

CHAPTER ONE : ORIENTATION AND STATEMENT OF THE PROBLEM

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1.1. INTRODUCTION

Humans are biologically designed to survive and the single greatest competitive advantage is the ability to learn. (Jensen, 1995: iv)

The ability to learn, individually, in groups, in organisations and as a country, is a critical factor in the progress and development of society as a whole. Traditionally, definitions of learning have been based on behaviouristic, mechanistic and cognitive theories (Glasser, 1986; Knowles, 1990). This has led to the assumption that learning is the internalisation of external knowledge, and is under the control of a single internal source of self-regulation, namely executive self-regulation (Iran-Nejad, 1990). This viewpoint defines learning as a growth process dependent on internalising events into a “storage” system that corresponds to the environment (Knowles, 1990). Therefore, most traditional learning theorists view learning as a process by which behaviour is changed, shaped or controlled, with an emphasis on growth and cognitive development (Knowles, 1990; Glasser, 1986). However, these assumptions undermine the creative and multimodal nature of learning, limiting learning to the simple incremental learning of facts and definitions, which in turn is responsible for the achievement and motivational problems many students experience (Glasser, 1986; Iran-Nejad, 1990; Gardner, 1985; Knowles, 1990; Jensen, 1995). It appears that behaviouristic and cognitive theories are too narrow to explain the complexity of the learning process as their primary focus is on concept attainment to the exclusion of concept formation or invention (Glasser, 1986; Jones, 1968, in Knowles, 1990). Hence an approach to learning is needed that moves away from viewing learning as a process of controlling, changing or shaping behaviour, to one that views learning as competency development.

The development of Humanistic Psychology (founded in 1963) carries this trend of thought further in that the image of man is recast from a passive, reactive recipient to an active, seeking, autonomous and reflective being (Rogers, 1969). According to Rogers (1969), learning is seen as having a quality of personal involvement; as being self-initiated; as pervasive; as evaluated by the learner; and finally, as having meaning as its essence.

This view is expanded by Maslow (1970) who identifies the goal of learning to be self-actualisation. Jourard argues that “the learner has the need and the capacity to assume responsibility for his own continuing learning” (1972: 66). This humanistic view of learning has been formulated into a theory by Glasser (1986) which he calls “learning control theory”. Learning control theory is a biological theory of how humans function as living creatures. It has as its basic premise the contention that all behaviour is an attempt to satisfy needs that are built into the genetic structure of the brain, and thus all motivation is internal, as opposed to external - as claimed by behaviourists and cognitivists. Control theory contends that it is impossible to force or bribe a person into doing quality work. That is, learning is not a process of shaping change in behaviour, rather it is an internally motivated creation of meaning (Glasser, 1986). Iran-Nejad (1990) elaborates on this idea by defining learning as the creative reconceptualisation of internal knowledge. He further proposes that there are two different sources of internal self-regulation; one that controls the sequential conscious aspect of learning, and another that controls the simultaneous non-conscious aspect. Furthermore, to extend the domain of learning beyond simple incremental memorisation, both sources of self-regulation have to be activated.

Both the behaviouristic and cognitive theories, which utilise computers and mechanistic processes as analogies, define learning as a change in behaviour that is largely controlled by an external source, and that will result in an accrual of knowledge facts. By contrast, humanistic theories, which have the functioning of the human brain as their analogy, define learning as an internally motivated and controlled process that results in the recreation of conceptual knowledge with the emphasis on meaning. Behaviouristic and cognitive theories emphasise the educator, the agent of change who presents stimuli and reinforcement for learning and designs activities to induce change. A humanistic approach, by contrast, emphasises the person in whom the change occurs, and learning as the act or process by which behavioural change, knowledge skills and attitude are reconceptualised. In this, a humanistic approach to learning appears to be a more accurate description of human functioning than a behaviouristic and cognitive approach. Extensive research has been conducted in the fields of contemporary neuroscience and neuropsychology and has led to the identification of the brain’s preferred way to learn, confirming the latter statement (Glasser, 1986; Gardner, 1985; Iran-Nejad, 1990; Jensen, 1995; Knowles, 1990; Johnson, Johnson & Holubec, 1986; Lozanov, 1978; Dhority, 1991; Springer & Deutsch, 1989; Buzan, 1991; Diamond, 1988). However, behaviouristic and cognitive theories tend to dominate the philosophy of learning institutions with what are believed to be negative

effects on the learning abilities of students and clients and the realisation of their potential. The adoption of predominantly behaviouristic and cognitive philosophies is possibly due to a lack of integration between research on the brain and standard education practices.

In addition, the behaviouristic and cognitive theories provide neat ways of “measuring” and “packaging” students and clients into controlled environments, and are thus convenient to educationalists and learning institutions. The humanistic approach recognises the complexity and individuality of human nature, and consequently the complex and involved task of facilitating learning. This approach is not as convenient or controllable.

Cremin (1981, in Knowles, 1990) indicates that the revolution in learning that began in the twentieth century and is continuing into the twenty-first century may be as fundamental as the original invention of formalised learning institutions. A strong case for the adoption of alternative approaches to learning is made by Capra (1982). He argues that “we are trying to apply the concepts of an outdated world view - the mechanistic world view of Cartesian-Newtonian science - to a reality that can no longer be understood in these terms. We live in a globally interconnected world, in which biological, psychological, and environmental phenomena are all interdependent. To describe this world appropriately, an ecological perspective is needed that the Cartesian world view cannot offer” (Capra, 1982: 19). Capra further argues that a fundamental change is needed in thoughts, perceptions and values, and thus, attitudes. The beginnings of this change are visible in most areas and are likely to result “in a transformation of unprecedented dimensions, a turning point for our planet as a whole” (Capra, 1982: 19). Thus, a paradigm shift is needed in order to create new learning systems that focus on the development of potential which is achieved through teaching *how* to learn and not *what* to learn. There are many reasons for a paradigm shift in learning, not the least of which is that in the USA more than 40% of school-going children are diagnosed as having some kind of learning problem (Jensen, 1995; Thornburg, 1991, in Jensen, 1995; Simon, 1987). However, it is felt that this percentage is in fact higher, closer to 90% than 40%, and that the reason for this high percentage is the system within which pupils are being “educated”. The current educational system is producing “educational casualties” (Simon, 1987), rather than innovative lifelong learners. This constitutes a major problem because learning is an ongoing process that crosses all walks of life, and the application of traditional behaviouristic and cognitive learning systems is not preparing children for life (Knowles, 1990). According to Mitchell (1986, in Buzan & Dixon, 1976), society needs a more extended view of what normal human potential is, implying

that high achievers are the norm and not the exception. This involves a totally new and broader approach to the perception of learning, and, therefore, of educating and remediating.

Furthermore, focusing on the purpose and nature of learning responds to the need to integrate communication skills with academic content, which is another reason for the paradigm shift in learning specifically in the field of speech and language therapy (Paul-Brown, 1992). The academic environment requires competent communication skills - both oral and written - as prerequisites for school success (Bunker, McBurnett & Fennimore, 1987). A student's successes and failures in school are bound up in the way they share and create meaning through language (Thornburg, 1991, in Jensen, 1995).

This implies an expanded role for the speech-language therapist working in educational settings, who has traditionally employed a clinical model of intervention focusing on the oral linguistic aspects of language (Simon, 1987; Paul-Brown, 1992). This approach has led to a focus on deficits and remediating deficits - a symptomatic approach. For example, viewing syntax, semantics, pragmatics and auditory processing as separate variables while ignoring the reading and writing aspects of communication leads to fragmented services that drill splinter skills (Simon, 1987; Bunker et al, 1987; Paul-Brown, 1992). In the field of education, specifically Simon (1987) postulates that well-meaning traditional speech-language approaches have actually ended up creating "educational casualties" as a consequence of segregating and labelling students, leading them to become addicted to 1:1 attention. This has led to the development of passive attitudes towards learning by falling into patterns of "learned helplessness" due to believing their "disabled" labels (Damico, 1987). Alternative service delivery approaches have consequently emerged in response to the increasing awareness of the inefficiency of traditional approaches to communication, with immediate impact on the role of the speech-language therapist. "The evolution from 'speech-therapist' to 'communication instructor' has been the result of adopting an educational vs a medical model, through integrating communication instruction into the student's natural learning environment, and through collaborating with other educators" (Johnson, 1987: 225).

Thus, the most significant implication arising out of the literature related to the development of lifelong innovative learners with proficient communication skills, concerns the need to move from teaching and facilitating specific skills to the teaching of strategies to enable students to

attain mature language repertoires and communication competence with adequate problem-solving skills (Thornburg, 1991, in Jensen, 1995; Derry, 1990).

The speech-language therapist, with a background in language, communication, psychology, speech and hearing science, linguistics, and learning theory, is eminently qualified to become involved in the integration of a geodesic approach to the process of learning and intellectual development, which indicates an expanded role for the speech-language therapist working with learning problems (Paul-Brown, 1992).

Speech-language therapists should view themselves as language specialists concerned with the prevention and remediation of communication difficulties by focusing on the process of learning and intellectual development (Thornburg, 1991, in Jensen, 1995). The speech-language therapist is seen to play an important role academically in assisting with adapting the child's academic instruction so that he can achieve to the best of his ability (Committee on Language, Speech and Hearing Services in Schools, 1983, in Shapiro, Champagne & de Costa, 1988). This implies that a complex relationship exists between language used for learning and intellectual development and language used for communication, highlighting the need for a paradigm shift in the perception of learning. In view of the foregoing, the current research highlights and emphasises the necessity of a learning paradigm change if educational institutions are to facilitate the development of innovative lifelong learners that can make a contribution to society. The overall objective of the current research is therefore to create and explore an alternative system to the traditional learning system. The system proposed, the Mind-Mapping Approach (MMA), is believed to provide a better way to assist learners - teachers, therapists, pupils and clients alike - in becoming innovative lifelong learners. This is because the theoretical base of the MMA incorporates the principles inherent in the philosophy of geodesic learning, which is the suggested alternative philosophy upon which the perception of learning should be based, and which falls within the realms of a humanistic approach. The MMA framework provides a basis for bridging the gap between the unique individual learner and the design and delivery of the learning experience.

In addition to the system of the MMA, a theoretical model is also developed in the current research which explains the process of thinking and learning induced by using geodesic approaches. The assumption underlying the model is that the type of thinking induced by a geodesic system, such as the MMA, is more effective in terms of realising potential than a

traditional system which inhibits potential. This is due to the geodesic philosophy being based on the natural laws of the biological and neuropsychological functioning of the brain (Jensen, 1995; Gardner, 1985; Lozanov, 1978; Buzan, 1991). The latter is in contrast to traditional educational and institutional systems of facilitating learning and communication, which are based on unnatural behaviouristic, mechanistic and cognitive philosophies which undermine the complexity and hence the potential of human nature.

The question arises whether the MMA is an effective framework that will bring about a paradigm shift in learning from a behaviouristic and cognitive approach to a geodesic approach. In order to answer this question, a literature review of the philosophies that have influenced learning, and their effect on education and therapy is provided.

1.2. THE CONCEPTUALISATION OF LEARNING, THINKING AND THE INTELLECT

Human potential is judged by the individual's ability to learn and make sense of his world.
(Campbell et al., 1992)

The term intelligence has been used synonymously with concepts such as thought processes, cognitive capacities, cognitive skills, forms of knowledge, and the process of learning (Gardner, 1985; Buzan, 1991; Russell, 1986; Hinton & Anderson, 1981; Iran-Nejad, 1989; Allport, 1980; Fodor, 1983; Gazzaniga, 1977; Derry, 1990; Jensen, 1980; Block & Dworkin, 1976). The research adopting a more geodesic approach to learning and potential indicates that the development of intelligence is based on the effectiveness of the thought processes which lead to enhanced learning (Feuerstein, 1980; Dhority, 1991; Lozanov, 1978; Jensen, 1980, 1995). Furthermore, this approach to intelligence views individuals as having a number of domains of potential intellectual competence which they are in a position to develop if normal and appropriate stimulating factors are available (Gardner, 1985; Allport, 1980; Hinton & Anderson, 1981). This is in contrast to the traditional perception of thinking and intelligence which perceives human cognition to be unitary, and views intelligence as a single inherited trait which can be reliably assessed through an hour long pen and paper test (Boring, 1950, in Gardner, 1985; Gould, 1981). The latter may predict academic success, or how well the

individual will perform academically. Intelligence testing is not, however, able to predict the potential of the person to think and solve problems creatively in authentic environments (Feuerstein, 1980; Dhority, 1991). The recognition of the ineptness of the intelligence testing paradigm in assessing human potential has rendered alternative approaches a necessity. A paradigm shift in the perception and definition of thinking and intelligence has occurred over the past century. A literature review of this paradigm shift and its influence on learning, intelligence, education and therapeutic approaches was conducted in order to trace the changes in the perception of the definition of learning and intelligence. This paradigm shift is illustrated in Figure 1.1 and is discussed in what follows.

1.3. THE INTELLIGENCE QUOTIENT (I.Q.) APPROACH

1.3.1. THE PHILOSOPHY

The Intelligence Quotient (I.Q.) approach (see Figure 1.1), which started in the early 20th century with Galton (1907, in Gardner, 1985), is based on the devising of tests with which to rank human beings by comparing performance on various measures purportedly measuring intellectual abilities. The underlying philosophy is that the powers of intellect can be assessed via the accuracy of completing different tasks numerically determined. Therefore the end-product, as opposed to the process, is of paramount importance. Piaget (1977, in Gardner, 1985), amongst others, criticised this focus, claiming that how a person solves a problem is more important than whether they arrive at the correct answer. The I.Q. approach does not look at how new information is assimilated, or how problems are solved, or determine the potential for future growth. Therefore, critique levelled at the I.Q. approach led to the conclusion that this empirical and mathematical approach, which is based on unrelated microscopic tests with predictive value about success in school, provides limited information on how the mind and brain work in the realisation of potential (Jensen, 1980; Gardner, 1985; Feuerstein, 1980). The influence of the I.Q. movement on theories of learning, education and therapy has been, and still is, profound even though research over the last forty years has highlighted the limitations of this approach (Jensen, 1980, 1995; Feuerstein, 1980; Gardner, 1985; Feldman, 1980).

