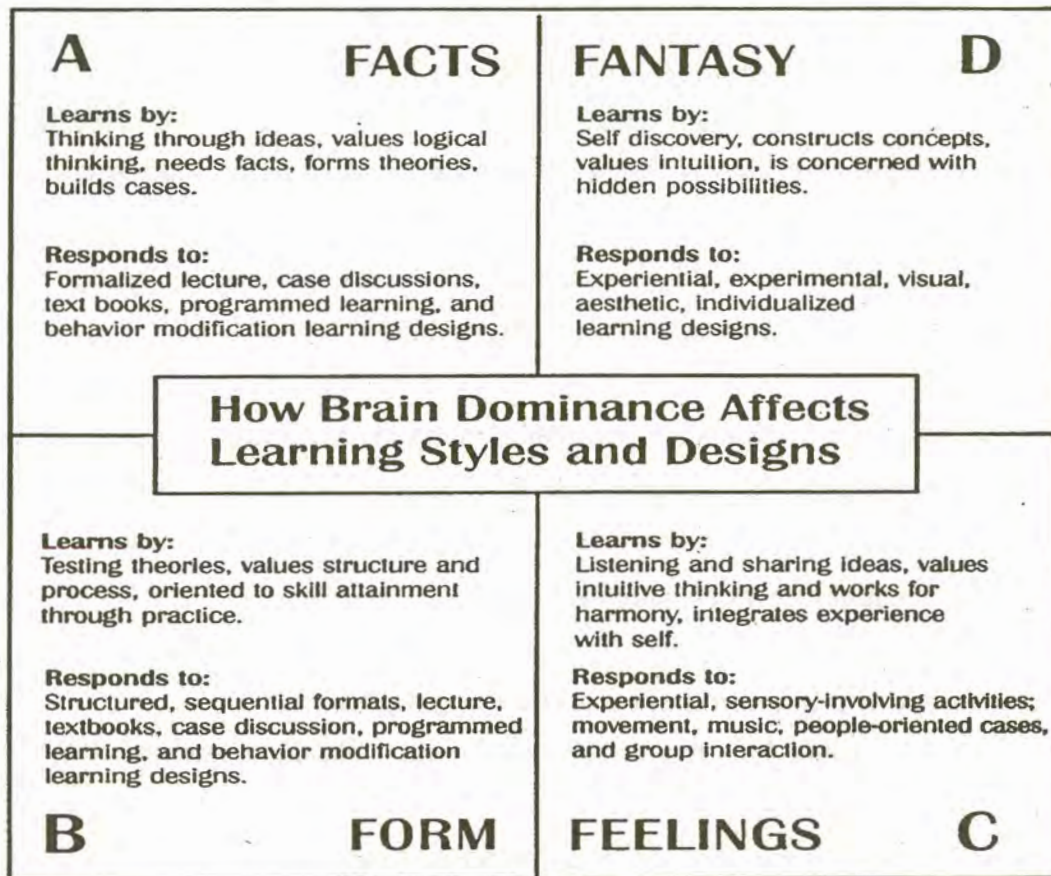
The adjective pairs are a second quantified measurement included in the profile. This measurement (from 0 to more than 10) indicates which quadrants are most preferred (highest score) for learning under a stress situation and could change although it is usually very consistent with a learner's profile.

❑ **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

A FACTS	FANTASY D
Learns by: Thinking through ideas, values logical thinking, needs facts, forms theories, builds cases.	**Learns by:** Self discovery, constructs concepts, values intuition, is concerned with hidden possibilities.
Responds to: Formalized lecture, case discussions, text books, programmed learning, and behavior modification learning designs.	**Responds to:** Experiential, experimental, visual, aesthetic, individualized learning designs.

How Brain Dominance Affects Learning Styles and Designs

Learns by: Testing theories, values structure and process, oriented to skill attainment through practice.	**Learns by:** Listening and sharing ideas, values intuitive thinking and works for harmony, integrates experience with self.
Responds to: Structured, sequential formats, lecture, textbooks, case discussion, programmed learning, and behavior modification learning designs.	**Responds to:** Experiential, sensory-involving activities; movement, music, people-oriented cases, and group interaction.
B FORM	FEELINGS C

(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	- focus on learning process - does not quantify measurement - lacks reliability and validity
Myers-Briggs Model	MBTI	- psychometric instrument - non-specific for educational purposes
Dunn & Dunn's Learning Style Model	PEPS	- poor test/re-test reliability - lacks construct validity
McCarthy's 4MAT System	-	- limited research - provides only guidelines to facilitator - does not quantify measurement of individual preferences
Herrmann's Whole Brain Model	HBDI	- combines brain dominance (the whole brain) and thinking style preference - gives an individualized quantified measurement of thinking

preference

- proven to be a valid and reliable
  instrument

From Table 4 in 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.