LEAF, CAROLINE MARY

THE MIND-MAPPING APPROACH: A MODEL AND FRAME WORK FOR GEODESIC LEARNING

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THE MIND-MAPPING APPROACH:

A MODEL AND FRAMEWORK FOR GEODESIC LEARNING

BY
CAROLINE MARY LEAF

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This thesis is dedicated to ...

my husband Mac,

and my children

Jessica, Dominique and Jeffrey

for more love, support and inspiration

than can be measured.

This thesis is also dedicated to

discovering the gift of potential in every person.

In a gentle way you can shake the world.

Ghandi

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ABSTRACT

TITLE:	The Mind-Mapping Approach: A Model and Framework for Geodesic Learning
NAME:	Caroline Leaf
PROMOTER:	Prof. I.C. Uys
CO-PROMOTER:	Prof. B. Louw
DEPARTMENT:	Communication Pathology
DEGREE:	D. Phil.

The current study identifies the reasons why change in traditional perceptions of learning is needed by tracing the philosophies of traditional methods and their effect on the perception of learning, and proposes an alternative geodesic approach, the Mind-Mapping Approach (MMA). Inherent in the model is the implication that traditional methods do not facilitate effective holistic thinking and as a result, do not produce effective lifelong learners. Extrapolated from the MMA model and its assumptions, is a practical framework, the MMA, that, when implemented within learning environments, will foster geodesic thinking which is in natural compliance with the functioning of the brain and therefore to be preferred.

The study tested the validity of the above assumption by providing training in an alternative geodesic approach, the MMA, to a group of 45 teachers and therapists that work with learning disabled pupils - this comprised the first experiment of this study. The teachers and therapists in turn used the MMA methods with their pupils (639) - this comprised the second experiment of the study. In this way both the MMA as a geodesic framework, and the actual effectiveness of the MMA training programme in conveying geodesic principles, were evaluated.

The results indicated that although significant benefit was derived by the teachers and therapists from the MMA training, these were conservative. Furthermore, the overall longitudinal trends of the pupils' results also indicated that a significant positive change was experienced by the pupils with the introduction of the MMA methods, but not to the extent predicted. It is speculated that this conservative, although significantly positive improvement

in the teachers, therapists and pupils is attributed to the fact that the MMA methods are geodesic facilitating improved thinking, problem-solving and research skills, and innovative learning. However traditional methods of teacher training, testing and evaluating do not facilitate these skills as their emphasis is on the accrual as opposed to creation of facts. It is possible therefore that the conservatively positive results of this study reflect the "carry-over" effect of geodesic training. It can be said that the partial application of the MMA methods by the teachers and therapists did improve the performance of the pupils and that this study was therefore successful, but that the results would have been more positive had the pupils been evaluated in a way that matched the geodesic training. In addition, the study provides valuable information regarding the effect of geodesic systems on traditional systems of learning.

OPSOMMING

TITLE:	Die Breinkaartbenadering: 'n Model en Raamwerk vir Geodetiese Leer
NAAM:	Caroline Leaf
PROMOTOR:	Prof. I.C. Uys
MEDEPROMOTOR:	Prof. B. Louw
DEPARTEMENT:	Kommunikasiepatologie
GRAAD:	D. Phil.

Hierdie studie identifiseer die redes vir die noodsaaklikheid om tradisionele leerpersepsies te verander deur die filosofiee van tradisionele metodes en hul effek op die leerpersepsie na te gaan, en dit stel 'n alternatiewe geodetiese benadering voor, bekend as die breinkaartbenadering (BKB) (Engels: mind-mapping approach (MMA)). Inherent in die model is die implikasie dat tradisionele metodes nie doeltreffend holistiese denke voorthelp nie, en gevolglik nie doeltreffende lewenslange leerlinge voortbring nie. 'n Praktiese raamwerk word uit die BKB-model en sy aannames ekstrapoleer, nl die BKB wat, wanneer dit binne leeromgewings geimplementeer word, geodetiese denke sal bevorder wat in natuurlike voldoening is met die funksionering van die brein en derhalwe verkieslik is.

Die studie het die geldigheid van die bogenoemde aanname getoets deur opleiding in 'n alternatiewe geodetiese benadering, die BKB, te verskaf aan 'n groep vna 45 onderwysers en terapeute wat met leergestremde leerlinge werk. Dit het die eerste eksperiment van die studie uitgemaak. Die onderwysers en terapeute het op hul beurt die BKB-metodes met hul leerlinge (639) gebruik, wat die tweede eksperiment van die studie uitgemaak het. Sodoende is beide die BKB as 'n geodetiese raamwerk en die eintlike doeltreffendheid van die BKB-opleidingsprogram in die oordra van geodetiese beginsels geevalueer.

Die resultate het aangedui dat, alhoewel onderwysers en terapeute beduidend baat gevind het by die BKB-opleiding, dit konserwatief was. Verder het die langstendense van die leerlinge se resultate ook aangedui dat 'n noemenswaardige positiewe verandering deur leerlinge

ervaar is met die invoering van die BKB-metodes, maar nie in die mate wat voorspel is nie. Daar word bereken dat die konserwatiewe, alhoewel aansienlik positiewe verbetering in die onderwysers, terapeute en leerlinge toeskryfbaar is aan die feit dat die BKB-metodes geodeties is, wat verbeterde denke, probleemoplossing en navorsingsvaardighede, sowel as innoverende leer moontlik maak. Tradisionele leer-, opleidings-, toets- en evalueringsmetodes fasiliteer egter nie hierdie vaardighede nie, aangesien die klem op die memorisering van feite val. Dit is dus moontlik dat die konserwatief positiewe resultate van hierdie studie die “oordra”-effek van geodetiese opleiding weerspieel. Daar kan gese word dat die gedeeltelike toepassing van die BKB-metodes deur onderwysers en terapeute die prestasie van die leerlinge verbeter het, en dat die studie dus suksesvol was, maar so ‘n manier geevalueer kon word wat die geodetiese opleiding geewenaar het. Die studie verskaf ook waardevolle inligting rakende die effek van geodetiese stelsels op tradisionele stelsels.

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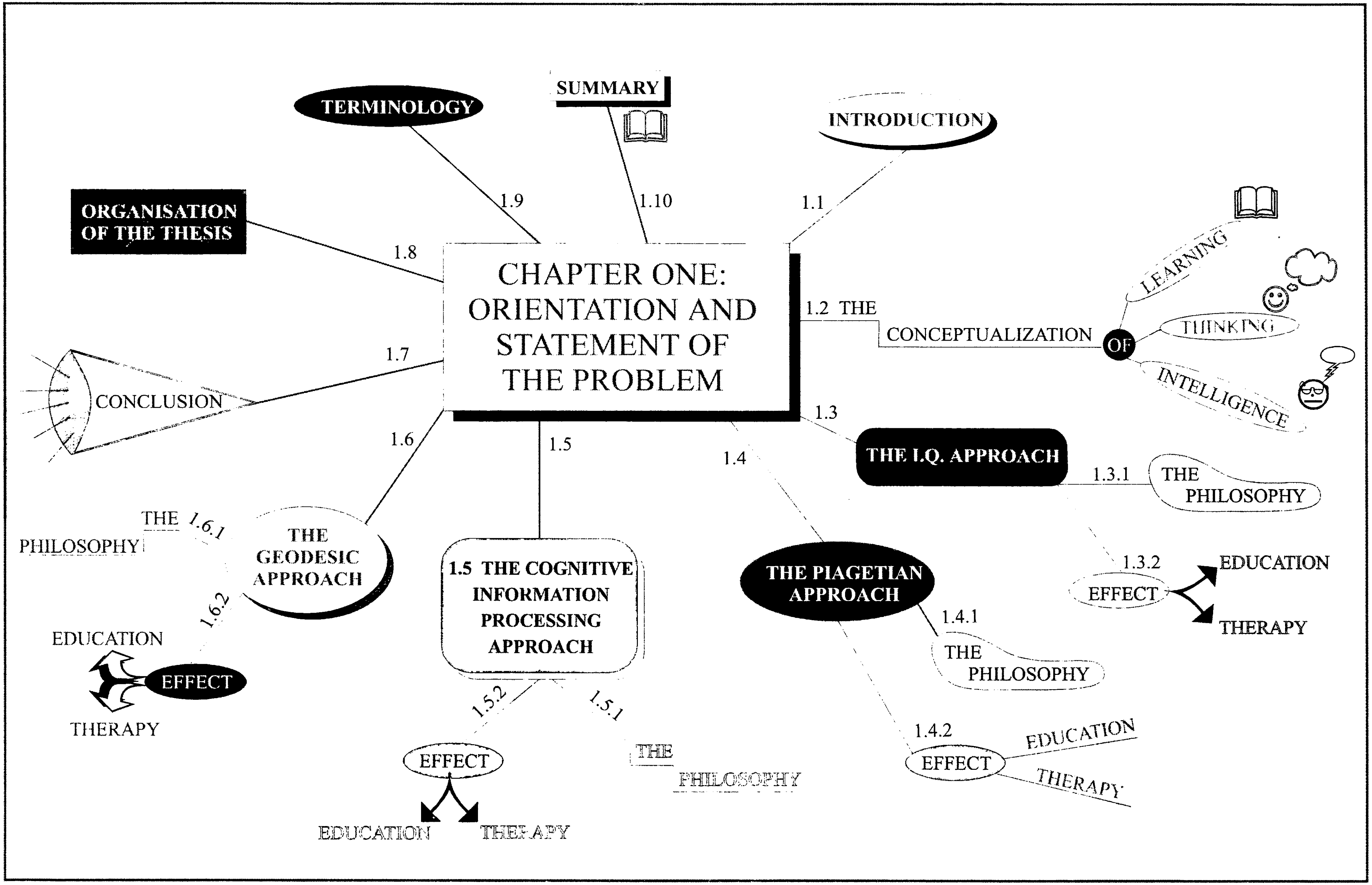

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CHAPTER ONE : ORIENTATION AND STATEMENT OF THE PROBLEM

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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 cognitists. 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 synonomously 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).

Corel → 1-FIG 11.cdr

IQ APPROACH

PHILOSOPHY

- Focus on end-product
- Predictive of school success
- Learning conscious and sequential
- Empirical
- Unrelated linguistic & mathematical tasks used to rank individual

EFFECT EDUCATION & THERAPY

- Literal / rote learners
- Incremental internalization
- "Teacher tell, pupil listen" paradigm
- Emphasis logical / linguistic thinking
- Emphasis on factual content
- Motivational problems
- Match static student to static system

PIAGETIAN APPROACH

PHILOSOPHY

- Process orientation
- Developmental cognitive stages
- Problem solving

EFFECT EDUCATION & THERAPY

- Influence material selected in syllabi and therapy = limiting
- Logical / linguistic tasks
- Motivational problems
- Incremental internalization
- Literal/rote learners

INFORMATION PROCESSING APPROACH

1960 - 1980's

PHILOSOPHY

- No room for non-conscious
- Microgenetic steps involved in problem-solving tasks
- Learning active and sequential and conscious
- Mechanistic
- Computer analogy
- General problem solving skills
- Central executive
- Limited short term memory
- Tote units

EFFECT EDUCATION & THERAPY

- Simple facts mastered before complex
- Emphasis logical linguistic thinking
- Incremental internalisation
- Learning result effortful sequential conscious
- Motivational problems
- Literal/rote learners
- Attention - slow, hierarchichal thinking

THE GEODESIC APPROACH

1980'S - 1990's

PHILOSOPHY

- Focus on symbolic vehicles of thought
- Biologically based on how brain functions - brain-compatible
- Considers 90% of learning to occur on non-conscious level
- Multisource self-regulation theory
- Learning is the reconceptualization of knowledge
- Cognitive-emotive link
- Authentic environments
- Multimodal
- Focus on process vs product

EFFECT EDUCATION & THERAPY

- Multimodal stimulation
- Organised study methodology
- Can allocate & delegate attention
- Self motivated & self regulated
- High achievers
- Teacher & therapist = facilitators
- "how" & "why" about concepts more important than accruing "what"
- Adaptive learners - can learn well in different contexts
- Deep processing of knowledge on conceptual level
- Learning enjoyable and easy - "learn like a child"

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

DEVELOPED BY: C. LEAF

NOTE: SOURCES IN TEXT

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) "décalage" 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 fuction 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.

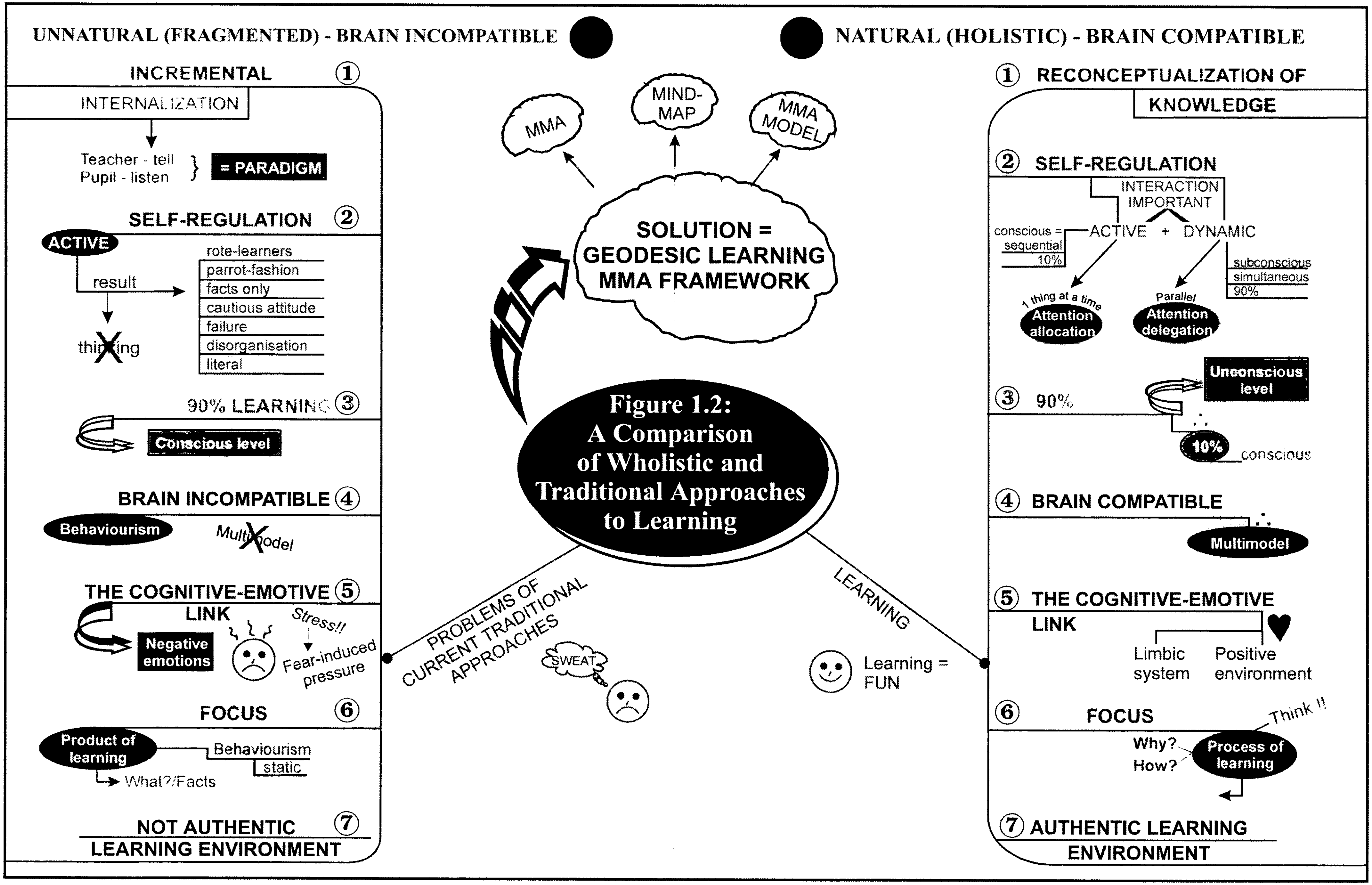
Hence, an environment that is created to follow the natural neuropsychological functioning of the brain could be considered geodesic. The differences between a traditional unnatural approach and a non-traditional natural approach to education and therapy are emphasised when compared visually (see Figure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



1-FIG12.CDR

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; Dhority, 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:**

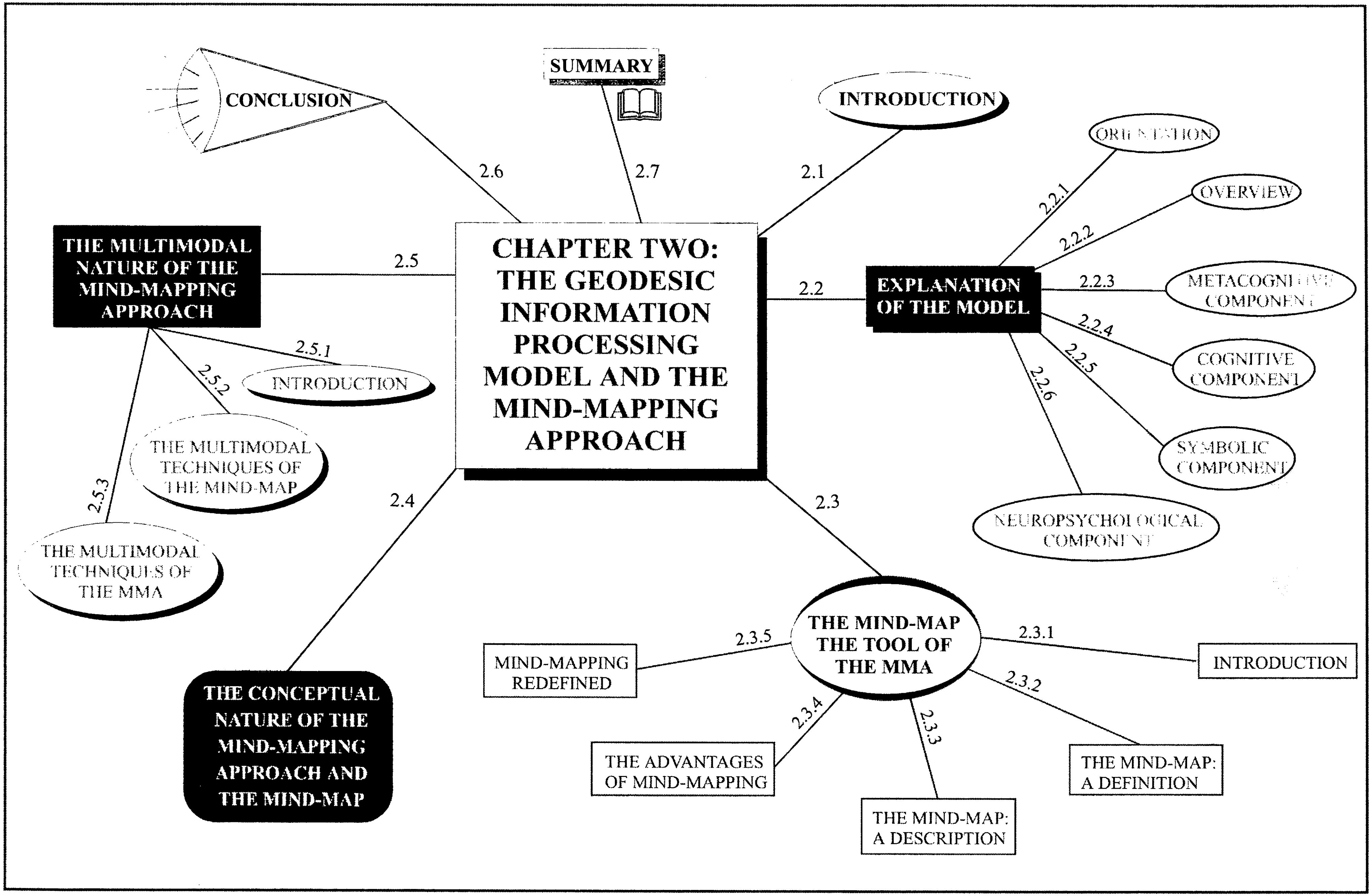
Learning is the creative reconceptualisation of internal knowledge controlled by active and dynamic self-regulation (Iran-Nejad, 1990). It has a quality of personal involvement; it is self-initiated; it is pervasive; it is evaluated by the learner; its essence is meaning (Rogers, 1969). All learning 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)



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

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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 Suggestopeadia; 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

Fig 2.1

A3.

The geodesic information processing model as invoked by the Mind-Mapping Approach 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.

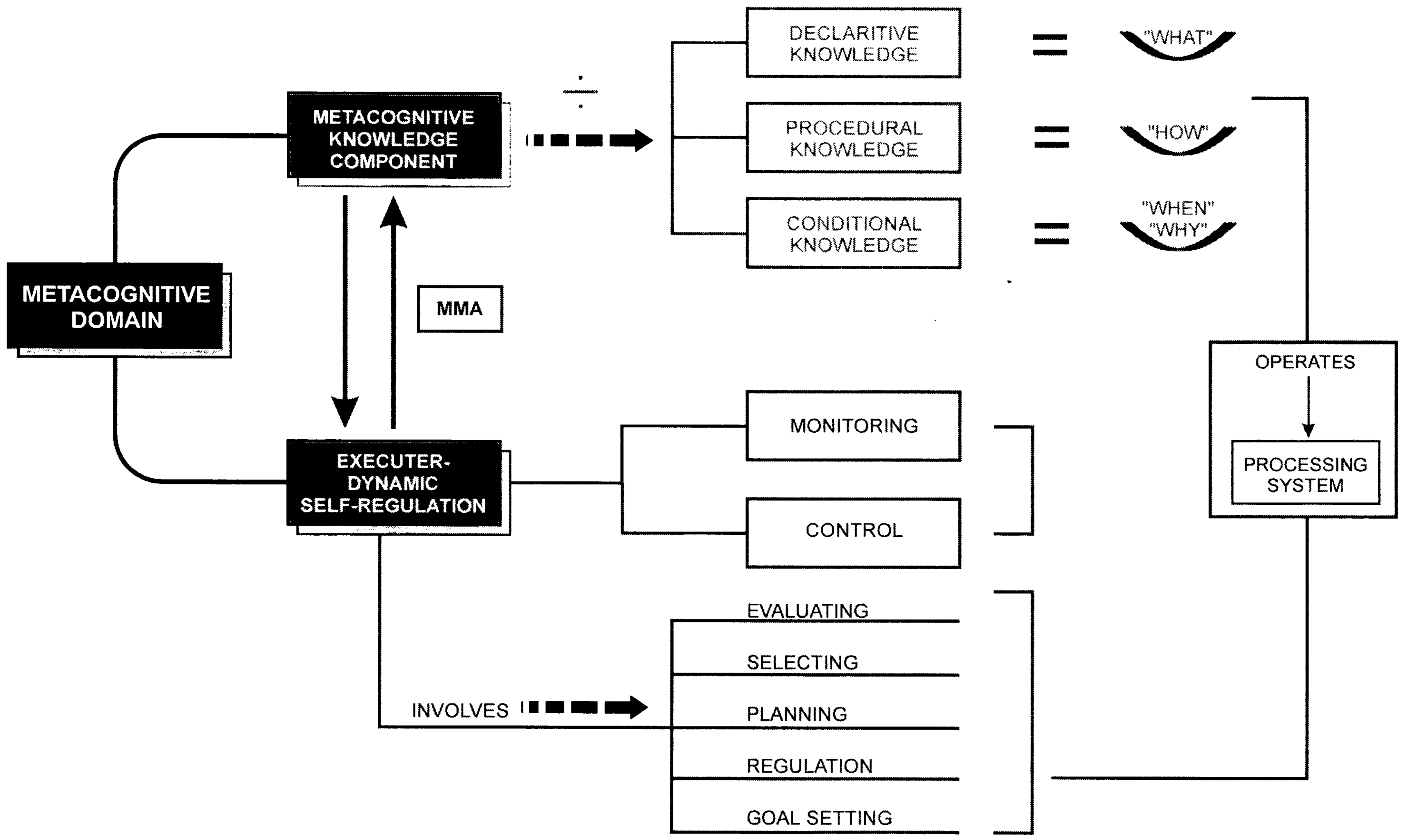

Figure 2.2: The Metacognitive Domain

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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-consious 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 completive 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;

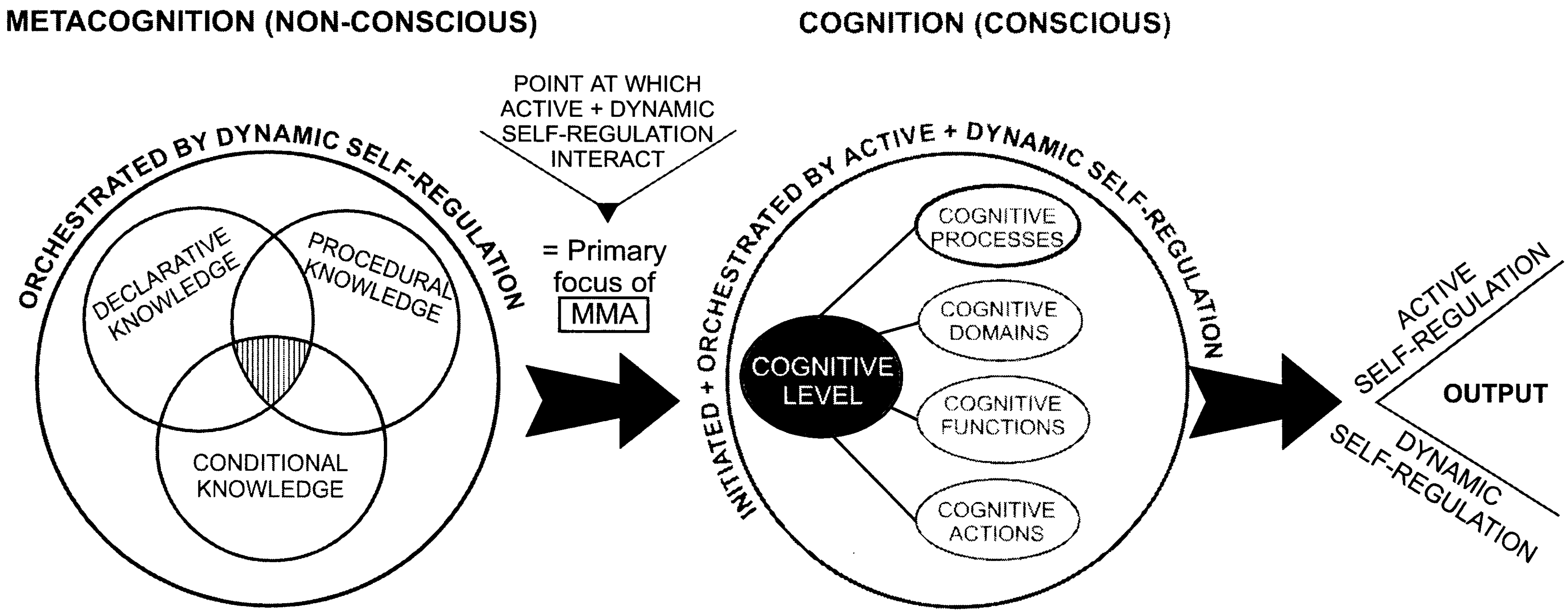

Figure 2.3: The Interaction between Active and Dynamic Self-Regulation

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- 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.

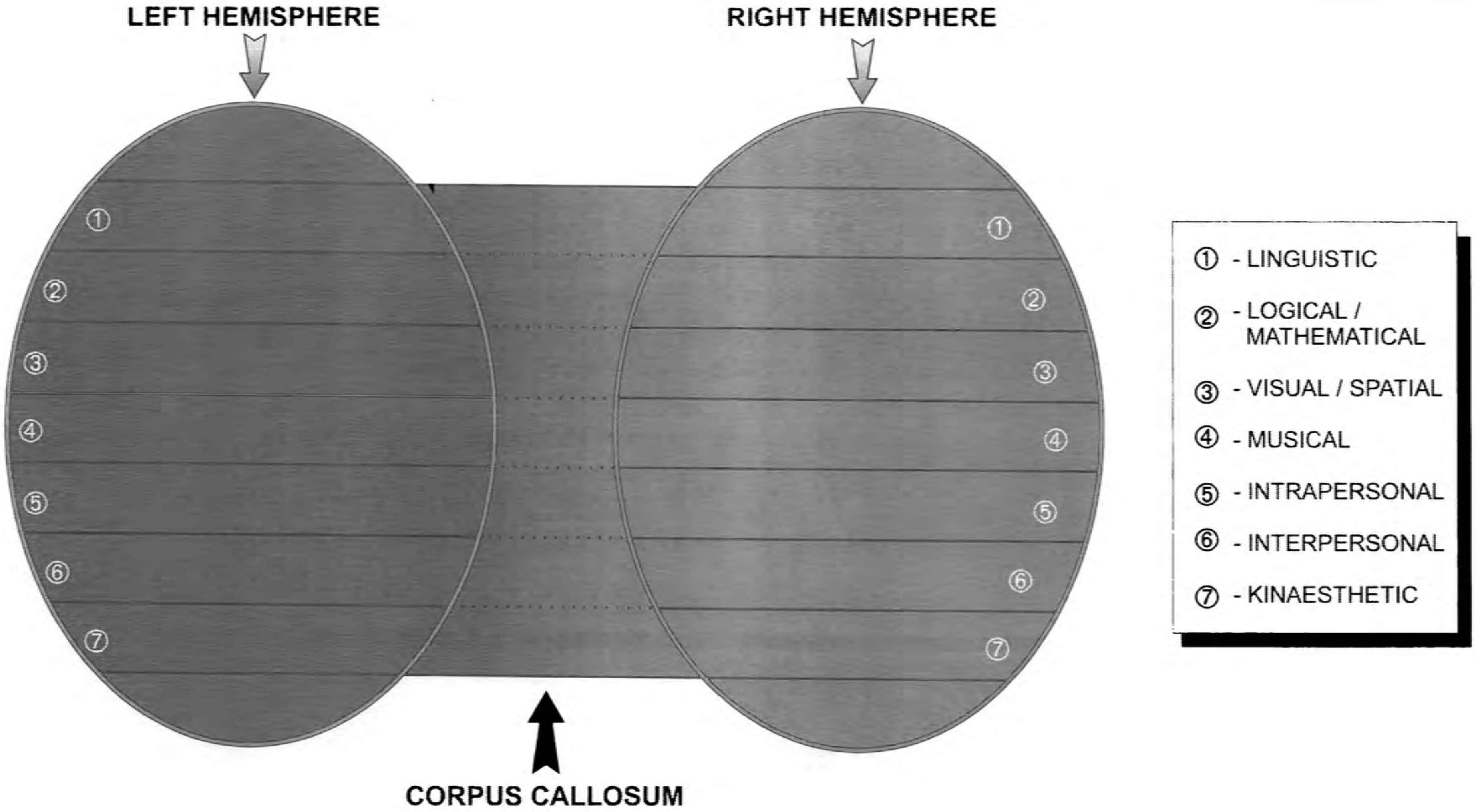

Figure 2.4: A Schematic Representation of the Neurobiological Arrangements of the Metacognitive Modules

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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 synonomously, 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 concommitant 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 catgorisations 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 kinaesthesis 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 representive 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-planed: 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 the 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 fullfill 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

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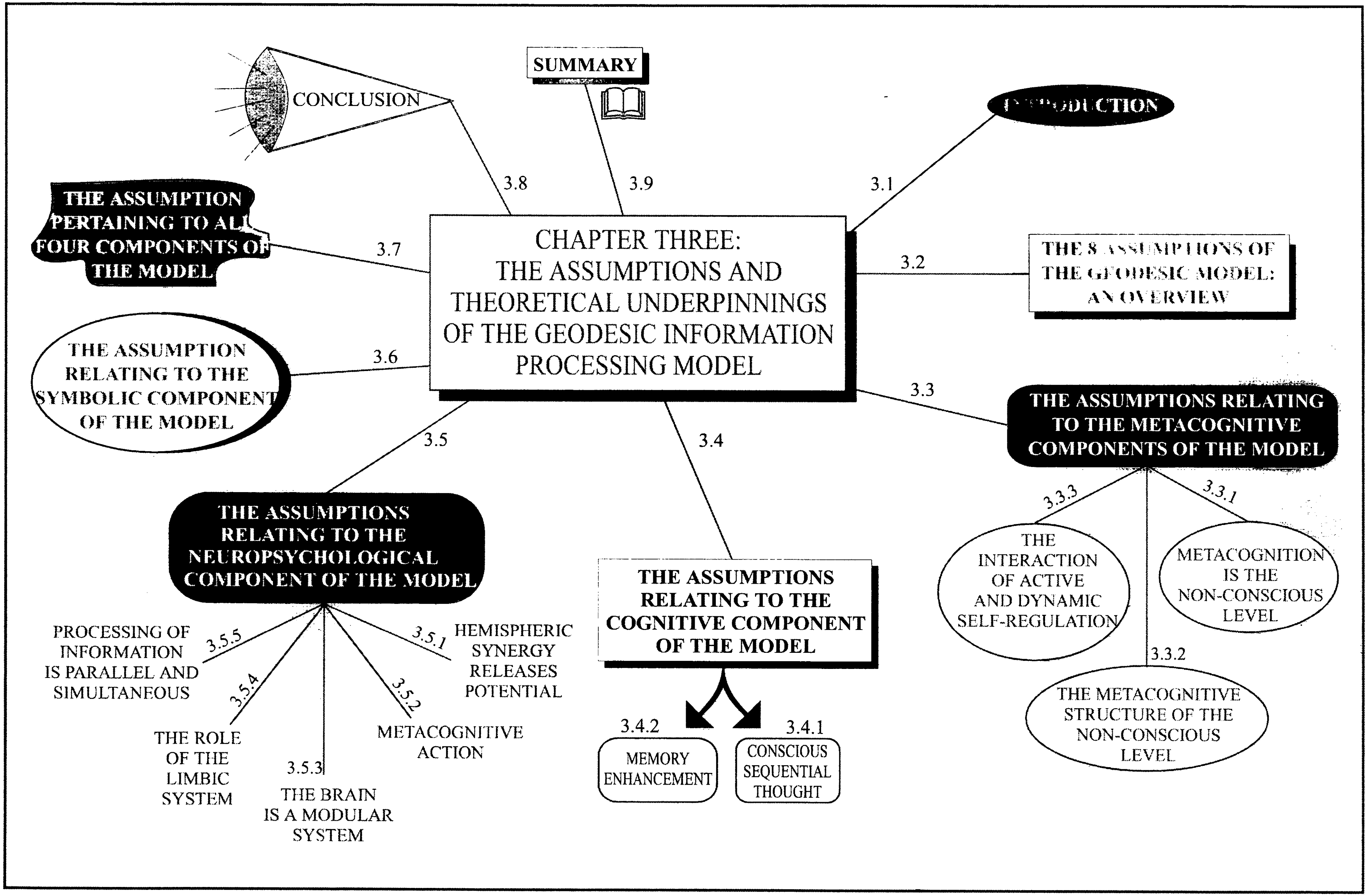

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3.1. INTRODUCTION

In order to facilitate the development of innovative life-long learners with effective communication skills, alternative approaches to the perception of learning and the development of human potential are needed. It has been proposed in the foregoing discussions that geodesic frameworks such as the MMA invoke the ability to process information more effectively than traditional behaviouristic and cognitive frameworks and hence the better realisation of potential. This more efficient thought processing is illustrated in the information processing model (see Figure 2.1). There are various assumptions upon which this model is based. It is the objective of this chapter to examine these assumptions and their theoretical underpinnings, as they lead to a redefinition of the non-conscious level, metacognition, cognition and learning. These redefinitions are pivotal in the explanation of the effectiveness of a geodesic approach to intervention and education. In what follows the eight assumptions of the model are briefly outlined and then each is discussed in detail.