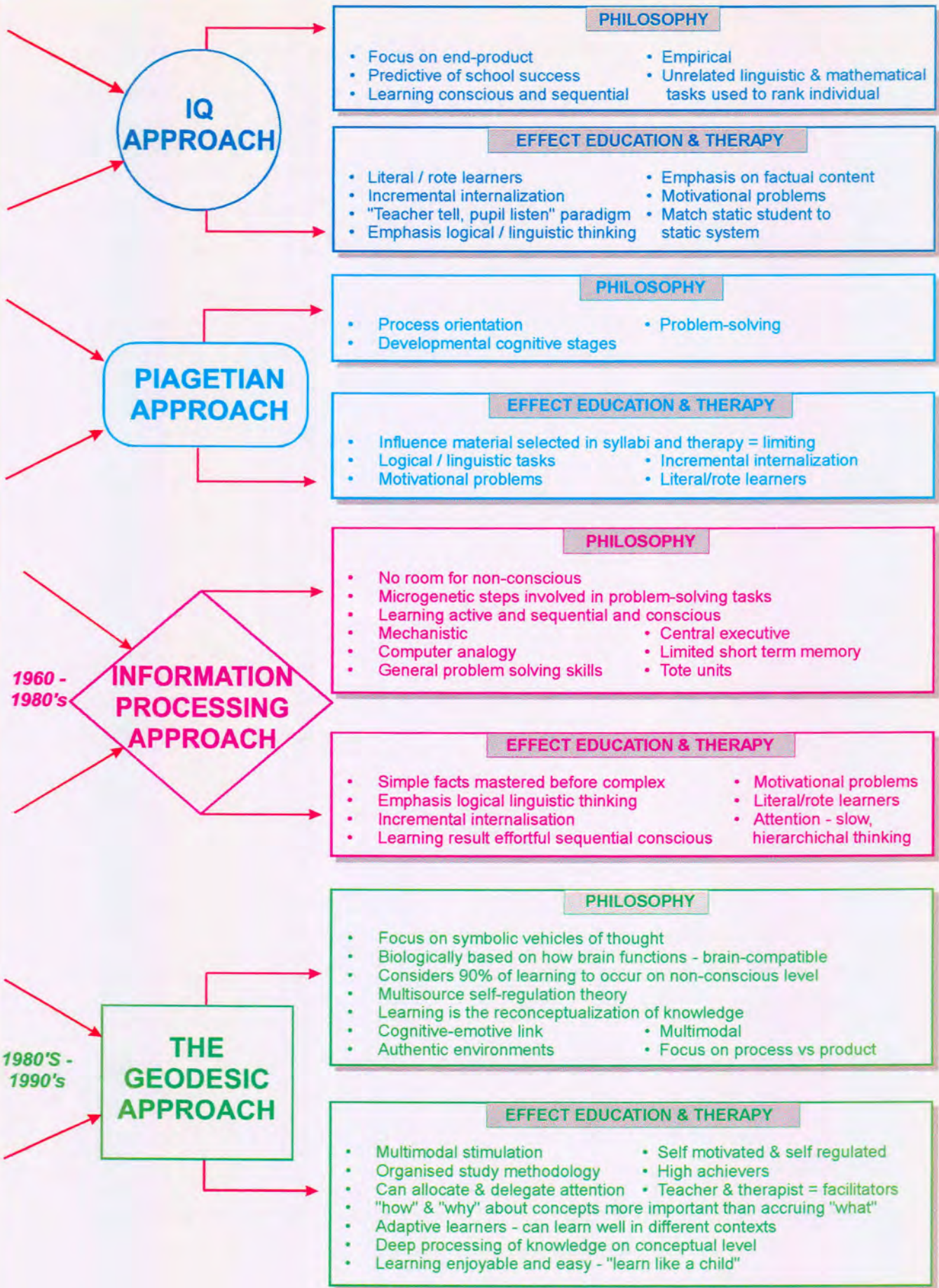


Figure 1.1: The Paradigm Shift in Thinking / Learning / Intelligence

NOTE: SOURCES IN TEXT

DEVELOPED BY: C. LEAF

1.3.2. THE EFFECT ON EDUCATION AND THERAPY

The most widespread use of I.Q. testing has been for the evaluation of individuals for specific purposes, namely school (mainstream, special or other), industrial or military placements. The traditional use of tests and measurements is often guided by the basic assumption that the academic environment is static, and the successful student is the student whose functioning matches the requirements of the system (Feuerstein, Jensen, Kaniel & Shachar, 1986). This concept of the academic environment as a static system is paralleled by the concept of an individual as a static system which cannot be modified (Thornburg, 1991, in Jensen, 1995; Feuerstein et al., 1986).

Therefore a system of categorisation arises, the objective being to find the “fit” between the system and the pupil, which leads to labelling. There is no attempt to create new systems in the school, or new capacities in the individual within this approach. The I.Q. movement also resulted in emphasis being placed on improving students’ learning of factual content and so-called basic skills. This emphasis on the end-product resulted in the neglect of the development of fundamental mental processes (Bransford, 1979). More emphasis was placed on what students know within a specific time frame than on their ability to realise gaps in their current knowledge and hence learn effectively. The I.Q. movement therefore led to learning outcomes being valued more highly than the learning process. As a result, teaching in most classrooms tends to emphasise the rote learning of factual knowledge (Adams & Wallace, 1991). Adams and Wallace (1991) argue that even though there have been some small changes in syllabi and examinations towards an enquiry-based approach to learning, little attention has been given to analytical, evaluative or creative thinking, or to the application of knowledge in problem-solving. Accordingly, “teacher’s skills are locked into the paradigm of teacher tell - pupil listen” (Adams & Wallace, 1991: 105). Furthermore, the content overload of most syllabi limits even the most creative teachers from applying a more process-oriented approach where active thinking can be developed. This would detract from a product-oriented approach, which requires memorisation, often precise, in order to accrue marks. This situation represents “a serious inhibition of the development of children’s potential ability - for future learning, for citizenship, for parenthood, and not least, for gainful employment” (Adams & Wallace, 1991: 105).

1.4. THE PIAGETIAN MOVEMENT

1.4.1. THE PHILOSOPHY

A paradigm shift in the philosophy of thinking, learning and intelligence occurred as a result of the research conducted by Piaget between 1920 and 1977. Piaget (1963, 1977, in Gardner, 1985), who was originally trained in the Intelligence Quotient tradition, advanced a philosophy of the intellect that was quite different to that of intelligence testing. He believed that it is not the accuracy of the child's responses that is important, but rather the lines of reasoning the child invokes to solve the problem. His approach is therefore process orientated as opposed to product orientated.

In Piaget's (1977, in Gardner, 1985) view, the study of human thought assumes that an individual is trying to make sense of the world, and does this by continuously hypothesising about the objects and events in the world around him. Ultimately he is attempting to generate knowledge that is a coherent account of the world (Gardner, 1985). In doing this, the individual passes through various stages of cognitive development from infancy to adolescence, in which he becomes increasingly more adept at thought. Piaget's approach is developmental and thus posits that certain cognitive abilities only appear at certain stages (1977, in Gardner, 1985). Unless in possession of that cognitive ability, an individual is unable to perform the tasks of that stage. Piaget (1977, in Gardner, 1985) also considered that the basic categories of time, space, number and causality are central to the human intellect, which is in contrast to the beliefs of the architects of intelligence testing (Gardner, 1985).

1.4.2. THE EFFECT ON EDUCATION AND THERAPY

The apparent strengths of Piaget's theory, which have made Piaget a prominent theorist of cognitive development, have had profound impact on education and therapy. In both education and therapeutic contexts, the selection of what to teach and how to remediate students at each level is primarily based on what students are cognitively able to do at that particular stage. For example, Piagetian theory indicates that a child cannot conserve numbers, classify consistently and abandon egocentrism until they are in the concrete operational stage at approximately 6-8 years old (grade 1-2). Thus, teaching a child to read and write and work with number-concept

associations can only occur around this age. However, it has been found that children in the pre-operational stages can solve tasks said to entail concrete operations (Montessori, 1989; Gardner, 1981; Flavell, 1963). Montessori (1989) repeatedly showed that children are ready to learn to read and write, as well as to develop number-concept associations and the conservation concept to the extent that they can perform the four basic mathematical operations, between the ages of three and six years. Montessori (1989) indicated that this is the sensitive period in which to develop these skills, and that trying to teach these concepts at a later stage will make them more difficult to learn. Gardner (1981) and Flavell (1963) found that when various adjustments were made to the experimental tasks entailing concrete operations, most of these tasks could be performed in the pre-operational stages, as early as three years old. Thus, the kinds of concepts developed in therapy and educational settings are limited by the Piagetian approach.

Furthermore, the Piagetian experiments primarily dealt with logical, mathematical concepts couched predominantly in linguistic terms, but paid scant attention to other intellectual thought processes, specifically creativity, spatial, kinaesthetic, musical and inter- and intrapersonal abilities (Gardner, 1985). Piaget (1977, in Gardner, 1985) claimed that there was a universal pattern to the operations that he had uncovered, and that they could therefore be applied to any manner of content. Research, however, indicates that rather than a whole series of abilities coalescing at about the same time, as Piaget indicates, theoretically-related abilities emerge disparately (Flavell, 1963; Gardner, 1981, 1986). Thus, Piaget's (1956) "d calage" concept has become the rule rather than the exception (Flavell, 1963). Finally, Piaget (1959, 1969, in Gardner, 1985) described the concept of egocentric speech as a useless accompaniment to a child's activity. Vygotsky (1986, in Braten, 1991), in contrast, maintained that egocentric speech serves to orientate mental conscious understanding and help overcome difficulties (Brown, 1978). In Vygotsky's theory, egocentric speech activity is viewed as being intimately and usefully connected to the child's thinking (Brown, 1978). Vygotsky (1986, in Braten, 1991) argues that a child will solve a problem by talking to himself. This thinking out loud facilitates cognition into adulthood and is not just restricted to young children (Iran-Nejad, 1990). A process-oriented approach to developing intellect should focus on "talk" (Iran-Nejad, 1990). Hence silent classrooms, which do not allow for the importance of egocentric speech, inhibit the learning process.

Applying a strictly Piagetian approach in the selection of concepts in education and therapy is therefore limiting, in that the tasks will lack sufficient challenge to stimulate, as well as being

harder to learn than if the Montessori philosophy of sensitive periods is adopted. For example, teaching a child to read and write between the ages of 6-8 years is more difficult than between the ages of 3-6 years. It appears that the Piagetian approach underestimates the cognitive and metacognitive abilities of the child. In addition, the focus on the logical domain alone limits the universal application of the approach. The approach is not multimodal and holistic and, as such, does not facilitate the creation of authentic brain-compatible environments. Despite the fact that the Piagetian approach focuses on process rather than product, on the “how” as opposed to the “what” of learning, it emphasises the thinking process involved in logical and linguistic tasks only. The emphasis in current educational settings is predominantly on factual content. This is believed to be the result of trying to match cognitive ability with content, but overlooking the thinking element of Piaget’s philosophy.

1.5. THE COGNITIVE INFORMATION PROCESSING APPROACH

1.5.1. THE PHILOSOPHY

The Piagetian movement was followed by a third paradigm shift in the field of thinking and intelligence - the mechanistic cognitive science or information processing movement (Broadbent, 1958; Neisser, 1976, in Gardner, 1985; Nebes, 1974, in Leaf, 1990; Baxter, Cohen & Ylvisaker, 1985; Sternberg, 1979). This movement used experimental methodology to explore the steps involved in the tasks proposed by Piaget and other cognitive theorists. An attempt was made to provide a microgenetic picture of the mental steps involved in thinking tasks in order to illuminate their microstructure. In the focus on the process of thinking, classical information processing intelligence theory provides a more dynamic view of what happens during the course of problem-solving. The latter is viewed as comprising three stages, input, encoding-storage-retrieval, and output (Baxter et al., 1985). However, as is the trend with behaviourism, which has influenced the basic philosophy of classical information processing theory, there has been a search for general laws and processes (capacities that can cut across any manner of content and that can be considered truly fundamental, such as perception and memory), and horizontal processes (Flavell, 1963; Gardner, 1985). The implication is that there is a higher-order control mechanism that controls these basic all-encompassing psychological laws. This approach uses the high speed microchip computer as its analogy. Reference is made

to concepts such as general problem-solving skills, which can be mobilised for any problem that can be stated; an overall planning or tote unit which uses feedback to determine the success of a task, thus moving information processing on to a metacognitive level; a limited short-term memory capacity which can be used up; a central processor which receives all input; and an executive function which determines deployment of capacities in pursuit of a goal (Broadbent, 1958; Nebes, 1974, in Leaf, 1990; Neisser, 1976, in Gardner, 1985; Sternberg, 1979). These concepts imply that a general problem-solving mechanism can be used on the full range of human thought processes. However, this view is simplistic and limited. On examining the kinds of problems that were used experimentally to create this hypothesis, it appears that they are similar, and tend to deal predominantly with logical-mathematical type thinking - as in Piagetian psychology (Gardner, 1985; Sternberg, 1979). The cognitive approach does thus not deal with the full spectrum of the thought processes.

Classical information processing theory regards attention and rehearsal as prerequisites for a fully fledged cognitive analysis of the stimulus, and implicitly identifies consciousness with the higher mental functions (Khilstrom, 1992, in Nelson, 1992). The subconscious is viewed as containing the unattended products of the perceptual system. The implication of this view is that unretrieved memories and unattended precepts do not make contact with higher mental processing, and therefore do not influence processing. This assumption implies that only one thing can be learned at a time because the central executive can only process one thing at a time. Hence, 90-100% of learning takes place on the conscious level when attention is actively allocated to the information being learnt (Bransford, 1979). As a result there is a constraint on executive control that determines the limits of learning (Iran-Nejad, 1990). This assumption implies that learning occurs slowly and hierarchically, with simpler facts being mastered before complex facts. Internal processes such as attention, prior knowledge and strategies contribute to learning only when under the conscious control of the active executive (Bransford, 1979). As a result, paying effortful attention (Bransford, 1979) to incoming events by the learner is viewed as the single most important regulator of academic learning.

Furthermore, classical information processing theory views learning as being the internalisation of external knowledge. This implies that background knowledge schemata serve as prediction instruments for the selection and processing of new events, through the process of hypothesis testing - similar to Piaget's (1952, in Gardner, 1985) principle of assimilation and accommodation (Iran-Nejad, 1990).

1.5.2. THE EFFECT ON EDUCATION AND THERAPY

The cognitive information processing philosophies of traditional educational settings, however, limit the domain of learning to committing facts and definitions to memory by constraining the role of the many sources that make a simultaneous contribute to learning (Bereiter, 1985). Bereiter (1985) argues that in using prediction-based learning, it is not theoretically clear how the learner can go beyond incremental fact learning, because, according to this theory, the assimilation of only schema-consistent facts is permitted, and schema-inconsistent facts will be ignored. Therefore, in applying this theory to academic settings, the result will be rote memorisation of facts, and the internalisation of facts for reproduction in the examination later becomes the goal.

This does not involve insight into the subject matter, or depth of processing for growth, or any attempt at understanding. Thinking and problem-solving are literally bypassed in this approach. Furthermore, evidence exists that indicates that approaches to learning do influence motivation (Entwistle, 1988; Entwistle & Ramsdon, 1983), so that the approximately 70% of students who view learning as incremental internalisation experience negative attitudes, fear of failure and a generally disorganised approach to learning. In contrast, the approximately 30% of students who view learning as understanding are intrinsically motivated, high achieving and have methodical study approaches (Entwistle, 1988).

In summary, it appears that traditional approaches to education and therapy are based on the I.Q., Piagetian, and classical information processing theories of learning. As discussed, these approaches all focus on a certain kind of logical or linguistic problem-solving; ignore neurobiology; do not deal with the higher levels of creativity; and finally, do not consider the ethnography of learning. The result of such approaches is less than optimal as, according to research, 70-90% of students are underachieving, many of whom require additional support in the form of therapy (Iran-Nejad, 1990; Bloom, 1984; Bishop, 1989). Bloom (1984) states that for more than thirty years students have been memorising facts and definitions without understanding them. Sizer (1984: 84) indicates that “students are all too often docile, compliant, and without initiative, painting a picture of considerable passivity towards academic learning and school”. A non-intelligent learning culture of not thinking has thus resulted, producing students who do not take responsibility for their learning, and who are reliant on external sources to do their thinking for them.