3.2 THE EIGHT ASSUMPTIONS OF THE GEODESIC MODEL: AN OVERVIEW

There are eight assumptions underlying the geodesic information processing model (see Figure 2.1 and Table 3.1). The first of these assumptions deals with the metacognitive component of the model. It is assumed that metacognition is the root of the thought process controlling the cognitive process and ultimately the symbolic output. Furthermore, the key to unlocking intellectual potential occurs when the metacognitive level is activated effectively. It is postulated that traditional approaches, which are not geodesic, do not take full advantage of the metacognitive potential of the brain, and that the full spectrum of metacognition is thus overlooked. Within a geodesic approach such as the MMA, it is assumed that the metacognitive level is more adequately activated.

The second assumption postulates that metacognition is the non-conscious level. This implies that the majority of complex higher cortical functioning and learning occurs outside conscious awareness (Reddy, 1979, in Iran-Nejad, 1990; Derry, 1990). The way that metacognition is conceptualised within the geodesic information processing model provides a structure for understanding and analysing the non-conscious level.

The third assumption deals with the concept of self-regulation and relates to the metacognitive and cognitive components of the geodesic information processing model. Traditionally, this is the conscious executive control of thought which forms part of the definition of metacognition (Costa, 1984; Harrison, 1993). According to Slife, Weiss and Bell (1985), self-regulation refers to the planning, monitoring and checking activities necessary to orchestrate cognition. Iran-Nejad (1990) however, argues that this type of self-regulation, termed active self-regulation, is only part of the self-regulation process, accounting for the learning of a functional knowledge base. Over-reliance on this active self-regulation results in rote learners and reduces learning potential (Iran-Nejad, 1990). It is proposed that an additional form of self-regulation, termed dynamic self-regulation, is required to overcome the inherent limitations of active self-regulation (Iran-Nejad & Chissom, 1988). Dynamic self-regulation is rapid, spontaneous, multimodal and co-ordinates the simultaneous as opposed to the sequential aspects of the learning process (Iran-Nejad & Chissom, 1988; Iran-Nejad, 1990). It is the interaction of these two types of self-regulation that will lead to more effective learning (Iran-Nejad, 1990, 1991). Within the geodesic information processing model, the interaction of the two types of self-regulation is viewed as the operating system of effective thought processing. This interaction triggers metacognitive action (see Figure 2.1).

The fourth assumption deals with the cognitive component, which is responsible for the conscious sequential aspect of learning. The activation of the cognitive process is reliant on its interaction with metacognition. This in turn is orchestrated by the interaction of active and dynamic self-regulation. Therefore, according to the geodesic information processing model, the conscious awareness, or the "thinking about thinking" aspect of the thought process is a more advanced level of cognition and not metacognition, as described in traditional definitions.

The fifth assumption, also dealing with the cognitive component, is that memory enhancement is part of the cognitive process. Therefore, although memory is stored on the non-conscious metacognitive level, the actual enhancing of the memory process is facilitated by various techniques that are consciously created on the cognitive level and expressed on the symbolic level.

The sixth assumption of the geodesic information processing model is concerned with the neuropsychological component (see Figure 2.1). Research has indicated that the most effective way of releasing the potential of the brain is through stimulating a synergistic wholistic and complementary pattern of processing between the two hemispheres (Sperry, 1961, in Zaidel, 1981; Ornstein, 1975; Levy, 1985; Springer & Deutsch, 1989). This will allow the natural, wholistic pattern-discrimination ability of the brain to function. Pribram (1971) argues that the brain extracts meaning through wholistic multisource pattern discrimination rather than through single facts or lists. The human brain is not designed for linear unimodal thought, but operates by simultaneously going down many paths (Hart, 1983). Hart (1983) stresses the importance of presenting and assimilating information in larger patterns before the details. Thus, a geodesic framework will need to utilise formats of presenting and assimilating information that allow synergistic multimodal pattern discrimination to occur. The techniques of the MMA, specifically the Mind-Map, are assumed to stimulate multisource pattern discrimination that is brain-compatible (Leaf, 1990; Leaf et al., 1993).

The seventh assumption of the geodesic information processing model deals with the symbolic component (see Figure 2.1). The symbolic component is the expression of the metacognitive action, which is operationalised through the cognitive process. The symbolic component deals with the capacity of human beings to express and communicate meanings through using some symbolic vehicle (Allport, 1980). It is assumed that the symbolic component reflects the thought processing of the person, and is the medium through which the thought process can be manipulated.

The eighth assumption, relating to all four components of the geodesic information processing model, indicates that intelligent learning is the result of the reconceptualisation of knowledge (Iran-Nejad, 1990). The reconceptualisation of knowledge is the end result of the thought process invoked by a geodesic framework such as the MMA. This is in contrast to traditional perceptions of learning which view learning as the incremental internalisation of external knowledge (Reddy, 1979, in Iran-Nejad, 1990; Samples, 1975; Costa, 1984). This latter definition cannot account for the complex creative process involved in intelligent learning and limits learning to the development of a factual knowledge base.

In the ensuing discussion, each of the eight assumptions and their theoretical underpinnings will be explored (see Table 3.1). The assumptions are examined under each of the components of

Table 3.1: The assumptions and theoretical underpinnings of the Geodesic Information Processing Model

LEVEL	ASSUMPTIONS	THEORETICAL UNDERPINNINGS
METACOGNITION	1. Metacognition is the non-conscious level that accounts for the bulk of learning 2. The metacognitive structure of the non-conscious: (1) Metacognitive modules (2) Metacognitive processing systems (3) Metacognitive domains 3. The interaction of active and dynamic self-regulation is the operating system of effective thought processing.	– Automaticity research – Multi-source self-regulation theory – Modular theory – Suggestopeadia – Multiple intelligence theory – Lurian theory – Metacognitive research – Descriptive system theory
COGNITION	4. The cognitive component is the level on which conscious sequential thought occurs. 5. Memory enhancement, as part of the cognitive process, is contextual and content based specific to each module.	– Self-regulation theory – Cognitive research – Taxon and local memory – Memory enhancement research
NEURO-PSYCHOLOGICAL	6.1 Synergy between the hemispheres releases potential. 6.2 Metacognitive results in the activation of descriptive systems through the process of pattern recognition and feedback creating open systems. 6.3 The brain is a modular system of interlinked functional systems. 6.4 The limbic system needs to be activated in order to reconceptualize useful knowledge. 6.5 The processing of information occurs in a parallel simultaneous fashion on a non-conscious level, and in a sequential way on a conscious level.	– Hemisphericity research – Topographic inhibition theory – Descriptive systems – Pattern - recognition – Feedback – Modularity theory – Cognitive-emotive theory – Suggestopeadia – PDP theory – Modular theory
SYMBOLIC	7. The capacity to express and communicate using some symbolic vehicle.	– Symbolic system modular theory
METACOGNITION **COGNITION** **SYMBOLIC** **NEURO-PSYCHOLOGICAL**	8. Intelligent learning is the reconceptualization of descriptive systems leading to new knowledge.	– Self-regulation theory – Suggestopeadia

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TABLE 3.1

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the geodesic information processing model, namely, metacognition, cognition, neuropsychology and symbolism. The implications of each of the assumptions for the MMA geodesic framework will also be discussed.

3.3. THE ASSUMPTIONS RELATING TO THE METACOGNITIVE COMPONENT OF THE MODEL

There are three assumptions relating to the metacognitive component of the geodesic information processing model. The first deals with metacognition being the level on which most learning occurs. The second proposes that metacognition provides a structure for the non-conscious level. The third assumption is concerned with the conception of self-regulation and relates to both the metacognitive and cognitive component. A discussion of each assumption follows.

3.3.1. METACOGNITION IS THE NON-CONSCIOUS LEVEL THAT ACCOUNTS FOR THE BULK OF LEARNING

Theoretical underpinnings

The first assumption relating to the metacognitive component, is concerned with the non-conscious level being the root of the thought process where the majority of learning occurs. Various theories have contributed to the assumption that the bulk of learning occurs on the non-conscious as opposed to the conscious level. These theories include: automaticity research (Fodor, 1983; Reddy, 1979, in Iran-Nejad, 1990, in Iran-Nejad, 1990; Allport, 1980; Gazzaniga, 1977; Gardner, 1985; Iran-Nejad, 1990); the two-source theory of self-regulation (Iran-Nejad, 1990; Iran-Nejad & Chissom, 1988); suggestopaedic theory (Lozanov, 1978; Dhority, 1991); and modular theory (Gardner, 1985; Feldman, 1980; Saloman, 1979; Gardner & Wolfe, 1983). These authors indicate that a great deal of complex cognitive activity occurs outside conscious awareness. According to Reddy (1979, in Iran-Nejad, 1990) and Donchin (1991, in Nelson, 1992), approximately 90 per cent of learning takes place on the non-conscious level. This is corroborated by Lozanov (1978), who indicates that potential is released by the activation of the subconscious stores.

This perception of the non-conscious level is in contrast to traditional theories that limit the role of the non-conscious level to dealing with the elementary perceptual analysis of the physical features of environmental stimuli (Nebes, 1974, in Leaf, 1990). Traditional theories indicate that attention and rehearsal are prerequisites for cognitive analysis.

This implies that unattended precepts and unretrieved memories do not make contact with higher mental processing, and therefore do not influence consciousness (Khilstrom, 1992, in Nelson, 1992). Therefore, classical information processing theory cannot account for the process of learning due to the constraints placed on attention, the lack of consideration of the non-conscious level, and the belief that the existence of horizontal processes such as a general problem-solving device, perception, memory, and the like cut across heterogenous content.

In an attempt to explain this expanded role in the perception of the non-conscious level, the theories mentioned above were explored. This literature indicates that cognitive activity can become automatised (Fodor, 1983) and unconscious in the sense that it is unavailable to introspective awareness, yet still influences the cognitive end-product. Hence, metacognition influences cognition. The concept of the non-conscious level is therefore not limited to elementary perceptual analysis of the physical features of environmental stimuli, but can be expanded to include mental processes operating on knowledge structures (Nelson, 1992). This implies that events can affect mental functions even though they cannot be consciously perceived or remembered. This concept is termed attention-delegation (Iran-Nejad, 1990), and indicates that an active allocation of attention is neither sufficient nor always necessary in the learning process. Attention-delegation power is the power to continue an ongoing contribution to the learning process even after the conscious executive has focused attention elsewhere (Iran-Nejad, 1990). Therefore, attention-delegation power remains alert throughout the whole time that internal reconstruction occurs on a task until task completion relieves attention-delegation.

Implications for the MMA

Applying the above research findings to the MMA, it is assumed that the bulk of learning occurs on the non-conscious level, and that this level is the metacognitive level. This is the level on which the metacognitive action of the processing systems, of the metacognitive domain(s) selected, occurs (see Figure 2.1). The metacognitive action results in the activation of existing descriptive systems (Goldberg & Costa, 1981), which are utilised in the reconceptualisation of new descriptive systems. Therefore, by implication, this is the level on which thinking begins, and is the root of the thought process. It is also the level where new descriptive systems are reconceptualised and stored (Pribram, 1971; Goldberg & Costa, 1981). It is proposed that this level is metacognition, which is in contrast to traditional perceptions of learning and thought which view this level as cognition. As discussed previously, conscious sequential processing cannot account for the complex creative learning process, implying that there are limitations inherent in the traditional definitions of cognition and the non-conscious level.

It is postulated that the MMA activates higher mental functions on a non-conscious metacognitive level, and that these higher mental functions are not always initially available to introspection due to the process of attention-delegation. This process is clearly evidenced in the way a person who is not proficient in using the concept of Mind-Mapping creates a Mind-Map. Initially the idea that each concept must go on its own line with an organised pattern of association between the lines, is particularly difficult to integrate. This can be seen in the structure of the Mind-Map (see Chapter Two).

It is assumed that the higher mental function involved is not yet accessible to introspection and still under the control of attention-delegation. As proficiency improves, so the awareness of how to carry out the cognitive strategy - that is, the placement of each concept on a line with appropriate associations between them - improves. When this occurs, the higher mental function(s) orchestrating this particular activity has moved into consciousness (onto the cognitive level) becoming available to introspection. At this stage the higher mental function is refined. That is, an interplay between metacognitive knowledge and experience activates the same or different cognitive strategies to complete the goal of the task as efficiently as possible. These refined strategies are then automatised through experience and are once more rendered to the non-conscious, but will impact positively by being used automatically in the future creation of a Mind-Map. This process is evidenced in that, once the person has integrated the strategy of single concepts per line in an associated way, the error is seldom repeated, implying that the strategy has become automatised (rendered to the non-conscious level) yet will still impact when creating future Mind-Maps. This process is known as attention-delegation (Iran-Nejad, 1990).

The MMA assists in automatising (Fodor, 1983) as well as activating the metacognitive action which will orchestrate the complex cognitive tasks. This automatisation process renders the metacognitive action outside of conscious awareness, yet still available to influence higher mental functions, be they of a communicative or academic nature. Thus, the MMA facilitates the reconceptualisation of descriptive systems (Goldberg & Costa, 1981) and assists in rendering them to the non-conscious level, where they will impact on the reconceptualisation of new useful knowledge (Derry, 1990).

3.3.2. THE METACOGNITIVE STRUCTURE OF THE NON-CONSCIOUS LEVEL

3.3.2.1. Introduction

This assumption implies that, when one refers to metacognition, the non-conscious level is being alluded to. Therefore the MMA model is proposing a structure for the seemingly metaphysical conception of the non-conscious level. This in turn strengthens the contemporary geodesic perception of the expanded role of the non-conscious level because it provides a way of analysing the complex higher cortical functioning that is purported to be occurring on this level.

This assumption is founded on the research on metacognition (Flavell, 1978; Nelson, 1992; Derry, 1991; Paris & Winograd, 1990) and the implied relationship with modular research (Hinton & Anderson, 1981; Feldman, 1980), Lurian theory (Luria, 1980), multiple intelligence theory (Gardner, 1985), self-regulation theory (Iran-Nejad, 1990) and descriptive system theory (Goldberg & Costa, 1981). These theories cut across and link various fields of research. It is the interrelationship of these theories that has led to the uniqueness of this element of the assumption, namely, that metacognition provides a structure for the non-conscious level.

This structure of the metacognitive non-conscious level is visually demonstrated in Figure 3.1, and described in the ensuing discussion. The theoretical underpinnings and implications for the MMA are highlighted for each of the three elements of the structure of the non-conscious level. These elements are the metacognitive modules, the processing systems of the metacognitive modules and the metacognitive domains of the processing systems.

3.3.2.2. The metacognitive modules

Theoretical underpinnings

The first component of the non-conscious level of the geodesic information processing model comprises seven metacognitive modules. A metacognitive module is a cluster of intellectual abilities that form the raw material of thought (Gardner, 1985; Feldman, 1980). These modules influence the thinking process because each produces a specific type of thought based on their

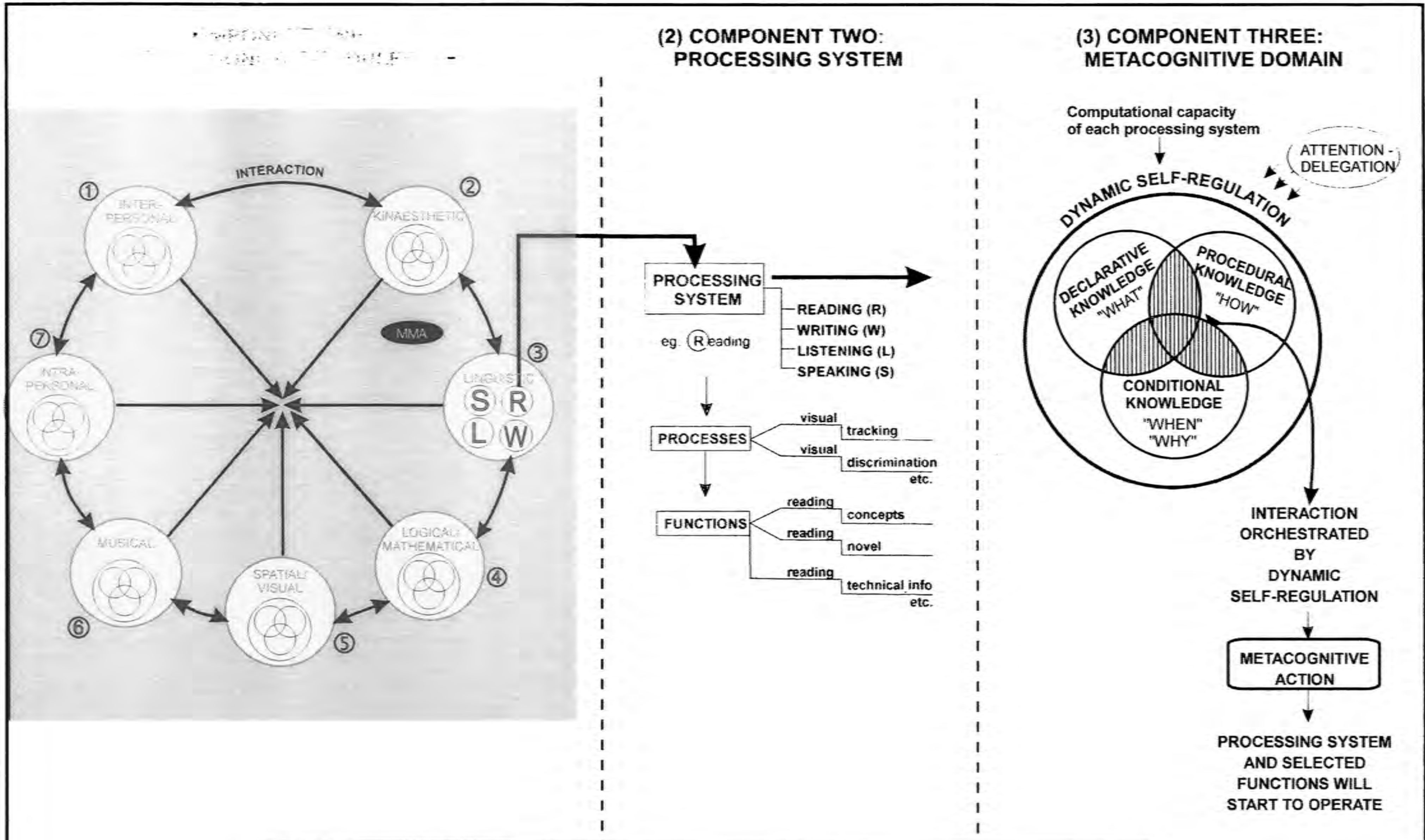

Figure 3.1: The Metacognitive Structure of the Non-Conscious

DEVELOPED BY: C. LEAF

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nature (Feldman, 1980). Higher order thinking such as problem solving, originality, common sense, wisdom, and metaphorical capacity, are the result of the interaction between the modules (Gardner & Wolfe, 1983). Interaction is facilitated by multimodal approaches which tap into the abilities of each module.

The concept of modules is based on the theory of multiple intelligences as developed by Gardner between 1978 and 1985, and Gardner and Wolfe (1983). This theory posits that intelligences are sets of intellectual potentials, or raw computational capacities, of which all individuals are capable by virtue of their membership of the human species (Gardner, 1985). He stresses that human intelligence needs to be genuinely useful: "human intellectual competence must entail a set of skills of problem-solving enabling the individual to resolve genuine problems or difficulties he/she encounters, and, when appropriate, to create an effective product - and must also entail the potential for finding or creating problems - thereby laying the groundwork for the acquisition of new knowledge" (Gardner, 1985: 61). The spectrum of intelligences (Gardner & Wolfe, 1983) includes: linguistic, logical/mathematical, spatial/visual, kinaesthetic, musical, interpersonal and intrapersonal. Gardner (1985) and Gardner and Wolfe (1983) have broken from the common tradition of intelligence theory which stipulates that human cognition is unitary, and that individuals can be described as having a single quantifiable intelligence (Campbell, Campbell, & Dickinson, 1992). Therefore, intellectual behaviour is evidenced in many different ways.

The notion that human cognition consists of a number of special purpose cognitive modules which are dependent on the neural structure of the brain has been endorsed by Fodor (1983), Gazzaniga (1977), Allport (1980), Rozin (1975), and Hinton and Anderson (1981). The operation of these metacognitive modules may be considered autonomous in two senses: each operates according to its own principles, and the operation of each module is not necessarily subject to conscious use (Fodor, 1983; Allport, 1980; Hinton & Anderson, 1981; Gazzaniga, 1977). The modules operation is therefore controlled predominantly through the attention-delegation process. On occasion the contents of the modules will be available to conscious introspection through attention-allocation, but they basically operate in the presence of certain forms of information to be analysed. Thus, metacognition operates at the non-conscious level, as discussed in the previous assumption. In fact, Gardner (1985) argues that the potential to become aware of the operation of the modules may be a special feature of human beings. It is postulated that when this occurs, active and dynamic self-regulation interact.

Implications for the MMA

Although individuals possess the full spectrum of intelligences, some individuals possess varying amounts of each combined in different ways, thus revealing specific cognitive features. According to Campbell et al. (1992), educational and intervention programmes have focused predominantly on linguistic and mathematical intelligence, minimising other forms of knowing. The MMA focuses on the activation and development of all seven intelligences due its multimodal and conceptual nature. It is these seven intelligences which delineate the contents of each metacognitive module on the model.

On the geodesic model, intelligences are renamed metacognitive modules. This is done as each intelligence is made up of sets of "know-how" knowledge, that is, tacit knowledge of how to execute a cognitive act (Gardner, 1985). In the study of skills and abilities, it is customary to make a distinction between "know-how" knowledge, and "know-that" knowledge. The latter is propositional knowledge about the actual set of procedures involved in execution (Campbell et al., 1992; Derry, 1991). Therefore, the intelligences described by Gardner (1985) are limited to one type of metacognitive knowledge, and do not fully explain what occurs when information is processed.

It is proposed that the true release of potential will occur not only when "know-that" and "know-how" knowledge are combined, but also when "know-when" and "know-why" knowledge and self-regulation are added to the formula. Therefore the metacognitive modules of the MMA model expand the notion of intelligences to include not only "what" knowledge, but also "how" and "when/why" knowledge and their self-regulation systems, covering the full spectrum of metacognition. In using the interrelationship between the conception of multiple intelligences and metacognition in the MMA model, a more accurate explanation for the processing of information and development of intellectual potential is provided. This is visually demonstrated and described in Chapter Two.

3.3.2.3. The processing systems of the metacognitive modules

Theoretical underpinnings

The second element of the metacognitive non-conscious is that each metacognitive module consists of processing systems and functions which realise the potential of the metacognitive modules (see Figure 3.1). The conception of processing systems and functions is based on the application of Lurian theory (1963 to 1982), which suggests that the brain does not work in individual bits, nor as a general whole, but as a series of interlaced and interlinked systems. Therefore the brain is not a conglomerate of interconnected working parts, but an infinitely integrated self-regulating system.

A processing system is a result of a whole system of processes. For example, the processing system of reading, which would be part of the linguistic metacognitive module, is made up of various processes such as the visual tracking of letters, the visual discrimination of letters, and the combining of the letters into a unit of meaning. The processing system of reading also has various functions, such as reading for factual knowledge, or reading a novel. A processing system is represented neurologically as a functional system composed of interrelations of different parts of the brain. A function fulfils or realises the processing capacities of functional systems (Luria, 1980). Functions are localised, but functional systems and their processing systems are distributed in the brain because they are made up of the localised functions (Luria, 1980).

According to Luria (1980), if a functional system is damaged, it can be reconstructed by using a different set of functions in different parts of the brain. This hypothesis is corroborated by Leaf (1990), who found that a client suffering a closed head injury significantly improved their cognitive performance after being exposed to Mind-Mapping therapy. It was postulated that the improved performance was the result of the reconstruction of functional systems.

Implications for the MMA

Each metacognitive module on the model comprises various processing systems. Processing systems are divided into functions which will eventually be expressed on the symbolic level by the cognitive action (see Figures 2.1 and 3.1). A processing system is viewed on the MMA model as the channel through which the intellectual abilities specific to a particular domain are expressed. Therefore it is posited that the MMA, due to its brain-compatible nature, will maximise the selection and integration of functions into the most efficient processing systems to operationalise the cognitive acts, resulting in optimal performance.

3.3.2.4. The metacognitive domain

Theoretical underpinnings

The third element of the metacognitive structure of the non-conscious level is the metacognitive domain (see Figure 3.1). This is the computational capacity upon which the complex realisations of the processing systems of the metacognitive modules are based.

This concept of the metacognitive domain reflects the idea that human beings are so constituted as to be sensitive to certain informational content (Gardner & Wolfe, 1983; Feldman, 1980). When a particular form of information is presented, various mechanisms in the nervous system are activated to carry out specific operations on it. From the repeated use of, elaboration of, and interaction among the computational devices, will flow forms of knowledge that can be termed useful and intelligent. Therefore a computational device can be visualised as a set of natural kinds of building blocks out of which productive lines of thought and action are built (Goodman, 1976, in Gardner, 1985).

From the literature on metacognition, it is postulated that a metacognitive domain can be subdivided into declarative, procedural and conditional knowledge (Derry, 1990; Paris & Winograd, 1990). These three types of metacognitive knowledge (declarative, procedural and conditional knowledge) are knowledge about what factors interact in which ways to influence the course and outcome of cognitive enterprises (Flavell, 1978). Derry (1990) defines declarative knowledge as an organised collection of facts and concepts, comprising many disciplines such as History, English and Science. For example, knowing that a noun is a person, place or thing is declarative knowledge. Procedural knowledge is knowledge of "how", performance capabilities or action sequences involving symbol manipulation, such as the ability to read, write or solve algebraic problems (Mastropieri & Bakker, 1990). Being able to identify the method required to solve a quadratic equation represents procedural knowledge. Finally, conditional knowledge is the "when" and "why" of applied knowledge and strategies, and is therefore a combination of declarative and procedural knowledge.

According to Flavell (1978), metacognitive experiences are any affective experiences that accompany or pertain to any intellectual enterprise. He also indicates that metacognitive experiences are especially likely to occur in situations that stimulate a lot of careful, highly complex thinking (Flavell, 1978). Borkowski, Schneider and Pressley's (1989) model of efficient information processing confirms this viewpoint. In their model these authors demonstrate how metacognitive components of declarative, procedural and conditional knowledge influence cognitive strategy selection and use in order to achieve the end result, which is efficient cognition.

Implications for the MMA

Each processing system within each metacognitive module on the MMA model has a computational capacity known as the metacognitive domain. This metacognitive domain operates the processing systems of the metacognitive modules. When the three elements of the metacognitive domain (declarative, procedural and conditional knowledge) interact, the result will be metacognitive action (see Figure 3.1). Metacognitive action directly influences the cognitive level. The quality of the interaction determines the quality of the cognitive action, and ultimately, the symbolic output.

The interaction of the three types of metacognitive knowledge is influenced and orchestrated by dynamic self-regulation. Dynamic self-regulation refers to metacognition in action, or how metacognition orchestrates cognitive aspects (Paris & Winograd, 1990). It is proposed that the MMA influences dynamic self-regulation, thus facilitating elaborate interaction amongst these computational devices, the metacognitive domains, to produce intelligent forms of knowledge. A chemical analogy can be used to explain the interaction of the metacognitive domains as facilitated by the MMA. The metacognitive domains are elements in a chemical system, the basic constituents of which can combine to form compounds of various sorts and into equations that result in various processes and products. The metacognitive domains of the metacognitive modules, while initially raw and unmediated, have the potential to be involved in symbolic systems through mediation (Gardner, 1985). It is postulated that the MMA provides this mediational system, facilitating the combination of raw elements into productive intelligences and performance.

Therefore, the monitoring of cognitive enterprises proceeds through dynamic self-regulations controlling the actions of and interactions among the three types of knowledge of the metacognitive domain. It is postulated that the MMA stimulates this dynamic interplay, which will affect the cognitive function, and ultimately, the symbolic output. Thus, cognitive strategies achieve cognitive progress, and a knowledge of what and how to use these cognitive strategies is the result of the metacognitive action of the metacognitive domains. The latter is invoked by the MMA which by implication invokes highly active and complex thinking.

3.3.3. THE INTERACTION OF ACTIVE AND DYNAMIC SELF-REGULATION IS THE OPERATING SYSTEM OF EFFECTIVE THOUGHT PROCESSING

The third assumption deals with the concept of self-regulation and relates to the metacognitive and cognitive components of the geodesic information processing model.

Theoretical underpinnings

The assumption stated above is based on Iran-Nejad's (1990) two-source theory of self-regulation. Iran-Nejad (1990) proposes two different sources of internal self-regulation in contrast to the traditional idea of one, as discussed in Chapter Two.

In adopting a two-source perspective on internal self-regulation, the conception of interaction becomes significant. This interaction is important because of its potential implications for academic learning and education in general. The ensuing discussion evaluates the advantages of the interaction between active and dynamic self-regulation.

A single source theory (conduit or traditional) of internal self-regulation implies that change only occurs when the internal executive directly allocates attention to the source of change (Anderson, 1985; Schneider & Shiffrin, 1977), resulting in incremental internalisation. Thus it is a sequential one-thing-at-a-time process, which is limiting. The two-source theory, by contrast, implies that constructional change is governed by attention-delegation and allocation, and not by attention-delegation alone. Attention-delegation is the ability of the dynamic self-regulatory process to continue its ongoing contribution to internal reconstruction even after the executive moves immediate attention to another site (Iran-Nejad, 1990). This occurs when the central executive controlling active self-regulation interacts with the local component which is dynamic self-regulation.

Dynamic self-regulation involves the actions of evaluating, planning and self-regulating (Iran-Nejad, 1990). Furthermore, dynamic self-regulation is seen as being the route to the so-called "vastly untapped subconscious stores" that Lozanov (1978) refers to in the science of suggestopaedia. Iran-Nejad and Chissom (1988) propose that dynamic internal self-regulation is a possible solution to how the internal construction system manages to overcome the inherent limitations of the executive control. The dynamic control concept suggests that brain microsystems and subsystems can use local resources in as many independent sites as necessary to regulate their own activity.

Furthermore, it is proposed that it is dynamic self-regulation that maintains alertness in the components throughout the whole time that internal reconstruction on the particular task is in process (Iran-Nejad, 1989, 1990). This is in accordance with the implication from the literature that cognitive activity can become automatised (Fodor, 1983), and therefore unconscious in the sense that it is not available to conscious introspection, yet still influences the cognitive end-product.

Implications for the MMA

The primary objective of the MMA is to create autonomous independent learners (Slabbert, 1989), and it is believed that this objective will only be achieved when interaction between dynamic and active self-regulation are activated. Once this interaction occurs, the cognitive process is activated. Cognition is regulated by metacognition, and carries the metacognitive action of the processing system through to the symbolic expressive level. It is hypothesised that the MMA plays a role in activating and enhancing this interaction.

Thus the implication of the two-source theory for the MMA model is that the metacognitive experiential component can be likened to dynamic self-regulation controlling the metacognitive non-conscious process. Active self-regulation can be viewed as the executive of the conscious cognitive process carrying out the metacognitive function.

On the cognitive level, dynamic and active self-regulation will interact to produce the output, thus the conscious level and non-conscious level will influence output. There will however, be times when only active self-regulation operates alone, for example, when a new production is being learnt for the first time. Once this production starts to become internalized, active and dynamic self-regulation will interact, resulting in improved depth of processing. It is further proposed that the quality of the interaction will determine the effectiveness of learning and, ultimately, the development of intelligence. It is at this level that the MMA is believed to make its greatest contribution that is, the enhancement of the interaction process.

Iran-Nejad (1989, 1990) argues that young children are much more effective learners than older children because of the authenticity of the environment in which they learn and its inherent relationship with the multisource nature of learning. An authentic environment will facilitate the interaction between active and dynamic self-regulation. Older children, by contrast, become increasingly more proficient in their use of active self-regulation, which in itself is not negative. However, it becomes a problem when over-reliance on the untrained or even ill-trained active executive occurs, resulting in over-reliance on learning strategies at the expense of dynamic self-regulation (Iran-Nejad, 1989, 1990). This results in sequential rote learners reducing potentials. The objective, by implication, would be to have interaction between active and dynamic self-regulation. This can be facilitated by geodesic approaches such as the MMA.

Therefore, it is postulated that the MMA allows the interaction to occur, enabling the learner to engage in multimodal encoding unencumbered by potential interference from sequential one modality at a time executive encoding. The MMA process also allows the active executive, which develops with maturity and which is increasingly intentional (Iran-Nejad, 1990), analytic and sequential, to interact positively with dynamic self-regulation. Thus metacognition and its executor, dynamic self-regulation, can be trained to optimise the cognitive process by developing active self-regulation using geodesic approaches such as the MMA.

Chi (1985) argues that the more expert or experienced one becomes within a field, the more dynamic self-regulation controls the situation. Evidence of the latter would be the use of more effective problem-solving strategies by an expert as opposed to a novice (Chi, 1985). Chi (1985) found that novices attacked a problem by trying various paths until the correct solution was arrived at. In contrast, experts reflected on a problem in order to conceptualise it, and used underlying principles to form hypotheses to be tested towards the solution (Chi, 1985). It is felt that the process of becoming an expert is dependent on the quality of the interaction of dynamic and active self-regulation, which can be facilitated by the MMA. This is important because considerable evidence has accumulated that suggests that an emphasis on metacognition during training can result in significant long-term improvements in cognitive tasks (Bereiter, 1985; Bransford, 1979).

The geodesic framework of the MMA uses a cognitive task analysis (Redding, 1990) where the metacognitive skills of the expert are analysed, and the discrepancy between the expert and the novice performance is fed back to the novice. This is in contrast to traditional behavioural approaches which specify training objectives, materials and behavioural criteria needed to meet performance objectives. It is posited that cognitive task analysis facilitates the interaction between active and dynamic self-regulation because it has a process orientation as opposed to the product orientation of behaviourism.

3.4. THE ASSUMPTIONS RELATING TO THE COGNITIVE COMPONENT OF THE MODEL

In this section two assumptions relating to the cognitive component of the geodesic information processing model are presented: that cognition is the level on which conscious sequential thought occurs and that it is also the level on which memory enhancement occurs.

3.4.1. THE COGNITIVE COMPONENT IS THE LEVEL ON WHICH CONSCIOUS SEQUENTIAL THOUGHT OCCURS

Theoretical underpinnings

The fourth assumption of the geodesic information processing model is that the cognitive component accounts for the conscious sequential allocation of immediate attention to a task. The cognitive component is viewed as a construct of the mind apart from the metacognitive component, and not as another level of the same process as in traditional perceptions of cognition. This is in accordance with much of the recent, more geodesic views on cognition and metacognition (Brown, 1990; Flavell, 1978; Khilstrom, 1992, in Nelson, 1992; Iran-Nejad, 1990; Gardner, 1985; Gardner & Wolfe, 1983). The difference between traditional behaviouristic approaches and geodesic approaches to cognition lies in the perception of the role that cognition plays in the learning process. Cognition is traditionally viewed as the level where intentional, voluntary or executive self-regulation occurs (Bereiter, 1985; Brown, 1978; Costa, 1984).

However, as already discussed under the self-regulation assumption, learning on this level occurs slowly and hierarchically, with knowledge of simpler facts being mastered before more complex structures (Iran-Nejad & Chissom, 1988). According to traditional cognitive behaviouristic approaches, this is the level on which complex learning occurs, and metacognition is the level where conscious analysis of the cognitive process occurs. This would imply that metacognition is the consciously analytical part of the cognitive process, a separate higher level of cognition and a very conscious process (Reddy, 1979, in Iran-Nejad, 1990; Slife et al., 1985; Brown, 1978). However, this traditional assumption of the distinction between cognition and metacognition cannot account for the creative and multisource nature of learning, as conscious sequential and effortful attention-paying results in committing facts and definitions to memory and not creative problem-solving. There must be another level involved in order to account for both fact learning and the creative problem-solving learning of complex schemata. Geodesic approaches to learning and intellect (Lozanov, 1978; Dhority, 1991; Gardner, 1985; Iran-Nejad, 1990) recognise the limitations of trying to learn complex schemata in a conscious sequential manner only, and indicate that this conscious cognitive component can therefore only account for about 10 per cent of learning. In accordance with the literature on the expanded role of the non-conscious level and self-regulation, cognition and metacognition are redefined in order to account more accurately for the creativity and multisource nature of thought and learning. These definitions are discussed in the next section.

Implications for the MMA

Metacognition and the role of self-regulation have already been discussed under the first three assumptions. In this section the difference between cognition and metacognition is highlighted. This difference is visually demonstrated in Figures 2.1 and 2.3. Within the geodesic framework of the MMA, the cognitive level accounts for the conscious thinking that occurs directly before the symbolic act which is the output. This conscious thinking is slow and sequential and operates under the control of active and dynamic self-regulation thus requiring effortful attention-paying. The conscious cognitive process can range from basic thinking skills to higher levels of abstract thought depending on the quality of the metacognitive interaction, as well as the interaction of active and dynamic self-regulation. Cognition within the MMA geodesic approach is also viewed as the process that operationalises the metacognitive action, and is thus the result of the interaction of active and dynamic self-regulation.

The effectiveness of cognition is therefore dependent on the interaction with metacognition, as well as the efficiency of metacognition. Metacognition, on the other hand, is viewed as the non-conscious level where the bulk of learning occurs. By implication, if something is conscious, it has been moved onto the conscious cognitive level by the interaction of dynamic and active self-regulation. In contrast to cognition, the non-conscious metacognitive level is viewed as being fast, simultaneous and active in the creative assimilation, reconceptualisation and processing of the information that will be utilised on the cognitive level.

3.4.2. MEMORY ENHANCEMENT IS PART OF THE COGNITIVE PROCESS AND DEPENDS ON CONTEXT AND CONTENT

Theoretical underpinnings

The fifth assumption posits that the enhancement of memory, which will eventually be stored on the metacognitive modular level, occurs on the cognitive level. This assumption is based on the literature reviewing how memory can be improved (Buzan, 1991; O'Keefe & Nadel, 1978; Russell, 1986; Dhority, 1991; Lozanov, 1978; Jensen, 1995; Feldman, 1980; Boller & Rovee-Collier, 1992).

The framework adopted in the MMA for reviewing long-term memory systems is that proposed by O'Keefe and Nadel (1978) because it adopts a modularity perspective which is geodesic. O'Keefe and Nadel's theory (1978) indicates that each module of knowledge has its own memory system specific to that module, for example linguistic or spatial mathematical. Each module would thus possess adapted formats of memory, which allow their specific characteristics to be realised (Gardner, 1985; Feldman, 1980).

O'Keefe and Nadel (1978) discovered a critical biologically-based difference between the two ways new information is dealt with: the brain sorts and stores information according to whether it is embedded in context or content (Jensen, 1995). The difference between the two is that information embedded in context (episodic/locale memory) is stored in relationship to a particular location or circumstance with which it is associated and categorised. In contrast, information embedded in content (semantic/taxon memory) is unrelated factual information contributing to the knowledge base of memory (Jensen, 1995).

Referring back to the structure of the non-conscious level (see assumption two and Figure 3.1) and the metacognitive domain specifically, context and content memory can be compared to declarative, procedural and conditional knowledge. Declarative and procedural knowledge, unless associated with each other and with conditional knowledge, will simply become content memory. Content memory does little to contribute to creative problem-solving learning and the development of potential as knowledge of unrelated facts is not deep processing. This type of learning is often the result of conscious cognitive rote-learning under the control of active self-regulation alone. In order to create context memory, the declarative, procedural and conditional knowledge need to be associated meaningfully.

Research has indicated that context memory has unlimited capacity, forms quickly, is easily updated, requires no practice, and is used effortlessly by everyone (Jensen 1995; Hand, 1986; O'Keefe & Nadel, 1978). This would indicate that context memory is under the control of dynamic self-regulation on the metacognitive level. According to Boller and Rovee-Collier (1992), this natural context memory is based on movement, music, activation of all sensory modalities, sounds, puns, relationships, associations and position in space and time. In addition the formation of natural memory is motivated by curiosity, novelty and expectations. Information embedded in content (semantic) is, by contrast, usually learned through rote and by following lists. The learning of content without a context is difficult for the brain (Hart, 1983). Unfortunately this type of learning is typified by traditional academic approaches (Hart, 1983; Dhority, 1991; O'Keefe & Nadel, 1978; Jensen, 1995). It tends to lead to rote learning without thinking. According to O'Keefe & Nadel (1978), this taxon (content) system is categorical and will disintegrate if the information goes unrehearsed. Therefore, by adding pictures, sounds, colour, dimension, and passionate involvement to the learning process, a context is built up around the conceptual information, causing the memory to be placed within the context (locale) system (Hand, 1986). Furthermore, according to Calvin and Ojemann (1994), active memory is an organised pattern of synaptic strengths, but it needs an overall pattern of associations to give it meaning. Thus memory improves when context has been established through associated and categorised patterns.

On a biological level, when something learned is rehearsed, the axonal and dendritic connections enlarge allowing for more chemical transmission to be emitted into the synapse, which in turn makes it easier for the message to be passed on (Hand, 1986). When a learned item is practised in many ways, the neurons make new connections with different cells, networking the information by branching the message to different sites in the brain (Hand, 1986; O'Keefe & Nadel, 1978).

Implications for the MMA

In the geodesic information processing model, memory is seen as part of the cognitive process, where the new descriptive systems are reconceptualised. Once a new descriptive system is reconceptualised, it is stored in the appropriate metacognitive domains of the specified metacognitive modules in the form of declarative, procedural, and conditional knowledge. Therefore, reconceptualisation of new knowledge is actualised and enhanced on the cognitive level, then stored on the metacognitive level, where it will be used in the future reconceptualisation of new knowledge.

The process of storing is enhanced by organisation, association and categorisation in the selected information, which are facilitated by the spatial pattern structure of the Mind-Map. The actual structure of the Mind-Map contributes to the enhancement of natural memory because "the information can also be stored in a fabric or weave of 'mental space' which is a thematic map of the intellectual landscape, where learning occurs as a result of changes in location or circumstance, or the use of thematic teaching, storytelling, visualisation and metaphors" (Jensen, 1995: 205). The Mind-Map's structural nature builds meaning networks which enhance an organised useful development of knowledge. The Mind-Map thus facilitates the networking of information across the brain-building patterns of meaning.

Organisation is enhanced when the context is provided, such as when concepts as opposed to key words are used in the creation of the Mind-Map, as concepts are contextually based and key words are content-based. The MMA is context building, which facilitates the placement of information in the context (locale) system. During the creation of the Mind-Map using the MMA, colour, patterns, images and dimension, movement and sound are all used to provide a context for the information. In this way declarative, procedural and conditional knowledge are interrelated, which improves memory. Additionally, in the MMA, specifically in the output stage, the learner is encouraged to make the work "come alive" through the use of intensified sensory input.

3.5. THE ASSUMPTION RELATING TO THE NEUROPSYCHOLOGICAL COMPONENT OF THE MODEL

The sixth assumption of the MMA model is concerned with the neuropsychological aspects of: synergy between the hemispheres, pattern recognition, modularity, the limbic system and parallel and sequential processing. Each of these aspects of the neuropsychological component is examined separately in order to establish the theoretical underpinnings and implications for the MMA.

3.5.1. ASPECT ONE: *Synergy between the hemispheres releases potential*

Theoretical underpinnings

In order to release potential, the left and the right cerebral hemispheres need to function synergistically, which is the natural performance capability of the brain (Jensen, 1995). Therefore, in order to perform on a higher level cortically, the two hemispheres need to process information in a complementary fashion. In order to establish the theoretical underpinnings of the harmonious functioning of the brain, the research on hemisphericity needs to be examined.

Speculation concerning the nature of hemispheric asymmetry has followed research with split-brain patients and other investigations into the functioning halves of the brain (Sperry, 1961, in Zaidel, 1981; Ornstein, 1975; Diamond, 1972, in Leaf, 1990; Zangwill, 1975; Levy, 1985). The issues surrounding hemispheric specialisation are diverse, complex and sometimes controversial. An exploration of hemisphericity reveals that the true development of potential lies in the collaborative effort of both hemispheres.

Since the split brain research (Sperry, 1961, in Zaidel, 1981; Ornstein, 1975; Levy, 1985), the idea that the two hemispheres are specialised for different modes of thought has led to the concept of hemisphericity, which refers to the idea that an individual relies more on one hemisphere than on the other. This different utilisation of the hemispheres is presumed to be reflected in the individual's cognitive style (Jensen, 1995; Springer & Deutsch, 1989; Kline, 1990).

This research has also led to a progression of labels describing the processes of the left and right hemispheres (Dhority, 1991). According to Springer & Deutsch (1989) the most widely cited characteristics of left and right hemisphere processing may be divided into five main groups which form a kind of hierarchy, namely:

- ❑ Left hemisphere: verbal, sequential, logical / analytical, rational, western thought
- ❑ Right hemisphere: non-verbal / visuo-spatial, simultaneous, gestalt, intuitive, eastern thought.

However it would appear that the difference between the hemispheres is in the way they process information, as opposed to their having different abilities (Springer & Deutsch, 1989; Levy, 1985; Jensen, 1995).

The left hemisphere has a more sensory and motor-specific processing function, the right hemisphere a more associative processing function, and these functions are complementary. This indicates that what are major capabilities of one hemisphere, are minor capabilities of the other hemisphere (Levy, 1985). The hemispheres are in fact, able to perform each other's functions in different complementary ways (Goldberg & Costa, 1981; Levy, 1985). Sagan (1977) indicates that left and right hemisphere processing has to interact in a complementary way to produce higher cortical functioning. He argues that in order to solve complex problems in changing circumstances, both cerebral hemispheres are required and the corpus callosum plays an important role in the integrating process. In the normal functioning brain, both hemispheres share in mental activities (Kimura, 1973). According to Hand (1986) scientists have yet to discover one higher intellectual function controlled entirely by one hemisphere. Levy (1985) has confirmed that both sides of the brain are involved in nearly every human activity - it is all a matter of timing and degree of involvement. Gazzaniga (1985, in Jensen, 1995: 14) argues that "events occurring in one hemisphere can influence developmental events occurring at the same time at very remote parts of the other hemisphere". The right cerebral hemisphere processes wholistically in a random fashion, and the left processes parts in a sequential fashion (Jensen, 1995). Thus, the right hemisphere has a greater capacity for dealing with informational complexity and for processing many modes of representation of a task. The left hemisphere is better at tasks requiring fixation on a single often repetitive mode of representation. Most cognitive and metacognitive tasks require a combination of both types of processing (Jensen, 1995; Levy, 1985).

The relaying of information between the hemispheres occurs via the corpus callosum. The corpus callosum, the largest of the hemisphere's interconnecting nerve fibres, plays an important role in the synergistic processing of information and the development of patterns of meaning. The corpus callosum has been seen as an interhemispheric integrator, a means of updating each hemisphere regarding information received by the other, and even suppressing one hemisphere while the other takes over some activity (Myers, 1956; Ferguson, 1985, in Larsson & Starrin, 1988; Sidtis & Gazzaniga, 1983, in Gardner, 1985). However, according to Springer & Deutsch (1989) and Cook (1984) this viewpoint does not account for the corpus callosum's complex interconnections to so many regions of the brain. Cook (1984) alternatively describes the role of the corpus callosum as a topographical inhibitor which shows how activation of complementary aspects of almost any function in the two hemispheres can occur. That is, an excited neuron on one side sends a generalised message to the other. This message would call on related programmes in order to prompt further understanding. One of the assumptions underlying Cook's (1984) model is that related aspects of some item in memory are represented in the brain anatomically near each other, or at least access to these related aspects is provided by neighbouring neurons.

Implications for the MMA

The MMA uses techniques that stimulate a synergistic processing between the hemispheres. These techniques include colour, images, patterns, dimension, movement and concepts arranged in a logical, analytical and associative way using spatial and pattern principles. In the Mind-Map one shifts from the parts to the whole constantly in a simultaneous fashion, and this alternating between the gestalt picture and the sequential details facilitates complementary interaction between the hemispheres (Jensen, 1995). Linear monochromatic note-taking, by contrast, only allows sequential "one-thing-at-a-time" analysis of information which obscures a gestalt impression and thus limits the potential flexibility of thought. Due to the nature of the MMA, the right hemisphere's ability to deal with informational complexity is facilitated at the same time as the left hemisphere's ability to focus on repetitive modes of representation and single fixations. Therefore sequential single items of knowledge, as well as the simultaneous patterns of meaning arising out of categories of associated information, are both dealt with on the Mind-Map. This is in contrast to linear representations which only deal with sequential single items of knowledge.

Cook's (1984) topographic inhibitory model explains why the Mind-Map structure is so effective as an associative tool for the creative expansion of ideas. According to Cook (1984), the two hemispheres are designed to collaborate with each other during the thinking and learning process. Using the left hemisphere alone for higher cortical functions will limit the quality of the information processing, leading to rote type learning. The MMA, which takes advantage of the processing capabilities of both hemispheres, will facilitate the collaborative effort between the hemispheres. Cook's (1984) model accounts for why the Mind-Map stimulates ideas. The spatial arrangement of the networks of thought that are developed on the Mind-Map are literally the visual representation of the synaptic connections between the neurons. Synaptic connections that are anatomically linked by the axons and dendrites across both hemispheres will, when activated, release a flow of electrical activity across these associated connections. These connections represent the cognitive associations made between the information in the problem-solving stage of the learning process. These cognitive associations are represented visually on the Mind-Map. This is the reason for the rule of one word per line, with each progressive line growing out of the previous one, that has to be applied when Mind-Mapping. Each concept on the Mind-Map has to be represented as closely as possible to the concept it is associated with, in a logical rational fashion. This arrangement of inter-relationships grows deductively from the central global theme outwards and inductively inwards in an associative way. Linking lines are used to show the associations between nodes; by implication, the closer the nodes are together, the more closely associated are the concepts. Thus, the interlinking lines represent the route of access between complementary associated ideas, allowing for more flexibility in thought.

Therefore the Mind-Map becomes the visual or overt representation of the raw material of the non-conscious, which are the linked synaptic connections. Looking at the pattern of the Mind-Map will serve to activate the associations made on the anatomical level. This is the stimulation of ideas referred to earlier. Furthermore, because Mind-Maps are overt, they are open to manipulation. Useful knowledge out of which meaning can be extracted will not arise out of a selection of random associations between the right and left hemispheres. Rather, this arrangement will be organised with recognisable patterns of associations. Thus, two distinctly different patterns of neuronal excitation are produced within bilaterally identical regions, allowing the two brains momentarily to hold different perspectives on the same information (Cook, 1984).

The more organised the bilateral representation, the more efficient the metacognitive action, leading to more effective cognitive action, and, ultimately, more effective symbolic output. It is proposed that the MMA enhances this process because organisation of concepts is fundamental to the Mind-Map. By implication, therefore, a disorganised Mind-Map would indicate that the different perspectives being held in the two hemispheres at the same time are random and have literally not made connection and are therefore not reconceptualising useful knowledge. The Mind-Map would allow the identification of how the new patterns are incorrect.

3.5.2. ASPECT TWO: *The metacognitive action results in the activation of descriptive systems through the process of pattern recognition and feedback, creating open systems*

Theoretical underpinnings

It is assumed that the MMA invokes the interaction of declarative, procedural and conditional knowledge regulated by dynamic self-regulation, which results in metacognitive action. This metacognitive action in turn activates existing descriptive systems through a process of pattern-recognition and feedback. These descriptive systems are used to reconceptualise new knowledge. The result is that open systems of processing are created.

Research into the pattern recognition nature of the brain and the way in which the brain deals with incoming information has led to the above assumption of the geodesic model (Hyden, 1977; Hart, 1983; Pribram, 1971; Jensen, 1995; Nummela & Rosengren, 1985; Anokhin, 1976, in Buzan & Dixon, 1976; Goldberg & Costa, 1981). The concept of descriptive systems and the pattern-recognition nature of the brain are central issues in the motivation for the multi-dimensional as opposed to linear structure of the Mind-Map.

A descriptive system is a built-in organisational scheme that the brain has for dealing with incoming information (Goldberg & Costa, 1981). Depending on the type of new information to be learned, certain descriptive systems will be activated and processing will occur. The level of complexity of the cognitive act will determine how efficiently and how many descriptive systems are activated (Goldberg & Costa, 1981). The activation of descriptive systems is done through the process of pattern recognition (Pribram, 1971; Hart, 1983; Hyden, 1977). Pattern-recognition occurs when patterns in the environment are recognised, and our nerve cells either block or pass on that message according to a recognition factor which is similar to Anokhin's expectation and experience concept (Anohkin, 1976, in Buzan & Dixon, 1976). This will lead to the secretion of excitatory or inhibitory chemicals and this in turn is the process through which we learn and remember (Hand, 1986: Hand & Stein, 1986: Hart, 1983). Therefore, the brain constructs maps of external and internal stimuli.

The areas in the brain responsible for pattern-detection and concept creation contain structures that categorise, discriminate and recombine the various brain activities occurring in different kinds of global mappings (Hart, 1983). Pribram (1979) indicates that the brain extracts meaning through wholistic pattern discrimination rather than singular facts or lists, and that the initial stages of processing are parallel rather than serial. Pribram (1979) argues that feature analysis and meaning extraction are the result of pattern matching as opposed to feature discrimination and detection.

Consequently, the human brain is not designed for linear thought, but operates by simultaneously going down many paths (Hart, 1983). Hart (1983) emphasises the importance of presenting information in larger patterns before the details - in other words deductively. Hence, the traditional notion of presenting information sequentially building up to the whole is incorrect. Rather one needs to develop analogical patterns where the gestalt is presented first, and then the details.

Nummela and Rosengren (1985) emphasise the importance of patterns in learning and state that the neocortex is both a pattern maker and pattern detector in the creation of meaning and reconceptualisation of knowledge. Therefore, the structures in the brain, instead of categorising outside inputs from sensory modalities, categorise parts of past global mappings according to modality, the presence or absence of movement, and the presence or absence of relationships between perceptual categorisations (Jensen, 1995). The pattern detection structures in the brain must be able to activate or reconstruct portions of past activities of different types of global mappings, for example, those involving different sensory modalities. In addition, these pattern detection structures need to be able to recombine, repattern, reformulate, or compare the patterns (Jensen, 1995). Every new pattern (newly reconceptualised knowledge structure) is relegated to the non-conscious (Hart, 1983; Jensen, 1995; Lozanov, 1978). The process of reconceptualising new patterns of knowledge utilises both the conscious and non-conscious levels (Jensen, 1995).

The process of acquiring descriptive systems is enhanced by feedback. Feedback is necessary to generate information about the effectiveness of the brain's programmes, and is essential for optimal brain functioning (Hart, 1983; Dhority, 1991). This concept of feedback relates to the research done by Anokhin (1976, in Buzan & Dixon, 1976), which indicates that the choice neurons have is based on feeding back to the neuron the results of the action selected. He also found that the more that was expected from the neuron, the more the neuron responded by growing additional dendritic connections. This research has been corroborated by Rosenzweig (1976, in Buzan & Dixon, 1976), who has shown that an increase in connections between neurons results in improved cognitive functioning. Thus "high quality, high volume input is the raw material on which the brain thrives " (Dhority, 1991: 22).

As the learner interacts with the environment, proteins present in nerve cell membranes apparently enable the activation of large numbers of neurons simultaneously (Springer & Deutsch, 1989). The more sensory channels used to input information, the greater the number of storage sites activated (Hyden, 1977). According to Hyden (1977), the working hypothesis is that protein differentiation caused by experience and learning will secure the concomitant activation of all the neurons which have undergone a similar differentiation from the same stimulus. It does not matter in what part of the brain the neurons are located, at learning neurons become highly active in a collaborative way across both hemispheres. The learning mechanism of the brain is active and not reactive as in a conditional behaviouristic system (Hyden, 1977; Hand, 1986).

Implications for the MMA

The emphasis of the MMA is on the meaningful acquisition of useful knowledge through the utilisation of a non-linear multidimensional diversified patterned format. The MMA considers the role of the non-conscious level and acknowledges the role of implicit intuitive knowledge. The emphasis is on meaning and intrinsic motivation.

The Mind-Maps are the patterned "tools" of the MMA. Mind-Maps help the patterns in the environment to be recognised. It is postulated that during the process of Mind-Mapping, the activation of descriptive systems across both hemispheres is enhanced and improved because the Mind-Map is a pattern that stimulates the collaboration of electrical activity across the hemispheres which activate the pattern recognition process in the brain. More specifically, the patterns arising out of the MMA activate the knowledge arranged in global mapping formats within each metacognitive module (linguistic, spatial, mathematical, etc). The logical associated arrangements between the perceptual categorisations on the Mind-Map result in efficient activation of the descriptive systems of the modules. This assists in the recognition of the inter-relationships between the information, which results in creative integrated learning. The pattern-making nature of the brain is of paramount importance in the creation of brain-compatible environments. This serves as further motivation for proposing the MMA as a framework within which to develop meaningful learning.

The actual structure of the Mind-Map invokes pattern recognition because of its deductive/ inductive nature. That is, concepts are stored and presented on the Mind-Map radiating deductively outwards from a central point, and inductively inwards towards a central point. This leads to analogical reasoning being applied in the creation and interpretation of the Mind-Map, making the MMA an active process approach. Programmes are created by having a correct general idea (activation of background knowledge), and then by gradually reducing error through the feedback process (Hart, 1983). According to Dhority (1991), what a learner needs is to be guided and encouraged as he acquires descriptive systems which requires much trial and error. The Mind-Map provides a way of observing programme selection, the acquisition of descriptive systems and the reconceptualisation of knowledge, as the Mind-Map visually represents the thought process.

Furthermore, through feedback, the MMA creates an open system of learning which allows a larger number of processing units to be activated in order to create the most efficient state of activation across the whole system. This could be equated on a psychological level with the highly efficient performance of a cognitive task such as problem-solving. Hence the “open system” that is created within the MMA framework is not a randomised flow of information, but a highly organised creative structured process. In other words, freedom within structure is created.

An environment is created that conforms to the natural neuropsychological functioning of the brain, allowing increased expectation and thus increased interconnections between neurons, leading to enhanced metacognitive and cognitive functioning. Rosenzweig and Bennet (1976), in their attempt to ascertain the biological processes involved in learning and memory, have confirmed the susceptibility of the brain to actual physical and clinical changes from different types of exposure. Their research indicates that what is needed is to find better means of “packaging” information to aid learning and retrieval. Thus, the MMA is an attempt to provide a framework within which to package information in order to create open systems. The MMA provides learners with a way to conceptualise ideas, shape thinking, understand better what they know, and finally, to create meaning from within, using the process of feedback.

A Mind-Map can be viewed as a way of observing mental processes in action because as one creates, these tracings by the hand are actually sensory representation of the electrochemical signals being passed from one neuron to another. The Mind-Map format ensures that storage and retrieval will be more efficient than if a linear format is used. The latter forces thinking into a linear sequence when the mind is processing different levels of information rapidly in a parallel way, and thus obscures the thought process. Linear thinking is not compatible with the way the brain functions, and for this reason, problems in organising, sequencing, logic, and categorisation will be experienced.

Cultural and individual differences may influence the repertoire of pre-existing codes or descriptive systems. The MMA will allow the individual to express this individuality of thought patterns (Leaf, Uys & Louw, 1993). By manipulating the thought patterns an individual can develop into an independent autonomous learner and advantage can be taken of the open system of the mind.

All the sensory channels are induced by the geodesic methodology of the MMA,. It could thus be hypothesised that the MMA increases the number of proteins present in the nerve cell membranes, which increases the efficiency and rate of firing, and hence more activation and better cognitive functioning.

3.5.3. ASPECT THREE: *The brain is a modular system of interlinked functional systems*

Theoretical underpinnings

The mental processes of the brain can be conceived of as having independent or encapsulated modules each operating according to its own rules and showing its own processes (Feldman, 1980; Gardner, 1985). These modules, although independent, all interact to produce metacognitive and cognitive activity. A modular system's perspective favours vertical models like language, musical processing, and visual analysis, each with its own characteristic mode of processing, as opposed to horizontal processes like general perception and memory (Gardner & Wolfe, 1983).

The conception of modularity and functional systems in the brain was initially devised by Anokhin (1976, in Buzan & Dixon, 1976), and later developed in the functional system theory by Luria (1963 to 1982), and has been supported by Fodor (1983), Gazzaniga (1977), Allport (1980), Rozin (1980), and Hinton and Anderson (1981). Luria's theory is different from the research that attempts to ascribe certain whole functions to the left hemisphere and others to the right. The modularity perspective (Luria, 1982; Gardner, 1985; Gazzaniga, 1977; Rozin, 1980; Allport, 1980; Hinton & Anderson, 1981) views the brain as being organised into independently functioning modules that have representation across both hemispheres. Neurologically, the modules are represented as modular columns of neuronal cells ascending from the cortex to the subcortex to the limbic system across the left and right hemispheres (Luria, 1978; Gardner, 1985). Each module is viewed as having its own processor and memory. That the modules work together in the execution of complex tasks is accepted, but as Gardner (1985) says, at any one historical moment, one can specify the modules as independent units.

Research in neurology has shown that there are units of subserving microscopic abilities in the individual columns of the sensory or frontal area (Rosenzweig & Bennet, 1976; Diamond, 1988; Mountcastle, 1978; Zaidel, 1985). It has also been shown that there are much larger units visible to inspection which serve more complex and molar functions such as linguistic abilities - much like Luria's functional systems (Mountcastle, 1978; Crick, 1981; Hubel, 1980, in Gardner, 1985). These studies suggest a biological base for modularity.

Gardner's extrapolation of modularity is developed in his theory of the "multiple intelligences", where an intelligence is viewed as a vertical module of knowledge such as linguistic, spatial, or musical, as already discussed. Furthermore these studies have suggested the presence of areas in the brain that correspond at least roughly to certain forms of cognition, as well as implying a neural organisation for different modes of information processing (Gardner & Wolfe, 1983; Springer & Deutsch, 1989).

Implications for the MMA

The modularity perspective provides a more geodesic way of analysing the knowledge base of long term memory as well as providing a more accurate explanation for the synergistic functioning of the brain. In a modularity perspective, knowledge is grouped into vertical as opposed to horizontal categories. For example linguistic knowledge has representation across both hemispheres within a modular column of neuronal cells. If linguistic knowledge is the stimulus, and a geodesic framework such as the MMA is used, then the resultant electrical activity will be activated within the linguistic module across the left and right hemispheres in a complementary fashion allowing two perspectives of the same information to be held at the same time. This will allow associations to be made that would not occur if the left hemisphere was stimulated alone as in traditional approaches.

Based on Gardner's (1985) theory, the MMA identifies seven such groupings (see Figure 2.4) of knowledge. These seven groupings of knowledge, or metacognitive modules in the MMA model, represent the basic knowledge base that is used to reconceptualise new knowledge which occurs constantly from infancy to death. The way in which newly reconceptualised knowledge is stored in relation to the existing knowledge base determines whether the knowledge will be useful in that it will be able to be used creatively in a problem-solving context. Using a geodesic approach such as the MMA, knowledge will be stored associatively in an organised categorised way across both hemispheres, allowing the information to be recalled and therefore used more easily. If the interaction of declarative, procedural and conditional knowledge is facilitated, as in the MMA, the result will be effective multimodal memory storage because the contextual as opposed to content memory will be used. Traditional rote learning approaches, by contrast, will only store unrelated factual information resulting in content memory.

Therefore, the implication of a modularity perspective for the MMA is that it provides a biological base for the conception of processing systems and metacognitive modules and domains. Furthermore it subserves the conception that both hemispheres need to work together to realise potential, that the functional unity of the brain cannot be broken, and that if the two sides of the brain work together in a complementary fashion, both sides will produce more than if only one side is used.

3.5.4. ASPECT FOUR: *The limbic system needs to be activated in order for useful knowledge to be reconceptualised*

Theoretical underpinnings

The limbic system plays a critical role in the development of potential as it mobilises the cerebral resources and this triggers the utilisation of the non-conscious stores. In this way, the depth of processing is increased.

Research into the association between emotion and the metacognitive patterning needed for learning has established the ways in which the limbic system influences learning. Ornstein (1987), Sobel (1990, in Jensen, 1995), and Rosenfield (1988) argue that emotions influence learning in two ways: positive emotions influence the depth of processing, and allow the brain to make better perceptual maps. Maclean (1978) indicates that emotions, hormones, and feelings all affect learning. Research into the memory of animals indicates that the midbrain plays a role in learning (Jensen, 1995). Studies by McGaugh and Intrioni-Collision (1990) have verified the role of limbic area, hormones and the amygdala in long-term memory. The work of O'Keefe and Nadel (1978) has established the role of the hippocampus in learning and indexing.

The literature pertaining to the cognitive-emotive link suggests that once the limbic system is involved, the activation levels in the neural circuitry are stronger and more reinforcing, resulting in better memory storage and intellectual function (Hand, 1986). De Andrade (1986: 111) indicates that "not all pieces of information matter from the viewpoint of the mobilisation of the cerebral resources: only those that penetrate the limbic system serve as a trigger for the utilisation of reserves not used". He argues that in order for information to penetrate the limbic system, it needs to be emotised, that is, rationally defined objectives need to be clearly translated into mental representations through the use of emotions, using the auditory, visual and kinaesthetic channels. Maclean (1978) has shown that the limbic system receives information from all intero- and exteroreceptive systems and elaborates it into emotional sensations. It appears that the mental non-conscious is the link with the limbic system, and that suggestive phenomena tap the non-conscious. Thus, the limbic system is the link to the development of usefully reconceptualised knowledge.

Suggestopaedia (Lozanov, 1978) recognises the potential of non-conscious mental activity in increased recall of existing descriptive systems, and in the reconceptualisation of new knowledge. Utilising and refining the methods of relaxation, music and yoga breathing, he produced a method that has been found to be greatly effective in learning. The three psychophysiological laws upon which his work are based reveal his integrated view of the brain. These are: the global participation of the brain, the simultaneous process of analysis and synthesis, and the indivisible participation of the conscious and non-conscious (Dhority, 1991). Furthermore, Lozanov's (1978) three inseparable fundamental principles correspond with Hart's (1983) concept of pattern detection, which he argues are activated more efficiently through the accessing of the non-conscious. Thus Lozanov's (1978) approach is also neuropsychological, and complementary to the MMA, and for this reason elements of this approach are incorporated into the MMA. Nelson (1988) proposes a process model which demonstrates the interconnectedness between imagery and the limbic system and in which the cognitive process of imagery activates the limbic system. In other words, thinking in images may increase neurotransmitter activity in the limbic area. Nelson (1988: 368) states that "since imagery affects the limbic system and hypothalamus, it can assist in bringing emotional memories to conscious view, modulate emotional reactions and enhance motivation".

Implications for the MMA

The emotive-cognitive link has important implications for the MMA in that the approach aims to create a positive attitude in the learner towards the learning task so that the learner will become autonomous and self motivated. The MMA incorporates strategies from suggestopaedia, as initially proposed by Badouin and developed into an applied educational science by Lozanov (1978). These strategies are used in combination with the Mind-Map in order to facilitate the cognitive-emotive link.

The MMA assists in the process of attaching emotions to each event and thought, forming patterns of meaning to construct the larger picture. The Mind-Map itself is an enjoyable activity as it allows learners to bring their own talents, cultural perspectives and individual perceptions to the task (Leaf, Uys & Louw, 1993). It allows learners to gain control over the learning situation as they are able to observe their cognitions due to the overt nature of the Mind-Map and thus gain immediate feedback. Furthermore, clinical application has proved that if a positive active emotional involvement is not invoked, the individual battles to create Mind-Maps successfully on an independent level (Leaf, 1990).

Nelson (1988) indicates that there are three keys in making imagery most responsive to the limbic system: rhythm, movement and emotions. In translating these keys into practical techniques in the MMA, elements of the science of suggestopaedia, as developed by Lozanov (1978), have been utilised in adapted formats. All three of these keys, namely, rhythm, movement and emotions, are therefore utilised in the techniques of the MMA. This relaxes the limbic system's negative potential, allowing intellectual pursuit to progress more readily. The teacher and/or therapist, using a geodesic approach such as the MMA, will facilitate the activation of the limbic level of the individual through the use of music, imagery, relaxation, and laughter, which appeal to all the modalities.

It has been clinically observed that when initially learning to create Mind-Maps, clients are dependent and concrete in their thought processes, and sometimes negative towards the activity due to the active involvement required in the thinking process (Leaf, 1990). This attitude could be a result of the traditional environment that tends to invoke rote learning and hence a lack of active thinking. At a point in mediation, however, a change is evidenced in the independent utilisation of the Mind-Map as a study and organisational strategy. Until this stage is reached, the Mind-Map process will have limited success. Therefore until the learning situation is experienced on an emotional level, it is not processed deeply enough to be stored on the metacognitive level and stimulate effective metacognitive action. Once the cognitive-emotive link is experienced, however, the task becomes automatised into the metacognitive level. It is postulated that the active processing invoked by the geodesic nature of the MMA is more likely to induce the cognitive-emotive link than traditional approaches, resulting in the deeper processing that is required for creative intelligent learning.

Motivation is tied to emotional response and therefore fear or anxiety will inhibit motivation (Hart, 1983). Hart terms this downshifting, where cognitive activity is stopped because the emotion overrides the reasoning ability. Positive emotional responses evoked through imagery can maximise motivation by overriding negative emotional responses from the limbic system (Nelson, 1988). One of the rules of the Mind-Map is the use of imagery in the creation, as well as in the output (the memorising of the Mind-Map). The learner is told to visualise, to make the Mind-Map "come alive".

This stage of the Mind-Mapping process is known as the creative visualisation stage as opposed to "learning", with its negative connotations. The creative visualisation process appeals to the function of the amygadala, which is involved in imagination and retrieving or storing memories (Restak, 1979). Certain steps of the creative visualisation process are repetitive and require the involvement of the visual, auditory, and kineasthetic modalities. This appeals to the function of the hippocampus, which is involved with storage and retrieval of memories (Restak, 1979). As a structure, the hippocampus is responsive to repetitive stimulation (rhythm), and spatial-motor sensations (Restak, 1979; Springer & Deutsch, 1989). Thus the use of music throughout the MMA will appeal to the hippocampus because of its rhythmic nature, which matches the heart rate and breathing which are controlled by the limbic system. The Mind-Map, as the "tool" of the MMA, is structurally full of visual imagery in its multidimensional shape, and in the use of pictures, symbols and colour. Thus, the MMA and the Mind-Map, due to their nature, activate the limbic system, which results in improved cognitive functioning.

3.5.5. ASPECT FIVE: *Processing of information occurs in a parallel simultaneous fashion on the non-conscious level, and sequentially on the conscious level*

Theoretical underpinnings

On the non-conscious level the processing of information is fast and parallel, and on the conscious level, processing is sequential and slow (Reddy, 1979, in Iran-Nejad, 1990; Iran-Nejad, 1990). Therefore, the nervous system is seen to process information in a predominantly simultaneous parallel fashion. Learning situations need to reflect this in order to be successful. Hinton and Anderson (1981) developed a model called parallel distributed processing (PDP) also known as connectionism, in order to explain the parallel processing of information on the non-conscious level.

The PDP model (Hinton & Anderson, 1981) has the brain as its conceptual analogy for the human information processing system - especially the synaptic connections among neurons. This is in contrast to classical information processing theory, the analogy of which is the microchip of the high speed computer. In addition, the PDP model considers that almost all information processing, including the higher mental functions involved in language, memory and thought, occurs on the non-conscious level. This is in accordance with the assumptions of the metacognitive component.