1.6. THE GEODESIC APPROACH

1.6.1. THE PHILOSOPHY

Many educators, philosophers and psychologists concur that an important goal of education and therapy is to teach thinking skills. Consequently, an alternative approach that focuses on the dynamics of the thought process has arisen. This approach can be termed the geodesic movement, and represents a fourth paradigm shift in thinking, learning and intelligence research (see Figure 1.1).

Proponents of the geodesic approach focus on the symbolic vehicles of thought, namely the activities and products of the human mind such as language, mathematics, visual arts and gestures (Gardner, 1985; Iran-Nejad, 1989, 1990; Allport, 1980; Hinton & Anderson, 1981; Crick, 1981; Hubel, 1980, in Gardner, 1985; Mountcastle, 1978; Saloman, 1979; Feldman, 1980). The geodesic movement moves away from the search for general problem-solving devices and horizontal structures such as memory, attention, and perception, and focuses more on vertical components, hence providing a more molar and molecular analysis of the nervous system (Gazzaniga, 1977; Allport, 1980; Fodor, 1983; Gardner, 1985). This approach is not entirely new, as facets of the mind were already recognised in ancient Greek philosophy, and it can thus be seen as a type of rejuvenated faculty psychology (Gardner, 1985).

The geodesic movement does not merely focus on the linguistic, logical and numerical symbols of Piagetian and classical information processing theories, but also focuses on a full range of symbol systems encompassing musical, bodily, spatial and personal symbol systems, and is consequently multimodal (Gardner, 1985). Each symbol system can be viewed as an independent functioning cluster of intelligences making up that particular symbolic domain, and, although separate, the domains do interact in the thinking process (Gardner & Wolfe, 1983). The geodesic movement is biologically oriented and is based on brain organisation and maturational capacity. Thinking is perceived to consist of a number of special purpose cognitive devices, or clusters of abilities presumably dependent on neural “hard-wiring” in the brain (Allport, 1980).

Feldman (1980) indicates that cognitive accomplishments may occur in a range of domains, some of which are universal, such as the logical-mathematical domain which forms the basis of experimentation within the I.Q., Piagetian and information processing movements. Some are culturally specific such as reading, which is important in some cultures and not in others. Within each domain, there are steps ranging from novice to expert, making the movement developmental. However, there are great inter-individual differences in the speed at which an individual passes through the stages from novice to mastery in the different domains. Furthermore, in contrast to Piaget's theory, success at negotiating one domain does not invoke the other domains (Feldman, 1980). The development of the domains is dependent on internal genetic factors as well as on external cultural factors (Gardner, 1985; Feldman, 1980).

Therefore the geodesic movement represents a shift from cognitive theories of knowledge to cognitive theories of how the nervous system functions (Berninger, Chen & Abbot, 1988; Clancey, 1990; Iran-Nejad, 1990; Gardner, 1985; Hinton & Anderson, 1981). This development suggests that simultaneous learning in diverse local sites and subsystems of the nervous system is the rule for learning, as opposed to the one-thing-at-a-time rule of traditional approaches. According to Iran-Nejad (1990), if previously unrelated local sites in the brain, representing domains, are stimulated simultaneously in a brain-compatible way, they will combine in configurations not previously experienced and result in higher levels of functioning. This simultaneous learning hypothesis, which is central to the geodesic movement, suggests that more than active conscious control is needed to think, learn and release potential. It implies that another kind of control must also be operating on the subconscious level, and that both types of control are needed in effective learning (Iran-Nejad, 1987).

This control is called dynamic self-regulation, which can be defined as the regulation of the interaction of the internal components or modules, implying that the brain's subsystems and microsystems must be capable of regulating local internal construction processes on their own (Iran-Nejad, 1987, 1989, 1990; Iran-Nejad & Chissom, 1988, 1989). Dynamic self-regulation is simultaneous, implying that simultaneous functioning is the prerequisite for fact learning, as opposed to the other way around as in the traditional I.Q., Piagetian and information processing approaches. Furthermore, dynamic self-regulation operates on the non-conscious level, yet will impact on the conscious level through a process of attention delegation, which is the power to continue contributing to the learning process even though not conscious (Iran-Nejad, 1987, 1989, 1990; Iran-Nejad & Chissom, 1988, 1989). The latter idea is in accordance with

contemporary cognitive theories which reveal the impact of non-conscious mental structures on the conscious (Khilstrom, 1992, in Nelson, 1992; Hinton & Anderson, 1981). Research reveals that 90% of learning occurs on the non-conscious level (Reddy, 1979, in Iran-Nejad, 1990; Hinton & Anderson, 1981; Gardner, 1985; Lozanov, 1978; Dhority, 1991).

This simultaneous, non-conscious process permits individuals to engage in multimodal encoding, unencumbered by potential interference from one-modality-at-a-time executive encoding which is characteristic of many learners exposed to traditional approaches, and results in a cautious literal attitude to learning. Learning, in the traditional mode, becomes increasingly analytical, intentional and potentially very sequential because the learner is using the rehearsal-memorisation strategy of allocating immediate attention to every physical item of the task over and over again, without regard for the powerful contributions of spontaneous, tacit and explicit attention delegation processes of dynamic internal self-regulation (Iran-Nejad, 1987, 1989, 1990). Self-regulated learning research represents a way of creating a more thinking-oriented approach to learning. In addition, a resourceful learner needs to change his learning intentions away from those aimed at optimising the conditions for encoding and decoding, from other-regulation to self-regulation (Iran-Nejad, 1990; Gardner, 1985). A fundamental tenet underlying current geodesic learning research is that a mediator cannot cause learning in an individual, learning must be created by the learner. Thus, the mediator should structure the environment to facilitate the learning process (Feuerstein, 1980; Montessori, 1932).

Research regarding self-regulated learning is evident in diverse origins that range from behaviourism to modern psychology (Zimmerman & Schunk, 1989). Extensive research into the area of metacognition, specifically on declarative, procedural and conditional knowledge, has proposed learning strategies for overcoming the limitations of active self-regulation (Derry, 1990; Paris & Winograd, 1990; Mastropieri & Bakken, 1990). Little is known, however, about the internal sources that foster self-regulation. The current traditional assumption that active executive control is the only source of self-regulation may be responsible for the relatively lack of moderate success in the area of learning strategy instruction.

Furthermore, the geodesic movement does not view learning as incremental internalisation, but as the reconceptualisation of previously learned knowledge (Iran-Nejad, 1987, 1989, 1990). Reconceptualisation implies that an old schema is used to learn a new schema, not through simply making additions, but through a process more analogous to a chemical combination

(Bereiter, 1985). Simply making additions, which is implicit in incremental internalisation, does not result in a gain in complexity. In other words, the combination of the old schema with the new results in the reorganisation of a new “compound” that is qualitatively different, but not more complex than the old one (Iran-Nejad, 1989, 1990).

Therefore, mental schemata need to be viewed as transient structures and not as long-term memory building blocks (Iran-Nejad, 1987; Iran-Nejad & Ortony, 1984; Schallert, 1982). Algebraically, this reconceptualisation could be expressed as follows: $X + Y = Z$, where Z is qualitatively different to X - the old schema. Incremental internalisation would therefore be represented as: $X + Y = XY$.

Finally, the geodesic movement also considers the cognitive-emotive link, an issue that has been extensively researched by many authors. Thus, if students are emotionally engaged while learning, there will be cortical involvement from the outer cortex, through the subcortical areas, to the limbic system across both the left and right hemispheres (Hand, 1986; de Andrade, 1986; Lozanov, 1978; Maclean, 1978). Various authors have proved this point in various manners. Machado (1984) emphasises the pre-eminent role of the limbic system in learning and intellectual development, specifically the role of the hippocampus, hypothalamus and amygdala. Maclean’s (1978) triune brain theory also stresses the importance of the interaction between the limbic system and the neocortex in the development of intelligent learning. Lozanov (1978) suggests creating a more child-like (emic) relaxed state for learning through involvement of the limbic system. Lozanov (1978: 38) indicates that “misguided teaching and/or intervention deforms the natural mechanisms of learning resulting in effortful conscious rote type learning”. Therefore, successful reconceptualisation of knowledge occurs when the limbic system is invoked in the process of learning.

1.6.2. THE EFFECT ON EDUCATION AND THERAPY

The geodesic movement posits that dynamic self-regulation controls internal learning processes from infancy by facilitating interaction between the modules. As children grow older their learning becomes increasingly intentional, sequential and analytical. Emphasis on the latter at the expense of the former results in the failure to develop more than a tiny part of the capacity for learning with which they were born, and which was used naturally during the first two years of life. According to Holt (1964: vii) “children have a way of learning that fits their condition, and which they use naturally and well until we train them out of it”. Traditional academic

cultures develop the active executive at the expense of the dynamic executive, which leads to the active executive being ill-trained, and the limbic system not being effectively invoked.

This results in the acquisition of pathological mental sets that lead to the belief that the only way to learn and improve intelligence is to internalise the external, to be told and to accrue facts without necessarily thinking about them, from an external source - be it a person or book. The traditional learning environment is therefore not authentic or compatible with the natural laws of the neuropsychological functioning of the brain, and is unnatural. Research has shown that once the incorrect mental set is eliminated the whole approach to learning and the development of intelligence changes (Iran-Nejad, Ortony & Rittenhouse, 1989). The maxim that everything can be acquired through work, although fundamentally true, is incorrectly understood and students get the idea that they must make extreme efforts to memorise (Lozanov, 1978).

The implication of the geodesic movement is that learners must be trained to use active and dynamic self-regulation in a balanced natural way. This will allow them to become highly adaptive, to learn better in different contexts, and to know how to allocate, as well as delegate attention (Iran-Nejad, 1990). "They will be good at not losing sight of the forest while paying attention to the individual trees, and not losing sight of the individual trees while they inspect the forest as a whole" (Iran-Nejad, 1990: 581). Learners need to acquire mental sets about learning that are different from that fostered in the traditional academic setting. Therefore, "knowledge of the world can exist neither in the child, nor in the world; it must be learned through the process of internal construction that brings internal and external sources together" (Iran-Nejad, 1990: 580).

In summary, the geodesic movement perceives learning, thinking and the development of intelligence as the reconceptualisation of internal knowledge (Iran-Nejad, 1987, 1989, 1990). This alternative, representing a fourth paradigm shift in learning and intelligence (see Figure 1.1), is compatible with the natural neuropsychological laws of the functioning of the brain, recognising the natural multisource and simultaneous nature of learning, which necessitates dynamic internal self-regulation in addition to active control. This compatibility with the natural functioning of the brain is further enhanced by increasing the authenticity of the learning environment, which is done by stressing the multimodal nature of the brain, as well as the cognitive-emotive link. This implies making the environment, and the mediation that the

individual receives in that environment, as closely representative of the learning situation of a child as possible.

Hence, an environment that is created to follow the natural neuropsychological functioning of the brain could be considered geodesic. The differences between a traditional unnatural approach and a non-traditional natural approach to education and therapy are emphasised when compared visually (see Figure 1.2).

1.7. CONCLUSION

It is concluded that the most important consequence of a geodesic approach is the global restructuring of academic and therapeutic learning contexts and assumptions, in accordance with each of the aspects of the definition of geodesic. One way of accomplishing this is to devise approaches to learning and the development of intelligence that incorporate these aspects, and that can be practically implemented. A framework and model, the Mind-Mapping Approach (MMA), was developed in an attempt to facilitate this paradigm shift from traditional behaviouristic and cognitive models of learning, to geodesic models of learning (Leaf, 1990, 1993).

The MMA is a combination of strategies, both therapeutic and educational, that were selected, combined and developed according to their ability to fulfil the requirements of being geodesic. The Mind-Map itself is the main strategy of the MMA, while the other strategies are complementary to the Mind-Mapping technique. A Mind-Map is an overt way of summarising and representing information that is holistic, and through its use, the thinking process becomes observable, and thus open to manipulation. The MMA can also be used in the presentation of material; in the understanding of concepts; in any planning or organisation of books, reports, lectures, meetings, study, daily tasks, or future activities; in brainstorming; and in problem-solving. In short, the MMA can be used in any situation where there is a flow of information between the mind and the outside world, no matter in which direction the flow.

The act of creating the Mind-Map invokes a more efficient process of thinking that is geodesic because it is a brain-compatible technique (Leaf, 1990; Buzan, 1991; Russell, 1986). Therefore,

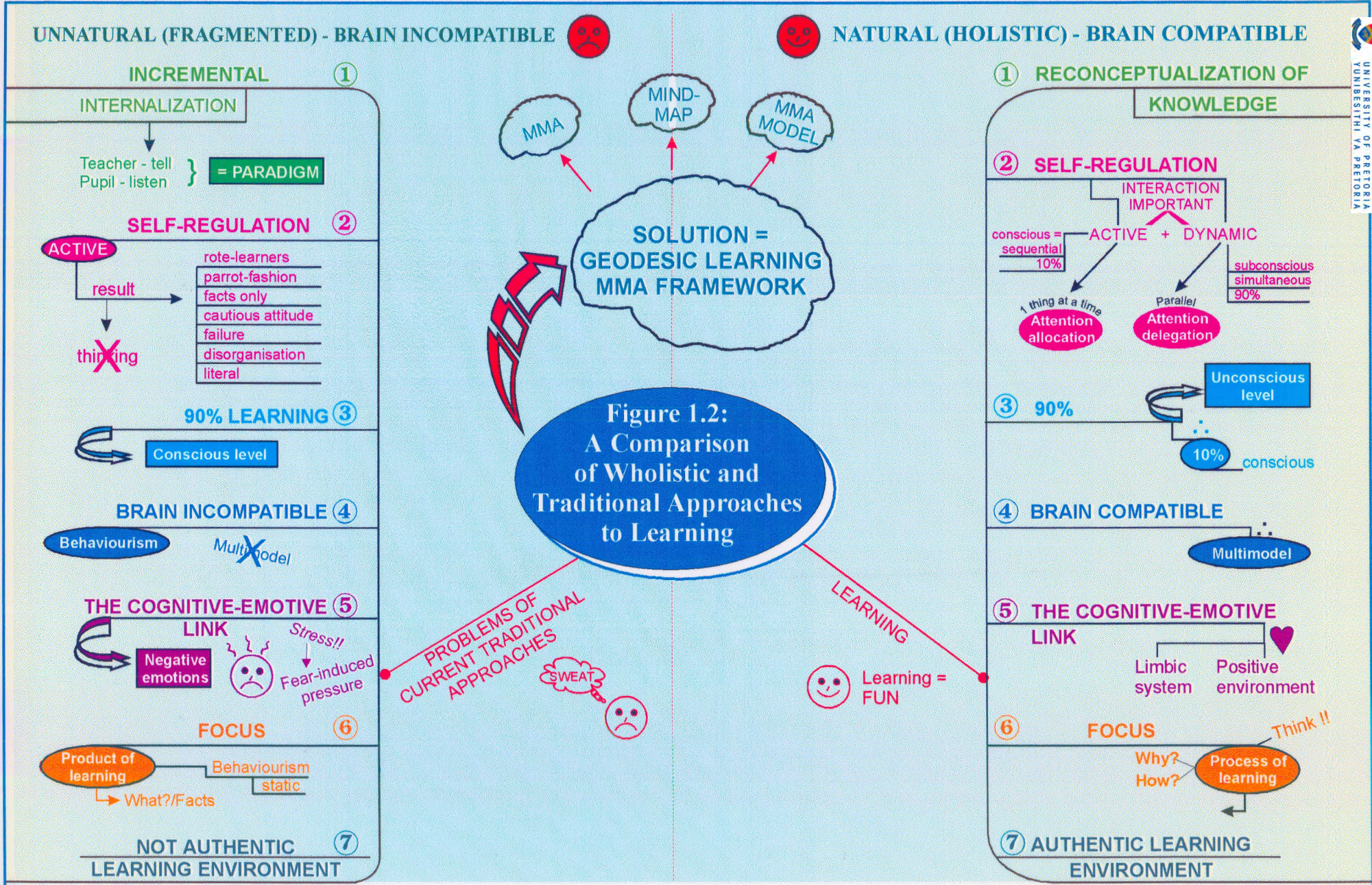


Figure 1.2:
A Comparison
of Wholistic and
Traditional Approaches
to Learning

Figure 1.2: A Comparison of Wholistic and Traditional Approaches to Learning

DEVELOPED BY: C. LEAF

the Mind-Map is the “tool” for developing more effective processes of thought, which will lead to the reconceptualisation of useful knowledge, and hence, improved intelligence.

In order to explain the process of thinking that is invoked when implementing the MMA, as well as to demonstrate the effectiveness of the technique, the MMA information processing model was developed. The reasoning behind the MMA information processing model of thought is deductive. It traces the thought process from the highest cortical brain functions and activity to its basic biological activity. The MMA information processing model was created in order to illustrate the geodesic nature of thought processes, particularly as invoked by the MMA. It illustrates the underpinnings of the geodesic concept, as presented in the definition, which are grouped into four levels, namely:

- ❑ **METACOGNITIVE LEVEL** - which is the non-conscious level where approximately 90% of learning occurs, the level on which dynamic self-regulation is operable orchestrating the interaction between, and the action of, the modules or domains
- ❑ **COGNITIVE LEVEL** - the conscious level where approximately 10% of learning takes place, the level where the metacognitive action is operationalised and orchestrated by active and dynamic self-regulation
- ❑ **SYMBOLIC LEVEL** - the expression and communication of the of the cognitive action through some symbolic format, including the Mind-Map itself
- ❑ **NEUROPSYCHOLOGICAL LEVEL** - the link between the psychological process and the nervous system, the neuropsychological link.

The aim of the current research, therefore, is to explore the effectiveness of the MMA framework in bringing about the paradigm shift from a cognitive and behaviouristic approach to learning, to a geodesic approach to learning. The effect of the geodesic methods of the MMA on the academic learning environment will be evaluated according to the academic changes that pupils experience as a result of exposure to the MMA methods from the teachers and therapists. The research is thus an attempt to prove that working within the geodesic framework of the MMA, individuals have a better chance of realising their potential for learning. It is postulated that this kind of process-oriented approach will improve the students’ metacognitive skills, which will in turn improve cognitive functioning, and hence their output.

It is also hypothesised that the target group to receive direct training should be the teachers and therapists, as it is they who will implement the paradigm shift from content-based teaching to process-oriented facilitation within “brain-compatible” environments. In conclusion, the MMA provides a framework within which to realise potential, as well as a vehicle of change for the changing role of the teacher and speech-language therapist in learning environments.

1.8. ORGANISATION OF THE THESIS

CHAPTER ONE : ORIENTATION AND STATEMENT OF THE PROBLEM

The first chapter serves as an orientation to the subject, geodesic learning, and motivates the choice of the field of study. It is an exposition of the logical foundation and reasoning of the study based on the literature related to learning and intelligence theory, neuropsychology, metacognition and Mind-Mapping. Furthermore it provides the chapter outline, and the terminology. More specifically, the chapter explores the paradigm shift that has occurred in the perception of learning and intelligence and the resultant effect on teaching and speech and language therapy. The need for a paradigm shift to a geodesic approach to learning is highlighted.

CHAPTER TWO : THE GEODESIC INFORMATION PROCESSING MODEL AND THE MIND-MAPPING APPROACH

In chapter two, the geodesic nature of the MMA and the Mind-Map is explored, highlighting their compliance with the natural neuropsychological functioning of the brain. The geodesic information processing model, developed to explain the thought process invoked through the implementation of the MMA, is described. This consists of a schema of the model incorporating all the neuropsychological and metacognitive concepts inherent in the model, accompanied by a full explanation of its operation.

CHAPTER THREE : THE ASSUMPTIONS AND THEORETICAL UNDERPINNINGS OF THE GEODESIC INFORMATION PROCESSING MODEL

In this chapter, each of the assumptions of the MMA and geodesic information processing model are explored by examining their theoretical origins. In this way, the theoretical underpinnings of the MMA are established in order to demonstrate why the MMA invokes more effective thought processing than traditional approaches.

CHAPTER FOUR : METHODOLOGY

Chapter four describes the experimental methodology, the aims and the procedures of the empirical research. The research design employed is an adapted ABA design as the standard form of a control group could not be employed. Longitudinal historical trends are established which serve as controls, as well as providing information on trends. Three data sets were created in order to deal with the dependency in the data. Non-parametric testing was used as the data do not follow a normal curve distribution. The experimental, training and evaluation procedures are discussed in full.

CHAPTER FIVE : RESULTS

In chapter five a quantitative and qualitative description of the results according to the two main aims and the sub-aims of the study are presented and analysed in order to determine whether the hypotheses are accepted or rejected. The results are presented in terms of the two groups of subjects - the teachers/therapists and the pupils - in order to examine the effect of the MMA programme on each.

CHAPTER SIX : DISCUSSION AND INTERPRETATION OF THE EMPIRICAL RESEARCH

This chapter includes a discussion of the MMA and the geodesic model in relation to the results obtained in this study as well as in the light of the literature in this area. The effectiveness of the MMA programme on the teachers and therapists and the pupils is discussed. Theoretical implications are extrapolated in relation to the research aims, highlighting the need to change to a more geodesic learning environment.

CHAPTER SEVEN : CONCLUSIONS AND IMPLICATIONS

Chapter seven presents the various implications arising out of the study, which are discussed in terms of their unique contribution and/or their expansion of the literature. Future research related to the implications is also suggested. A general conclusion regarding the contribution of the research is provided.

APPENDICES

The appendices supply important information for the replication of the study. They comprise the questionnaire given to the teachers and therapists; definition criteria; the training programme presented to the teachers and therapists; the Mind-Maps that were used in training; a summary of the videos shown; and a reading list.

1.9. TERMINOLOGY

In this section specific terminology employed in this study is defined.

❑ **Mind-Mapping:**

A way of structuring information according to the way the brain functions, stimulating a synergistic processing between the hemispheres' enhancing potential (Leaf, 1990; Buzan, 1991): the creative, synergistic, symbolic expression of the raw material of consciousness, that is, the synchronised activity and reactions which is the raw material of consciousness.

❑ **Mind-Mapping Therapy:**

The application of the concept of Mind-Mapping to intervention, thus providing clients with a more efficient operating system which allows them to use their potential more efficiently (Leaf, 1990).

❑ **The Mind-Mapping Approach (MMA):**

A combination of strategies in which the Mind-Map is the medium or the "tool" for stimulating the most effective utilisation of brain potential.

❑ **Brain-compatible:**

The brain's natural function of comparing, patterning, organising and creating is being optimally activated. Environments, methods and systems that facilitate the natural laws of neuropsychological functioning of the brain (Nummela & Rosengren, 1985; Springer & Deutsch, 1989).

❑ **Geodesic learning:**

A global comprehensive approach to learning which aims to create a richly varied instructional environment saturated with "authentic" input, which engages as much of the brain as possible. It involves the global participation of the brain, the simultaneous processes of analysis and synthesis, and finally, the simultaneous participation of the conscious and non-conscious (Lozanov, 1978; Dhorigy, 1991). The concept incorporates the following aspects:

- Learning is the reconceptualisation of knowledge and not incremental internalisation. Thus learning is a change between qualitatively different concepts, creation by reorganisation, not the memorisation of isolated materials in preparation for tomorrow's learning of more authentic materials (Iran-Nejad, 1990; Gardner, 1985).
- Self-regulation involves the interaction of both active and dynamic aspects, as opposed to just the active aspects (Iran-Nejad & Chissom, 1989).
- Ninety per cent of learning occurs on the subconscious level and therefore the influence of the subconscious on learning through the process of attention delegation is of vital importance to the development of intelligence (Gardner, 1985; Iran-Nejad, 1990).
- Authentic learning environments are multimodal, multidimensional and flexible, as opposed to static and unrealistic as in traditional approaches. Learning contexts should therefore be arranged in such a way that the spontaneous or dynamic learning approaches worked for children before school continue to work for them in school - full of the opportunities of real-life contexts (Jensen, 1995).
- The cognitive-emotive link needs to be considered. The role of the limbic system is of vital importance in the functional unity of the brain (Machado, 1987).
- The *focus* of learning needs to be on the *process* and not the *product*. Thus, the "how and why" is more important than the "what" (Jensen, 1995).
- Interhemispheric harmony - the release of potential - occurs when a synergistic processing between the two hemispheres is facilitated (Springer & Deutsch, 1989).

□ **Metacognition:**

Metacognition is the non-conscious level where 90% of learning occurs. It impacts on the cognitive level. Cognition is the conscious level which is only accountable for approximately 10% of learning (Iran-Nejad, 1990; Bereiter, 1985; Dhority, 1991; Gardner, 1985).

□ **Learning:**

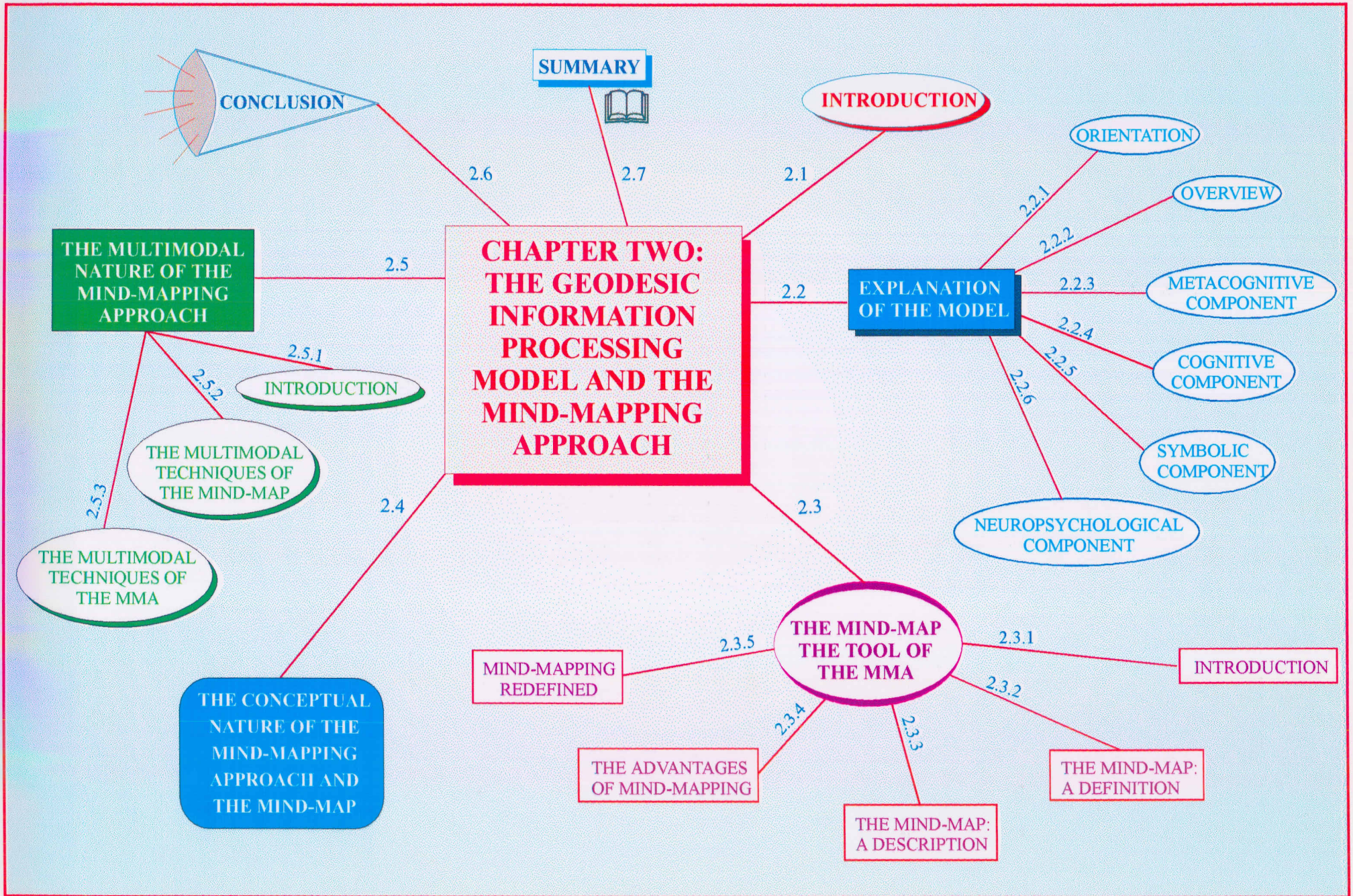
Learning is the creative reconceptualisation of internal knowledge controlled by active and dynamic self-regulation (Iran-Nejad, 1990). It has a quality of personal involvement; it is self-initiated; it is pervasive; it is evaluated by the learner; its essence is meaning (Rogers, 1969). All learning is in process and related to the ongoing lives of learners, and much of what is important learning cannot be measured (Jensen, 1995).

1.10. SUMMARY

Chapter one explores the paradigm shift that has occurred in the perception of thinking, learning and intelligence, and the concepts of the process of learning that have governed teaching and intervention. An attempt is made to highlight the problems of current approaches as well as the reasons for these problems. It is postulated that a framework that is geodesic - such as the MMA - may be a possible framework to operationalise the paradigm shift from a behaviouristic and cognitive model of learning to a geodesic model of learning. The speech-language therapist, due to the paradigm shift that has occurred in the field of Speech and Language Pathology, has an important consultative role to play in the area of learning and the development of intelligence in academic environments.

**WHAT LIES BEHIND US
AND WHAT LIES BEFORE US
ARE TINY MATTERS
COMPARED TO WHAT LIES
WITHIN US**

Einstein (1979: 43)



SUMMARY



CONCLUSION

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ORIENTATION

OVERVIEW

EXPLANATION OF THE MODEL

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COGNITIVE COMPONENT

SYMBOLIC COMPONENT

NEUROPSYCHOLOGICAL COMPONENT

THE MIND-MAP THE TOOL OF THE MMA

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2.1. INTRODUCTION

In view of the complex nature of learning, intellectual potential and communication, approaches of a more geodesic nature need to be adopted by educationalists and speech-language therapists in learning institutions in order to increase the efficacy of service delivery (Simon, 1987). This implies a paradigm shift from traditional behaviouristic and cognitive approaches to geodesic approaches to learning and communication (Gardner, 1985; Dhority, 1991; Jensen, 1995). This paradigm shift can be facilitated by practical frameworks incorporating geodesic principles. The MMA is viewed as a framework of this nature.