The PDP model postulates the existence of a large number of processing units or modules each doing a specific task in both hemispheres. The systems mutually influence each other once activated, until the whole system is in a state of activation, which represents the information being processed (Hinton and Anderson, 1981). Allport (1980) and Hinton and Anderson (1981) propose that the modules interact simultaneously in parallel to produce intelligent knowledge rather than sequentially in series, which limits the process of thought. Furthermore, Hinton and Anderson (1981) indicate that each module is specifically keyed to and activated by a certain kind of information making them content dependent. Therefore in the PDP model it is assumed that information about an object is distributed widely across the system rather than being localised in any particular unit (Khilstrom, 1992, in Nelson, 1992). The PDP model abandons the traditional assumption that information is processed in a sequence of stages (Hinton & Anderson, 1981). Parallel processing allows information to be analysed rapidly as large numbers of activated units can influence each other at any particular moment in time, which results in information being analysed very rapidly. Both the number of simultaneously active processing units, and the speed at which they pass information among themselves may exceed the span of conscious awareness (Khilstrom, 1992, in Nelson, 1992). It can be postulated that consciousness is a matter of time rather than activation. Therefore the implication is that unconscious processing is fast and parallel, while conscious processing is slow and sequential (Khilstrom, 1992, in Nelson, 1992; Iran-Nejad, 1990).

More specifically, cognitive activities are related, not to the quantity of information to be processed, but to the presence of particular patterns to which specific neural structures must resonate, known as pattern-detection (see assumption five, section 3.4.2.). Hinton and Anderson (1981) and Allport (1980) indicate that the modules operate in parallel with the module that fires the most, dominating the cognitive activity.

Allport (1980) claims that every production system, or module of knowledge, is content dependent, thus cognitive activities are related to the presence of particular patterns to which particular neural structures resonate (1980). The research of Eriksen and Botella (1990) and Crick (1981, in Jensen, 1995) also verifies the parallel processing nature of the brain which is multi-path and multimodal, with very little learning occurring in an orderly sequential fashion. According to Ornstein (1975), many things are done at once on a biological, physical and intellectual level. Hart (1983) argues that the brain operates simultaneously on many different levels of processing in a world of colour, imagery, emotion, shape, intensity, sound, taste, and more. The brain assembles patterns, composes meaning, and sorts life experience. Therefore, it appears that parallel as opposed to serial processing is natural to the functioning of the brain.

Implications for the MMA

The geodesic nature of the MMA allows rather than restricts the natural parallel processing nature of the brain. When the neural structures of the brain are allowed to process in a predominantly parallel way, learning becomes more creative and therefore more effective. More specifically, the MMA facilitates parallel firing in the metacognitive module that is predominantly being stimulated, as well as interaction between the modules. This is because of the patterned nature of the Mind-Map, which activates the multimodal and multi-path nature of parallel firing within and between the metacognitive modules. Conscious serial processing of information, the result of linear traditional stimulation, cannot produce the same effect because linear presentation is not a meaningful pattern. Neural structures respond to context dependent patterns that are meaningful. If there is no associated patterning forming in the knowledge, then the neural response is limited to creating content as opposed to context memories. The MMA therefore provides a learning situation which reflects the natural parallel processing ability of the brain.

3.6. THE ASSUMPTION RELATING TO THE SYMBOLIC COMPONENT OF THE MODEL

The seventh assumption is concerned with the symbolic expression of thought, which is the final stage of the geodesic model.

3.6.1. THE MIND-MAP IS THE SYMBOLIC EXPRESSION OF THE THOUGHT PROCESS

Theoretical underpinnings

The symbolic component deals with the capacity of humans to express and communicate meaning using some symbolic vehicle. Symbol use has been the key in the evolution of human nature, giving rise to myth, language, art science (Gardner, 1985). Thus the focus of the symbolic level is on the symbolic vehicles of thought. It involves the understanding of language, mathematics, visual arts, gestures and other human symbols. According to Gardner (1985), Allport (1990), Fodor (1983), much of what is distinctive about human cognition and information processing involves the deployment of these various symbol systems. A major issue of this approach is whether the operation of one symbol system, such as language, involves the same abilities and processes as music, gesture and Maths. The symbolic perspective seeks to compose a developmental portrait not only of linguistic, logical and mathematical symbols of classic Piagetian theory, but on the full range of symbol systems encompassing musical, bodily, spatial, and personal symbol systems (Gardner, 1985).

Implications for the MMA

In the MMA model, the symbolic level is the expression of the cognitive act which has operationalised the metacognitive action. Therefore, the quality of the symbolic output is dependent on cognition, which, in turn, is dependent on metacognition. In the MMA, the Mind-Map, as the overt "tool", becomes the symbolic vehicle of the processing of information, a way of observing the product of the human mind. The Mind-Map shows the thought process that is behind the symbolic output. On the MMA model (Figure 2.1), only the linguistic module is developed due to the orientation of the current research.

Each of the other six modules can also be expanded through the metacognitive and cognitive levels to their specific symbolic expression. However, the Mind-Map requires input from all the different modules to produce intelligent knowledge, and thus serves as a tool for encouraging their interaction. The Mind-Map can therefore be used to monitor, develop and improve the symbolic level, which is seen as the capacity to communicate meaning.

The symbolic system approach becomes the link between the nervous system with its structures and functions, and the culture with its roles and activities. According to Gardner (1985: 300), "in dealing with symbols like words or pictures, with symbolic systems like maths or language, with symbolic products like scientific theories or literary narratives, we have commerce with entities and levels of analysis, that can address both biology and anthropology". In other words the symbolic systems approach advocates the use of systems that follow the natural neuropsychological functioning of the brain. The MMA may provide a brain-compatible route from raw intelligences to effective symbolic expression.

3.7. THE ASSUMPTION PERTAINING TO ALL FOUR COMPONENTS OF THE MODEL

The eighth assumption relates to the metacognitive, cognitive, symbolic and neuropsycholgical components of the model.

3.7.1. INTELLIGENT LEARNING IS THE RECONCEPTUALISATION OF DESCRIPTIVE SYSTEMS LEADING TO NEW KNOWLEDGE

The final assumption of the MMA model deals with the conception of intelligent learning. This assumption is the result of the integration of all the components of the MMA model and therefore refers to the metacognitive, cognitive, symbolic and neuropsychological levels.

Theoretical underpinnings

Two assumptions govern traditional approaches to learning, namely, that learning is the internalisation of external knowledge, and that it occurs under conscious executive control

(Iran-Nejad, 1989, 1990; Reddy, 1979, in Iran-Nejad, 1990). As the result effortful attention-paying is seen as the single most important regulator of learning. According to Iran-Nejad (1990) this limits the domain of learning to committing facts and definitions to memory.

In adopting a geodesic approach, learning is alternatively viewed as the creative reconceptualisation of internal knowledge involving a "discontinuous change from a structure with one wholistic character (or quality) to another structure with a different wholistic character" (Iran-Nejad 1990: 577). Thus, learning a complex schema is not simply an incremental enlargement of a simpler one through internalisation or assimilation of more external facts, or making internal modifications to the simpler schema (Iran-Nejad & Chissom, 1988). It is literally the creation of new parallel descriptive systems to accommodate the new knowledge. As in the formation of crystals, each new piece that is added is a complete new complex unit lying alongside the piece that it is associated with. Reconceptualisation involves the spontaneous reinterpretation of previously encoded facts but with the benefit of hindsight (Kintsch, 1980). Learning new information leads to recomprehension and reinterpretation of previously encoded information. Gestalt psychologists indicate that mental constructions are not simple constructions with something added, but are more analogous to chemical combinations where something new is formed that is qualitatively different (Bereiter, 1985). Therefore as something new is being learned, the previously encoded facts and other internal knowledge spontaneously reorganise into new combinations.

There is evidence that students who regard learning as internalising external knowledge suffer from fear of failure, negative attitudes and a disorganised approach to learning (Derry, 1990; Paris & Winograd, 1990). Iran-Nejad (1990) argues that the incremental internalisation hypothesis may actually impair learning strategies because there will be an over-reliance on active self-regulation as opposed to the use of both active and dynamic self-regulation. This counterproductive conception of learning sends learners along the ineffective path of effort, resulting in learning seldom going beyond committing facts and definitions to memory (Bloom, 1984).

Implications for the MMA

A fundamental principle of the reconceptualisation of knowledge as opposed to incremental internalisation is that a qualitative shift occurs from one organic whole to another (Iran-Nejad, 1990). In other words, existing schemata are used to reorganise and create new parallel schemata. Therefore it is not an incremental enlargement of a simpler schema through the assimilation of more external facts; rather is it a recreation of a new schema.

The reconceptualisation as opposed to incremental internalisation approach implies that simultaneous functioning is a prerequisite for sequential fact learning and not the other way around (Iran-Nejad, 1990). Reddy (1979, in Iran-Nejad, 1990) observes that the conduit framework (the conception of learning as being the internalisation of external knowledge, ready-made in books, lessons, notes) is responsible for the cautious attitude displayed by students in academic settings. For example, when asked to summarise, students “play safe” and cannot break away from the original phrasing. Clinical experience has shown that this conduit framework inhibits creative thinking.

Furthermore, the traditional approach to learning has stressed its active nature where one thing is learned at a time because the central executive level can only process one thing at a time (Bransford, 1979). Even in Vygotsky’s sociocultural theory the contribution of the individual learner is left out because other-regulation governs the inter and intra psychological functioning (Wertsch, 1985). Iran-Nejad (1990) and Harrison (1993) argue that motivational problems may be symptoms of maladapted internal self-regulation processes because of the focus on external at the expense of internal self-regulation.

In order to create Mind-Maps, knowledge has to be reconceptualised, as incremental internalisation cannot explain the results obtained when Mind-Mapping. This is because structurally the arrangement of the Mind-Map is deductive outwards and inductive inwards. This implies that analogical thinking is required to process the concepts. In the deductive arrangement, the concepts are associated and categorised from the general to the specific, and the converse applies for the inductive arrangement. A simple listing of facts will therefore have no place on a Mind-Map. In order to fit into the schema, the information has to be creatively reconceptualised implying that the meaning has to be sought via the active redesigning of existing descriptive systems.

The organisation of the information will not necessarily follow the outline of the information in the external source (teacher, text, audio-visual). It has to be reconstructed by the learner in order to create meaning and depth of processing. The traditional culture in schools that fosters rote memorisation of facts arranged in linear monochromatic lists does not require creative thinking

(Sizer, 1984). He argues that "students are all too often docile, compliant and without initiative" (Sizer, 1984: 84).

The Mind-Mapping process, by contrast, requires the active extraction, expansion and representation of meaning constructs, and is therefore a process of schema-building. In order to build schemata, concept meanings embedded in a framework of propositions are needed (Novak & Gowin, 1984). According to Novak and Gowin (1984: 15), a proposition is "two or more concepts labelled and linked by words in a semantic unit". In order to recognise and build these concept-propositional schemata, the metacognitive interaction of declarative, procedural, and conditional knowledge required is facilitated by active and dynamic self-regulation. Meaningful learning proceeds most easily when new concepts are subsumed under more inclusive or general concepts (Novak & Gowin, 1984). This is allowed for in the deductive/inductive arrangement of the Mind-Map discussed earlier. Novak and Gowin (1984) indicate that the representation of general to specific concepts should be hierarchical in arrangement. However, it is felt that this process too closely represents the monochromatic listing which obscures thinking (Kline, 1990), and encourages conduit-type thinking. The representation of concepts needs to be more multidimensional, which is more brain-compatible, as in the Mind-Map structure. Adopting Iran-Nejad's (1990) definition of learning as a multisource internal reconstruction process, both fact learning and the learning of complex schemata can be explained. The MMA refines this process due to its organisational associative conceptual nature.

Intelligent learning and the resultant realisation of potential will result when knowledge is reconceptualised into meaningful descriptive systems. This can only occur when a brain-compatible environment is created which in turn facilitates the full spectrum of metacognition to be activated. A fully activated metacognitive system will result in more effective cognitive processing and, consequently, superior symbolic output.

3.8 CONCLUSION

It has been proposed that a geodesic approach, such as the MMA, invokes more effective thought processing and learning than traditional behaviouristic approaches. At the core of a geodesic approach are the features of brain-compatibility and simultaneous learning which account for its effectiveness. These brain-compatible features were explored under the eight assumptions of the MMA model which led to a redefinition of the roles allocated to the non-conscious level, the conscious level, metacognition, cognition, and learning.

Within the geodesic approach of the MMA, metacognition is viewed as the root of the thought process and the level on which the bulk of learning occurs. Furthermore, metacognition is viewed as being synonymous with the non-conscious level and as providing a structure for analysis of the non-conscious. The non-conscious level processes information rapidly, simultaneously and in parallel, and is orchestrated by dynamic self-regulation. The non-conscious level is also viewed as influencing the conscious level and, because the non-conscious level is metacognition, this is the level where the thinking process starts. This is in contrast to traditional approaches which perceive metacognition as the "thinking about thinking" level. These views regard metacognition as a higher or more abstract form of cognition, sometimes even as a separate process, but nevertheless as a very conscious sequential thinking activity implying that the bulk of learning occurs on the conscious level. Traditional approaches view the conscious level as the level on which cognition and metacognition occur, accounting for most learning, and relegate the non-conscious level to a very basic perceptual role.

Cognition, within the geodesic approach of the MMA, is perceived as occurring on a separate level, where conscious sequential thinking occurs under the control of active and dynamic self-regulation. This conscious thinking can range from basic thinking skills to higher level abstract thought and "thinking about thinking" skills (the traditional role of metacognition). The effectiveness of cognition is dependent on the effectiveness of metacognition and the interaction between the two, which in turn is dependent on the interaction between active and dynamic self-regulation.

Learning, within the bounds of the MMA geodesic approach, is viewed as the reconceptualisation of knowledge as opposed to incremental internalisation. Therefore simple schemata are not simply added to, but are recreated as new schemata are associated with the existing schemata. In this way factual as well as complex creative problem-solving learning can be accounted for.

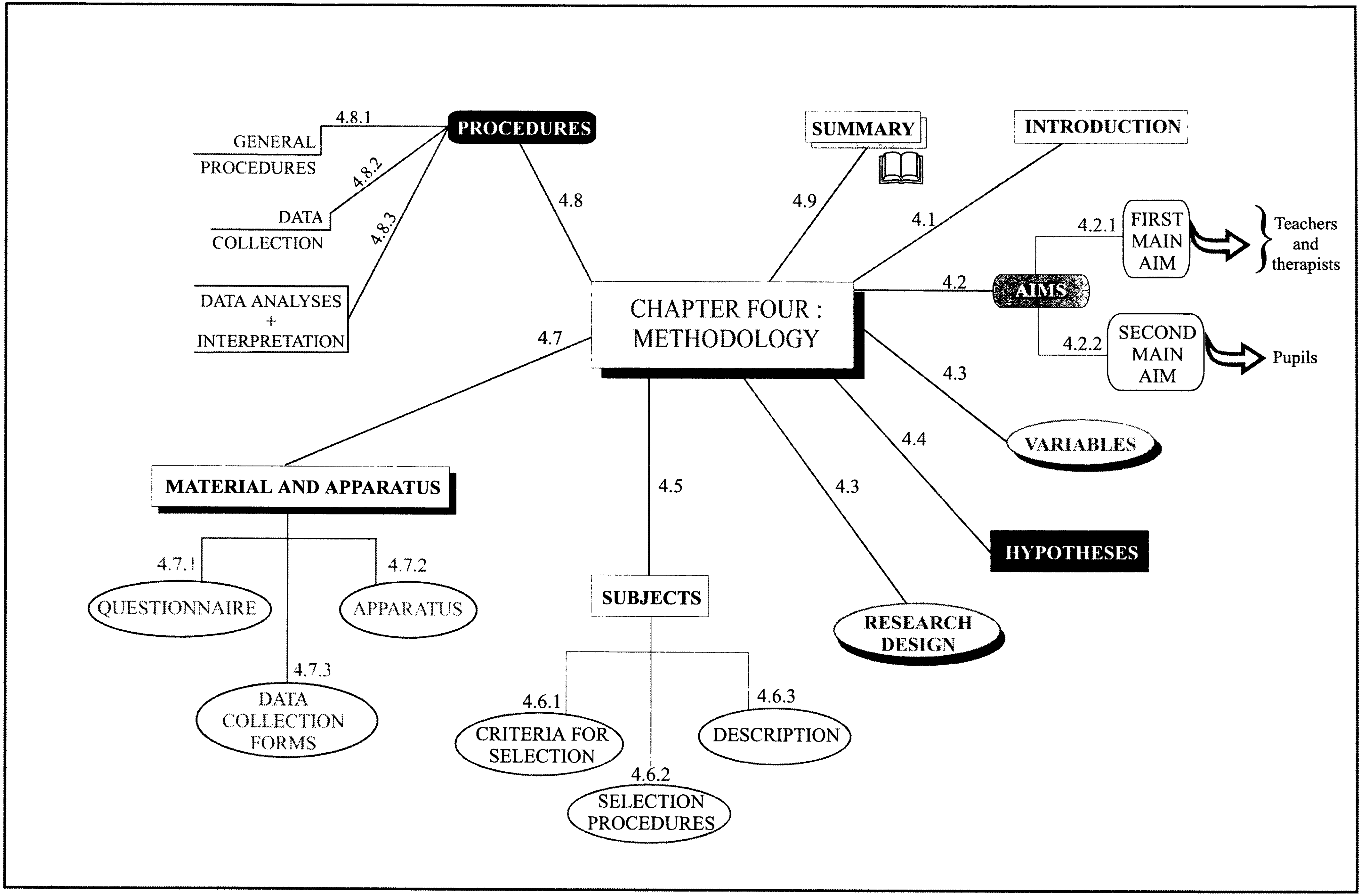
Finally, the MMA is brain-compatible due to the neuropsychological emphasis, in that the techniques used stimulate a synergistic processing between the cerebral hemispheres, activate the limbic system and facilitate the natural pattern-recognition nature of the brain, allowing parallel processing within the modules to occur. Therefore, the MMA provides an alternative approach to the perception of learning. It is a comprehensive model and framework that falls within the realms of a humanistic geodesic approach, which is believed to be more appropriate in the facilitation of learning than traditional approaches. The present research set out to test this assumption experimentally.

3.9. SUMMARY

In this chapter, the four components of the geodesic information processing model, and the eight assumptions arising out of them, are explored in order to identify their theoretical underpinnings and implications for the MMA. These four components are the metacognitive, cognitive, symbolic and neuropsychological. These assumptions led to a redefinition of metacognition, cognition, the conscious level of thinking, the non-conscious level of thinking, and intelligent learning. The geodesic model, therefore, is seen to provide an alternative approach as well as a theoretical base to the perception of learning. The objective of the chapter was to develop a theory explaining why the geodesic framework of the MMA invokes more effective thought processing than traditional behaviouristic approaches to education and therapy.

ALL WE ARE DOING IN LIFE
IS CATCHING UP WITH WHAT
OUR BRAIN ALREADY KNOWS

Gazzaniga (1977: 76)



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4.1. INTRODUCTION

Current learning theory and education is based on a cognitive behaviouristic approach (Novak & Gowin, 1984; Paul-Brown, 1992) and hence, consideration of the metacognitive and neuropsychological aspects of the learning process are neglected (Gardner, 1985; Derry, 1990). Efforts to understand the learning process must build upon a knowledge of the interaction of the biological and psychological processes (Luria, 1980; Gardner, 1985).

Furthermore, a global model of learning needs to integrate the individual within an authentic learning environment allowing personal growth under self-regulation (Iran-Nejad, 1990). According to Paul-Brown (1992), focusing on the purpose and nature of learning responds to the need to integrate communication skills with academic content.

Education requires competent communication skills - both oral and written - as prerequisites for school success (Bunker, McBurnett & Fennimore, 1987). Therefore, the speech-language therapist, with a background in language, communication, developmental psychology, speech and hearing sciences, linguistics and learning theory, is eminently qualified to become involved in the integration of communication, learning and education (Damico, 1987; Bunker et al., 1987; Paul-Brown, 1992; Tattershall, 1987). This expanded role of the speech-language therapist to promote overall school success requires flexibility and can best be achieved in a consultative and collaborative manner (Paul-Brown, 1992; Simon, 1987).

In view of the complex nature of learning, as well as the limitations of current approaches to learning in education, a more geodesic approach to learning is needed. It is proposed that the MMA is such an approach, that can be used to facilitate a wholistic approach to learning and, hence education. Furthermore, the emphasis of the MMA is on the facilitation of improved information processing and communication through a strategic versus skill-based approach, and as such, employs the concepts of consultation and collaboration in its implementation.

The underlying philosophy of the MMA is that traditional frameworks inhibit rather than enhance effective thinking as they are not neuropsychologically and metacognitively oriented, and thus not geodesic. In order to investigate the assumptions and effectiveness of the MMA model, and in doing so to underscore the need to change to geodesic methodologies if innovative lifelong learners are to be developed, a language learning disabled population was selected for the current study.

The language learning disabled population has various constraints limiting their ability to become good information processors and innovative learners (Borkowski, Schneider & Pressley, 1989). The literature indicates that in general, language learning disabled pupils are more passive, lower in self-efficacy, and are less strategic in terms of learning skills with weaker problem-solving abilities than their average achieving counterparts (Borkowski et al., 1989; Derry, 1990; Paris & Winograd, 1990; Erskine, 1986; Palmer et al., 1989; Zakaluk & Klassen, 1992). Some of these problems are due to environmental factors, such as parents being inconsistent in teaching their children to be strategic and organised during early critical stages of development; teachers focusing on product and content versus processes; society rewarding success rather than effort, and goal achievement rather than progress (Derry, 1990; Zakaluk & Klassen, 1992; Iran-Nejad, 1990).

It is thus not surprising that many students, both those in the mainstream and those with language and learning impairments, experience problems with innovative learning, thinking and achieving to the best of their potential. Simply stated, students often spend the majority of their learning years in environments that inhibit instead of promoting the development of their potential. If pupils already have an identified language and learning disability, they will be even more constrained by systems and environments that "de-educate" (Johnson, 1987).

If a geodesic approach could be shown to have a positive effect on the performance of language-learning disabled students, this would be a strong motivation to change all learning philosophies to a geodesic philosophy. It is therefore the purpose of the current study to determine the effectiveness of a geodesic approach to learning, the MMA, as a collaborative and consultative model which provides a different system and environment in education and therapy.

4.2. AIMS

The overall objective of the current study is to determine the effectiveness of the MMA training programme in enabling teachers and therapists working with language-learning disabled pupils to create geodesic learning environments and consequently improve the thinking, learning and potential of their students.

4.2.1. FIRST MAIN AIM

The first main aim was to determine the effectiveness of the MMA programme in increasing, changing and improving the knowledge, attitudes and skills of a group of teachers and therapists with regard to geodesic principles to a level of expertise which would enable them to incorporate these principles into their therapy and teaching. In order to achieve this the following sub-aims were arrived at:

- To establish the **knowledge**, **attitude** and **skills** of the teachers and therapists regarding geodesic learning principles in terms of the categories of neuropsychology and metacognition **before** and **after** attending the MMA programme;
- To determine the **change** in the teachers' and therapists' knowledge, attitude and skills regarding these principles; and
- To determine the influence of age, language and qualifications on the teachers' and therapists' knowledge, attitude and skills in these areas.

4.2.2. SECOND MAIN AIM

The second main aim was to determine the effectiveness of the application of the MMA principles by the teachers and therapists on the academic and learning performance of pupils in three remedial schools as ascertained by changes in percentages for English, Afrikaans, Maths and cultural subjects (History, Geography, Science, Biology, Health, Environmental Studies). The sub-aims were formulated as follows:

- To establish the longitudinal trend of academic results in the selected schools over 1991 and 1992: in general, per phase, per standard and per subject, to act as a baseline and control, and to correlate this with the 1993 results, to determine the change that occurred;
- To establish the longitudinal trend of each subject per phase and per standard, in order to determine in which subject the MMA methods had the most influence..

4.3. VARIABLES

In the current study there are two types of variables - the independent variable and dependent variable. The independent variable is an extraneous dynamic that attempts to alter the situations of the experiment, and is therefore controlled by the investigator (Leedy, 1989). The independent variable of the current research is the Mind-Mapping Approach (MMA) training programme.

The dependent variables are not controllable and will influence the outcome of the experiment in certain ways and therefore require consideration (Leedy, 1989). The dependent variables of the current research include:

- The knowledge, attitude and skills of the teachers and therapists regarding geodesic learning principles;
- The biographical variables of age, language and qualifications of the teachers and therapists;
- The academic results of the pupils.

Age, language and qualifications are considered to be dependent variables as they may have a significant effect on the receptiveness of the teachers to the MMA training, as well as to their application thereof. Knowledge, attitude and skills regarding geodesic learning principles are important in that they have a correlational relationship in terms of change (Byron, 1986). Thus all three must change significantly to effect a paradigm shift to a new concept. Finally, the changes that occur in the academic results of the pupils will indicate the influence of the independent variable, the MMA programme, on pupils in remedial academic settings.

4.4. HYPOTHESES

The following hypotheses were formulated, namely:

H1 There would be a positive change in the teachers' and therapists' knowledge, attitude and skills after the MMA programme.

H2 There would be a positive change in the pupils' academic results after the introduction of the MMA programme.

H3 There would be a positive change in knowledge regarding the geodesic learning principles of the MMA in terms of the categories of neuropsychology and metacognition.

H4 There would be a positive change in attitude regarding the geodesic learning principles of the MMA in terms of the categories of neuropsychology and metacognition.

H5 There would be a positive change in skills regarding the geodesic learning principles of the MMA in terms of the categories of neuropsychology and metacognition.

H6 : The biographical variables of age, language and qualifications would have an influence on the change in knowledge, attitude and skills of the teachers and therapists.

H7 The natural trend of academic results for the language-learning disabled would be a negative downward trend, that is, results would worsen as pupils progressed through to higher standards.

H8 The introduction of the MMA geodesic principles by the teachers in 1993 would alter the natural trend positively.

H9 Phase 2 (standards 2, 3 and 4) would demonstrate the most benefit from exposure to the MMA learning principles, followed by phase 3 (standard 5), and then phase 1 (grades 1, 2, standard 1).

H10 Academic performance in cultural subjects would demonstrate the greatest improvement after the pupils' exposure to the MMA, followed by English, then Afrikaans, then Maths.

4.5. RESEARCH DESIGN

The adapted ABA design (Table 4.1) of the current research is essentially a pre test post test control group design which examines the cause and effect of an extraneous variable (the MMA training programme), and therefore falls within the realms of experimental methodology (Leedy, 1989). The design was adapted as follows: firstly, the nature of the data under examination required the establishment of longitudinal trends to serve as baseline measures as well as controls; secondly, the effectiveness of the dependent variable (the MMA programme) is evaluated on two levels - change in the teachers and therapists, as well as change in the pupils; thirdly, a descriptive survey technique, the questionnaire, was incorporated into the study in order to extrapolate the common pattern or the norm that the phenomena under investigation (the teachers and therapists' knowledge, attitude and skills regarding learning and thinking - the dependent variables) follow and how these change. Figure 4.1 illustrates the tectonic structure of the research design.

According to the basic structure of this methodology, the research comprised two experiments: one, the training of ***teachers and therapists*** in the MMA programme; and two, the application of the MMA programme in education and therapy with the ***pupils*** by the teachers and therapists.

Table 4.1 : The Tectonic Structure of the Research Design

EXPERIMENT ONE		EXPERIMENT TWO	
	TEACHERS AND THERAPISTS		**PUPILS**
A¹	Baseline and control (Pre-questionnaire)	**A¹**	Baseline and control (1991 + 1992 Academic results)
B	Direct training	**B**	Exposure - Indirect training
A²	Post-evaluations (= Post-questionnaire)	**A²**	1993 Academic results

In the first experiment the three stages of the ABA design were as follows. The first or pre test stage (A1) involved the questionnaire given to the teachers and therapists to provide a baseline measure. This baseline measure is assumed to reflect the pattern or the norm of the phenomena under investigation (Leedy, 1989). In this instance, the data obtained from the pre questionnaire was the knowledge, attitude and skills of the teachers and therapists regarding geodesic learning principles before exposure to the MMA programme. The second stage (B) involved the training of the teachers and therapists in the MMA programme. This served as the experimental stage. Finally, the third or post test stage (A2) involved the teachers filling in the same questionnaire four months after training with an additional section.

In the second experiment there were also three stages. Stage one (A1) involved the establishment of the longitudinal trends of academic results for English, Afrikaans, Maths and cultural subjects prior to the intervention, to act as a baseline. As these trends were established over time (1991-1992), they also served as the controls for the experiments with the pupils. The second stage (B) of the experiment with the pupils involved the introduction and exposure to the pupils of the MMA programme in education and therapy by the teachers and therapists. This served as the experimental phase. Stage three (A2) was the post test phase, where the pupils' academic results for 1993 were compared to the trends established for 1991-1992.

The attempt to alter the patterns of the questionnaire reponses and the academic results was made by the introduction of an independant variable (B) - the MMA training programme. This independent variable was introduced in two ways, directly to the teachers and therapists, and indirectly to the pupils. Therefore two levels of influence were being explored: the changes in the teachers and therapists, as well as the effect of these changes on the pupils' academic results and general performance in the classroom, through the introduction of the MMA principles to the pupils by the teachers and therapists.

It should be noted that the reason the baseline measure and the control are the same is that during the time frame that the experiment was carried out, all the teachers, therapists and their pupils in the schools selected were exposed to the MMA principles. Control for the teachers and therapists was established on the basis of paired testing (A1 to A2), as they completed the same questionnaire pre and post training with a four month time delay in between. Comparison of their knowledge, attitude and skills regarding geodesic principles was carried out through direct comparing of their responses to the questions pre- and post-training. The teachers and therapists thus served as their own controls. As regards the pupils, the control group could not be a simultaneously selected group unexposed to the experimental variable. Instead, an historical trend of academic performance over a two-year period was established, against which the performance of the experimental group was measured. Further details of the exact design appear under pupil selection procedures below.

The design of the current study also emphasises factors of external validity in that establishing a trend over time as a basis of comparison enables one to generalise the effect of the experimental variable to other similar academic groups (Leedy, 1989; Borg & Gall, 1971, in Gardner, 1985).

The use of a random sampling as well as longitudinal trends increases the control and therefore the accuracy of making generalisations (Leedy, 1989). In addition, the descriptive survey method of the questionnaire enables generalisations to be made about the knowledge and attitude of a specific group of teachers and therapists with regard to traditional perceptions of learning, and how these might change as a result of exposure to alternatives, as long as bias is acknowledged.

4.6 SUBJECTS

Two groups of subjects were utilised in the current study: the teachers and therapists, and the pupils.

4.6.1. CRITERIA FOR SELECTION

Certain criteria were determined for the selection of the two groups of subjects in this study. These were as follows.

Teachers and therapists

There were three criteria for the selection of the teachers and therapists:

1. The subjects had to have either a teaching or therapy qualification (speech-language, remedial teaching, psychology, occupational therapy) in order to ensure that they had the necessary backgrounds to enable them to work with pupils with language-learning disabilities.
2. The subjects had to be working in special education settings specifically with pupils with language-learning disabilities in order to ensure that they had experience with pupils with language and learning disabilities.
3. The subjects had to understand English as the MMA course was conducted in English.

Pupils

There were three criteria for the selection of the pupil group:

1. Pupils had to have identified language and learning disabilities in order to qualify as subjects for the study.
2. Pupils had to be in traditional special education environments for language-learning disabled pupils in order to qualify as subjects for the study.

3. Pupils had to be in a primary school setting as the current study was conducted on pupils from grade one to standard five in order to qualify as subjects for the study.

4.6.2. SELECTION PROCEDURES FOR THE SUBJECTS

Three remedial schools were selected which were dual medium, GED schools from grade one to matric. The curriculum and organisation within the schools were therefore the same. The following selection procedures were then carried out for the two groups of subjects of the current study.

Teachers and therapists

The course was offered to all teachers and therapists in the primary sections of each of the three remedial schools. A talk was given which provided an overview of the present research and the benefits of the programme. Forty-five teachers and therapists, approximately 75% of the total possible number, opted to take part. Of these, 36 were teachers and 19 were therapists.

Pupils

Pupils were selected from grade one to standard five across the three selected remedial primary schools. A computerised formula was used to randomly select a group of pupils for each of the years 1991, 1992 and 1993. The 1991 and 1992 pupils were to act as a control and baseline, whilst the 1993 pupils were to form the experimental group. The random sampling procedure resulted in a total of 461 pupils - or more accurately, sets of academic results - out of approximately 3000 for 1991 and 1992, and 329 sets of results for 1993 out of approximately 1000. This gave a total of 790 sets of academic results, referred to as dataset one.

It was then realised that the random selection resulted in some pupils appearing two or three times, and thus the results of these pupils were used in two or three years. This dependency factor affected the purity of the data. For this reason, those pupils who appeared more than once were traced backwards from 1993 to 1991, and a second pupil group was created by identifying from the raw data pupils that had complete records over three consecutive years. The academic results of this group of 75 pupils is referred to as dataset two.

The data from this group were purer, but the group was still not large enough to deduce statistical implications, and was actually only a subset of the total pupil group. Furthermore, on sorting the data of this pupil group, it was found that the weighting was uneven. That is, of the

75 pupils, 57% were in phase three, 16% were in phase two and 26% were in phase one. As this uneven weighting would influence the accuracy of the final results, it was decided that the academic results of the second pupil group would only accurately reflect what was happening if analysed within the entire pupil group. For this reason a third dataset was created from the first two datasets. In order to account for the dependency, the data were grouped into various combinations by statistical procedures. The total sample size of the third data set was 639 sets of results.

4.6.3. DESCRIPTION OF THE SUBJECTS

4.6.3.1. Teachers and therapists

Table 4.2 provides a summary of the description of the teachers and therapists who acted as subjects. Across the three schools selected, there were 26 teachers (grade 1 to standard 5), three speech-language therapists, 12 remedial teachers, three occupational therapists and one psychologist. Of the 26 teachers, 13 worked in phase one, nine in phase two and four in phase three. Details of the ages, language and qualifications of these subjects appear in the Results chapter.

<u>Table 4.2</u> : Teacher / Therapist Description

STATUS	PHASE 1	PHASE 2	PHASE 3	TOTALS
	Gr I / ii / Std I	**2 / 3 / 4**	**Std 5**	
TEACHERS	n = 13	n = 9	n = 4	26
SPEECH THERAPISTS	n = 3	------- → -------- →	-------- →	3
OCCUPATIONAL THERAPISTS	n = 3	------- → -------- →	-------- →	3
PSYCOLOGIST	n = 1	------- → -------- →	-------- →	1
REMEDIAL	n = 12	------- → -------- →	-------- →	12
				45

* Therapists were not restricted to a phase - worked across all phases

4.6.3.2. Pupils

All pupils selected had identified language and learning disabilities and were either English or Afrikaans speaking.

The pupils were grouped into phases 1, 2 and 3 (see Table 4.3). This was the equivalent of the categorisation in the schools into junior primary, senior primary and junior high school. The categorisation reflects the curricula and teaching methodology, which are adapted to each age group.

Table 4.3 : The Phase / Standard Grouping

PHASE	GRADE / STANDARD PER PHASE
ONE	Grade One Grade Two Standard One
TWO	Standard Two Standard Three Standard Four
THREE	Standard Five

4.7. MATERIAL AND APPARATUS

The material and apparatus used in the study are described forthwith.

4.7.1. THE QUESTIONNAIRE

A questionnaire was complied for use in the study.

4.7.1.1. The aim of the questionnaire

A questionnaire compiled with the aim of tapping the teachers' and therapists' qualitative knowledge, attitude and skills about geodesic learning principles was administered prior to and shortly after the experiment, that is, the MMA training programme.

The objective of the questionnaire was to identify whether there was a predominantly traditional behaviouristic attitude to the learning and intellectual process pre-training, and if this changed post-training and, if so, how.