In order to examine the geodesic nature of the MMA a theoretical and conceptual model was developed. This information processing model is postulated to reflect the processing of information as invoked by the MMA. It is proposed that this process of thought is more effective than that invoked by traditional linear approaches, and as such, will result in more efficient learning and in the development of intellectual potential. This theoretical model also serves as a foundation for the expansion of the concept of the Mind-Map (Buzan, 1991; Leaf, 1990; Leaf, Uys & Louw, 1993). The expanded view of Mind-Mapping views the Mind-Map as the key which accesses the non-conscious levels of the brain. The Mind-Map is seen to directly access and influence the thought processes serving to unlock the potential of the brain. Hence the Mind-Map will be shown to be the creative symbolic visualisation of the raw material of consciousness, that is, the synchronised electrical-chemical reactions of the neurons.

In this chapter the information processing model is examined and the geodesic nature of the model and of the Mind-Mapping Approach is illustrated.

2.2. EXPLANATION OF THE MODEL

2.2.1. ORIENTATION

In this section, the geodesic information processing model, which was developed to explain the thinking process invoked by using the techniques of the MMA, is explained. The model was

developed in order to explain how information is processed, while working within the geodesic MMA framework. The emphasis of the MMA is to capitalise on the natural multimodal functioning of the brain in order to reconceptualise useful knowledge and develop potential.

The four components of a geodesic approach, namely metacognition, cognition, neuropsychology and symbolism, are incorporated into the geodesic model. The theoretical underpinnings of the development of the model have been derived from contemporary brain research: the work of Iran-Nejad (1990) on the two-source theory of self-regulation; Lozanov's (1975, 1978) development of Suggestopedia; Gardner's (1980, 1985) research on symbolic systems and the multiple intelligence theory; contemporary metacognitive and cognitive research, specifically on the role of the non-conscious (Flavell, 1978); and finally symbolic system approaches to information processing which use the brain as the analogy for the mind (Hinton & Anderson, 1981).

The geodesic information processing model is presented in schematic form in Figure 2.1. This is accompanied by a gestalt overview of its operation, followed by an in-depth explanation and discussion of its components and their operation.

2.2.2. AN OVERVIEW OF THE OPERATION OF THE GEODESIC INFORMATION PROCESSING MODEL

The geodesic information processing model (Figure 2.1) is an hypothetical model that traces the information processing pathway from the input - which can be internal, external or both - to the output whilst using the MMA. It is, however, postulated that this model can be extrapolated to explain any approach that strives to facilitate the processing of information within an environment that follows the natural laws of functioning of the brain.

As the result of an internal or external input, or both, information begins to be processed. If the MMA is utilised, specific metacognitive module(s) will be activated by a pattern-matching process. This will result in the activation of the processing systems of the specific metacognitive module(s) to be involved in the task.

In order for the processing system to operate, metacognitive action needs to be instituted, that is, the interaction of declarative, procedural and conditional knowledge executed by dynamic self-regulation. This will lead to the selection of the function to be carried out, facilitated by the

activation of existing descriptive systems to assist in the reconceptualisation of the new knowledge, and the cognitive process will begin. At this point, active and dynamic self-regulation interact. The quality of this interaction is controlled by the geodesic nature of the MMA.

The cognitive domain has to match the processing system already selected, and therefore the cognitive requirements of content, form and use will need to be met before quality processing can continue. If the cognitive requirements are fulfilled, then the cognitive function(s) will be selected to carry out the cognitive task to completion. In order to operationalise the cognitive function(s), cognitive action begins. Finally, the result of the information processing will be expressed through a symbolic format which is known as the output. The evidence of the newly reconceptualised knowledge is visually available on the Mind-Map, and represents the overt evidence that thought has taken place.

The geodesic information processing model is divided into four components, namely the metacognitive, cognitive, symbolic and neuropsychological components. The operation and interaction of each of these components is now discussed.

2.2.3. THE METACOGNITIVE COMPONENT

2.2.3.1. Introduction

The metacognitive component comprises seven metacognitive modules, each of which can be broken down into processing systems. Each processing system is made up of functions that realise the potential of that processing system. This realisation of the potential of a processing system is made possible by its computational capacity, the activation of the metacognitive domain.

2.2.3.2. The seven metacognitive modules

The metacognitive modules represent the knowledge base of the mind, categorised into seven groups based on the multiple intelligence theory (Gardner, 1981, 1985). These seven are not exhaustive but are seen to be representative of the range of human knowledge and intellectual potentials (Gardner, 1985; Gazzaniga, 1977; Kline, 1990).

The seven modules are the linguistic, logical /mathematical, visual/spatial, musical, inter- and intrapersonal, and kinaesthetic domains of knowledge. According to Gardner (1985), owing to heredity, early training or both, some individuals will experience greater development within some domains of knowledge than others, but every normal individual should develop each domain to some extent.

In life, these domains of knowledge (called metacognitive modules in the current model because of the metacognitive and information processing perspective) work in harmony, and so their autonomy may be invisible. However, Gazzaniga (1977) argues that they function as independent units each with their own cognitive characteristics. It is therefore proposed that the integrative cognitive nature of the MMA facilitates the interaction of these modules. When these modules interact, higher order thinking is produced because the net result of the interaction between modules improves the quality of interaction within modules. Strength in the sum of the parts is the fundamental principle of this modular perspective. The quality of higher cortical functions is influenced by the harmonious interaction of modules which is facilitated by creating environments that tap the abilities of all the modules, as opposed to just one or two, as is the case with traditional approaches. Synchronised interaction is facilitated within multimodal frameworks such as the MMA.

It should be noted that in Figure 2.1 (the geodesic information processing model), the expansion from the metacognitive level to the cognitive level, to the symbolic level is shown only in the linguistic metacognitive module. However, it is proposed that each metacognitive module follows this selfsame expansion within its domain of knowledge.

2.2.3.3. The processing systems and their functions

A metacognitive module is further subdivided into processing systems which are the result of a whole system of functions. These are represented neurologically by interrelations of different parts of the brain, based on Luria's (1980) conception of functional systems.

Each metacognitive module has its own specific processing systems, which are represented across both hemispheres in the brain. The processing systems are made up of functions which are locally represented in specific areas of either the left or right hemisphere of the brain. For example, the linguistic metacognitive module has various different processing systems such as reading, writing, communicating and listening. Each of these, in turn, can be divided into their

functions. Thus, for the processing system of reading, the function could be reading to find the key concept, or reading a complex technical manual, or reading a novel for pleasure. Each of these functions requires different cognitive approaches and is made up of various different steps - termed cognitive actions - which will operationalise the cognitive task.

2.2.3.4. The metacognitive domain - the computational capacity

A computational capacity exists at the core of each metacognitive module which is unique to that particular metacognitive module, and on which its complex realisations are based. From the repeated use of, interaction among, and elaboration of the various computational devices, forms of knowledge will eventually flow that could be termed useful, thus contributing to intelligence. These forms of knowledge have the potential to be involved in symbol systems, and will ultimately be expressed on the symbolic level.

More specifically, these computational capacities, which are unique to each of the metacognitive modules, are termed the metacognitive domains. A metacognitive domain comprises declarative, procedural and conditional knowledge with its executor being dynamic self-regulation. Each processing system operates under the direction of the metacognitive domain for that particular metacognitive module. Figure 2.2 illustrates this relationship schematically.

2.2.3.5. An example of the interplay in the metacognitive domain

A hypothetical example of the dynamic interplay between the declarative, procedural and conditional knowledge components, and their executor - dynamic self-regulation as invoked by the MMA - would involve the following. Initially an externally- or self-imposed goal is established (the equivalent of internal or external input). The existing metacognitive knowledge concerning this particular objective leads to the conscious metacognitive experience (interaction between active and dynamic self-regulation) that the objective may be difficult to achieve. This metacognitive self-regulation, combined with additional metacognitive knowledge, results in the selection and use of the cognitive strategy (termed cognitive act on the schema) of asking questions of oneself or knowledgeable other people. The answers arising from this exercise stimulate additional metacognitive experiences about the success of the task, which represents the interaction between active and dynamic self-regulation.

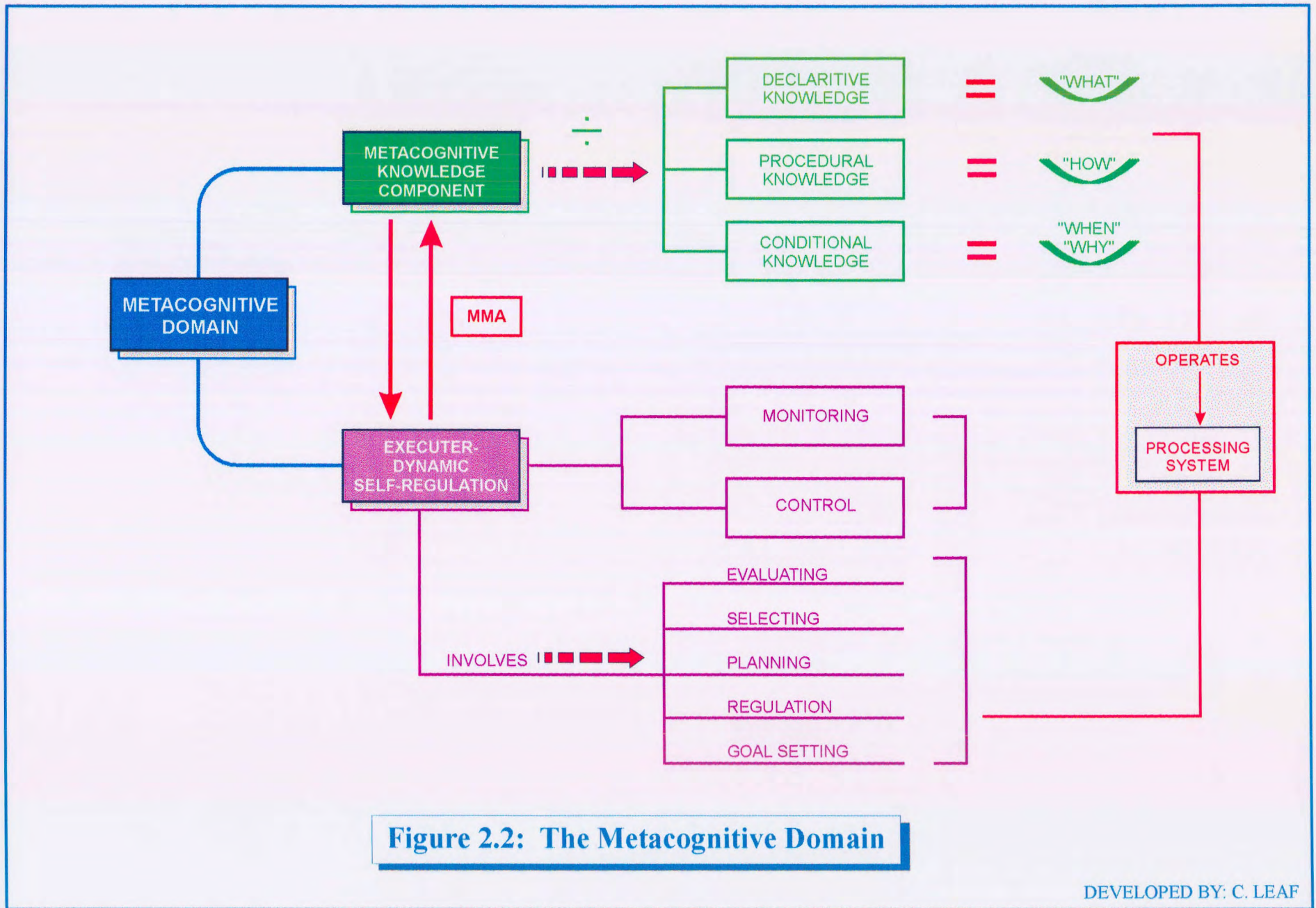


Figure 2.2: The Metacognitive Domain

DEVELOPED BY: C. LEAF

These experiences, guided by relevant metacognitive knowledge (declarative, procedural and conditional), investigate the cognitive strategy (cognitive act) of surveying, to establish whether it forms a coherent whole which provides a solution to the problem. This overview may result in the identification of difficulties with consequent activation by metacognitive knowledge and experience (active and dynamic self-regulation) of the same or different cognitive strategies. This interplay continues until the symbolic representation is achieved, which is the final creation of the Mind-Map

2.2.3.6. The activation of the metacognitive module - metacognitive action

In order to activate a metacognitive module, the components of the metacognitive domain (declarative, procedural and conditional knowledge) need to interact. This interaction results in metacognitive action, and is orchestrated by dynamic self-regulation. The quality of the interaction of the metacognitive domain determines the eventual output.

In the creation of the Mind-Map, all three types of knowledge need to be considered when selecting the concepts, as well as when representing these in an associated way. The process of creating the Mind-Map enhances the interaction of declarative, procedural and conditional knowledge, resulting in metacognitive action.

When metacognitive action occurs, the process of cognition begins. As mentioned earlier, 90 per cent of learning takes place on the non-conscious level (Gardner, 1985; Iran-Nejad, 1990; Reddy, 1979, Iran-Nejad, 1990). The rationale for this is that “intelligent” learning is creative and multisource, and hence takes place on the non-conscious level (Iran-Nejad, 1990).

Traditional approaches assume that learning occurs under active conscious executive control, namely from a single source termed metacognition (Iran-Nejad, 1990; Dhority, 1991). As a result effortful attention (Iran-Nejad, 1990) is viewed as the single most important regulator of learning (Bereiter, 1985). This limits the domain of learning. In the current study, based on a literature review on the non-conscious and self-regulation, metacognition is redefined as occurring on the non-conscious level (Iran-Nejad, 1990; Bereiter, 1985; Dhority, 1991; Lozanov, 1978; Flavell, 1978). These authors postulate the notion that external and internal stimuli are far too complex to manage or hold with only the mechanisms of our conscious attention. Hence the non-conscious level is not viewed as simply containing the unattended or unimportant percepts, but as the level where the complex mental activity occurs. A structure for

the non-conscious level is postulated, thus providing a broader definition of metacognition. By implication, 90 per cent of learning is taking place when metacognitive action is in process, and hence this is the level that should be targeted in intervention and mediation.

The activation of the non-conscious stores triggers metacognitive action. The MMA can be seen as this trigger. By implication, the MMA focuses at the root level of the learning process, and therefore predominantly on the non-conscious. Conversely, the cognitive functions that have been activated by metacognitive action, and that are orchestrated by active and dynamic self-regulation, only represent approximately 10 per cent of the learning and reconceptualisation of knowledge process (Reddy, 1979, in Iran-Nejad, 1990; Lozanov, 1975).

2.2.3.7. The neurobiological level of metacognitive action

On a biological level, modular columns of neuronal cells ascending from the cortex to the subcortex to the limbic system across the left and right hemispheres, represent the metacognitive modules and functional systems (Feldman, 1980; Saloman, 1979;). Metacognitive action is represented as the distributed parallel activation of dendritic interconnections from the cortex to the limbic system across both hemispheres.

2.2.3.8. The neuropsychological level of metacognitive action - pattern recognition

On a neuropsychological level, metacognitive action can be perceived as the activation of the descriptive systems (Goldberg & Costa, 1981), or organisational codes. The number of descriptive systems activated is dependent on the complexity of the cognitive task. These will be used to reconceptualise new descriptive systems based on pattern recognition. The Mind-Map's pattern structure facilitates the pattern recognition process, as well as making it available to introspection, and in this way more efficient use of the descriptive systems can be made.

2.2.3.9. The interaction of active and dynamic self-regulation

Active self-regulation occurs on a conscious level, which implies that conscious introspection can occur. This is the result of the interaction of dynamic and active self-regulation (see hypothetical example above). According to Iran-Nejad (1990), this interaction has important implications for learning because the quality of this interaction distinguishes between effective and ineffective approaches to learning. Therefore, active and dynamic self-regulation have to interact in order to produce cognition. Once the cognitive process is instituted, active and dynamic self-regulation should continue to interact, and the non-conscious will impact on the conscious level through attention delegation. This will lead to "quality learning". However, if

active self-regulation starts to operate at the expense of dynamic self-regulation, which can occur if the facilitation is brain-antagonistic (Jensen, 1995), as in traditional approaches, then the quality of learning lessens and learning becomes more rote-like.

A single-source theory of self-regulation implies that the central executive must monitor constructive change by directly allocating attention to the source of change (Reddy, 1979, in Iran-Nejad, 1990). The two-source alternative (Iran-Nejad, 1990) implies that active allocation of attention is neither sufficient nor always necessary. An activated descriptive system (the result of metacognitive action) can influence a cognitive task, even though it may be outside conscious awareness. Therefore the activated descriptive system will still influence higher mental functions or cognitive tasks and strategies being used to complete a goal - be it of a communicative or academic nature. This is known as attention-delegation power, which is the power to continue an ongoing contribution to internal reconstruction even after the executive spotlight moves on to another site (Iran-Nejad, 1990).

The most direct source of interaction between active and dynamic self-regulation occurs when specific attention is allocated to the components (Iran-Nejad, 1990). These are the declarative, procedural and conditional knowledge components of the metacognitive domain in the information process model. It is postulated that this interaction is enhanced by the MMA due to its metacognitive nature. This process is evidenced during the act of creating a Mind-Map, where essentially declarative, procedural and conditional knowledge is stored. In the selection of a concept, metacognitive action sequences are established which indicate the associative relationships in a deductive and inductive way, therefore analogically. Thinking on this level is considered to be deep processing as the metacognitive level is actively involved.

If the incorrect concept is selected due to lack of comprehension or the attempt to learn in a rote fashion, incorrect action sequences will be stored, which will affect recall. This is easily rectified by reviewing the networked patterned nature of the Mind-Map. In this way the metacognitive components (which have become conscious by their visual symbolic expression on the Mind-Map, and therefore regulated by active self-regulation) will be activated.

However, the metacognitive action sequences are governed by the non-conscious level (Anderson, 1986, in Springer & Deutsch, 1989), and therefore dynamic self-regulation, and will be activated on a non-conscious level. Hence, in order to rectify the incorrect action sequences,

active and dynamic self-regulation have to meet and interact. It is this interaction that becomes a primary focus of the MMA because, as already stipulated, the quality of interaction will distinguish between effective and ineffective approaches to learning. It is hypothesised that the MMA improves the quality of the interaction because it accesses the cognitive and metacognitive levels in its construction. Figure 2.3 illustrates the relationship between active and dynamic self-regulation and metacognition and cognition. Therefore, the metacognitive non-conscious is the highest level of thought, where qualitative, intelligent and useful knowledge is reconceptualised. Traditional forms of stimulation will result in only partial activation of this level, and hence the lack of activation of potential.

2.2.4 THE COGNITIVE COMPONENT

2.2.4.1. Introduction

The cognitive component of the geodesic information processing model represents what is traditionally assumed to be metacognition, that is, “thinking about thinking” (Flavell, 1978; Campione, Brown & Bryant, 1985). In the model, this level represents the level on which slow, conscious control of the thought process occurs. It is under the control of the central executive and is inherently sequential. The cognitive process begins after metacognitive action is instituted, when dynamic and active self-regulation interact.

2.2.4.2. The cognitive process

When metacognitive action is instituted, cognition, orchestrated by active and dynamic self-regulation, begins, the interaction between the two being of paramount importance. On the cognitive level, the metacognitive action is carried out to completion. This complete action is constantly enhanced by the use of the MMA framework. In order to complete the metacognitive action, the cognitive process will be instituted on the product of the metacognitive action. This is the process that is instituted as the Mind-Map is being made. These action sequence steps include the following:

- Attention allocation and delegation;
- Perception through all the sensory modalities;
- The decoding (analysis) of the incoming information (this involves the analysis of existing appropriate descriptive systems already called up when metacognitive action began) in preparation of the new reconceptualisation of knowledge;

METACOGNITION (NON-CONSCIOUS)

COGNITION (CONSCIOUS)

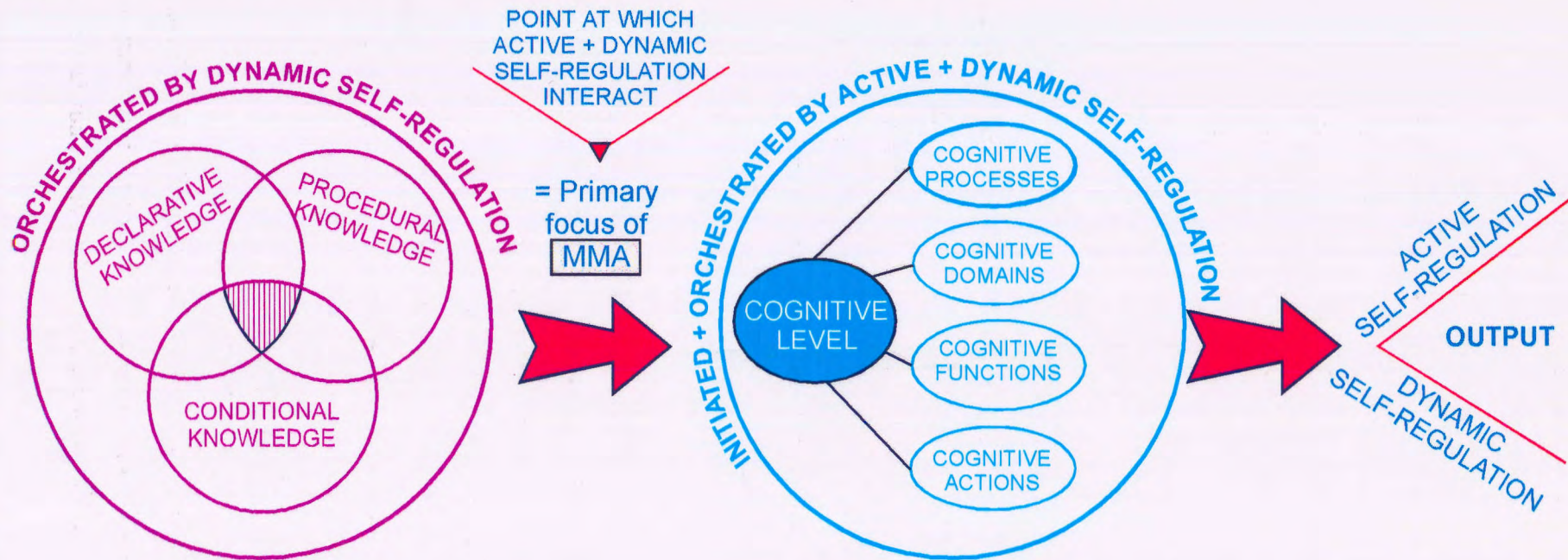


Figure 2.3: The Interaction between Active and Dynamic Self-Regulation

- ❑ The process of problem-solving, which includes reasoning, both deductive and inductive, resulting in inferences and judgements being made, and cause-effect relationships being established;
- ❑ The organisation of the resultant reconceptualisations into appropriately associated and categorised networks; and finally
- ❑ The synthesing (encoding) of information that will be effectively stored in memory (Flavell, 1978; Gardner, 1985; Iran-Nejad, 1990; Derry, 1990; Jensen, 1995; Dhority, 1991; Hart, 1983; Hand, 1986).

These cognitive processes occur within each of the cognitive domains which delineate the processing systems already activated on the metacognitive level, namely listening, speaking, reading and writing, in the case of the linguistic module. Each cognitive domain has various requirements that have to be fulfilled in order to create useful knowledge. These requirements (Bloom & Lahey, 1978) include: something to communicate (content); a structure for the communication (form); and, finally, a communicative intent (use).

The next phase of the MMA information processing model proposes that the cognitive process operates within each cognitive domain selected for the specific task at hand, if the cognitive requirements of useful knowledge have been fulfilled. Each cognitive domain is divided into cognitive functions, corresponding to the functions on the metacognitive level, which are further subdivided into cognitive actions. In this way the cognitive act operationalises the cognitive task.

2.2.4.3. An example of cognition in action

In selecting the cognitive domain (processing system) of writing, the cognitive function may be to write down a selected concept onto the Mind-Map. This is CF1 (cognitive function 1) on Figure 2.1. CF1 would then be made up of various cognitive acts (CA1, CA2 etc) which are the steps involved in carrying out CF1.

Thus, CA1 in this case would be the analysis of the phonemes that would afterwards have to be written. This involves the posterior parts of the left temporal zone (Luria, 1978). CA2 would involve the motoric expression of the lingual sound (Luria, 1980) in order to make the contents of the sound clear. This involves the inferior portion of the left post-central gyrus (Luria, in Leaf, 1990). CA3 is the transferring of phonemes into letters involving the spatial arrangement

of the graphemes, which involves the parietal-occipital part of the cortex (Luria, 1980). CA4 involves the sequencing of phonemes and graphemes while writing, which involves the pre-motor zone (Luria, 1980).

Finally, CA5 will involve the positioning of the word on the Mind-Map to fit into the associative network. Thus CA5, in this case, moves onto the symbolic level - namely level three on the information processing model.

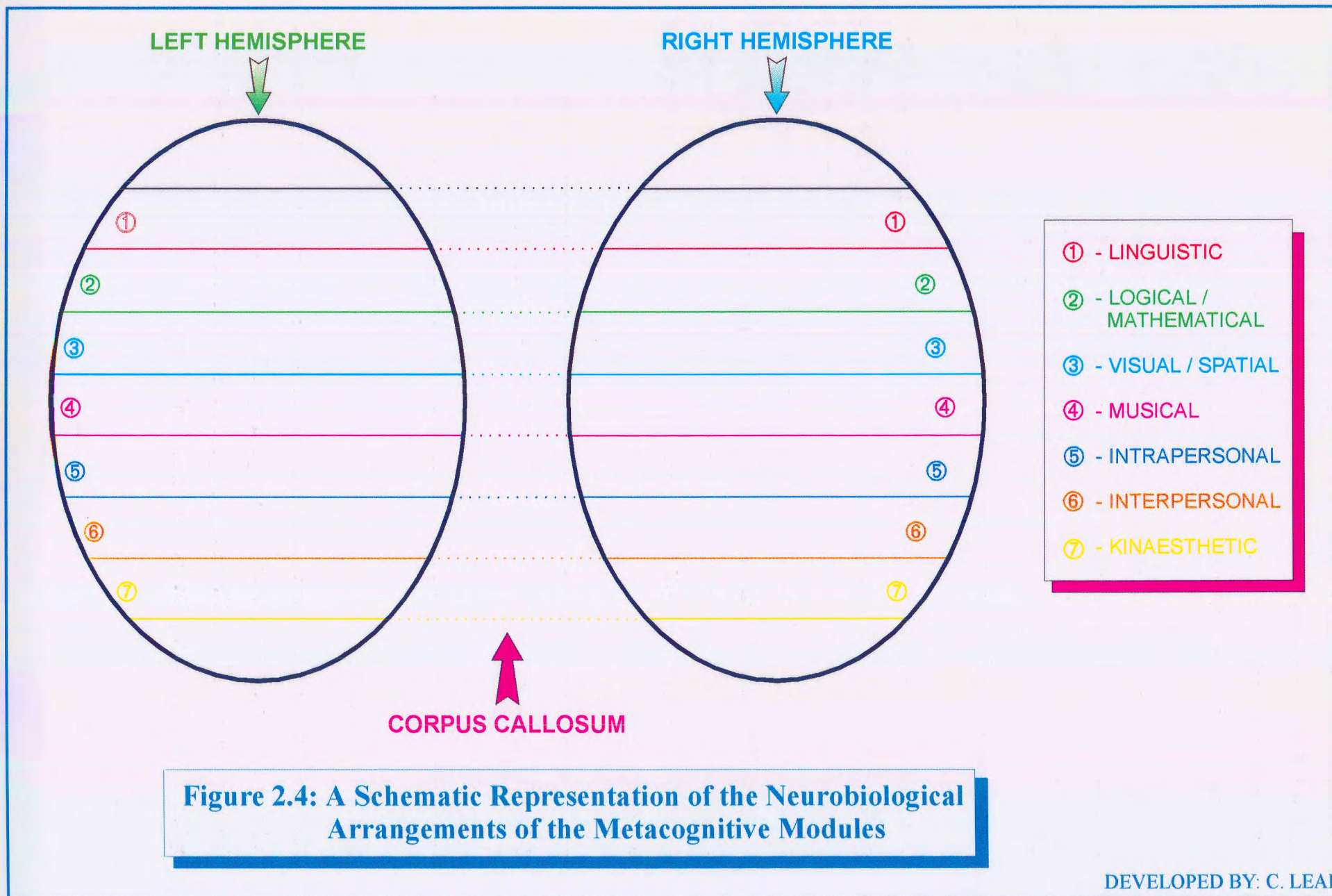
2.2.5. THE SYMBOLIC COMPONENT

The symbolic component comprises the expressive level of the cognitive action, which is in turn influenced by the metacognitive component. Functioning on the symbolic level is therefore the evidence that thinking and processing of information has occurred. This is expressed through a symbolic vehicle that is representative of the metacognitive module. For example, the linguistic metacognitive module can be expressed symbolically as oral expression, reception, written expression or reading, or all of these (see Figure 2.1). The Mind-Map facilitates and represents all four forms of expression. From the symbolic level, judgements of a person's thinking, learning, intellectual potential and communication skills are made. This implies judgements as to the effectiveness of cognitive and metacognitive skills. This occurs because metacognition influences cognition which in turn influences the symbolic output.

2.2.6. THE NEUROPSYCHOLOGICAL COMPONENT

The last component of the geodesic information processing model is the neuropsychological component, which deals with the relationship between brain function and behaviour (Tollman, 1988, in Leaf, 1990). This component is the link between the biological and cognitive levels. In order to fall within the realms of being geodesic, the brain-function-behaviour relationship cannot be overlooked (Dhority, 1991).

According to the model, the metacognitive modules are represented biologically as modular columns of neuronal cells ascending from the cortex to the limbic system across both left and right hemispheres. It is postulated that there are seven neuronal columns representing the seven metacognitive domains, as illustrated in Figure 2.4. As the result of input, electrical activity will flow across the columns. The more synergistic the input, the more synchronised the flow between the two hemispheres. It is postulated that when this occurs, larger areas of the brain will be utilised more efficiently.



It is believed that this synchronised synergistic flow will result in the metacognitive action being activated. Thus, the reserve capacities will be mobilised. In contrast, input from traditional approaches will result in reduced unsynchronised flow between the hemispheres resulting in only active self-regulation and effortful cognition occurring.