4.7.1.2. The design of the questionnaire

The questionnaire (see Appendix I) developed for this study was modelled on metacognitive and neuropsychological concepts related to learning and the development of potential and therefore applies to the decision-making domain (Jensen, 1995; Gardner, 1985; Campbell et al., 1991; Derry, 1991). It contained both closed (multiple choice) and open-ended items. The same questionnaire was used pre- and post-training, except that post-training questionnaire had an extra four open-ended questions which allowed the teachers and therapists to comment on how they had implemented the MMA programme, as well as the difficulties and/or positive effects of the programme.

The 51 questions were organised into different sections according to the area of knowledge being investigated. Section A dealt with biographical and identification data. Section B probed the academic learning process in school and therapy situations and comprised 18 closed questions. These questions included knowledge about the function of the brain and the importance of this knowledge in the learning situation, specifically in relation to memory and thinking. An example is “Is it necessary for students/clients to know how their brains function, in order to improve their learning skills?” Respondents were required to repond on a three-point scale, “yes”, “no” or “unsure”.

Section C also probed the academic learning process in schools, but dealt more specifically with how the teachers and therapists rated their knowledge of these concepts. There were nine closed questions in this section, an example being “How much do you know about creativity?” Respondents were required to rate their knowledge as “expert”, “some” or “little”.

Section D identified characteristics of the learning and thinking process, and was aimed at evaluating the teachers’ and therapists’ attitude to this process. There were 15 statements to be rated in this section, an example of the latter being: “The learning environment must be quiet and serious”. Respondents were required to rate the importance of each characterisitc on a four-point scale from "of no importance" to "of very great importance".

Section E (Appendix II) required the respondents to define certain terminology related to the learning, thinking and intellectual process and therefore comprised open-ended questions. The five items requiring definition were learning, memory, visualisation, accelerated learning and super teaching.

Section F (Appendix III) was only included in the post-training questionnaire. Four open-ended questions probed the way in which the teachers and therapists had applied the MMA training principles in their teaching and therapy. It also allowed for comment on any difficulty they had experienced, and whether they felt their pupils had benefited or not. Various categories of answers were identified by the examiner (see Appendix III). Question F1 deals with how the concepts of the MMA were applied in therapy or the classroom and had 16 categories. The respondents could have mentioned all 16 categories or just one and were marked accordingly. Question F2 tapped difficulties experienced with applying the concepts and had five categories. Question F3 required the respondents to indicate whether they felt their pupils had benefited from the application of the concepts and also had five categories. Question F4 allowed for any additional comments, and also had five categories.

The 51 items of sections B to F were categorised for analysis according to whether they dealt with metacognitive or neuropsychological aspects of geodesic learning principles. The division between the metacognitive and neuropsychological questions was not indicated on the questionnaire as it was used for analysis purposes only. The questions in the neuropsychology category concerned brain-behaviour relationships; and the metacognitive questions dealt with the roles of the conscious and non-conscious, comprehension, thinking skills, problem-solving and the concept of learning. Some questions had both neuropsychological and metacognitive elements in them and were analysed accordingly. These items were then further categorised into knowledge, attitude and skill components. This categorisation resulted in six categories for analysis namely (see table 4.2.): metacognitive knowledge (KM), metacognitive attitude (AM) and metacognitive skills (SM); neuropsychological knowledge (KN), neuropsychological attitude (AN) and neuropsychological skills (SN). Table 4.4 summarises which questions in each section of the questionnaire tapped which of the six categories.

Table 4.4 : Questionnaire Category Description

	KNOWLEDGE	ATTITUDE	SKILLS
NEUROPSYCHOLOGY	QUESTIONS: B : 1, 2, 3, 4, 7, 9, 11, 13, 18 C : 1, 3, 8, 9 E : 2, 3	B : 2, 3, 10 11, 12, 13 16, 18 D : 7, 9 E : 2, 3	B : 13, 14, 15, 16, 17 C : 4, 5, 6 E : 1, 4, 5
METACOGNITION	B : 13, 14, 15, 16, 17 C : 2, 4, 5, 6, 7 E : 1, 4, 5	B : 5, 8, 6 D : 1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 14, 15 E : 1, 4, 5	B : 13, 14, 15, 16, 17 C : 4, 5, 6 E : 1, 4, 5

4.7.2. THE APPARATUS USED FOR THE MMA TRAINING PROGRAMME

The apparatus used for the MMA training programme included a training manual, transparencies, videos, taped music and reference material.

4.7.2.1. The MMA training manual

The aim of the manual was to provide the content of the MMA training in a comprehensive manageable format making the training easier to follow. It was also intended a reference source for the teachers and therapists to use in the application of the MMA programme in their education and therapy.

The manual consists of 13 Mind-Maps created by the researcher for purposes of demonstration and explanation. The Mind-Maps contain the geodesic learning principles and how to apply these principles. The manual can be found in Appendix IVA and is not commercially available.

4.7.2.2. The MMA training transparencies

All the items in the training manual were put onto transparencies for projection. Additional transparencies were prepared for explanation purposes. These included examples of various levels of Mind-Maps and time-management Mind-Maps and can be found in Appendix IVB.

4.7.2.3. Videos

Two videos were also used in the MMA training programme in order to provide extra information on the brain and paradigm shifts. These were "The Enchanted Loom" (BBC production, 1986) of the brain's potential, and "Discovering the Future: A Question of Paradigms", (Charterhouse production, 1989). Appendix IVC contains a brief summary of each video as well as their references.

4.7.2.4. Music

A selection of baroque, classical and adapted baroque and classical music from the Learning Institute in America was used throughout training. The purpose of including the music was to demonstrate the beneficial effects of the music on concentration and attention. The list of the tapes and their sources can be found in Appendix IVD.

4.7.2.5. Reference material

Reference material pertaining to the concepts being trained in the MMA programme was made available for the participants to read if they wished to find out additional information about geodesic learning. A list of these books with full references is provided in Appendix IVE.

4.7.3. THE DATA COLLECTION FORMS

The data collection forms which were created and used for the recording of the pupils' academic results can be seen in Appendix V.

4.8. PROCEDURES

4.8.1 THE GENERAL PROCEDURE

The general procedure comprised eight phases and is presented in Figure 4.1. The components of the research design involved in each phase are also shown. It can be seen, for example, that phase two (A1 of experiment 1) was carried out in March, April and May 1993 of the experimental year. In the ensuing sections, the general procedure is discussed according to phase.

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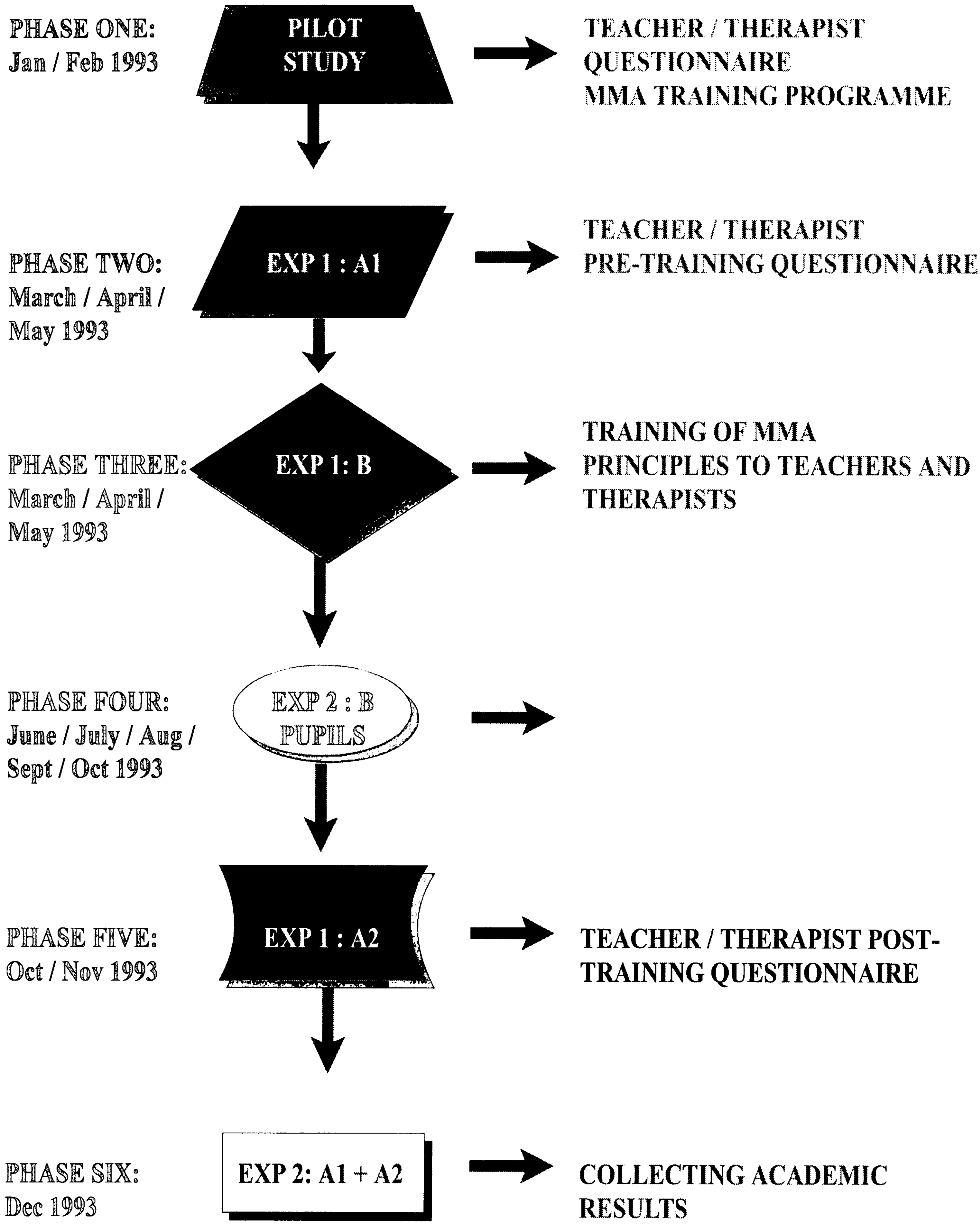


Figure 4.1 : Schematic layout of the order of the general procedure of the experiment

4.8.1.1. Phase one: The pilot study

The pilot study was conducted in two parts. The first part involved the application of the MMA programme in the training of 150 teachers and therapists cross-culturally. A survey was carried out by the researcher one month after completion of the training course using the interview method. The results indicated a positive response in that 70% of the teachers and therapists were using the method. However, one methodological problem became clear, in that the teachers and therapists requested hands-on training in the application of the principles. The MMA training course was consequently extended to include practical examples, as well as a three-hour practical session in the application of the MMA techniques in therapy and teaching situations.

The second part of the pilot study tested the questionnaire and involved a sample of fifteen teachers and ten therapists. The aim was to determine the effectiveness of the questionnaire in evaluating teachers' and therapists' knowledge, attitude and skills regarding the concepts of learning and the development of potential. The teachers and therapists were requested to read through the questionnaire and indicate, through the group interview technique, whether the language of the questions was clear, or whether any of the items was ambiguous, and whether the questions were phrased precisely enough to elicit the answers that the researcher was seeking. The results indicated that the questionnaire was able to fulfil its objectives and thus no changes were made.

4.8.1.2. Phase two (A1 of experiment 1): Pre-training questionnaire

The pre-training questionnaire was given to the teachers and therapists collectively just before the first session of training on day one of the MMA course. They were given 30-45 minutes to complete the questionnaire, which was then collected before training began.

4.8.1.3. Phase three (B of experiment 1): MMA training course

Phase three comprised a three-day (12 hour) MMA programme for the teachers and therapists. The details of the course are provided in Table 4.5. The table shows the time frame of the training, session breakdown, and the exact content covered trained in each session. Practical demonstrations were done using examples from the curricula of the schools involved as well as exercises in the training manual (Appendix IV).

Table 4.5 : The Procedure of the MMA Training Programme
Total Duration : 12 Hours

	Session	Time	CONTENTS	OBJECTIVE
DAY	1	30 min	**INTRODUCTION :** * Function of the brain * Synergy and geodesic principles * Human potential * Introduction to principles of MMA * Layout of course	* To increase the awareness of the geodesic and synergistic principles of the brain * To link above awareness to performance potentials
ONE	2	30 min	**VIDEO :** "The Enchanted Loom" A BBC Production on the latest research on the brain	* Reinforce principles discussed in introduction * Increase awareness of the potential of the brain * Stimulate thinking about brain and education
	3	15 min	**UPSIDE-DOWN DRAWING :** Participants have to copy an upside-down drawing	* The exercise provides practise of the synergy principles * To demonstrate how a difficult task becomes easy when synergy and geodesic principles are applied
	4	45 min	**PREPARATION :** * Brain-synergy exercises * Nutrition and the effect on the brain * Music and the brain * Relaxation * Visualisation	* Learning as an electrical-chemical process is explained and the effect of nutrition, music, relaxation and visualisation on the electrical-chemical process is discussed stressing the importance in relation to learning
	5	60 min	**EFFECTIVE READING SKILLS :** * Saccadic eye-movement theory * The pacer and hand movements * Mechanical eye movement exercises	* The important link between eye movements and comprehension is discussed and demonstrated. * Practice no how to achieve effective eye movements and hence improved comprehension is provided * Home programme given
	6	90 min	**LAWS OF MIND-MAPS :** * Discussion of laws of how to make mind maps * Demonstration of how to make mind-maps in all subjects	* A practical session by trainer demonstrating principles and the 'how' of mind-mapping * Course participants are required to copy the demonstrated mind-maps * Discussion of mind-maps and possible applications

	Session	Time	CONTENTS	OBJECTIVE
DAY	7	60 min	**JIG-SAW PUZZLE :** * The Overview * The Preview * The In-view * The Golden Rule for concept selection	* The metacognitive approach to identifying concepts is demonstrated and practised * The steps involved in making lesson summaries and mind-maps from books is explained and demonstrated
TWO	8	60 min	**REVIEW AND MEMORY :** * Memory rhythms * Creative visualisation * Mnemonics * Study periods	* The concept of taxon and locale memory and memory rhythms is explained. How mind-mapping facilitates more effective storage and recall is explained and demonstrated * The difference between rote-learning and thinking learning is demonstrated and explained
	9	30 min	**SUMMARY OF THE MMA :** Summary of all the geodesic principles of the MMA	* Consolidation of the principles of the MMA
	10	60 min	**PROGRAMME 1 :** * Story analysis and metacognition * Steps involved in applying the MMA Principles in therapy and teaching * The importance of geodesic principles in activating the metacognitive and cognitive level	* To understand the concepts involved in story analysis and the importance of training the metacognitive level * How to apply mind-mapping principles as a framework for teaching and therapy * To understand the importance of using geodesic frameworks in order to release potential.
DAY	11	120 min	**TEACHING MIND-MAPPING :** * How to teach mind-mapping to pupils of different ages * Demonstration of mind-mapping in all subjects as a teaching tool and study method	* To understand the different types of mind-maps * How to select and teach mind-maps according to age * Understanding the use of mind-maps as a study tool
THREE	12	120 min	**PRACTICAL SESSION :** * Practical session where course participants create own mind-maps on work related to their teaching subjects and type of therapy * Discussion of how to implement MMA geodesic principles in their school	* Course participants practice mind-mapping their own work individually and in groups under supervision. * Discussion encouraging participants to actively plan how they are going to implement the MMA geodesic principles

4.8.1.4. Phase four (B of experiment 2): Application of the MMA principles in education and therapy

From July to November, the teachers and therapists were expected to apply the concepts learned in the training programme in their education and therapy. They were encouraged to apply the principles in the presentation of lessons and therapy activities, as well as to teach the pupils how to use the methods as a study aid and research tool.

4.8.1.5. Phase five (A2 of experiment 1): Post-training questionnaire

Five months after the MMA training programme, the teachers were given the questionnaire again plus an additional four questions (section F). This was done by going to each of the three schools where the purpose of the post questionnaire was explained to the teachers and therapists collectively. They were given two days to complete the questionnaires, after which the researcher collected them from the school secretaries.

4.8.1.6. Phase six (A1 and A2 of experiment 2): The pupils' academic results

The researcher obtained the pupils' 1991, 1992 and 1993 academic results from the promotion schedules in the record files of the schools. This was done over the last two days of the 1993 school year.

4.8.2. DATA COLLECTION

The data for the teachers and therapists were collected from the pre and post questionnaires. The data for the pupils were collected from the promotion schedules for 1991, 1992 and 1993 in the record files in the office of each of the schools involved in the study.

4.8.3. DATA ANALYSIS AND INTERPRETATION

4.8.3.1. Recording procedures

The responses of the teachers and therapists to the questionnaire were coded according to which element of which question was selected. For example, if there were three options and a respondent chose the second, a 2 was recorded in the adjacent column on the questionnaire (see Appendix I). These codes were then recorded on the punch card processing sheets and fed into the computer as the raw data.

The data for the pupils were recorded by accurately tabulating the academic results for 1991, 1992 and 1993 onto the data collection forms (see Appendix V). These results were then recorded onto punch card processing sheets and fed into the computer as raw data.

4.8.3.2. Analysis Procedures

Statistical analysis provides "a quantitative method and a set of rules to determine if a particular experimental effect is reliable" (Kazdin, 1975: 286). However, certain data do not conform to a Gaussian curve and therefore the assumptions of normal distributions, means and standard deviations do not apply. Consequently different statistical approaches are required that will deal with non-normal curve data taking the singular characteristics of such data into account; this is known as non-parametric statistics (Leedy, 1989). The Wilks test (Lehmann, 1975) was used to test the data of the current research for normality and it was found that the data of the current study fell within the confines of non-parametric statistics due to their non-normal nature. The system of non-parametric statistics requires larger samples in order to yield the same level of significance as parametric testing (Leedy, 1989). For this reason, the current study had large sample sizes - 45 teachers and therapists and 790 pupils.

For the teacher/therapist group, the Wilcoxon signed rank test (Lehmann, 1975) was used to compare the pre versus post scores for the six categories of the questionnaire. The Wilcoxon signed rank test was also used to compare the pre and post values of the age, language and qualification groups. Descriptive statistics in terms of means and frequencies were obtained for each of the above groups.

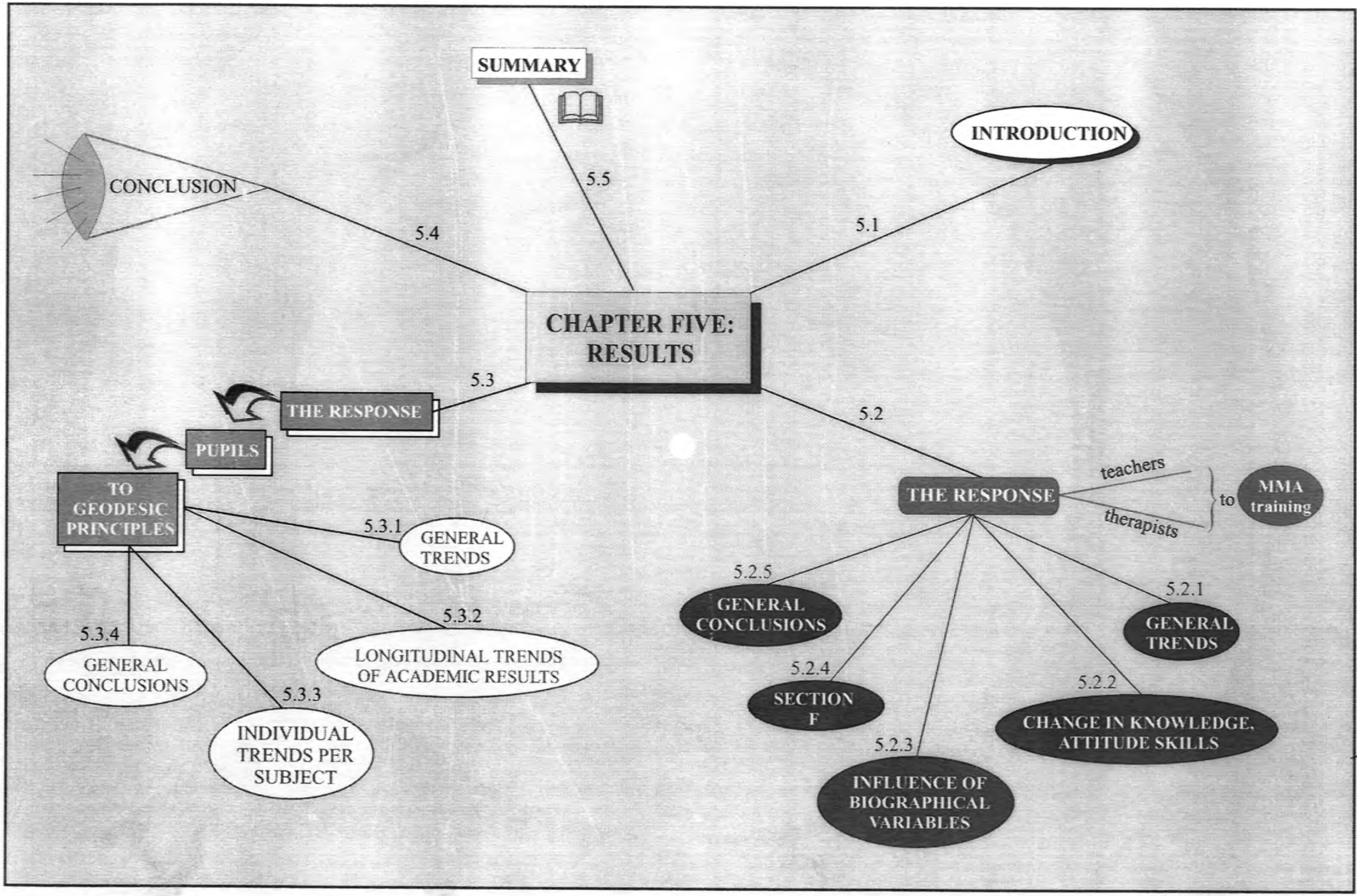
For the pupils, the dataset of results obtained from the first pupil group could not be used alone as there was too much dependency in the data which was not accountable. It was therefore merged with the dataset comprising the results of the second pupil group and procedures were applied to account for the dependency, as a result of which dataset three was formed. The Friedman test (Lehmann, 1975) was done on dataset two in order to establish the historical longitudinal data trend. This is a two-way analysis of variance procedure because the data were dependent. In order to establish the particular differences, a multiple comparison test based on Friedman sums was done.

Due to the structure of the data in dependent and independent subsets in the third pupil group, a combination test based on the Wilcoxon signed rank test (Lehmann, 1975) and the Wilcoxon rank sum test (Lehmann, 1975) was carried out. This testing was purer in that it made provision for the independent and dependent data. Descriptive statistics such as means, standard deviations and frequencies for the above two datasets were also established. This testing was used to establish the longitudinal trends of academic results in the remedial primary schools in general, per phase, per standard, and finally, intralongitudinally per subject.

The statistical results for both groups of subjects - the teachers/therapists, and the pupils - were represented using bar graphs for interpretation purposes.

4.9. SUMMARY

This chapter describes the planning and the implementation of the research, which investigates the efficacy of the MMA as an alternative approach to facilitate geodesic learning.
The aims and hypotheses are based on the premise that the MMA is an effective framework, underpinned on a model of geodesic learning, that will effect a change from traditional to the preferential geodesic learning. The tectonic structure of the research design, an adapted ABA design, is presented. The selection of the subjects is explained. The procedure is then described in terms of six phases, namely: the pilot study; the pre questionnaire; the training of the teachers and therapists; the exposure of the pupils to the MMA methods; the post questionnaire; and the collection of the pupils' academic results. Finally, the collection, recording and analysis of the data are elaborated on.



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CHAPTER FIVE: RESULTS

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5.5. SUMMARY 198

5.1. INTRODUCTION

The purpose of this study was to determine the effectiveness of the MMA training programme as a consultative tool for empowering teachers and therapists to create geodesic learning environments that will improve the thinking, learning and intellectual potential of their students.

In order to determine and draw conclusions about behaviour change, the experimental criteria are invoked to evaluate data (Risley, 1970, in Leedy, 1989). The experimental criteria determine whether intervention (in this instance the MMA training) has had a reliable effect on the behaviour (the teachers' and therapists' knowledge, attitude and skills regarding geodesic learning principles). Therefore this criterion is met when there is a reliable change in the subjects behaviour under specific experimental conditions (Uys, 1989).

In the current research, the experimental criteria will have been met if there is a statistically significant change in the teachers' and therapists' knowledge, attitude and skills regarding geodesic learning principles; and if this change in the teachers and therapists results in the improved academic performance of their pupils.

In order to evaluate whether the experimental criterion has been met, the data will be described in different ways, namely: qualitative analysis of the descriptive data and quantitative statistical analyses. The aim of this chapter is therefore to present the results of the correlation phases according to the aims of this study in order to describe the trends that occurred. Finally, the efficacy of the MMA training programme in effecting changes from traditional to more geodesic philosophies in the learning environment of therapy and teaching situations, will be discussed to determine whether the experimental criteria have been met.

5.2. RESPONSE OF THE TEACHERS AND THERAPISTS TO THE MMA TRAINING PROGRAMME: THE FIRST MAIN AIM

This section deals with the first main aim of the study, which was to determine the effect on teachers and therapists of the MMA training. The responses obtained from the pre- and post-training questionnaire are presented statistically and descriptively. A summary of the general trends is followed by detailed results corresponding to each of the sub-aims.

5.2.1. THE GENERAL TRENDS

Non-parametric statistical analysis of the pre and post questionnaires revealed a significant improvement in the teachers' and therapists' knowledge, attitude and skills regarding the geodesic learning principles of the MMA (Table 5.1). From this it would appear that the MMA training succeeded as a vehicle for effecting the change from traditional to more geodesic approaches in therapy and teaching.

More specifically, the scores in four of the six categories (Knowledge Metacognition; Attitude Neuropsychology; Skills Neuropsychology; Skills Metacognition) were statistically significant. Although the Knowledge Neuropsychology category did not show a significant improvement; the trend was positive, indicating that slight improvement may have occurred. In the last category (Attitude Metacognition), the trend was slightly, but not significantly, negative, indicating that change for the worse may have taken place.

When the trends were broken down according to various biographical variables (age, language and qualifications of the teachers and therapists), the overall results were as follows. The middle age group (31 to 50 years) showed the most significant improvement, followed by the younger age group (20 to 30 years). In terms of language, both the English-speaking and Afrikaans-speaking groups showed a significant improvement in knowledge, attitude and skills, with the Afrikaans group demonstrating more improvement. The bilingual group did not show a significant improvement although the trend was positive.

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<u>Table 5.1</u> : The change in knowledge, attitude and skills regarding the geodesic principles of the MMA

Results of the Wilcoxon Signed Rank Test: Comparing the 6 Pre vs Post Learning Categories of the Questionnaire (N = 45)					
CATEGORY	**PRE**		**POST**		**P-VALUE**
		S		**S**	**≤ 0.05**
KNOWLEDGE NEUROPSYCHOLOGY (KN)	0.61	0.11	0.63	0.06	0.2821
KNOWLEDGE METACOGNITION (KM)	0.45	0.10	0.54	0.10	0.0001 *
ATTITUDE NEUROPSYCHOLOGY (AN)	0.73	0.12	0.78	0.09	0.0067 *
ATTITUDE METACOGNITION (AM)	0.55	0.10	0.53	0.11	0.2363
SKILL NEUROPSYCHOLOGY (SN)	0.30	0.17	0.39	0.10	0.0003 *
SKILL METACOGNITION (SM)	0.48	0.10	0.55	0.10	0.0001 *
TOTAL SCORES (All six categories above)	**0.51**	**0.077**	**0.57**	**0.07**	**0.0001 ***

S = Standard deviation

With regard to the subjects' qualifications, the group that had a teaching qualification plus an extra qualification such as remedial or special education showed the most significant improvement. The group of other "professional" (speech-language therapists, psychologists, remedial teachers and occupational therapists) also demonstrated a significant improvement but not as much as the first group. The group that had only a teaching qualification did not show a significant improvement but the trend was still positive indicating that improvement did occur.

5.2.2. CHANGE IN KNOWLEDGE, ATTITUDES AND SKILLS REGARDING GEODESIC LEARNING PRINCIPLES

This section reports in detail on the teachers' and therapists' knowledge, attitudes and skills before and after the MMA training programme and the change that occurred.

5.2.2.1. Levels of knowledge, attitudes and skills before training

This information is presented in Table 5.1. and in more detail in the pre-training sections of Tables 5.2a-e and Figures 5.1a-e. The results revealed higher levels of neuropsychological and metacognitive knowledge than predicted pre-training. With regard to attitude, neuropsychological concepts were viewed by the teachers and therapists as being more important than metacognitive concepts. Lastly the teachers and therapists considered their skills regarding geodesic principles inadequate.

5.2.2.2. Levels of knowledge, attitudes and skills after training

This information is presented in Table 5.1. The overall statistical result across all six categories (Knowledge Neuropsychology, Knowledge Metacognition, Attitude Neuropsychology, Attitude Metacognition, Skills Neuropsychology and Skills Metacognition) indicates that a significant change occurred in the teachers' and therapists' knowledge, attitude and skills regarding metacognitive and neuropsychological concepts after training. This implies that the MMA programme was successful. However, an analysis of the individual categories and questions within the categories reveals that this change, although significant, did not occur to the extent predicted.

The means within the Knowledge Neuropsychology category changed from 0,61 per cent to 0,63, a non-significant change. The mean of 0,61 is fairly high, indicating that the respondents had a good knowledge of neuropsychological concepts prior to training.

Table 5.2a : The change in Neuropsychological Knowledge (KN)

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	YES	UNSURE	NO	YES	UNSURE	NO
B1	93.3%	0%	6.7%	88.9%	4.4%	6.7%
B2	84.4%	8.9%	6.7%	88.9%	4.4%	6.7%
B3	91.1%	6.7%	2.2%	88.9%	11.1%	0%
B4	4.4%	8.9%	86.7%	0%	6.7%	93.3%
B7	26.7%	11.1%	62.2%	13.3%	6.7%	80%
B9	88.9%	2.2%	8.9%	88.9%	8.9%	2.2%
B11	75.6%	22.2%	2.2%	86.7%	8.9%	4.4%
B13	97.8%	0%	2.2%	95.6%	4.4%	0%
B18	86.7%	8.9%	4.4%	93.3%	4.4%	2.2%

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	EXPERT	SOME	LITTLE	EXPERT	SOME	LITTLE
C1	8.9%	57.8%	33.3%	2.2%	88.9%	8.9%
C3	8.7%	64.4%	26.7%	4.4%	86.7%	8.9%
C8	4.4%	62.2%	28.9%	2.2%	80%	17.8%
C9	6.7%	71.1%	22.2%	6.7%	86.7%	6.7%

QUESTION	PRE-TRAINING VALUES					POST-TRAINING VALUES				
	ELEMENTS					ELEMENTS				
	1	2	3	4	5	1	2	3	4	5
E2	64.4%	68.9%	26.7%	20%	4.1%	80%	80%	28.9%	22.2%	13.3%
E3	6.7%	77.8%	6.7%	4.4%	0%	6.7%	91.1%	15.6%	2.2%	

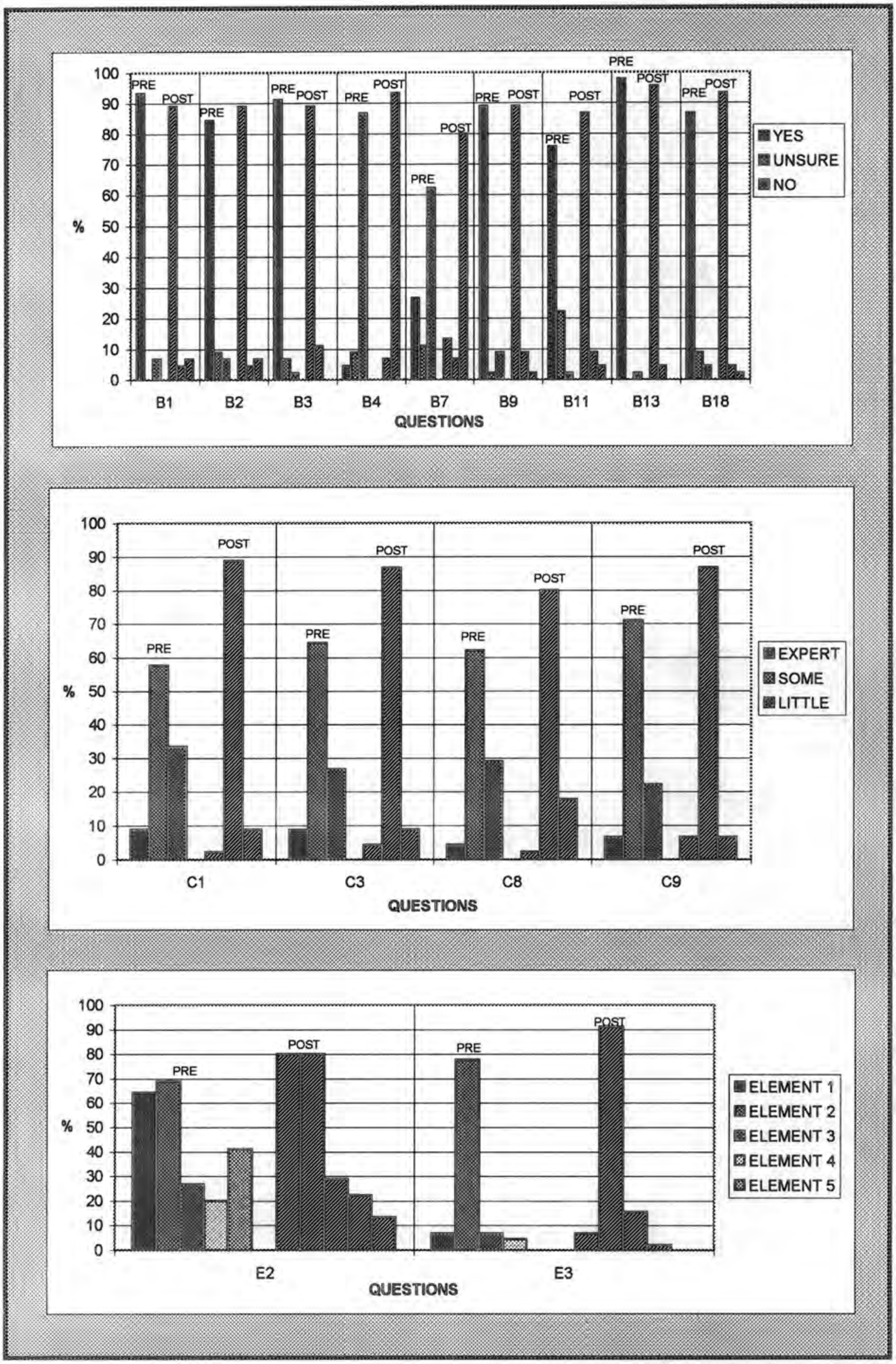

Figure 5.1a : The Change in Neuropsychological Knowledge (KN)

Table 5.2b : The change in Metacognitive Knowledge (KM)

QUESTION	PRE-TRAINING QUESTIONNAIRE VALUES			POST-TRAINING QUESTIONNAIRE VALUES		
	YES	UNSURE	NO	YES	UNSURE	NO
B13	97.8%	0%	2.2%	95.6%	4.4%	0%
B14	11.1%	28.9%	60%	22.2%	13.3%	64.4%
B15	57.8%	20%	22.2%	48.9%	20%	31.1%
B16	26.7%	28.9%	44.4%	51.1%	20%	28.9%
B17	88.9%	4.4%	6.7%	93.3%	0%	6.7%

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	EXPERT	SOME	LITTLE	EXPERT	SOME	LITTLE
C2	8.9%	31.1%	60%	2.2%	77.8%	20%
C4	6.7%	82.2%	11.1%	6.7%	91.1%	2.2%
C5	6.7%	75.6%	17.8%	17.8%	82.2%	0%
C6	15.6%	64.4%	20%	17.8%	82.2%	0%
C7	8.9%	62.2%	28.9%	13.3%	77.8%	8.9%