The metacognitive domain is represented biologically as the distributed parallel activation of dendritic interconnections and synapses within the neuronal columns of the modules across both hemispheres (Cook, 1984). Neuropsychologically, this results in pattern detection (Pribram, 1971; Hart, 1983), which is the calling up of existing descriptive systems to facilitate reconceptualisation of knowledge.

The cognitive component is represented as localised activation of neural connections in either the left or right hemisphere, because the processing systems at this stage are more specific (Springer & Deutsch, 1989). Finally the symbolic component is represented as parallel activation of the modules involved across both hemispheres because the symbolic expression is the result of synergistic action. Therefore the geodesic information processing model provides speculation as to the type of thinking that is induced when working within a geodesic framework. It traces the processing of information from the metacognitive level through to the symbolic output.

2.3. THE MIND-MAP: THE TOOL OF THE MIND-MAPPING APPROACH

2.3.1. INTRODUCTION

The MMA helps individuals to visualise concepts and to penetrate this structure and meaning in order to develop insight into the knowledge sought. The Mind-Map becomes the tool for facilitating, externalising and improving this process. In this section the Mind-Map is discussed by highlighting its metacognitive neuropsychological nature.

2.3.2. THE MIND-MAP: A DEFINITION

Mind-Mapping is a system for putting thoughts onto paper (Margulies, 1991). Whenever information is being taken in, Mind-Maps help organise it into a form that is easily assimilated by the brain and easily remembered (Russell, 1986). Whenever information is being retrieved from memory, Mind-Maps allow ideas to be noted as they occur, in an organised manner, obviating the relatively laborious process of forming neat monochromatic linear sentences and writing them out in full. They therefore serve as a quick and efficient means of review, facilitating recall.

2.3.3. THE MIND-MAP: A DESCRIPTION

A Mind-Map is created by using a central image, symbol or title representing the overall theme; subthemes grow out of the overall theme; concepts and/or images each on their own line grow out of the sub-themes, which act as nodes, and are linked by lines which give organisation and association to the Mind-Map, and therefore branch out deductively from the central image; symbols, images, dimension and colour are used to enhance the spatial multimodal nature of the Mind-Map (Leaf, 1990; Leaf et al., 1993; Buzan, 1991).

2.3.4. THE ADVANTAGES OF MIND-MAPPING

A Mind-Map allows the recording of large amounts of information on one page and the illustration of the relationships amongst the concepts (Margulies, 1991; Leaf, 1990; Leaf et al., 1993). This visual representation helps a person to think about a subject more globally, resulting in more flexible cognition.

The Mind-Map provides a geodesic framework for the developing networks of thought, and the visual observation of their effectiveness. Thus the Mind-Map provides a visual representation akin to a roadmap in that it shows the associative pathways of the information being organised. In order to work within a geodesic framework, multi-dimensional versus hierarchical structures need to be adopted (Margulies, 1991; Russell, 1986). Hence the Mind-Map is based on a circular branching arrangement that works outwards from a central theme. In contrast, traditional note-making methods involve the linear writing of only words, normally monochromatically, on lined paper, which stifles creative, flexible cognition (Margulies, 1991; Buzan, 1991).

The Mind-Map provides a way of externalising conceptual arrangements in an associated way that mirrors the natural functioning of the brain. Although it is not fully known how the specific mechanisms operating in the brain allow information to be stored, it is clear that the neural networks that become established are complex patterns with many interconnecting networks (Springer & Deutsch, 1989). This neuronal branching is similar to the networked idea-linked images of the Mind-Map. The naturalness of the patterned structure of the Mind-Map is further stressed if compared to the structure of natural elements such as lightning, chemical bonds, roots and branches of trees, and river deltas (Buzan & Dixon, 1976).

The natural organic structure of the Mind-Map shows how the brain processes information and links thoughts. This networked nature of the Mind-Map may account for the way alternating patterns of meaning are available when stored concepts are used to perceive meanings. Mind-Mapping therefore facilitates active problem-solving and extends the thinking process. The active process of creating the Mind-Map helps the individual to form associations in activating or retrieving existing descriptive systems, and in this way information processing is improved and pattern-recognition is assisted. The Mind-Map, by activating these networks, provides a medium for influencing thought.

Mind -Mapping in effect teaches the habit of thinking while learning. By adding the individual's own structure and insight to the topic, active participation in the learning process is engendered (Margulies, 1991). Furthermore, misconceptions and misunderstandings are immediately apparent due to the visual nature of the Mind-Map and are thus easily remediated. Thus, on a practical level, the Mind-Map can assist the student in detecting ambiguities and inconsistencies in the material under review, especially when the mediator becomes involved in clarifying concepts and propositions. According to Novak and Gowin (1984), this is "shared meaning", where the student is seen as bringing something to the learning situation. Mind-Mapping helps make evident concepts and their associations and facilitates reconceptualisation of knowledge for the learner. The teacher and therapist can use Mind-Mapping in the presentation of information, in the remediation of problems, as an assessment tool to evaluate the thinking process, as a way of determining pathways for organising meaning of concepts, and for sharing meaning.

2.3.5. MIND-MAPPING REDEFINED

In the two decades since the concept of Mind-Mapping was introduced, there has been increasing evidence that this process enhances multidimensional thinking skills and can actually improve intelligence (Leaf, 1990; Wenger, 1985; Margulies, 1991). According to Wenger (1985), the benefits of Mind-Mapping extend far beyond the practical applications of recording ideas into the realm of higher order thinking and increased intelligence. Thus, it is postulated that by using Mind-Mapping within a geodesic framework such the MMA, thinking, learning and the development of intellectual potential are enhanced. To allow for this expanded role, the concept of Mind-Mapping needs to be redefined as the symbolic expression of the creative synergistic cognitive and metacognitive processing of information. According to this view, a Mind-Map represents the raw material of the conscious and non-conscious states, that is, the synchronised electrical chemical reactions of the left and right hemispheres. In order to maximise the potential of the Mind-Map it needs to be used within the MMA. This will allow the natural neuropsychological and geodesic nature of the Mind-Map to be released. In the ensuing discussion, the conceptual and multimodal nature of the MMA framework and its tool the Mind-Map is explored in order to demonstrate their brain compatibility and geodesic nature.

2.4. THE CONCEPTUAL NATURE OF THE MIND-MAPPING APPROACH AND THE MIND-MAP

In the creation of a Mind-Map, only conceptual information is represented, in written words or visual symbols. This is because only 1-10% of words spoken, heard and read contain the general notion, that is, the essential words (Howe & Godfrey, 1977, in Russell, 1986). A person's mind does not recall in sentences, but in concepts and images and thus, approximately 90% of notemaking is unnecessary (Howe & Godfrey, 1977, in Russell, 1986; Buzan, 1991; Russell, 1986). Concepts contain the essence of the sentence, the remainder of the words being redundant and unnecessary for recall.

Concepts tend to be represented by the nouns and verbs in a sentence - though sometimes adjectives and adverbs may be significant enough to become concepts (Buzan, 1991; Russell, 1986). Concepts tend to be concrete rather than abstract, and it has been found that concrete words generate images faster than abstract words (Howe & Godfrey, 1977, in Russell, 1986).

Concrete images also generate richer images with stronger and more associations and are therefore better remembered (Howe & Godfrey, 1977, in Russell, 1986; Buzan, 1991; Gelb, 1988). Furthermore, when creating a Mind-Map, the challenge is to record ideas using not only concepts, but also symbols. In order to create a symbol, an image and a concept must be combined (Margulies, 1991). This requires that both the left and right cerebral hemispheres function synergistically in order to link images (predominantly processed by the right hemisphere), and concepts (predominantly processed by the left hemisphere). According to Novak and Gowin (1984), a person thinks in terms of concepts. Mind-Maps serve to externalise these concepts and improve the thinking process. Mind-Maps also serve to clarify to both teachers and students the small number of main ideas that must be focused on for any specific learning task. A concept represents a third level of meaning extrapolation (Leaf, 1990). The first is the “every word or sentence” level; the second is the “key word” level; and the third is the “concept” level. The latter represents a deeper level of processing because it is extracting the essential meaning of the message.

A key word is defined as “a word of great significance” and “an informative word used to indicate the content of a document etc.” (Concise Oxford Dictionary, 1995). Thus, a key word is the text minus the functor words and repeated words. There is still a lot of redundancy at the key word level; however, this is normally the level at which most students function when making summaries (Gelb, 1988; Margulies, 1991; Buzan, 1991; Russell, 1986). A concept, by contrast, can be defined as “a general notion; an abstract idea” (Concise Oxford Dictionary, 1995), and is therefore an abstraction that represents objects or events having similar properties (Caskey, 1986). A conception is also defined as an idea. Therefore, a key word represents a word in context; a concept represents the context, or the idea that will arise out of the interpretation of the key word in context, and as such requires in-depth processing. A concept incorporates relevance in brevity. Although key words and concepts are often used synonymously, a distinction can be made which is relevant to the creation of the Mind-Map, where only concepts are used. If only key words are selected, the context they were originally in tends to get lost and the information is stored in content or taxon (factual) memory. Selection of the concepts, however, results in context or locale memory making the information more useful, due to the associations and context that the information is given.

In order to reach the conceptual level of information, meaning has to be extracted from the key word in the context, which requires active processing. This meaning extraction will lead to the

reconceptualisation of knowledge and will require metacognitive interaction. The implication is that extraction of a concept will lead to meaningful learning, whereas the extraction of a key word will result in rote learning.

The aspect of learning that is distinctly human is the capacity for using written or spoken symbols to represent perceived regularities in events or objects (Novak & Gowin, 1984). Thus language is used to translate commonly recognised regularities into concepts - that can be used to describe thoughts, feelings and actions. An awareness of the explicit role that the symbolic level of language plays in the exchange of information is central to understanding the value and purpose of using concepts on the Mind-Map, and indeed is central to learning. Learning is experienced when there is recognition that a new meaning has been reconceptualised, and the concomitant emotion that accompanies this feeling is experienced. This emotion is termed “felt significance” by Novak & Gowin (1984), and allows the learner to evaluate their interpretation of concepts and their thinking process. In this way, the individual is self-regulating and hence, taking responsibility for their own learning.

Findings by Leaf (1990) and Leaf et al. (1993) indicate that representing key words as opposed to concepts results in poorly structured Mind-Maps that the individual does not understand, and therefore will not be able to reinterpret. Good concept selection results in well organised structures with appropriate categorisations and associations, providing patterns and images that facilitate learning and recall. It is hypothesised that when only key words are extracted from an external source, active self-regulation operates at the expense of dynamic self-regulation.

It is, however, the interaction of active and dynamic self regulation that leads to meaning being extracted from the world, and information being reconceptualised creatively. The creation of Mind-Maps by using concepts, as opposed to key words, invokes an interaction between active and dynamic self-regulation. This will lead to reflective thinking. Reflective thinking is controlled doing, involving a pushing and pulling of concepts, putting them together and separating them again (Novak & Gowin, 1984; Gelb, 1988). Reflective thinking involves the ability to solve problems, which in turn involves the ability to reason, infer, make judgements and identify cause/effect relationships (see Figure 2.1). Furthermore, learning of concepts is an activity which cannot be shared; it is a matter of individual responsibility (Gelb, 1988; Wenger, 1985). Meanings of concepts, however, can be shared, discussed, negotiated and agreed upon (Novak & Gowin, 1984). Thus reflective thinking allows the relationships between concepts to

be explored, and, because Mind-Maps are explicit, overt representations of the concepts and propositions or descriptive systems that a person holds, they act as “tools” for sharing meaning, identifying misconceptions, and negotiating meanings between conceptions. The Mind-Maps invoke the conceptual descriptive systems already in existence in the mind, and use these to reconceptualise knowledge through a process of reflective thinking.

2.5. THE MULTIMODAL NATURE OF THE MIND-MAPPING APPROACH AND THE MIND-MAP

2.5.1. INTRODUCTION

One of the main underlying principles of the MMA is the reliance on multiple sensory channels in both the input and output stages. The input stage is the reading, understanding, thinking, and selection of concepts, ending in the creation of the Mind-Map. The output stage involves the application of the new knowledge reconceptualised in the input stage on an oral and written level. Therefore, visual imagery, symbols, words, colour, dimension and movement are all required in the input stage, which is the creation of the Mind-Map. In the output stage (also termed creative visualisation), taste, smell, audition, touch and kinaesthesia are also invoked.

The simultaneous use of multiple sensory channels in dealing with external information is the rule rather than the exception in real-world authentic situations (Iran-Nejad & Ortony, 1984). The MMA takes advantage of this organic multimodal nature of the human knowledge reconstruction system. The multimodal encoding nature of the brain has also been emphasised by Bartlett (1932), who stressed the multiscore and reconstructive nature of remembering, stressing that these factors need to be emphasised in the learning process.

Furthermore, the internal executive does not have to move from the visual to the auditory to the olfactory subsystems to regulate learning one thing at a time - it is a simultaneous process (Iran-Nejad, 1990). Hart (1983), Lozanov (1978) and Krashen (1983, in Dhority, 1991) argue that a large volume of input which is not artificially simplified or logically sequenced, is essential for a fully functioning healthy brain. These researchers all recommend increasing the volume of real multisensory input by factors of up to ten times what students currently receive. Information

processing research and learning research must focus on the multimodal nature of the human knowledge reconstruction system in order to increase the holism of these approaches.

In the ensuing discussion, the manner in which multiple sensory channels are invoked using the MMA and the Mind-Map, as well as the importance of multiple sensory input to learning, will be explored.

2.5.2. THE MULTIMODAL TECHNIQUES OF THE MIND-MAP

The multimodal techniques of the Mind-Map include organisation, association, categorisation, visualisation, and conspicuousness.

2.5.2.1. Organisation

An individual's brain spontaneously imposes its own subjective organisation on all the material it remembers (Buzan, 1991; Russell, 1986; Anokhin, 1986, in Buzan & Dixon, 1976; Gardner, 1985; Springer & Deutsch, 1989). Even when the information is random, subjective organisation will aid recall. Thus the more deliberate organisation of material occurs, the more memory is facilitated. In the creation of the Mind-Map, the concepts selected need to be associated and categorised in order to create meaning. The propositional relationships between the selected concepts need to be decided on, and this relationship needs to be reflected structurally on the Mind-Map.

The creation of the Mind-Map allows this organisation to be made overt and visual in the structure of the pattern, and therefore available to introspection. If there are misconceptions and misunderstandings by the learner, this will be obvious from the organisation of the Mind-Map, which will not make sense. Meaningful learning proceeds most easily when new concepts are subsumed under inclusive broader concepts (the subthemes spoken of earlier). Mind-Maps need to be organised deductively outwards from the central overall theme; that is, the more general, more inclusive concepts need to be placed closer to the central theme, with progressively more specific, less inclusive concepts arranged outwardly. Therefore the tectonic organisation of the Mind-Map is analogical, requiring a deductive interpretation of meaning when moving outwards from the central point, and an inductive interpretation of meaning when moving inwards from the periphery of the Mind-Map. In this way, inferences, judgements and cause and effect relationships can be identified, facilitating the problem-solving process. The actual activity of organising is evidence of reconceptualisation. The process of working out where a

piece of information fits into a pattern, and the process of representing this conceptually as one concept per line, requires more active involvement than can be provided by active self-regulation alone. Active self-regulation needs to interact with dynamic self-regulation to increase depth of processing. As the Mind-Map is created, this interaction is facilitated due to the way the information has to be organised on the Mind-Map to make sense.

2.5.2.2. Association

Concepts that are closely associated are recalled together. It therefore aids memory if they are put together in notes (Margulies, 1991; Sylvester, 1985; Fodor, 1992). This reinforces association and the result will be a natural clustering of ideas into themes (Russell, 1986). The mind functions best when it has created rich connecting associative patterns among related units of useful information. According to Sylvester (1985), a continuous barrage of diverse facts in isolation, which often characterises classroom activity, will diminish the effectiveness of memory in conscious thought. Concepts need to be associated to give them meaning. The Mind-Map, as the end product of the MMA, loses meaning if inappropriate associations have been made.

Therefore, when using the MMA, facts are presented in association and not in isolation. In this way new knowledge becomes more meaningful and more effectively reconceptualised. Because of the large amounts of association involved in Mind-Maps, they can be very creative and they tend to generate new ideas and associations that have not been thought of before. Every concept on a Mind-Map is in effect the centre of another Mind-Map, therefore Mind-Maps could be generated *ad infinitum*.

Sylvester (1985) argues that a major curricular challenge should be to help students to develop patterns that create and associate concepts in the materials they study; and to develop memory strategies that can effectively locate factual information, examine mental images, and draw inferences from limited information within their memory. The Mind-Map, due to its associative nature, fulfils these requirements.

2.5.2.3. Categorising

Categorising or clustering is a natural result of having a well-defined central point which provides the overall orientation (Russell, 1986). The latter should be representative of the overall theme of the concepts to be explored. From the well-defined centre categories should radiate deductively outwards. Each category can be further subdivided into smaller sub-categories, and

so on. A category is a class or a division and there is an inexhaustive set of classes among which all things may be distributed. It is an a priori concept applied by the mind to sense impressions, and finally it is any relatively fundamental philosophical concept (Oxford English Dictionary, 1995). When the Mind-Map structure is used, each category is a subtheme of the overall theme. Themes and subthemes are categories of information, and can also be represented linearly.

However, the multidimensionality of the Mind-Map structure allows for the multiordinate nature of concepts to be represented in a way which cannot be represented monochromatically. Therefore, because categories are an exhaustive set of classes, they are multiordinate and will combine to form the total picture. This wholistic nature of categories can more effectively be represented on the Mind-Map structure than linearly.

A category represents a cluster of meaningfully associated concepts and as such, represents the ability to think deductively - that is, from the general idea to the specific detail. Pribram (1971) indicates that meaning is extracted by first identifying the wholistic pattern, and then filling in the details.

By utilising the Mind-Map structure, which is based on this principle, concepts have to be grouped into categories. Furthermore, the associative arrangement has to be such that the details also build up to the whole, which represents inductive reasoning. Therefore in categorising information, analogical reasoning, inferring, judging, and establishing cause/effect relationships, the problem-solving process is invoked.

2.5.2.4. Visualisation

Visualisation is a natural but subconscious facet of the human mind (Kline, 1990). As an element of cognitive thought it was first explored by Arnheim (1956, in Kline, 1990), who argues that for every thought, a corresponding visual image is formed which can be expressed in a symbolic format. According to Arnheim (1956, in Kline, 1988) over 10 per cent of the brain is devoted to processing visual data. It is therefore much easier to recognise something than to recall it. The MMA capitalises on this natural ability of the brain due to its visual nature, expressed in the structure of the Mind-Map, the use of colour, images, and dimension, and the activation of all the senses in both the input and output stages.

Kline (1990) argues that a large part of intelligence is the activation of the visual thinking process, and that this process operates at a non-conscious level, but is largely underutilised. It is postulated that the visualisation process is controlled by dynamic self-regulation which, as discussed previously, is largely neglected in current educational practices. The MMA allows the activation of dynamic self-regulation through its visual nature, enhancing the development of intelligence. Kline (1990: 245) states that “the secret of bringing your visual thinking usefully to life is to cultivate Mind-Mapping, representing each idea not just with a word, but also with a visual image. The practise this gives you could increase your intelligence, your sanity, and your sense of purpose”.

The mind can store pictures and retain them in memory better than words. Making use of pictures, images and symbols is therefore a requisite on the Mind-Map. Howe and Godfrey (1977, in Russell, 1986) compared the review value of Mind-Maps using shape, colour, boxes, and different lettering with ordinary prose notes, and found that recall improved 50% by using Mind-Maps. Specific ways of making the Mind-Map more visual include the following:

- ❑ Each word should be printed as opposed to using script as this gives a clearer visual image (Buzan, 1991; Russell, 1986). According to Russell (1986), lower case is preferable as it is more easily read and provides better shape recognition. Capitals should be used for main themes and categories to emphasise their importance.
- ❑ Each concept needs to be written on its own line, and each line should be joined to the succeeding line in order to give structure to the pattern, as well as to trace the deductive/inductive associations - the analogical flow. In this way the multiordinate nature of words is allowed to flow. Writing words in bubbles is less flexible and creates networks that tend to close in on themselves, making additions difficult. In conventional linear notes, spontaneous associations have to be held over until the place where they are relevant is reached, and by then the idea may have been forgotten. Because the Mind-Map expands in all directions, associations can be included as soon as they arise. “Thus the Mind-Map is an excellent interface between the brain and the spoken word” (Russell, 1986: 79). On the other hand, words on linking lines lead to topographic inhibition (Cook, 1984), as well as spreading activation (Anderson, 1986, in Springer and Deutsch, 1989).
- ❑ By using colour on the Mind-Map, the synergistic processing of the left and right hemispheres is encouraged (Springer & Deutsch, 1989). In addition colour emphasises

something as important. The more active the impression of what is being learned, the stronger the memory trace (Hand, 1986). According to Hand (1986) the spike of electrical activity in the brain increases markedly with things that are outstanding. This serves as a signal to the hippocampus and hypothalamus to produce increased levels of neurochemicals related to memory formation (Hand & Stein, 1986). The use of colour allows discrimination in the right visual cortex and activates memory.

- The Mind-Maps can be given depth by making the categories into three-dimensional shapes, providing the Mind-Map with a more solid visual structure. Arrows can also be used effectively to link and associate different areas in the pattern, contributing to the gestalt. Categories can be outlined or shaded to hold them together as a unit.

2.5.2.5. Conspicuousness

A concept that is outstanding and unique, and therefore conspicuous, is better retained in memory (Buzan, 1991; Russell, 1986; Margulies, 1991; Howe et al., 1977). In Mind-Maps, each centre is unique even though it is associated with other centres and concepts. The uniqueness is in the use of the different concepts each on their own line, different colours and different shapes - all the aspects discussed under visualisation. Wherever parts of the pattern stand out, they will lead to better recall.

2.5.3. THE MULTIMODAL TECHNIQUES OF THE MMA

The multimodal techniques of the MMA include the use of music, relaxation techniques, imagery and multiple sensory stimulation.

2.5.3.1. Music

Music is a powerful force in life and in learning (Amend, 1989). Evidence of its potency are its ritual, religious and therapeutic roles in human lives since the beginning of culture. As it is beyond the scope of this chapter to enter into an in-depth discussion of the merits of various musical forms dominant in cultures, a brief scientific analysis of the merits of this powerful medium for learning purposes will follow.

According to Amend (1989), music is dual-planned: on one plane are the basic elements which affect us physiologically, on the other plane are the compositional characteristics and structures which reflect and express the values of a culture (Amend, 1989). It may be the response to these multiple levels which makes music a powerful learning tool.

The use of music can be active or passive (Bancroft, 1985). Active methods are more creative and involve singing, playing of instruments. Passive methods involve the active process of listening as opposed to participation in the music making process, and are more suitable for therapeutic and pedagogical purposes (Bancroft, 1985). In the MMA the passive approach of listening to music is utilised because it has been proven that listening to music facilitates learning and makes it more pleasurable (Lozanov, 1978; Bancroft, 1985; Amend, 1989; Leaf, 1990; Wenger, 1985; Botha, 1985; Halpern & Savary, 1985).

Music facilitates learning because rhythm has measurable physiological effects on the body, specifically respiration, heart rate and pulse (Bancroft, 1985; Amend, 1989). Harmony, instrumentation and melody produce psychological effects on mood and personality (Bancroft, 1985). Music, specifically Baroque and classical styles, affects the electrical activity in the brain, accelerating the rate of learning (Hand, 1986). It does so by altering the alpha and beta cycles of the electrical wave forms of the brain to become complementary to each other (Lozanov & Gateva, 1989). This results in the activation of neurons, which relaxes muscle tension, changes pulse and produces long-term memories, which are directly related to the number of neurons activated in the experience (Hand, 1986; Hand & Stein, 1986; Leaf et al., 1993). Music relaxes major portions of the brain so that those that are active encounter little interference from other portions.

Music also assists in decreasing tension and therefore in relaxing a learner, thus improving concentration (Halpern & Savary, 1985; Hand, 1986). The purpose of using music in the MMA is therefore to increase the rate of learning, as well as to make the learning experience authentic and enjoyable. Most importantly, music appeals to the multimodal nature of the brain as music functions on a dual plane.

2.5.3.2. Relaxation techniques

Relaxation techniques are used in the MMA because they have been found to have a positive effect on learning and cognitive performance. Relaxation facilitates learning because it enhances synergistic processing between the hemispheres (Lozanov, 1978; Dhority, 1991; Larson & Starrin, 1988). The current research suggests that relaxation training may affect certain functional abilities of the left and right cerebral hemispheres. Lozanov (1978), Dhority (1991) and Hart (1986) indicate that relaxation facilitates complementary alpha/beta rhythms across both hemispheres, as well as impacting on the limbic system, and therefore is important

for learning and memory. According to Larson and Starrin (1988), research on relaxation indicates with reasonable certainty that relaxation training enhances and more fully utilises the potential activities dominant in the right hemisphere. This is done in a way that is complementary to the functioning of the left hemisphere, enhancing a synergy process between both hemispheres.

Setterlind (1983, in Larson & Starrin, 1988) conducted an extensive research overview of relaxation studies and concluded that all the various different relaxation techniques lead to similar physiological, psychological and behavioural results. No method appears to be universally superior and techniques chosen should be left to the individual. For this reason, the MMA provides the principles of relaxation and suggests, but does not specify, exercises. The MMA does however recommend the use of music during relaxation to enhance the multimodal process.

2.5.3.3. Mnemonics

Mnemonics and imagery play an important role in the MMA because they appeal to the cortex, subcortex and limbic system across both hemispheres and are therefore multimodal components (Hand, 1986; Nelson, 1988; Wark, 1986). According to Nelson (1988), the effects that thinking imagistically has on the body and mind include immune activity, memory, emotional regulation and states of consciousness. Pictures and graphic images in a text have been proven to improve learning (Alesandrini, 1982; Leaf, 1990).

According to Haber (1981), the use of pictures and images makes learning easier because they are organised automatically at the neural level. He extends Miller's (1956) notion of chunking for recall from the verbal to the visual modality, indicating that visual chunking occurs automatically because the human visual system has evolved to perceive holistic scenes. Nelson (1988) argues that imagery enhances the learning process because the limbic system is the mediator of imagery, and thus activates existing descriptive systems, and connects existing somatic responses to emotions. According to Pribram (1971), the limbic system regulates imagery as well as motivation, intuition, attention and memory. The implication is that imagery is linked to the emotional level, and using imagery will activate the limbic system, which will facilitate motivation, intuition, attention and memory, and hence the learning process. Therefore the use of images and imagery systems (mnemonics) will enhance the learning process as

imagery enables the learner to grasp the overall picture, and then to come back and fill in the details.

A critical variable in using images and mnemonics is the relevance of the illustration to the text. In other words, the image must illustrate the relation between concepts, as already discussed under the conceptual nature of the MMA. According to Arnheim (1979) illustrations need to show relations to be maximally effective.

Another variable requiring consideration is the concreteness of the image selected. On a concrete to abstract continuum, the more concrete the word, the more it aids memory (Jorgenson & Kintsch, 1973; Wark, 1986). Finally, it has been proven that self-generated images are more effective than images provided for students to use (Wark, 1986). However, the process is not automatic. Lutz and Rigney (1977) and Leaf (1990) found that assistance is required in creating images with increasingly complex technical information. It was also found that increasing proficiency with Mind-Mapping improved the ability to generate images (Leaf, 1990).

The use of imagery as a symbolic drawing, or as a mnemonic image, enhances comprehension and learning, and as such, is an important requisite of the MMA.

2.5.3.4. Multiple sensory input

Multiple sensory input is an extension of the imagery-limbic model discussed above because the most effective way to enhance the effect of imagery is to involve all the senses (Machado, 1986). The three keys in making imagery most responsive to limbic system activity are rhythm, movement, and emotions in imagery instructions (Nelson, 1988). Therefore seeing as well as hearing, feeling, touching, moving, smelling, and tasting should all be included in the imagery development at both the input and output stages of the MMA, contributing to its multimodal nature.

Furthermore multisensory approaches such as the MMA ensure more complete conceptual learning because they focus directly on those features which relate to the essentials of concept formation (Caskey, 1986). Multisensory input also enhances transfer of knowledge to other contexts, and provides opportunities for varied individual learning styles.

In conclusion, the multimodal nature of the MMA is compatible with the natural neuro-psychological laws of functioning of the brain, facilitating in the creation of a geodesic approach.

2.6. CONCLUSION

An examination of the nature of the MMA and the Mind-Map reveals their geodesic and hence brain-compatible nature. The MMA accomplishes this wholistic or geodesic objective because it provides a framework which allows material to be learned in a high-input, multi-sensorial and global way as opposed to the traditional linear, logical doses. The environment created by the MMA framework is filled with a rich array of stimuli in a relaxed inviting setting from which students can begin forming patterns in order to reconceptualise new knowledge. The multimodal design of the MMA facilitates recall because all the various multisensory factors that enhance recall have been brought together to produce a much more effective system of activating and representing thought patterns.

The multimodal factors enhancing information processing and memory on the Mind-Map specifically, are organisation, association, categorisation, visualisation, and conspicuousness. The additional multimodal factors of the MMA as a total system, enhancing information processing and memory and the thinking process in general, include the use of music, mnemonics, relaxation techniques and multiple sensory input.

Therefore, it can be concluded that the MMA fulfils the requirements of being geodesic and as such, provides an alternative approach within the geodesic movement to the facilitation of learning. In order to examine the philosophy of the MMA, the next chapter examines the assumptions upon which the theoretical model of the MMA is based. This in turn provides a strong theoretical base for the application of the Mind-Mapping Approach.

2.7. SUMMARY

In this chapter, the geodesic nature of the MMA and its “tool”, the Mind-Map, is investigated. This is done by the development of a theoretical model - the geodesic information processing model. It is postulated that this model reflects the processing of information as invoked by the MMA. This theoretical model also serves as a foundation for the expansion of the concept of the Mind-Map, allowing it to be redefined. Furthermore, it provides a theoretical base for the geodesic approach of the MMA. The conceptual and multimodal nature of the MMA and its “tool” the Mind-Map are also examined in order to demonstrate how they fulfill the requirements of being geodesic.

**IF THE HUMAN BRAIN WERE SO SIMPLE
THAT WE COULD UNDERSTAND IT,
WE WOULD BE SO SIMPLE
THAT WE COULDN'T**

Author unknown