QUESTION	PRE-TRAINING VALUES					POST-TRAINING VALUES				
	ELEMENTS					ELEMENTS				
	1	2	3	4	5	1	2	3	4	5
E1	0%	11.1%	2.2%	4.4%	71.1%	8.9%	15.6%	6.7%	11.1%	86.7%
E4	17.8%	8.9%	8.9%	13.3%	4.4%	26.7%	17.8%	11.1%	28.9%	11.1%
E5	13.3%	13.3%	37.8%	15.6%	17.8%	24.4%	13.3%	40%	28.9%	24.4%

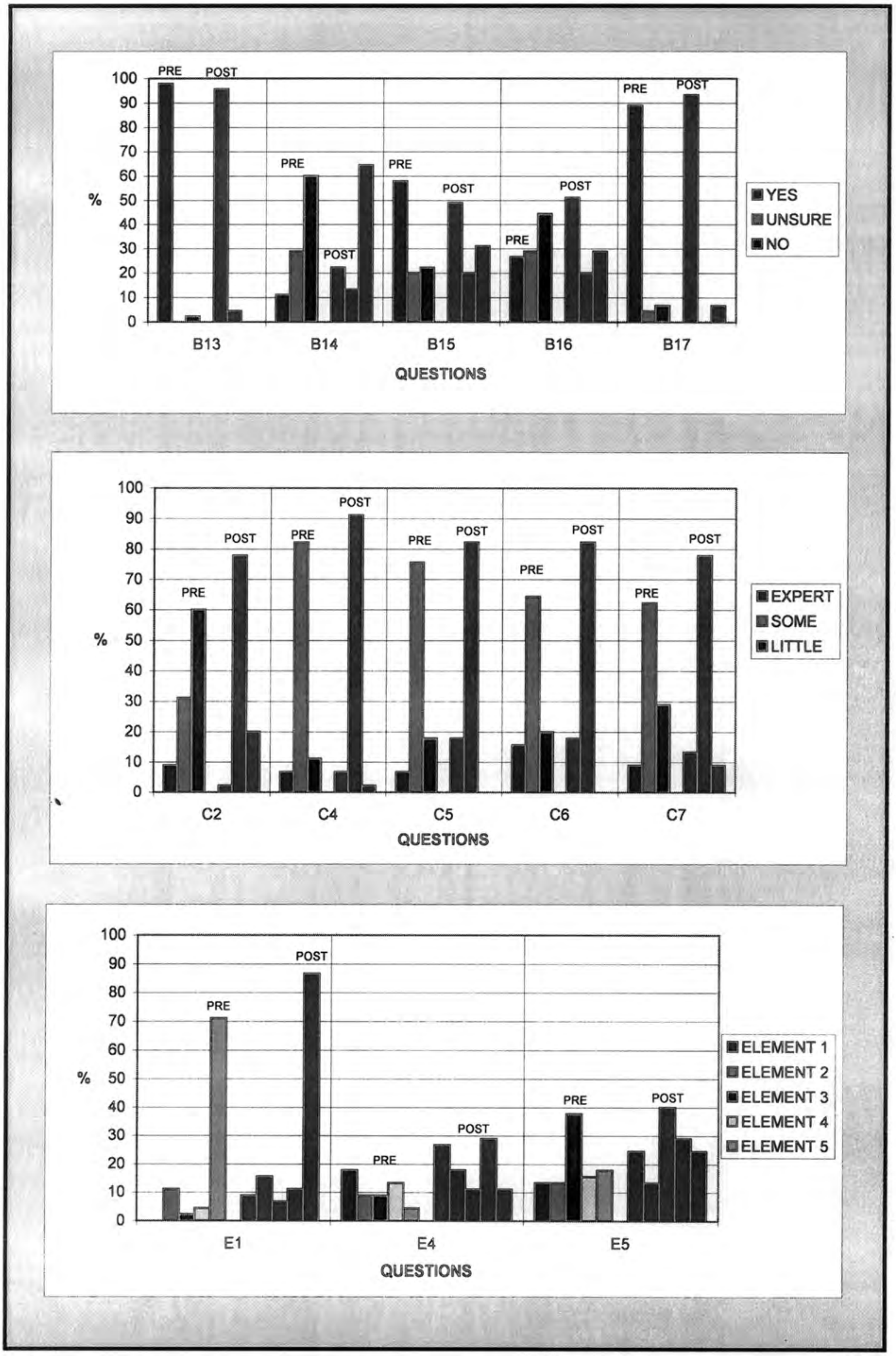

Figure 5.1b : The change in Metacognitive Knowledge (KM)

Table 5.2c : The change in attitude towards Neuropsychological Concepts (AN)

QUESTION	PRE-TRAINING VALUE			POST-TRAINING VALUE		
	YES	UNSURE	NO	YES	UNSURE	NO
B2	84.4%	8.9%	6.7%	88.9%	4.4%	6.7%
B3	91.1%	6.7%	2.2%	88.9%	11.1%	0%
B10	62.2%	8.9%	28.9%	77.8%	4.4%	17.8%
B11	75.6%	22.2%	2.2%	86.7%	8.9%	4.4%
B12	93.3%	4.4%	2.2%	88.9%	11.1%	0%
B13	97.8%	0%	2.2%	95.6%	4.4%	0%
B16	57.8%	20.0%	22.2%	51.1%	20.0%	28.9%
B18	86.7%	8.9%	4.4%	93.3%	4.4%	2.2%

QUESTION	PRE-TRAINING VALUE				POST-TRAINING VALUE			
	NO IMP.	SOME IMP.	GREAT IMP.	VERY IMP.	NO IMP.	SOME IMP.	GREAT IMP.	VERY IMP.
D2	0%	20%	35.6%	44.4%	0%	15.6%	37.8%	46.7%
D3	2.2%	11.1%	37.8%	48.9%	6.7%	2.2%	42.2%	48.9%

QUESTION	PRE-TRAINING VALUE					POST-TRAINING VALUE				
	ELEMENTS					ELEMENTS				
	1	2	3	4	5	1	2	3	4	5
E2	64.4%	68.9%	26.7%	20%	4.4%	80%	80%	28.9%	22.2%	13.3%
E3	6.7%	77.8%	6.7%	4.4%	0%	6.7%	91.1%	15.6%	2.2%	2.2%

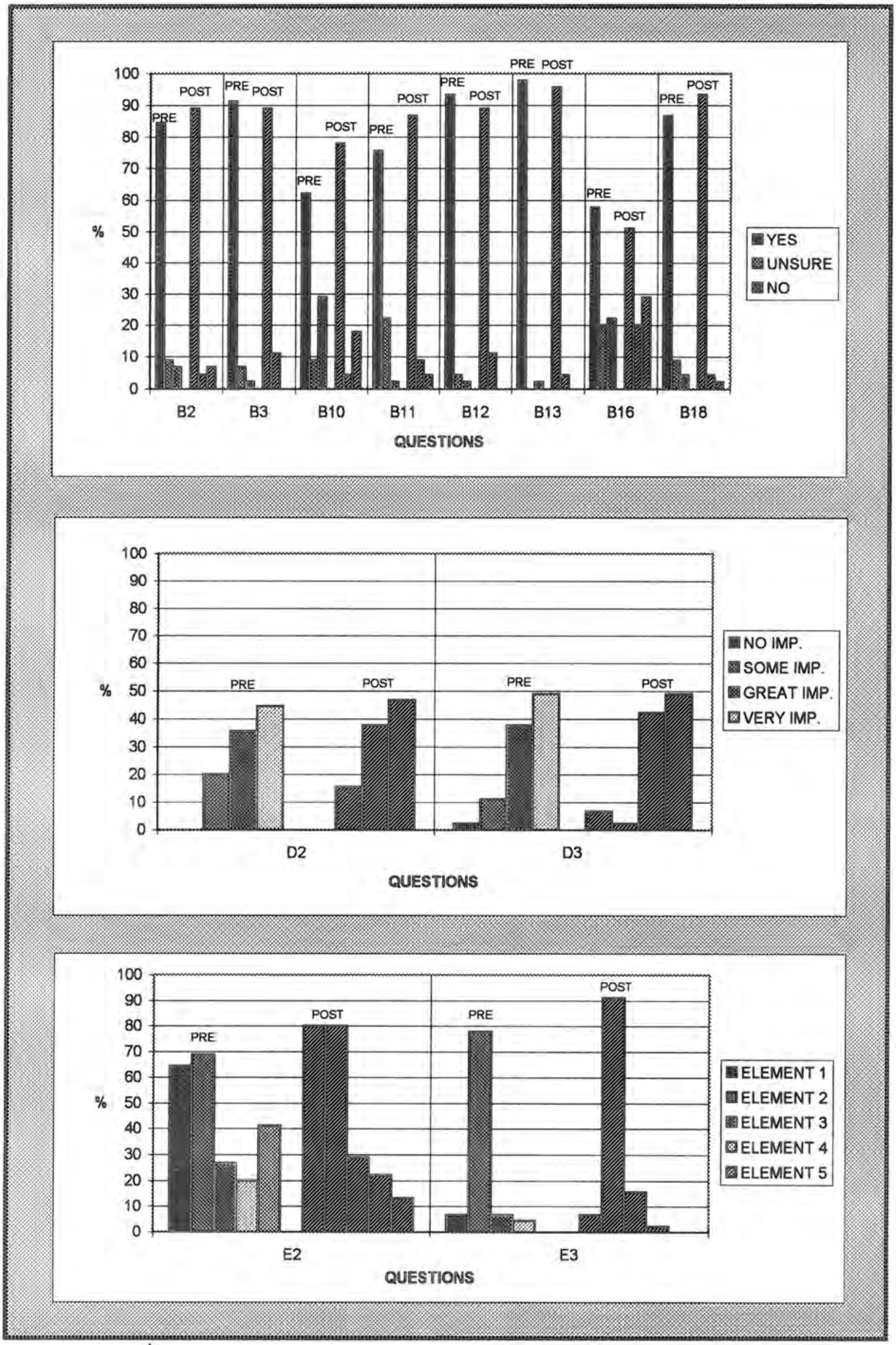

Figure 5.1c : The change in attitude towards Neuropsychological Concepts (AN)

lineup

Table 5.2d : The change in attitude towards Metacognitive Concepts (AM)

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	YES	UNSURE	NO	YES	UNSURE	NO
B3	91.1%	6.7%	2.2%	88.9%	11.1%	0%
B8	13.3%	26.7%	60%	15.6%	22.2%	62.2%
B6	46.7%	15.6%	37.8%	33.3%	44.4%	22.2%

QUESTION	PRE-TRAINING VALUES				POST-TRAINING VALUES			
	N.I.	S.I.	G.I.	V.G.I.	N.I.	S.I.	G.I.	V.G.I.
D1	4.4%	55.6%	20%	20%	13.3%	15.1%	20%	15.6%
D2	2.2%	46.7%	26.7%	24.4%	4.4%	33.3%	51.1%	11.1%
D3	6.7%	22.2%	37.8%	33.3%	6.7%	26.7%	40%	26.7%
D4	4.4%	24.4%	46.7%	24.4%	6.7%	28.9%	55.6%	8.9%
D5	17.8%	31.1%	33.3%	17.8%	26.7%	37.8%	28.7%	6.7%
D8	2.2%	8.9%	31.1%	57.8%	2.2%	15.6%	37.8%	44.4%
D10	2.2%	22.2%	24.4%	51.1%	2.2%	8.9%	22.2%	66.7%
D11	0%	15.6%	35.6%	48.9%	2.2%	6.7%	35.6%	55.6%
D12	0%	8.9%	40%	57.1%	4.4%	4.4%	35.6%	55.6%
D13	2.2%	6.7%	46.7%	44.4%	6.7%	28.9%	26.7%	37.8%
D14	4.4%	33.3%	37.8%	24.4%	8.9%	35.6%	24.4%	31.1%
D15	0%	2.2%	20%	77.8%	2.2%	4.4%	37.8%	55.6%

QUESTION	PRE-TRAINING VALUE					POST-TRAINING VALUE				
	ELEMENTS					ELEMENTS				
	1	2	3	4	5	1	2	3	4	5
E1	0%	11.1%	2.2%	4.4%	71.1%	8.9%	15.6%	6.7%	11.1%	86.7%
E4	17.8%	8.9%	8.9%	13.3%	4.4%	26.7%	17.8%	11.1%	28.9%	11.1%
E5	13.3%	13.3%	37.8%	15.6%	17.8%	24.4%	13.3%	40%	28.9%	24.4%

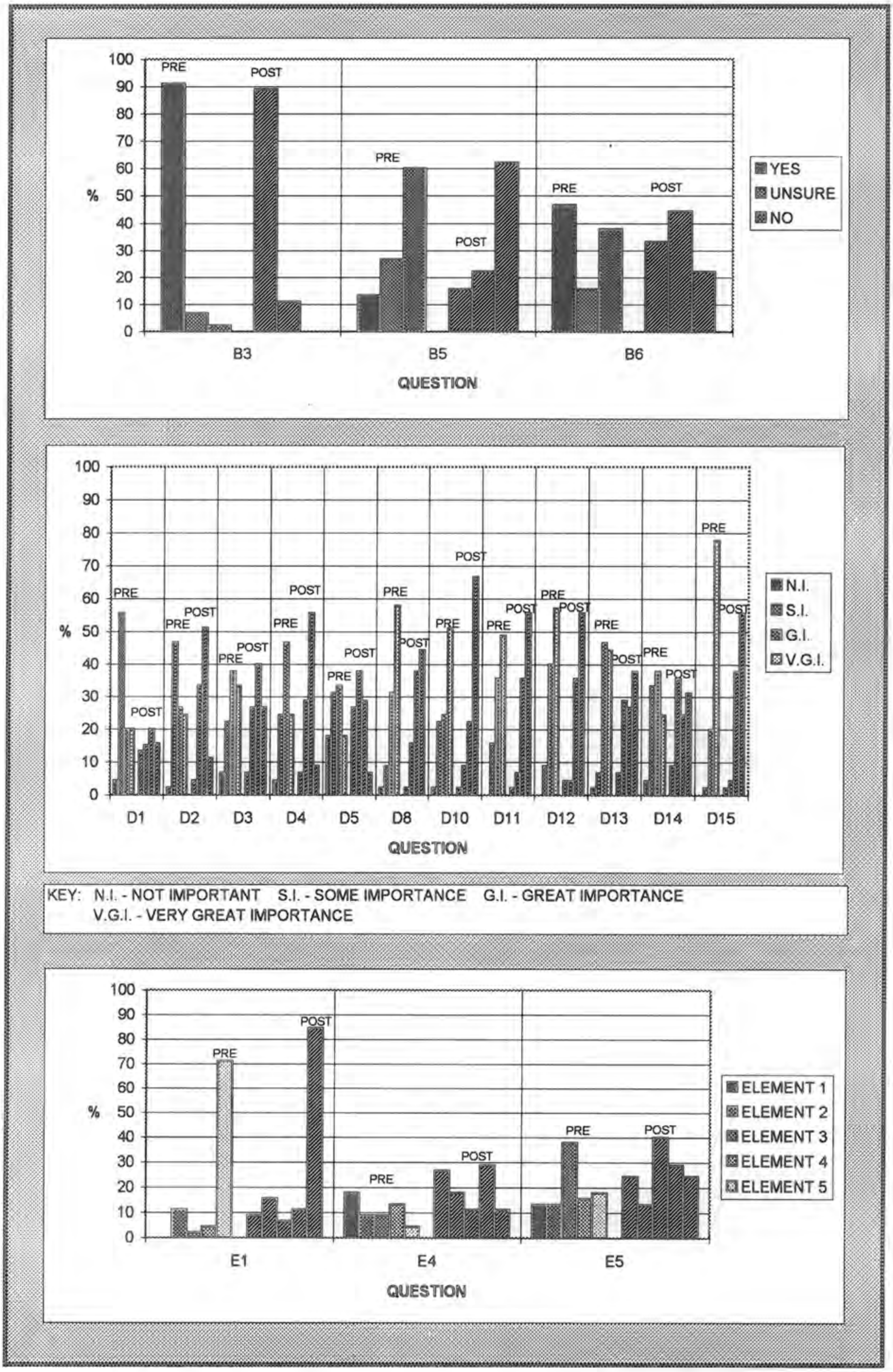

Figure 5.1d : The change in attitude towards Metacognitive Concepts (AM)

Table 5.2e **The change in Neuropsychological Skills (SN) and Metacognitive Skills (SM)**

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	YES	UNSURE	NO	YES	UNSURE	NO
B13	97.8%	0%	2.2%	95.6%	4.4%	0%
B14	11.1%	28.9%	60%	22.2%	13.3%	64.4%
B15	57.8%	20%	22.2%	48.9%	20%	31.1%
B16	26.7%	28.9%	44.4%	51.1%	20%	28.9%
B17	88.9%	4.4%	6.7%	93.3%	0%	6.7%

QUESTION	PRE-TRAINING VALUES			POST-TRAINING VALUES		
	EXPERT	SOME	LITTLE	EXPERT	SOME	LITTLE
C4	6.7%	82.2%	11.1%	6.7%	91.1%	2.2%
C5	6.7%	75.6%	17.8%	17.8%	82.2%	0%
C6	15.6%	64.4%	20%	17.8%	82.2%	0%

QUESTION	PRE-TRAINING VALUES					POST-TRAINING VALUES				
	ELEMENTS					ELEMENTS				
	1	2	3	4	5	1	2	3	4	5
E1	0%	11.1%	2.2%	4.4%	71.1%	8.9%	15.6%	6.7%	11.1%	86.7%
E4	17.8%	8.9%	8.9%	13.3%	4.4%	26.7%	17.8%	11.1%	28.9%	11.1%
E5	13.3%	13.3%	37.8%	15.6%	17.8%	24.4%	13.3%	40%	28.9%	24.4%

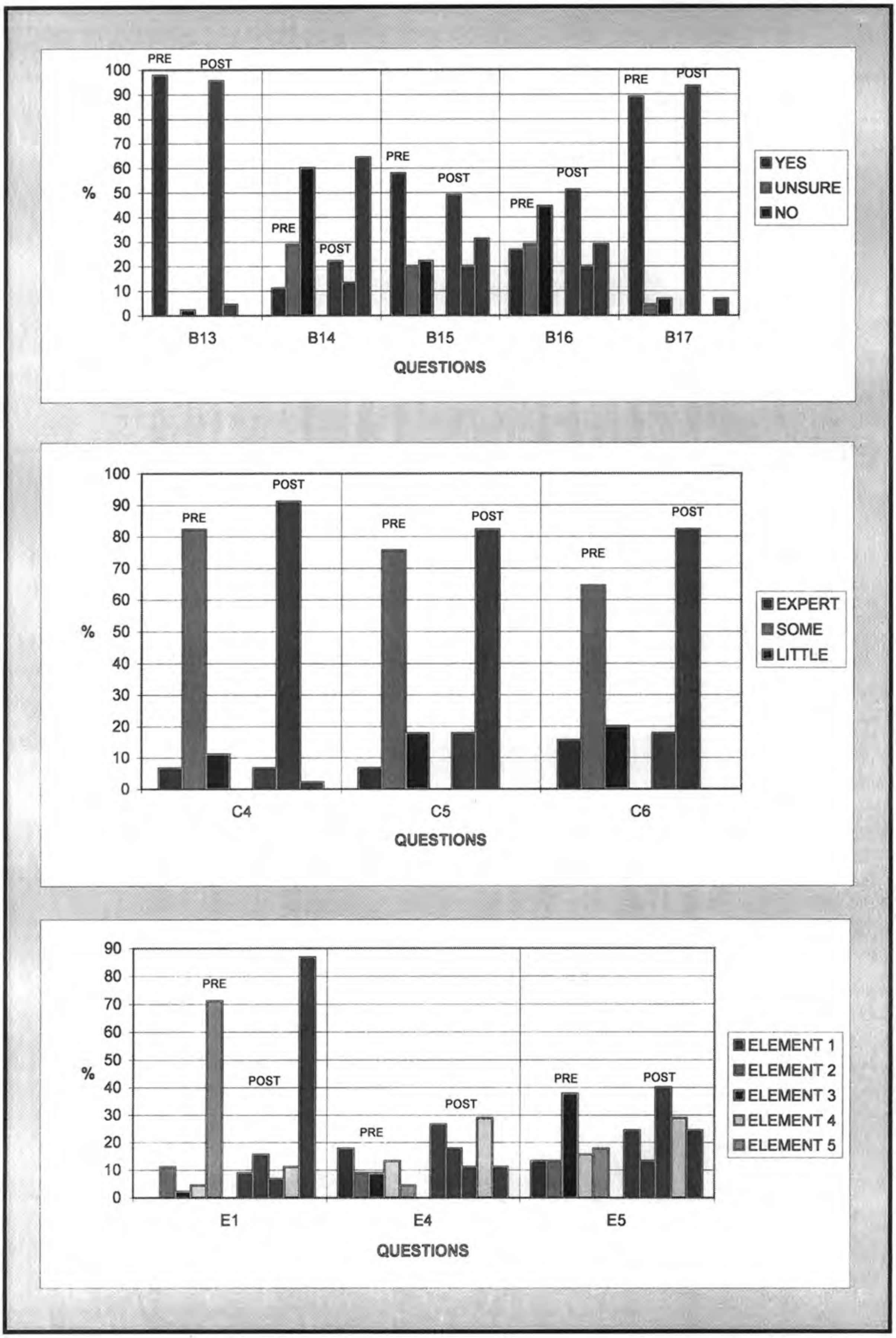

Figure 5.1e : The change in Neuropsychological Skills (SN) and Metacognitive Skills (SM)

The Attitude Neuropsychology category had even higher pre-training means (0,73), confirming that the respondents recognised the need to incorporate a more neuropsychological approach in teaching and education. The post-training mean for this category was 0,78, which was a significant change, implying that the respondents were more convinced of this fact after training.

By contrast, the means within the Knowledge Metacognition category were low before the training, but increased significantly after the training (0,54). However, the post-training means was still low, possibly indicating that the respondents' knowledge about metacognitive concepts was still weak. The respondents' attitude to metacognition was higher before the training (0,55) than their knowledge, but decreased after the training to 0,53, although this change is not significant. It appears that the respondents do not recognise the importance of metacognitive concepts.

In both the Skills Neuropsychology (SN) and Skills Metacognition (SM) categories, the means were low before the training (SN = 0,30; SM = 0,48). It is interesting to note that the Skills Neuropsychology category was lower than the Skills Metacognition category bearing in mind that the respondents' knowledge and attitudes were higher in respect of neuropsychology than metacognition before the training. Although both skills categories demonstrated significant changes after training, the means were still low (0,39 and 0,55 respectively).

In the ensuing sections a more detailed analysis of the respondents' answers in each of the six categories is provided. A qualitative analysis is provided through an examination of responses to specific questions.

5.2.2.3. The change in neuropsychological knowledge (KN)

Certain questions in the questionnaire were designed to analyse the teachers' and therapists' knowledge of neuropsychological concepts related to teaching and therapeutic situations. Table 4.4 shows which questions were concerned with this aspect and each of the other categories. The questions probed the teachers' and therapists' knowledge of brain-behaviour relationships and the importance of this knowledge in the learning situation.

More specifically, these questions dealt with the respondents' knowledge of how the brain functions, how a person learns, and whether this "how" knowledge will assist in the learning situation and in the release of potential. Also asked is whether a knowledge of the influence of music on the brain will influence learning; whether a knowledge of eye movements will influence reading; whether relaxing the brain affects learning; and whether a knowledge of how memory functions will improve learning. The objective was to determine the level of knowledge of the "how" of learning and whether the MMA training provided sufficient information to change these levels.

The overall statistical result for all the questions in this Knowledge Neuropsychology category (Table 5.2a and Figure 5.1a) indicates that there was a positive trend, as already discussed, but that this trend was not significant. Therefore, there was a slight improvement in the teachers' and therapists' overall knowledge of neuropsychological concepts after training.

However, the non-parametric statistical analysis of each of the Knowledge Neuropsychology questions on the pre and post questionnaire revealed that there was already a fairly high knowledge of the importance of the relationship between learning and the structure and function of the brain pre-training. For example, for question B1, prior to the MMA training 93,3% of the teachers and therapists (42 out of 45) indicated that a knowledge of the structure of the brain and its functioning in relation to learning is important. Only 6,7% of the teachers and therapists answered "no" to this question and none indicated that they were unsure. What is interesting to note is the change that occurred on this question after the exposure to the MMA training. Post-training frequencies revealed a drop in the "yes" category to 88,9% and a corresponding increase in the "unsure" category to 4,4%. The "no" category remained at 6,7%. Although not significant, this would seem to indicate that a few of the respondents felt more confused after the training than before. However, the high percentage of "yes" responses to question B1 would appear to indicate that the majority of the teachers and therapists are in agreement as to the importance of a knowledge of brain-behaviour relationships. This is in contrast to the traditional belief that this knowledge is not important.

A high percentage of "yes" responses on question B2 was also achieved by the respondents on the pre-training questionnaire but an improvement to 88,9% was achieved post-training.

Although this achievement was not significant, it was a positive trend indicating that some improvement in knowledge did occur.

The responses to question B3 followed a very similar pattern to the responses to question B1, whilst the responses to questions B4, 9, 11, 13, and 18 followed a similar pattern to the responses to question B2 (see Table 5.2a).

Question B7, which asked whether reading through one's work several times is the equivalent of learning, showed a much larger improvement after training than the other questions. Responses in the "no" category increased from 62,2% to 80%, with the "yes" and "unsure" category decreasing from 26,7% to 13,3% and 11,1% to 6,7% respectively. As this question was negatively stated, this is a positive result. This result is interesting in that the pre-training responses reflect the knowledge that most people have of how to learn, that is, by reading through one's work. The teachers' and therapists' knowledge in this regard changed considerably after the training, when they accepted that reading alone is not sufficient.

In section C, respondents had to indicate whether they had expert, some or little knowledge of certain concepts related to brain function and the learning process. These questions were slightly more ambiguously worded and thus more likely to identify what people really knew, as opposed to what they thought they ought to know (Jensen, 1995). In questions C1, 3, 8 and 9, the "some" category (that is, average knowledge) was the highest both pre- and post-training, but this category demonstrated much higher increases post-training than any of the categories in the section B questions.

For example, for question C1, which queried how much the teachers and therapists knew about one's eyes and the reading process, there was a 57,8% response in the "some" category pre-training. This increased to 88,9% post-training, with a corresponding decrease in the "little" knowledge category from 33,3% to 8,9%. These changes indicate an improvement in knowledge post-training.

In section E, respondents had to provide definitions for various concepts. In the Knowledge Neuropsychology category, these were "memory" and "visualisation". Each definition had five elements (see Appendix I), and respondents were credited for each element of the definition they provided. Table 5.5a provides the results of the statistical analysis of these responses. Examination of this table shows that there was a positive trend in that provision of elements of the definition by the respondents increased post-training. For example, for question E2, in the pre-training questionnaire 64,4% of the respondents were able to identify the first element of the definition of "memory". This rose to 80% post-training. Identification of the rest of the elements of both the "memory" and "visualisation" definitions showed similar improvements post-training, ranging from 2% to 13%.

In conclusion, in the Knowledge Neuropsychology category, although the overall trends were not significant, they were positive, indicating that some improvement in neuropsychological knowledge did occur post-training. The level of neuropsychological knowledge was already high pre-training, making it possible that the positive trend was evidence of a deeper understanding of existing knowledge levels, as opposed to a simple increase in knowledge levels and thus that an internal reconceptualisation as opposed to simple incrementalisation process occurred..

5.2.2.4. The change in metacognitive knowledge (KM)

The questions on the questionnaire that probed knowledge of metacognitive concepts are detailed in Table 4.4. These questions probed the teachers' and therapists' knowledge of the thought process; what it is and how it works; and the relationship of thinking to comprehension, problem-solving and learning in general. The objective of this section of the questionnaire was to evaluate understanding of metacognition and its importance in learning, and whether the MMA training provided sufficient information to change the level of understanding of the importance of applying metacognitive principles in teaching and therapy. Table 5.2b and Figure 5.1b provide the statistical results of the Knowledge Metacognitive category.

The overall statistical result for the Knowledge Metacognition questions indicate that significant change occurred in the teachers' and therapists' knowledge about metacognition. However, analysis of the individual questions revealed certain patterns in their perceptions. For questions B15, 16 and 17, the trend was positive, indicating an improvement in knowledge of metacognitive concepts in the post-training phase. For question B14, which queried whether reading faster would reduce the comprehension of the material being read, there was a different pattern. Prior to training, 60% of the teachers and therapists indicated "no", and post-training this increased to 64,4%. However, responses in the "yes" category increased significantly as well from 11,1% to 22,2%, which is a negative trend because reading faster does not reduce comprehension.

It appears that the teachers and therapists were mostly aware of the fact that reading faster does not reduce but enhances comprehension. This percentage is, however, low and thus does not affect the overall results. Responses to question B13 followed a similar pattern to B14.

Responses to all the C questions linked to the Knowledge Metacognition category demonstrated a significant positive change in terms of improved knowledge regarding metacognitive concepts. For example, question C6 probes knowledge about the nature of key concepts as opposed to key words, and how these relate to note-making, imagination and learning. Prior to training 64,4% of the teachers and therapists indicated that they had "some" knowledge; 20% indicated that they had "little" knowledge; and 15,6% indicated they had "expert" knowledge. In the post-training phase, the percentage of "some" responses increased to 82,2%, and of "expert" responses increased to 17,8%, whilst non-one indicated that they had "little" knowledge.

In the E questions, the teachers and therapists had to provide definitions for the concepts "learning", "accelerated learning" and "super teaching". Post-training, there was an increase in the identification of elements of the definition. For example, pre-training, no-one was able to identify element one of the definition of E1, "learning" (see Appendix II). After the training, identification of this element rose from 0% to 8,9%. Scores obtained on the remaining elements of the definitions showed an increase of between 2% and 16%.

In conclusion, it appears that the MMA training was successful in effecting a change in the teachers' and therapists' understanding of the importance of metacognition in the learning environment. However, the percentages in the pre-training phases were higher than predicted, and the percentages post-training were not dramatically higher than these. Thus the teachers' and therapists' knowledge levels in both categories (Knowledge Neuropsychology and Knowledge Metacognition) were higher than predicted to start off with and the MMA training possibly only consolidated this information. Once again, knowledge appeared to be reconceptualised as opposed to incrementalised.

5.2.2.5. The change in attitude towards neuropsychological concepts (AN)

Once again the specific questions on the questionnaire that probed this category are identified in Table 4.4. These questions examined the feelings, beliefs and behaviour tendencies directed towards brain-behaviour relationships, the learning situation and geodesic principles in order to determine the influence of attitude on the application of neuropsychological principles in teaching and therapy. Table 5.2c and Figure 5.1c present the statistical results in this category.

The overall statistical result for all the questions in the Attitude Neuropsychology category showed that a significant change took place. Analysis of the individual questions revealed certain patterns. Questions B2, 10, 11 and 18 showed improvements in the "yes" category with corresponding decreases in the "unsure" and "no" categories in the post-training phase. This indicates that there was a positive change in attitude of the teachers and therapists towards neuropsychological geodesic learning principles after training. For example, for question B10, which queries whether the average person is using limited brain potential, 62,2% of the respondents answered "yes" pre-training, 8,9% answered "unsure", and 28,9% answered "no". After the training, the "yes" scores increased to 77,8%; the "unsure" scores decreased to 4,4%, and the "no" scores decreased to 17,8%.

Questions B3, 12, 13 and 16 also demonstrated change, but in a negative as opposed to positive direction. For example, for question B16, which queries whether using a pacer whilst reading will improve comprehension, in the pre-training phase 57,8% responded "yes", 20% indicated "unsure", and 22,2% indicated "no". In the post-training phase, the "yes" responses decreased to 51,1%, the "unsure" responses stayed the same, and the "no" responses increased to 28,9%. The spread of these percentage was also very similar in this section, indicating that little change had taken place.

In questions D7 and 9, which queried whether imagination, intuition and playfulness, and feelings and random associations respectively are important in the learning situation, minimal change occurred. An increase did occur, but it was very small. For example, for question D7 the responses "of very great importance" only increased from 44,45 to 46,7%. This indicates that only one respondent changed their attitude.

In questions E2 and 3, which asked for definitions of memory and visualisation, there was a significant improvement in the correct identification of the elements of the definitions. This change ranged from 2% to 16%. For example, the percentage of respondents who correctly identified the first element of the definition of memory increased from 64,4% to 80%.

In conclusion, it appears that the MMA training did effect a change in the attitude of the teachers and therapists towards the importance of having a more neuropsychologically orientated approach to teaching and therapy. The low percentages and fairly even spreads, however, appear to indicate that although the attitudes of the teachers and therapists were influenced, they were not influenced significantly enough to induce major changes.

5.2.2.6. The change in attitude towards metacognitive concepts (AM)

The questions in the questionnaire relating to this category are identified in Table 4.4. These questions probed the teachers' and therapists' feelings, beliefs and behaviour tendencies towards thinking, both conscious and non-conscious, and towards the link between thinking and the learning situation. The objective of these questions was to investigate the influence of the MMA training on the attitude of the teachers and therapists towards incorporating metacognitive concepts in their teaching and therapy. Table 5.2d and Figure 5.1d provide the statistical results of this category.

The overall statistical result for all the questions of the Attitude Metacognition category indicate that no significant change took place. The trend for this category was in fact negative, whereas positive trends were found in the Knowledge Neuropsychology, Knowledge Metacognition and Attitude Neuropsychology categories already presented. This indicates either that the teachers' and therapists' attitude to metacognition was worse, or that they were more confused after training than before. For example, for question B6, which queried whether one works and achieves better under pressure, the percentage of teachers who answered "no" decreased from 37,8% to 22,2%, which was lower than predicted. However, the percentage who answered "yes" also decreased, from 46,7% to 33,3%, but the percentage who answered "unsure" increased from 15,6% to 44,4%. The increase in the unsure category indicates confusion. Similar patterns occurred with questions B3 and 8.

In the D section questions, which are particularly sensitive to attitudes towards metacognition, positive changes were determined for questions D1, 2, 3, 4, 5, 8, 10, 11 and

12, indicating that the trends changed according to what was predicted. However, the changes were minimal and the spread of percentages quite similar pre- and post-training. Therefore the changes that occured were not as large as predicted.

For example, for question D1, which queried whether the learning environment needs to be quiet and serious, in the pre-training phase 4,4% of respondents indicated this to be “of no importance” and 20% indicated this to be “of very great importance”. In the post-training phase, the first category increased to 13,3% and the “of very great importance” category dropped to 15,6%. The middle two categories stayed at similar percentages. Responses to questions D13, 14 and 15 also did not change in the direction predicted, that is, the attitudes were less in favour of geodesic principles than before training. Most respondents answered “of no importance” or “of some importance”, possibly indicating that the teachers and therapists were still not significantly convinced as to the effectiveness of geodesic principles, or that they were confused.

In the E questions, the ability to define “learning”, “accelerated learning” and “super teaching” improved. This possibly indicates that the respondents’ perception of learning was beginning to change, but because the percentages were low, there is still room for much change. However, this is in itself a positive result, as something was happening.

In conclusion, the results show that the MMA training did not influence the attitude of the teachers and therapists towards the importance of the incorporation of metacognitive concepts in therapy and teaching. However, a change in the respondents’ perception of learning was beginning to occur.

5.2.2.7. The change in skills in the application of neuropsychological and metacognitive principles (SN and SM)

It can be seen from Table 4.2 that the same questions probed the teachers’ and therapists’ skills in applying neurological principles and their skills in applying metacognitive principles. This section therefore considers the categories, Skills Neuropsychology (SN) and Skills Metacognition (SM) together. The objective of this section of the questionnaire was to determine how the teachers and therapists rated their skills in applying geodesic principles in the classroom and in therapy. Table 5.2e. and Figure 5.1e provide the statistical results of these categories.

The overall statistical result of all the questions in these two categories indicated that a significant positive change occurred. This indicates that when completing the post-training questionnaire, the teachers and therapists felt more able to apply the geodesic principles of the MMA in the classroom and therapy rooms. Responses to questions B13, 15, 16 and 17 changed significantly in the direction of an increase in knowledge post-training. B13 and 17 had high percentages prior to training, indicating a fairly high competence level in neuropsychological knowledge, which is consistent with previous discussions. B14 had a slightly negative answer indicating a possible confusion, and questions B15 and 16 had a fairly even spread across the three categories indicating that no dramatic changes occurred in the teachers' skills in those particular areas.

In the responses to the relevant questions from section C, the "some" category increased and the "little" category decreased, both significantly. The section E questions relevant to the skills categories, the definitions of "learning", "accelerated learning" and "super-teaching", once again showed significant improvement in terms of the identification of the elements of the definition, but these percentages were low as in the previous categories.

In conclusion, overall the teachers and therapists felt their skills had improved, but the low means indicate that there were not totally confident in their ability to apply neuropsychological and metacognitive concepts in teaching and therapy.

5.2.3. THE INFLUENCE OF BIOGRAPHICAL VARIABLES ON BEHAVIOUR CHANGE

The second sub-aim was to determine the influence of the biographical variables of age, language and qualifications of the teachers and therapists on the change in knowledge, attitude and skills regarding the geodesic principles of the MMA training programme.

In Tables 5.3a, 5.3b and 5.3c, the details of the respondents' age, language and qualifications are provided. Three age groups were formulated (Table 5.3a), namely, those teachers and therapists 30 years old or younger (group 1), those between the ages of 31 and 50 years (group 2); and those aged 51 or older (group 3). Of the 45 teachers and therapists, the largest number (20) fell into the middle category, followed by 17 in the older category, and 8 in the younger category.

Table 5.3a : The influence of age on the pre and post scores

AGE GROUP	N	PRE	POST	DIFF	P-VALUE
1					
(≤ 30 years)	8	0.5	0.57	0.07	0.0781 ** (p ≤ 1)
2					
(31-50 years)	20	0.51	0.57	0.06	0.0010 * ((p ≤ 0.05)
3					
(51+ years)	17	0.54	0.57	0.04	0.2769

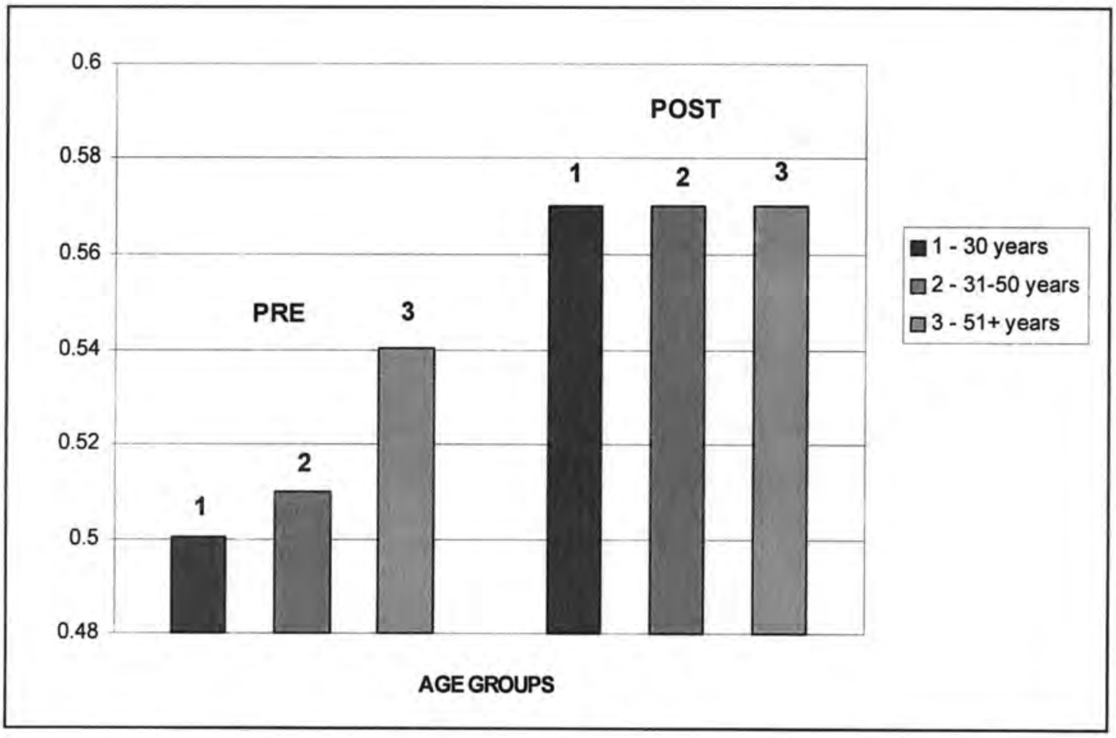

Figure 5.2a : The influence of age on the pre and post scores

Table 5.3b : The influence of language on the pre and post scores

LANGUAGE GROUP	N	PRE	POST	DIFF	P-VALUE
1					
English	25	0.51	0.56	0.04	0.0491 *
2					
Afrikaans	16	0.51	0.59	0.08	0.0010 *
3					
Eng / Afrik	4	0.56	0.58	0.02	0.6250

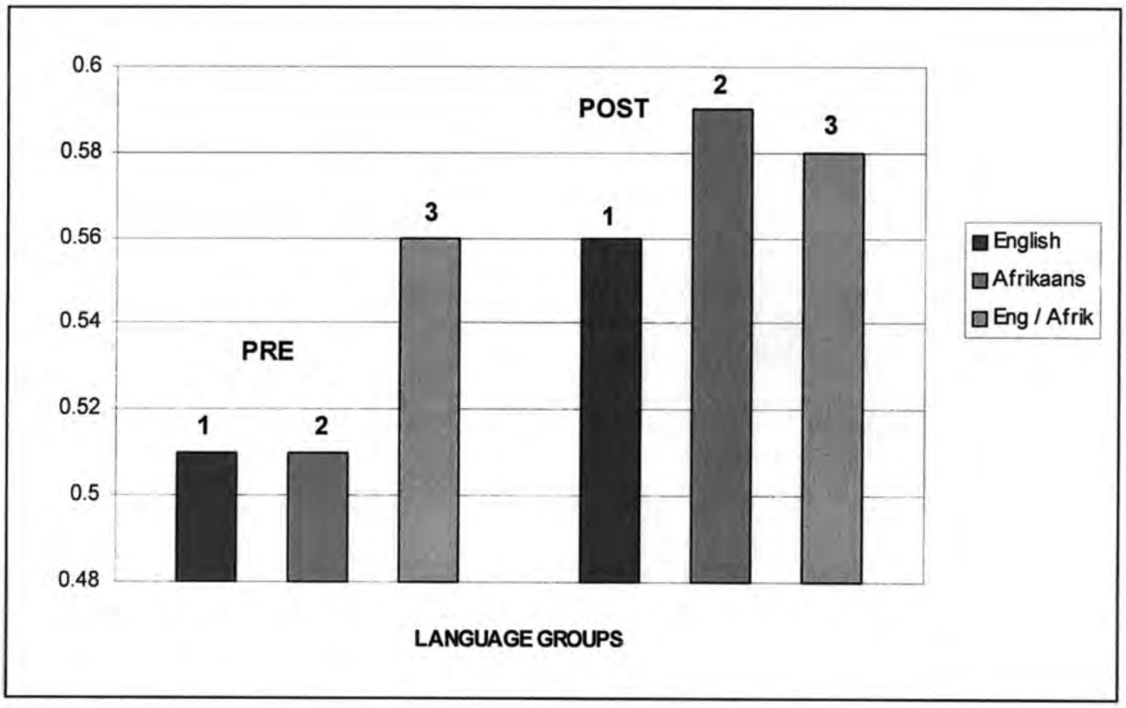

Figure 5.2b : The influence of language on the pre and post scores

Table 5.3c : The influence of qualifications on the pre and post scores

QUALIFICATION GROUP	N	PRE	POST	DIFF	P-VALUE
1					
Teaching	12	0.51	0.55	0.04	0.1748
2					
Teaching +	24	0.52	0.57	0.05	0.0082 *
3					
Professional	9	0.53	0.60	0.07	0.0391 *

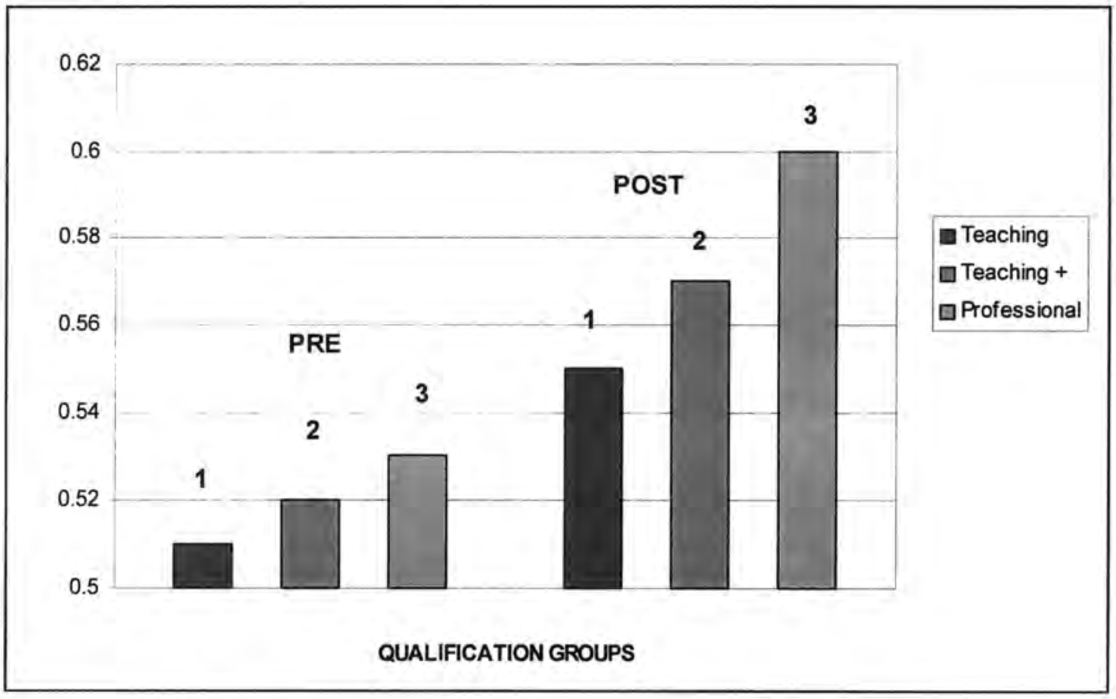

Figure 5.2c : The influence of qualifications on the pre and post scores

The respondents were also categorised into three groups with respect to language (Table 5.3b), namely English speaking (25); Afrikaans speaking (16) and bilingual (English and Afrikaans speaking) (4). In terms of qualifications (Table 5.5a) the respondents were categorised as those with a teaching qualification only (12); those with a teaching qualification plus an additional qualification such as remedial or special education (24); and the other "professional" group (speech-language therapists, psychologists, and remedial teachers (9).

The third sub-aim was to determine the influence of the variables of age, language and qualifications on the change in the teachers' and therapists' knowledge, attitude and skills regarding the geodesic principles of the MMA training programme.

5.2.3.1. The influence of age

The teachers and therapists was categorised into three groups with regard to age, namely:

- Group 1 - less than or equal to 30 years (n = 8)
- Group 2 - 31 to 50 years (n = 20)
- Group 3 - older than 50 years (n = 17).

Statistical analysis (see Table 5.3a and Figure 5.2a) revealed that group 2 showed the most significant improvement across all six categories on the questionnaire, indicating that this group responded the best to the MMA training. In group 1, the improvement was not significant on the 5% significance level, but was significant on the 10% significance level. This may be due to the small sample size. Although group 3 did not show a significant improvement on either significance level, a positive trend was identified indicating that improvement did occur.

An in-depth analysis of the results of each of the age groups (1, 2 and 3) in each of the six categories on the questionnaire now follows; these results are shown in Table 5.4a and Figure 5.3a.

In group 1, the youngest age group, only one of the six questionnaire categories, Skills Neuropsychology (SN) showed a significant improvement. The trend in the Attitude Metacognition category (AM) was slightly negative, but not significantly so, indicating that either no change took place or that the attitude to metacognitive concepts was slightly poorer after training than before.

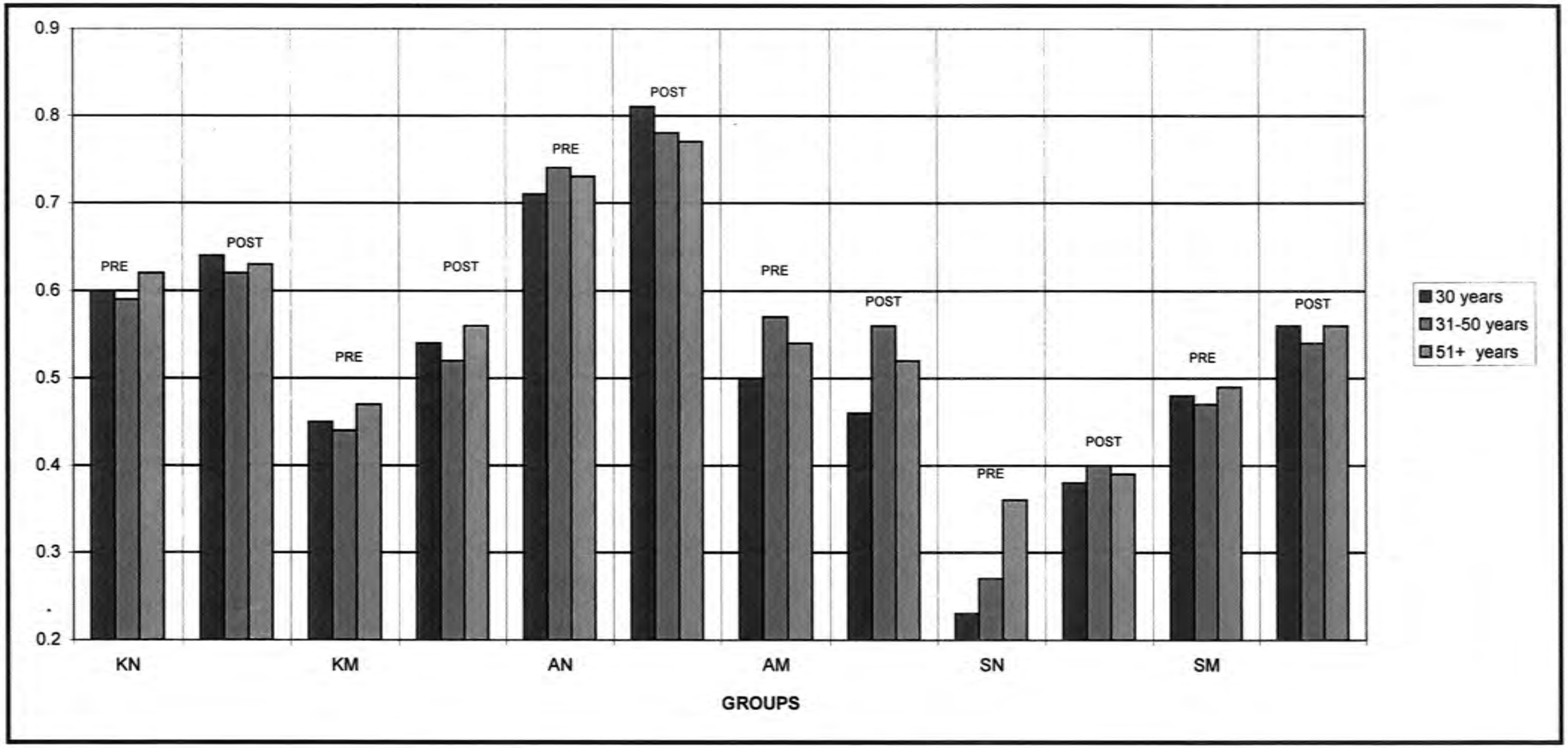

Figure 5.3a : The influence of age on the pre and post scores by learning category

KEY		
KN	=	Knowledge Neuropsychology
KM	=	Knowledge Metacognition
AN	=	Attitude Neuropsychology
AM	=	Attitude Metacognition
SN	=	Skills Neuropsychology
SM	=	Skills Metacognition

The other four categories (Knowledge Neuropsychology, Knowledge Metacognition, Attitude Metacognition and Skills Metacognition) all showed positive trends, indicating that improvement did occur, even though the changes were not significant.

In group 2, the middle age group, four of the six categories showed significant improvement, namely Knowledge Metacognition, Attitude Neuropsychology, Skill Neuropsychology and Skill Metacognition. Knowledge Neuropsychology showed a positive trend, although not significant. Attitude Metacognition showed a negative trend, as for group 1.

In group 3, the older age group, Knowledge Metacognition and Skills Metacognition demonstrated a significant improvement. Knowledge Neuropsychology, Knowledge Metacognition, Attitude Neuropsychology and Skills Neuropsychology all showed positive trends, although not significant. Once again Attitude Metacognition showed a negative trend.

In summary, group 2, the 31 to 50 year old category, showed the most improvement, that is, they responded the best to training, followed by the younger group (30 and under), then the older (over 50). In all age groups all the categories, except Attitude Metacognition, showed positive trends.

5.2.3.2. The influence of language

The teachers and therapists were categorised into three groups as to language, namely:

- ❑ Group 1 - English speaking
- ❑ Group 2 - Afrikaans speaking
- ❑ Group 3 - English and Afrikaans speaking.

Statistical analysis (see Table 5.3b and Figure 5.2b) revealed that groups 1 and 2 showed a statistically significant improvement overall. However, group 2's result was more significant than group 1 indicating that the Afrikaans group demonstrated the most improvement after training. Group 3 showed no significant improvement but the trend was positive. The lack of significance was probably due to the small sample size in comparison to the other two groups.

A detailed analysis of the results of each of the language groups in each of the six categories of the questionnaire follows; these results appear in Table 5.4b and Figure 5.3b.

In group 1, the English-speaking group, the categories Knowledge Metacognition and Skills Metacognition showed a statistically significant improvement. The categories Knowledge Neuropsychology, Knowledge Metacognition and Skills Neuropsychology showed improvement, although not significant. The trend in the Attitude Metacognition category was once again negative, although not significantly.

In group 2, the Afrikaans-speaking group, four of the six categories, Knowledge Metacognition, Knowledge Metacognition, Skills Metacognition and Skills Neuropsychology, showed significant improvement. In the category Knowledge Neuropsychology, the trend was positive, although not significantly. The trend in the Attitude Metacognition category was once again negative, but not significantly.

In group 3, English and Afrikaans speaking, no categories showed significant improvement. However, Knowledge Neuropsychology, Knowledge Metacognition, Skills Neuropsychology, and Skills Metacognition had positive trends. Both attitude categories, Knowledge Metacognition and Attitude Metacognition, were negative but not significantly so.

In summary, all trends for all the groups were positive except the Attitude Metacognition category and in one instance, the Knowledge Metacognition category. The Afrikaans group showed the most improvement as the positive trend was significant in more categories.

5.2.3.3. The influence of qualifications

Teachers and therapists were divided into three groups with regard to qualifications, namely:-

- Group 1 - teaching qualification
- Group 2 - teaching qualification plus another qualification, e.g. remedial, special education
- Group 3 – "professional" e.g. speech-language therapist, occupational therapist, psychologist, remedial teacher.

Table 5.4b : The influence of language on the pre and post scores by learning category

	KNOWLEDGE						ATTITUDE						SKILLS					
LANGUAGE GROUPS	**KN**			**KM**			**AN**			**AM**			**SN**			**SM**		
	PRE	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**
1 English n = 25	0.60	0.61	0.7246	0.45	0.53	* 0.0016	0.71	0.77	0.1310	0.52	0.50	0.3263	0.33	0.37	0.2610	0.47	0.55	* 0.0021
2 Afrikaans n = 16	0.62	0.65	0.3910	0.45	0.54	* 0.0067	0.74	0.80	* 0.0052	0.57	0.57	0.9399	0.24	0.42	* 0.0002	0.47	0.55	* 0.0084
3 Eng / Afrik n = 4	0.58	0.63	0.3750	0.51	0.55	0.2500	0.81	0.81	1.000	0.64	0.55	0.2500	0.28	0.38	0.5000	0.55	0.56	1.000

KEY:

KN = Knowledge Neuropsychology
KM = Knowledge Metacognition
AN = Attitude Neuropsycholgoy
AM = Attitude Metacognition
SN = Skills Neuropsychology
SM = Skills Metacognition

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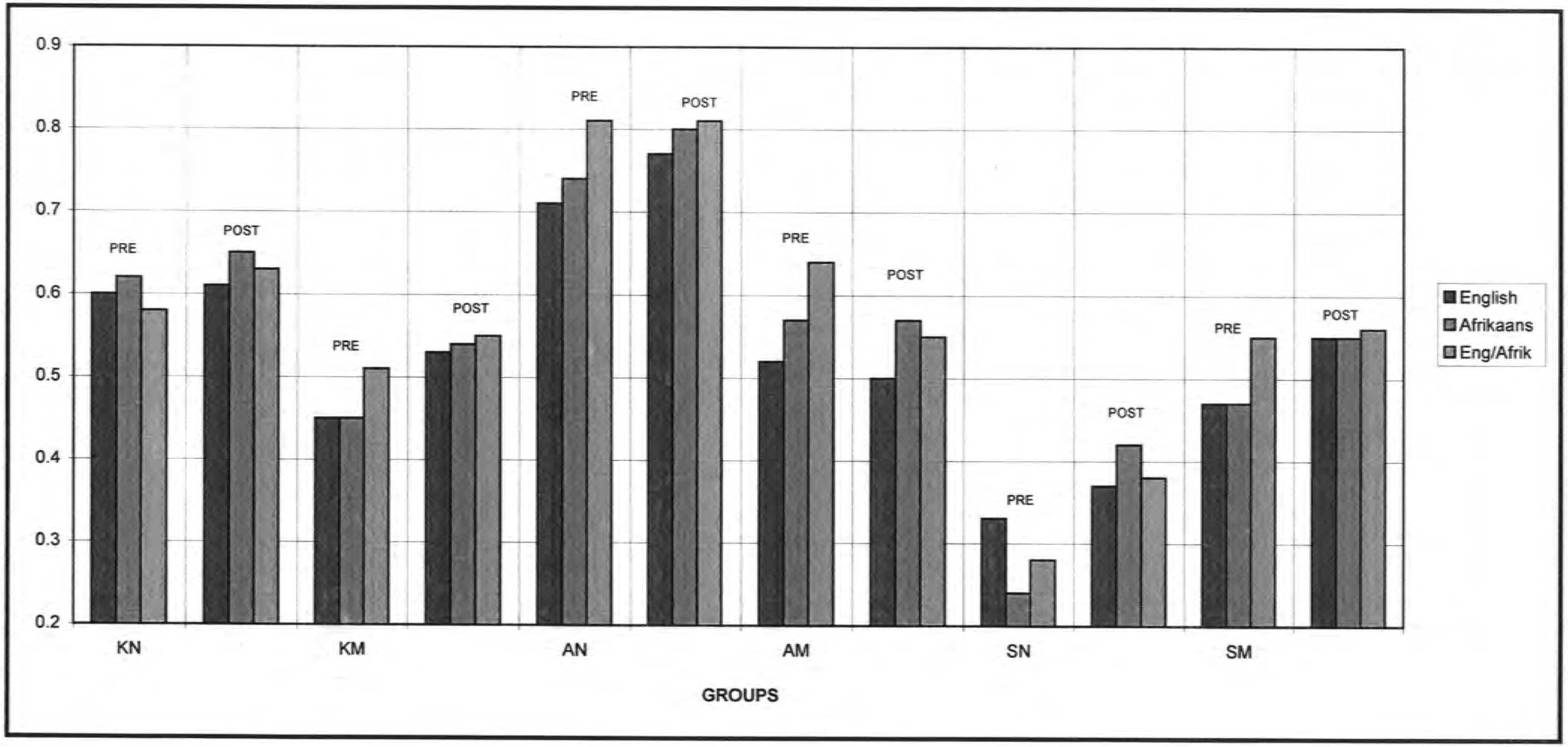

Figure 5.3b : **The influence of language on the pre and post scores by learning category**

KEY		
KN	=	Knowledge Neuropsychology
KM	=	Knowledge Metacognition
AN	=	Attitude Neuropsychology
AM	=	Attitude Metacognition
SN	=	Skills Neuropsychology
SM	=	Skills Metacognition

Statistical analysis (see Table 5.3c. and Figure 5.2c.) revealed that groups 2 and 3 showed significant improvement after training. In group 1 the trend was positive indicating improvement had occurred; however, this trend was not significant. This lack of significance was not due to the sample size as group 3 had a smaller sample size but the results were significant.

A detailed analysis of the results according to qualification group on the six categories of the questionnaire is now presented; these results may be found in Tables 5.4c and Figures 5.3c.

In group 1, only the Knowledge Metacognition showed significant improvement. The Knowledge Neuropsychology, Knowledge Metacognition, Skills Neuropsychology and Skills Metacognition categories all showed positive trends, although these were not significant. The Attitude Metacognition category was once again negative, although not significantly so.

In group 2, Knowledge Metacognition, Skills Neuropsychology and Skills Metacognition showed significant improvement. The categories Knowledge Neuropsychology and Knowledge Metacognition showed positive trends, although these were not significant. The Attitude Metacognition category showed a negative insignificant trend.

In group 3, "professional", the improvement in Knowledge Metacognition, Knowledge Metacognition and Skills Metacognition was significant on a 5% significance level, and in Skills Metacognition it was significant on a 10% significance level. The categories Knowledge Neuropsychology and Skills Neuropsychology showed positive trends, but these were not significant on either the 5% or 10% levels. The trend in the Attitude Metacognition category was once again negative, but not significantly so.

In summary, group 2 (those with teaching plus an extra qualification) showed the most significant improvement, followed by group 3 (those with professional qualifications). The group with a teaching qualification only did not show as much improvement as the other two groups. The results of the Attitude Metacognition category were negative in all three groups. Moreover, this category showed negative results for all the groups for each of the variables - age, language and qualification. This would appear to indicate a confusion in the attitude of the teachers and therapists towards the importance of metacognitive concepts in education and therapy.

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Table 5.4c : The influence of qualifications on the pre and post scores by learning category

	KNOWLEDGE						ATTITUDE						SKILLS					
Qualification Groups	**KN**			**KM**			**AN**			**AM**			**SN**			**SM**		
	PRE	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**	**PRE**	**POST**	**P-VAL**
Teaching n = 12	0.57	0.63	0.1289	0.47	0.52	* 0.0371	0.73	0.75	0.7695	0.53	0.51	0.8311	0.28	0.34	0.3828	0.48	0.52	0.1309
Teaching + n = 24	0.61	0.62	0.7689	0.44	0.53	* 0.0005	0.73	0.79	0.1255	0.55	0.54	0.3264	0.3	0.4	* 0.0118	0.47	0.55	* 0.0009
Professional n = 9	0.64	0.66	0.4688	0.45	0.57	* 0.0547	0.73	0.82	* 0.0039	0.56	0.53	0.4258	0.31	0.44	* 0.0156	0.49	0.58	0.0742

KEY:

KN = Knowledge Neuropsychology
KM = Knowledge Metacognition
AN = Attitude Neuropsychologoy
AM = Attitude Metacognition
SN = Skills Neuropsychology
SM = Skills Metacognition

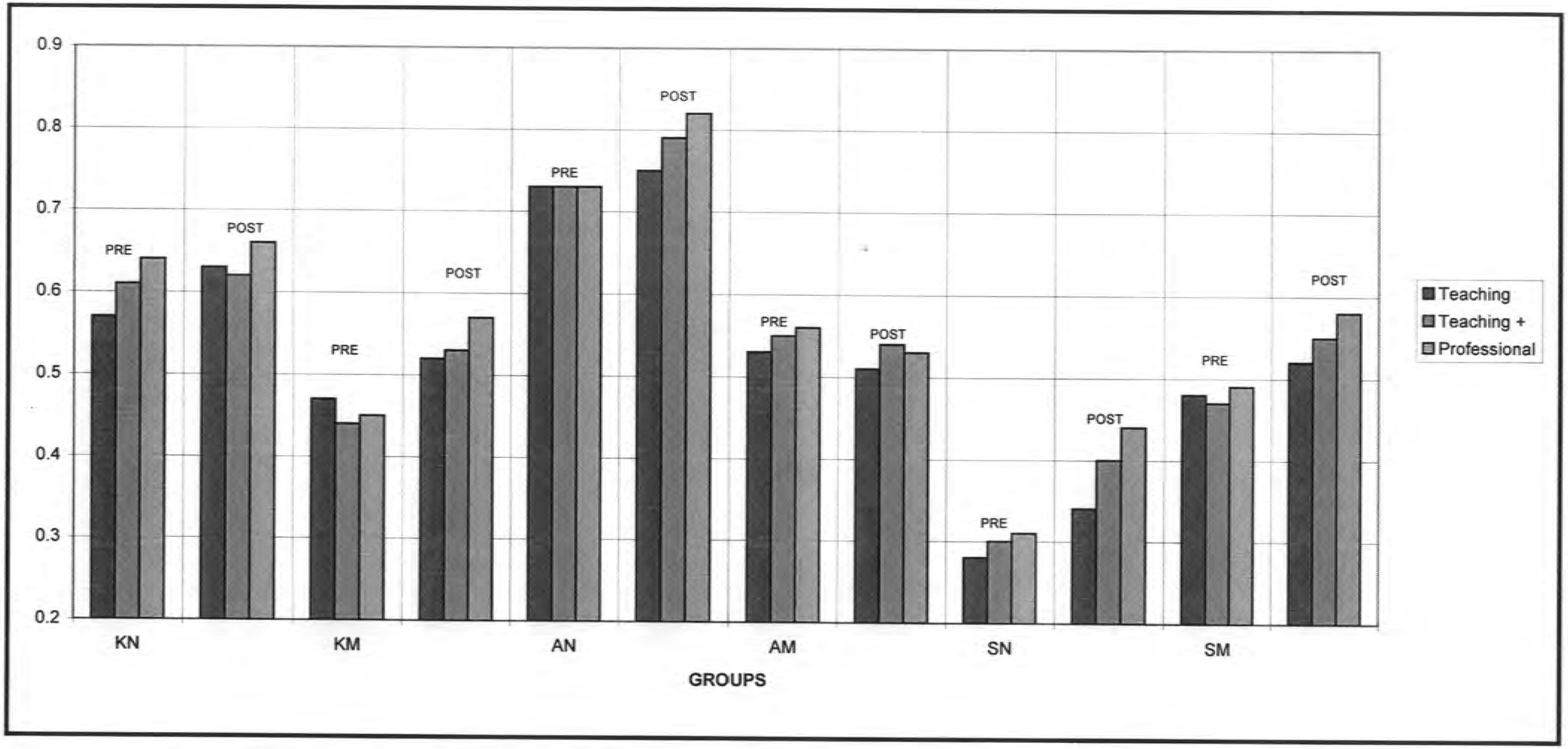

Figure 5.3c : The influence of qualifications on the pre and post scores by learning category

KEY		
KN	=	Knowledge Neuropsychology
KM	=	Knowledge Metacognition
AN	=	Attitude Neuropsychology
AM	=	Attitude Metacognition
SN	=	Skills Neuropsychology
SM	=	Skills Metacognition

5.2.4. ANALYSIS OF SECTION F OF THE POST QUESTIONNAIRE

The teachers and therapists had to fill in an extra section on the post questionnaire which provided them with the opportunity to explain how they had used the principles of the MMA and whether they had experienced any difficulty. Table 5.5 provides the statistical results obtained. Appendix III provides the categories of possible answers.

Question F1 asked whether the teachers and therapists managed to implement the concepts in their daily curricula, and if so, how. From the results it can be seen that 24,4% of the respondents experienced difficulty using the techniques daily. With regard to use of the techniques to teach specific subjects, 33,3% reported using the techniques to teach English but only 11,1% reported using them to teach Afrikaans. Only 2,2% actively used the techniques in Maths lessons. For other subjects, 22% used the techniques for the subjects of Biology and Science, which are taught in the higher standards. In the lower standards these subjects are taught as Environmental Studies, and it can be seen that the techniques were used by 40% of the respondents in this subject. Overall, approximately 75% of the teachers reported using the MMA method for cultural subjects. All the therapists who took part in the research reported using the methods in some form in therapy. Music was used in teaching and therapy by 62,2% of the teachers and therapists; 20% used the relaxation exercises, and 48,9% used the MMA methods as a study method for themselves as well as teaching the pupils.

In Question F2, respondents had to indicate whether they had experienced any difficulty in utilising the concepts of the MMA, and if so, which elements. Less than half the group, 37,8%, indicated that they had no problems with the application of the methods. The most difficulty was experienced with teaching the technique as a study method and getting the students to use the method as a study method independently, as 35,6% indicated problems in this area. Difficulty in teaching key concepts as opposed to key words was reported by 13,3% of the respondents. Only 8,9% indicated experiencing problems with organisation within the pupils' Mind-Maps. Lastly, 8,9% reported experiencing difficulty with using the method as a complementary teaching tool.

In Question F3, the respondents had to indicate whether they felt their clients had benefited from their use of the MMA geodesic principles. Twenty per cent of the teachers and therapists answered "no", but qualified it by saying that they had not really applied the principles.

Table 5.5 : Results of Section F of the post questionnaire

<table>
<tr><th>QUESTION</th><th colspan="16">FREQUENCY % PER ELEMENT OF QUESTION</th></tr>
<tr><td>F1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr>
<tr><td></td><td>24.4%</td><td>33.3%</td><td>11.1%</td><td>2.2%</td><td>13.3%</td><td>8.9%</td><td>2.2%</td><td>0%</td><td>2.2%</td><td>2.2%</td><td>40%</td><td>13.3%</td><td>24.4%</td><td>62.2%</td><td>20%</td><td>48.9%</td></tr>
<tr><td>F2</td><td>0</td><td colspan="3">1</td><td colspan="3">2</td><td colspan="3">3</td><td colspan="3">4</td><td colspan="3">5</td></tr>
<tr><td></td><td>37.8%</td><td colspan="3">8.9%</td><td colspan="3">2.2%</td><td colspan="3">13.3%</td><td colspan="3">2.2%</td><td colspan="3">35.6%</td></tr>
<tr><td>F3</td><td>0</td><td colspan="3">1</td><td colspan="3">2</td><td colspan="3">3</td><td colspan="3">4</td><td colspan="3">5</td></tr>
<tr><td></td><td>20%</td><td colspan="3">8.9%</td><td colspan="3">0%</td><td colspan="3">13.3%</td><td colspan="3">2.2%</td><td colspan="3">55.6%</td></tr>
<tr><td>F4</td><td>0</td><td colspan="3">1</td><td colspan="3">2</td><td colspan="3">3</td><td colspan="3">4</td><td colspan="3">5</td></tr>
<tr><td></td><td>60%</td><td colspan="3">6.7%</td><td colspan="3">2.2%</td><td colspan="3">4.4%</td><td colspan="3">0%</td><td colspan="3">26.7%</td></tr>
</table>

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55,6% of the teachers and therapists indicated that their pupils had benefited from the study method application and appeared to be more organised, and to demonstrate improved memory and improved problem-solving skills. 13,3% of the teachers and therapists felt that the pupils' ability to summarise and identify key concepts had improved. Only 8,9% felt the MMA principles were a complementary teaching tool.

In Question F4, the respondents had the opportunity to provide any extra comments. Sixty per cent of the respondents made no extra comment. The benefits of the study method application were stressed by 26,7% of the respondents. Only 6,7% indicated that there would be benefits in using a completely new geodesic approach in therapy and teaching; 2,2% stressed the benefits of the techniques in improving organisational and problem-solving skills; while only 4,4% indicated the benefits of using the method in developing the ability to identify the main concepts.

In conclusion, it appears that the principles and methods of the MMA were most used to teach English and cultural subjects. The main areas of difficulty appear to be in teaching the pupils to create Mind-Maps independently, to use the Mind-Map as a study method independently, and to select concepts. It appeared that teachers and therapists were creating Mind-Maps and the pupils were copying them. Finally, the teachers and therapists felt that the most benefit was derived from using the MMA techniques as a study method and for improving the pupils' memory and problem-solving skills.

5.2.5. GENERAL CONCLUSIONS REGARDING THE RESPONSE OF THE TEACHERS AND THERAPISTS

Of the six categories, four (Knowledge Metacognition, Knowledge Metacognition, Skills Neuropsychology and Attitude Metacognition) were found to have changed significantly. This change was positive indicating that the teachers and therapists knowledge, attitude and skills improved after the MMA training. However, the non-significant, although positive Knowledge Neuropsychology category, and the negative Attitude Metacognition category and the general low improvement percentages indicates that even though change occurred, it was not to the extent predicted. The knowledge and skill categories showed larger improvements than the attitude categories indicating a possible correlation between knowledge, attitude and skills. That is, in order to effect major changes, it would appear that the attitude category is the most important and most difficult area to influence and change, but without this change, no amount of knowledge or skill is really going to work (Byron, 1986). The results are consistent with findings in section 5.1 in that the means of knowledge and attitude to neuropsychology concepts is higher than that of metacognitive concepts; their confidence in their skills is low pre and post training.

This appears to be corroborated by the results of the F section of the questionnaire which really examines changes in the classroom and therapy room. The results obtained from the F section indicate that the teachers and therapists felt that the geodesic principles of the MMA are primarily providing an alternative way of studying and improving memory, and not as providing an alternative approach to learning and educating. The teachers and therapists did indicate that the method was useful in cultural subjects and that the music had a relaxing effect on the pupils. Finally the biographical variables of age, language and qualifications were found to influence the overall results in that the middle age group, the Afrikaans-speaking group and the group with a teaching qualification and an extra qualification, demonstrated the most significant improvement after the MMA training course.

5.3. RESPONSES OF THE PUPILS TO THE MMA GEODESIC PRINCIPLES: THE SECOND MAIN AIM

This section deals with the changes in academic performance of the pupils after exposure to the MMA geodesic principles by the teachers and therapists who acted as respondents to the questionnaire. Therefore, this section not only examines the natural trends that occur as a pupil progresses through the standards, and how these may or may not change with introduction of geodesic frameworks such as the MMA, but also examines the effectiveness of the MMA programme as a consultative framework and a vehicle of change for therapists and teachers. This necessitates a statistical as well as descriptive analysis of the results in order to draw conclusions.

All the results presented below are those of the third data set. As discussed in the methodology, data set one was not organised to account for the dependency factor making the results of this data set inaccurate. Data set two, created to establish a longitudinal historical trend, was a subset drawn from data set one. This data set was purer than data set one, but the small sample size (75), as well as the uneven weighting of the sample across standards, affected the accuracy of the results. Results of these two data sets are therefore not presented in full. However, reference

(75), as well as the uneven weighting of the sample across standards, affected the accuracy of the results. Results of these two data sets are therefore not presented in full. However, reference is made to the results of the first and second data sets, in relation to the results of data set three, in the general conclusion at the end of this section.

5.3.1. GENERAL TRENDS

The results obtained indicate that in general the academic trend in the three primary remedial schools was altered with the introduction of the MMA methods in 1993. Furthermore, it appears that the most positive response occurred in phase one (grades 1 and 2, and standard 1). A positive response also occurred in phase two (standards 2-4), but this change was just outside the significance level. Phase three (standard 5), by contrast, experienced negative effects with the introduction of the MMA methods. In terms of school subjects, it appears that the MMA methods worked most efficiently for English, followed by cultural subjects, then Afrikaans, then Maths.

5.3.2. THE LONGITUDINAL TRENDS OF ACADEMIC RESULTS

The trend of academic results over the baseline years and the experimental year is now examined in general, then per phase, then per standard and finally per subject.

5.3.2.1. The overall longitudinal trend in general

The overall longitudinal trend across all three phases and across all subjects (Table 5.6. and Figure 5.4) was determined to be significantly positive. However, the change between 1992 and 1993 was more significant than between 1991 and 1992 ($p = 0,00034$ versus 0,02581). Therefore, it appears that the introduction of the MMA principles in the experimental year made the trend significantly more positive.

5.3.2.2. The overall longitudinal trend per phase

In phase one the overall longitudinal trend (Table 5.7 and Figure 5.5) was significantly positive. However, the change between 1992 and 1993 had a higher positive significance ($p = 0,0000$) than between 1991 to 1992 ($p = 0,00888$). Thus, the trend was significantly altered in 1993.

In phase two (Table 5.7. and Figure 5.5.), the trend was significantly positive between 1991 and 1992. Between 1992 and 1993, the trend was not significant but remained positive.

Table 5.6 : The overall longitudinal trend of academic results: Results of Mixture Test of Wilcoxon Sum Ranks & Signed Ranks

1991 MEAN	1992 MEAN	P-VALUE 1991 - 1992	1993 MEAN	P-VALUE 1992 - 1993	STD. DEV.
53.93	55.69	0.02581 *	57.88	0.00034 *	1991 = 7.03 1992 = 7.81 1993 = 7.80

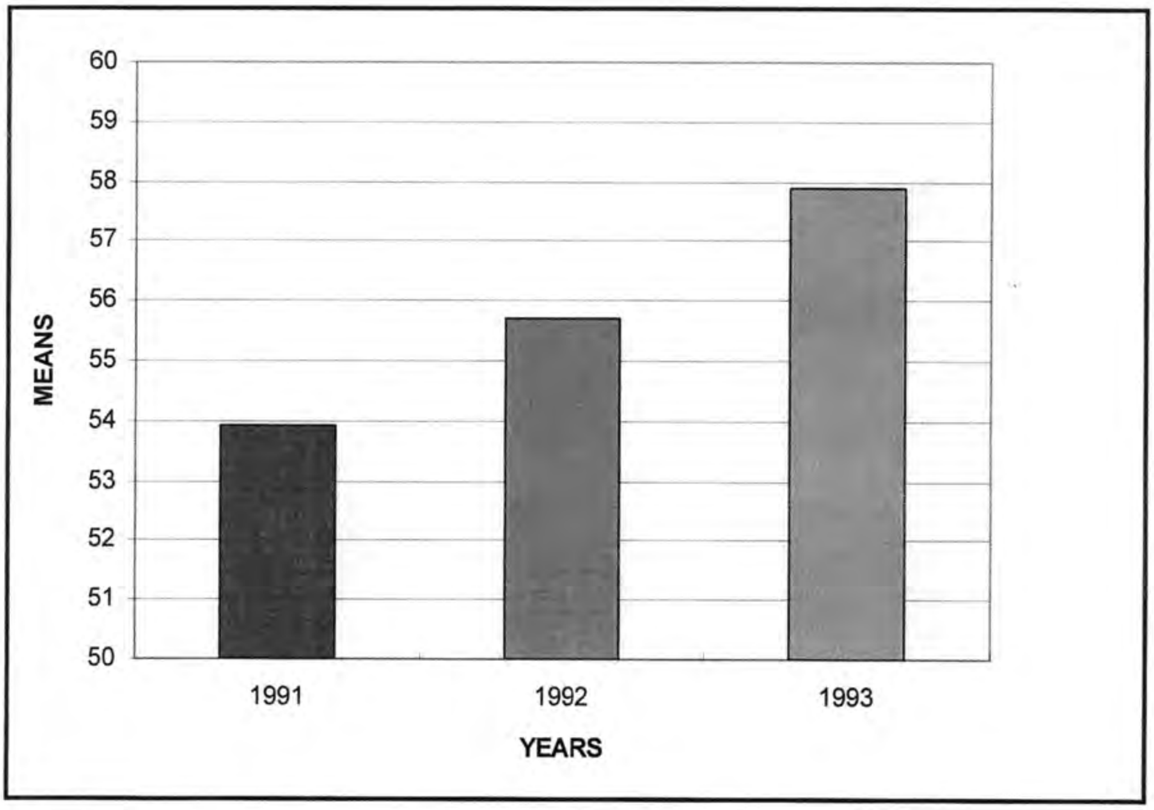


Figure 5.4 : The overall longitudinal trend of academic results

Table 5.7 : A comparison of the overall longitudinal trend of academic results of each phase: Results of Mixture Test of Wilcoxon Sum Ranks & Signed Ranks

PHASE	1991 MEAN	1992 MEAN	P-VALUE 1991-1992	1993 MEAN	P-VALUE 1992-1993	STD. DEVIATION		
						1991	1992	1993
1 Grade 1 - Std 1 n = 333	52.33	54.96	0.00888 *	59.68	0.000000 *	6.09	6.13	5.23
2 Std 2 -4 n = 388	55.14	57.48	0.03546 *	58.69	0.17423	8.39	7.98	7.37
3 Std 5 n = 260	53.83	54.08	0.16056	52.97	0.00031 *	8.24	8.81	7.17

Fig - Pg 184

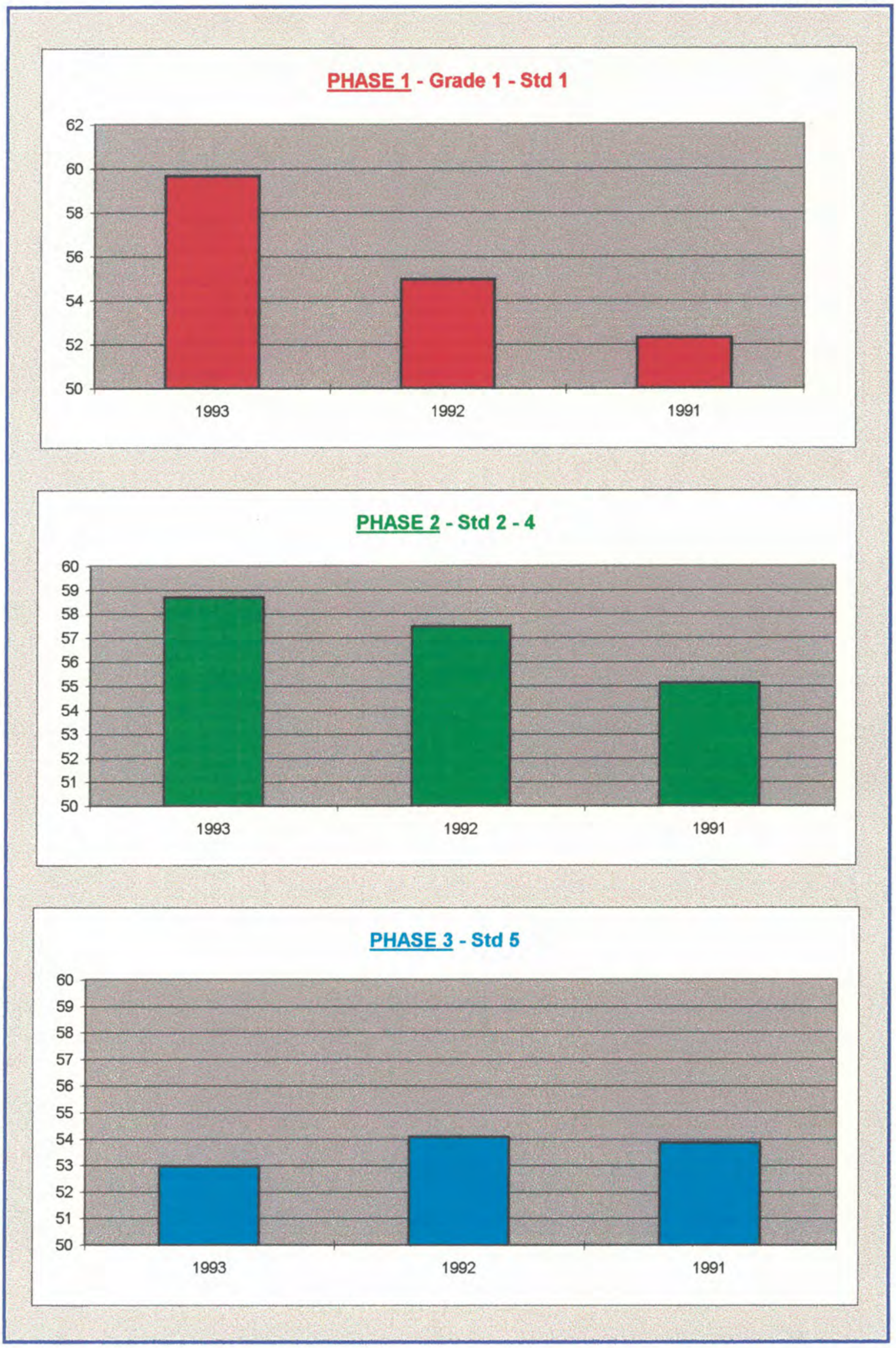


Figure 5.5 : The overall longitudinal trend of each phase of academic results

It can thus be intimated that the introduction of the MMA principles maintained the positive trend in phase two, but did not alter it.

In phase three (Table 5.7 and Figure 5.5), the trend was significantly positive between 1991 and 1992, but was significantly negative between 1992 and 1993. Thus, it appears that the trend worsened with the introduction of the MMA principles in 1993 in phase three. In summary, phase one responded the best.

5.3.2.3. The overall longitudinal trend per standard

The results of the overall longitudinal trend per standard can be found in Table 5.8 and Figure 5.6.

The academic results in grades one and two, standard one and standard three showed positive trends which were significantly altered in 1993 with the introduction of the MMA methods. In standard two the academic results for all the subjects demonstrated a positive trend that was maintained in 1993. In standard four the academic results for all the subjects demonstrated a positive trend that was altered negatively but not significantly in 1993. In standard five the academic results for all the subjects demonstrated a positive trend that was altered significantly in a negative way in 1993.

In summary, the overall trends for the academic results for all the standards were positive, but the MMA methods had a more positive effect on the subjects in the lower standards than the subjects in the higher standards.

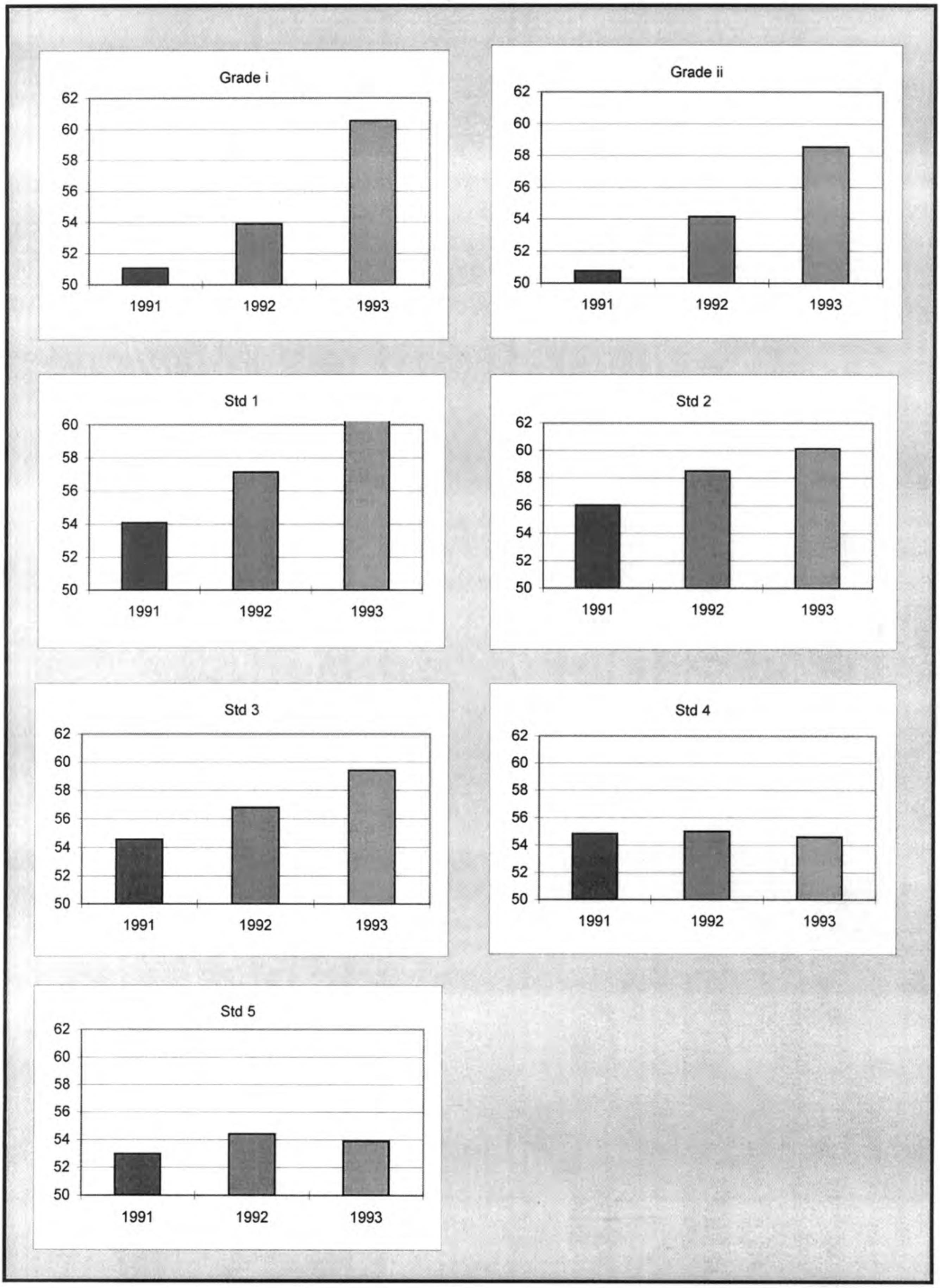
5.3.2.4. The overall longitudinal trend per subject

The overall longitudinal trends per subject can be seen in Table 5.9 and Figure 5.7. The overall trend for English between 1991 and 1992 was positive, but not significant ($p = 0{,}62865$). However, between 1992 and 1993 there is a significantly positive change ($p = 0{,}00000$). Therefore it can be said that the use of the MMA methods in the subject of English significantly altered the trend.

In Afrikaans the trend was positive but it appears that it was not altered by the MMA methods in 1993 because the differences between 1991 and 1992 and between 1992 and 1993 were both very similar non-significant changes.

Table 5.8 : A comparison of the overall trend of academic results per standard : Results of Mixture Test of Wilcoxon Sum Ranks & Signed Ranks Test

STANDARD	1991 MEAN	1992 MEAN	P-VALUE 1991 - 1992	1993 MEAN	P-VALUE 1992 - 1993	STD. DEVIATION 1991	1992	1993
Gr I (n = 80)	60.55	53.88	0.23720	51.05	0.00136 *	4.73	6.25	6.00
Gr ii (n = 73)	58.55	54.15	0.03148 *	50.76	0.00043 *	6.42	6.41	5.14
Std 1 (n = 92)	60.27	57.13	0.07459	54.08	0.00253 *	5.44	5.78	5.55
Std 2 (n = 92)	60.12	58.49	0.46323	56.02	0.24466	7.75	7.99	7.73
Std 3 (n = 92)	59.39	56.78	0.22501	54.56	0.02534 *	7.72	7.38	6.68
Std 4 (n = 93)	54.58	55.00	0.64484	54.82	0.36200	10.23	9.80	6.70
Std 5 (n = 145)	53.88	54.40	0.33364	52.97	0.00031 *	8.33	8.86	7.17



<u>Figure 5.6</u> : The overall trend of academic results per standard

Table 5.9 : The overall trend of academic results per subject : Results of Mixture Test of Wilcoxon Sum Ranks & Signed Ranks

SUBJECTS	1991 MEAN	1992 MEAN	P-VALUE 1991 - 1992	1993 MEAN	P-VALUE 1992 - 1993	STD. DEVIATION 1991	1992	1993
ENGLISH	53.73	54.44	0.62865	57.7	0.00000 *	8.54	8.63	7.54
AFRIKAANS	52.89	54.13	0.13288	55.44	0.18301	8.63	8.68	9.22
MATHS	53.80	56.26	0.07667	58.09	0.02373 *	12.95	12.95	11.88
CULTURALS	55.31	57.92	0.00614 *	60.29	0.00183 *	10.11	10.03	9.20

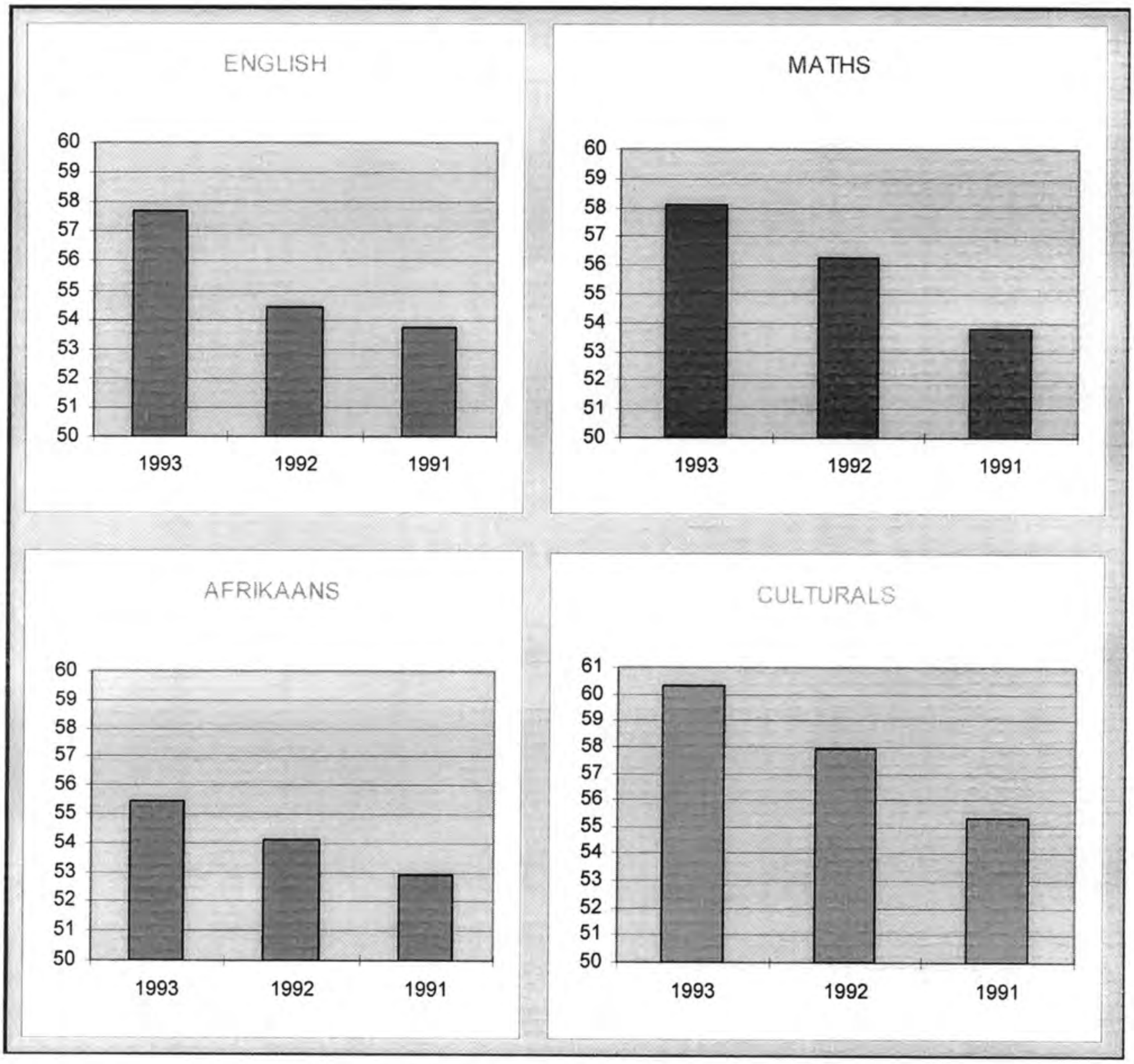


Figure 5.7 : The overall trend of academic results per school subject

The trend for Maths appears to have been altered in 1993 by the introduction of the MMA methods because the difference between 1992 and 1993 was significantly positive (p = 0,02373), whereas between 1991 and 1992 there was no significant change (p = 0,07667).

For cultural subjects the trend was significantly positive. Moreover, the trend appears to have been altered by the MMA methods because, although the difference between 1991 and 1992 was significantly positive (p = 0,00614), the improvement between 1992 and 1993 was increasingly significant (p = 0,00183).

In summary, if differences between the means for 1992 and 1993 are compared for each subject, it can be seen that the greatest difference occurred in English (difference = 3), and the least difference occurred in Afrikaans (difference = 2). Cultural subjects and Maths were in second and third place respectively.

5.3.3. THE INDIVIDUAL TRENDS PER SUBJECT

In this section how each of the school subjects, English, Afrikaans, Maths and cultural subjects, responded to the introduction of the MMA principles is evaluated. This is done by examination of the trends of each subject per phase and per standard.

5.3.3.1. The trend of each subject per phase

The trend of the academic results for each school subject per phase can be seen in Table 5.10 and Figure 5.8.

The academic results for **English** between 1991 and 1992 showed positive non-significant trends in phases one and two, but in phase three the trend was non-significantly negative. Between 1992 and 1993 the trend in phase one and two demonstrated significant positive changes (p = 0,00005 and 0,03685 respectively). In phase three, the negative trend of academic results was altered but non significantly so in 1993.

The trends of the academic results for **Afrikaans** between 1991 and 1992 were significantly positive in phase one, and non-significantly positive in phases two and three. In phase one the positive trend had a higher significance in 1993. In phase two, the difference between 1992 and 1993 (0,41053) was slightly closer to significance than between 1991 and 1992 (0,76312). However this result indicates that the trend did not change significantly, but was maintained with the introduction of the MMA principles in 1993. Moreover in phase three, the trend became significantly negative in 1993.

Table 5.10 : A Comparison of the trend of academic results per subject per phase : Results of Mixture of Wilcoxon Sum Ranks and Signed Ranks Test

SUBJECT	YEAR	PHASE 1		PHASE 2		PHASE 3	
		MEAN	STD. DEV	MEAN	STD. DEV	MEAN	STD. DEV
ENGLISH	1991	52.58	7.50	54.51	8.50	53.79	9.47
	1992	54.3	7.40	55.96	8.55	52.55	9.65
	P-Value 1991-1992	0.21301		0.52044		0.16056	
	1993	59.04	6.79	58.06	7.05	54.49	8.83
	P-Value 1992-1993	0.0005 *		0.03685 *		0.91298	
AFRIKAANS	1991	51.29	7.05	53.3	9.60	53.63	8.53
	1992	54.78	7.54	53.75	9.48	53.9	8.81
	P-Value 1991-1992	0.00468 *		0.76312		0.89199	
	1993	59.12	7.27	54.92	9.16	49.49	9.40
	P-Value 1992-1993	0.00472 *		0.41053		0.01401 *	
MATHS	1991	52.75	9.38	55.04	13.48	53.13	15.05
	1992	55.26	8.99	59.09	12.97	53.55	15.82
	P-Value 1992-1993	0.8383		0.04282 *		0.42122	
	1993	59.69	8.53	59.34	12.65	52.75	14.23
	P-Value 1992-1993	0.00092 *		0.72845		0.12603	
CULTURALS	1991	52.7	7.15	57.52	10.85	54.89	10.95
	1992	55.48	6.56	61.14	10.09	55.14	11.98
	P-Value 1992-1993	0.02229 *		0.01669 *		0.066380	
	1993	60.88	5.55	64.44	10.57	56.31	10.07
	P-Value 1992-1993	0.00000 *		0.21229		0.09361	

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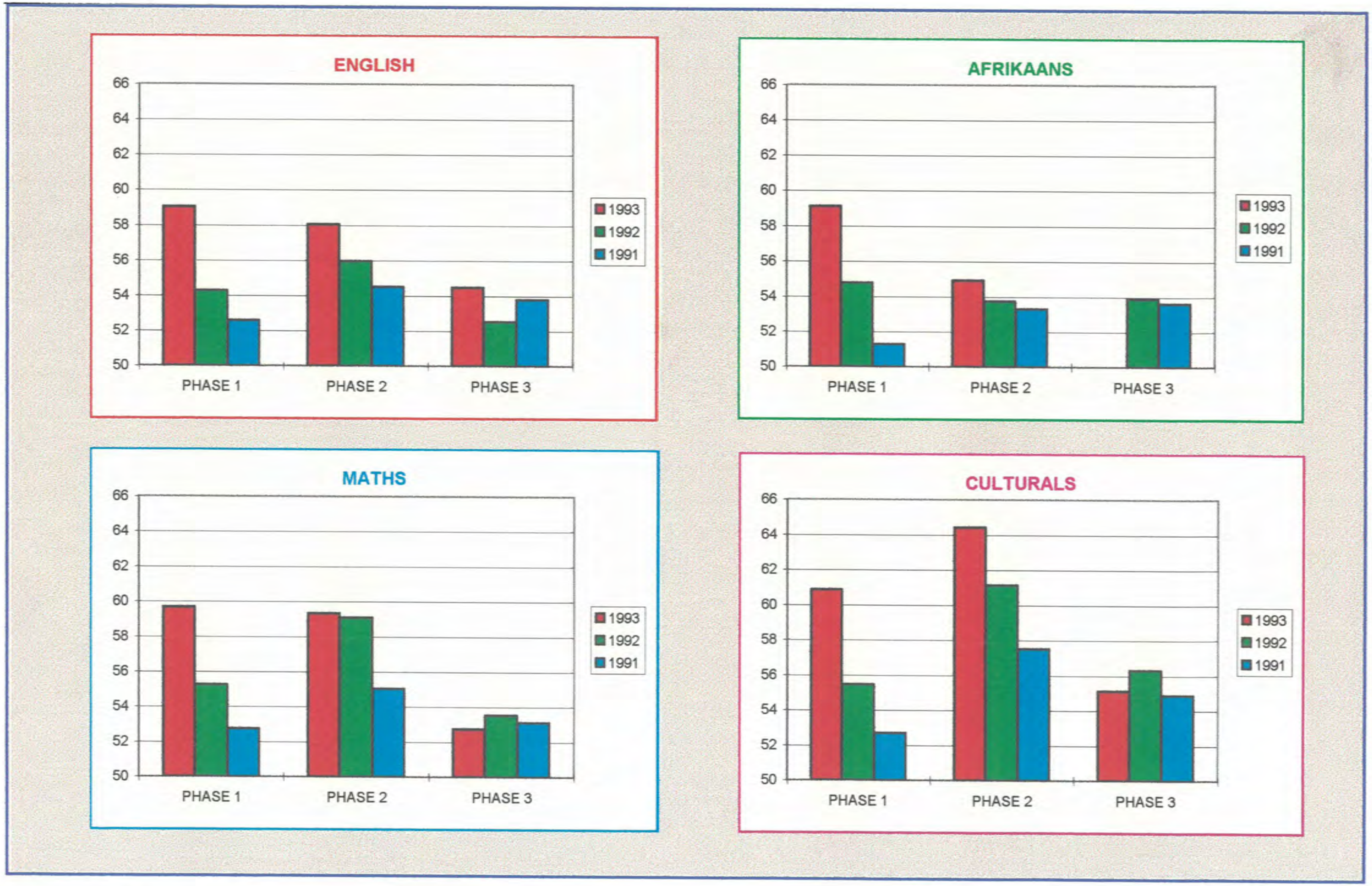

Figure 5.8: The trend of academic results per subject per phase

The trends of the academic results for **Maths** between 1991 and 1992 were non-significantly positive in phases one and three, and significantly positive in phase two. In phase one the trend demonstrated a significantly positive improvement in 1993. In phase two the trend was maintained, whilst in phase three the trend worsened but not significantly so.

The academic results for the **cultural subjects** between 1991 and 1992 demonstrated significantly positive trends in phases one and two, and a non-significant positive trend in phase three. In phase one the positive change between 1992 and 1993 (0,00000) was more significant than between 1991 and 1992 (0,02229). It can therefore be said that the trend was altered. In phases two and three, the non-significant positive trend was maintained in 1993.

In summary, it appears that all subjects responded equally well in phase one, significant changes being experienced for all subjects. In phase two, only English demonstrated a significant positive change, with Afrikaans, Maths and cultural subjects maintaining their positive trends, but without significant alteration. In phase three, the positive trend was maintained in English and cultural subjects but the trends in Maths and Afrikaans worsened.

The analysis of all the phase patterns confirms the results obtained from the overall longitudinal trends per subject reported in the previous section: it appears that performance in English benefited the most from the MMA methods, followed by cultural subjects then Maths, with Afrikaans showing the least benefit. However in phase one, all four subjects showed benefit indicating that the lower standards benefited more than the higher standards. These results are also consistent with the results identified under the general trends.

5.3.3.2. The trend of each subject per standard

The trends of each subject per standard can be seen in Table 5.11 and Figure 5.9.

In grade one, the academic results in all four subjects demonstrated positive trends between 1991 and 1992. These trends were altered in significantly positive way for English, cultural subjects and Maths in 1993, but not for Afrikaans. In grade two the pattern was almost identical to grade one.

Table 5.11 : A comparison of the trend of academic results of each subject per standard : Results of Mixture Test of Wilcoxov Sum Ranks and Signed Ranks Test

SUBJECT	YEAR	MEANS / STD'S							STD DEVIATION / STDS						
		i	ii	1	2	3	4	5	i	ii	1	2	3	4	5
ENGLISH	91	52.00	50.43	54.20	54.09	54.19	55.00	53.81	7.77	7.67	6.73	8.37	8.38	9.25	9.71
	92	53.68	54.12	56.08	56.25	55.08	53.83	52.96	7.51	7.43	8.02	8.97	7.74	9.62	9.70
	P-Value 1991-1992	0.73916	0.22249	0.52268	0.74346	0.51355	0.39669	0.34740							
	93	58.82	58.70	59.57	57.40	58.57	58.39	54.49	7.29	6.13	7.21	6.45	8.23	5.94	8.83
	P-Value 1992-1993	0.00925 *	0.00899 *	0.00510 *	0.59028	0.09774	0.24763	0.91298							
	91	49.40	50.00	53.20	54.32	53.11	52.31	53.99	5.83	6.03	7.41	8.32	9.60	11.69	8.49
	92	53.29	55.00	55.20	56.02	53.39	50.67	54.19	7.56	8.44	7.14	10.92	8.17	8.78	8.95
AFRIK.	P-Value 1991-1992	0.9932	0.11064	0.26514	0.91910	0.85192	0.49399	0.95665							
	93	58.24	57.50	61.52	56.63	54.69	52.14	49.49	7.58	6.17	7.66	9.27	8.68	9.37	9.40
	P-Value 1992-1993	0.40959	0.11367	0.00102 *	0.59028	0.72188	0.85883	0.01401 *							
	91	51.00	51.74	54.40	56.36	54.05	54.49	52.98	9.57	10.72	8.12	11.93	11.29	17.95	15.13
	92	54.21	53.24	57.94	61.48	58.05	55.83	53.76	8.89	8.95	9.70	11.44	12.93	16.25	15.70
MATHS	P-Value 1991-1992	0.57137	0.55229	0.11998	0.19826	0.09096	0.48465	0.58139							
	93	63.24	58.40	58.48	62.40	60.10	52.32	52.75	6.14	9.17	8.75	13.59	10.48	11.98	14.23
	P-Value 1992-1993	0.00041 *	0.02007 *	0.39009	0.58366	0.49592	0.24763	0.12603							
	91	51.80	50.87	54.50	59.32	56.89	56.54	54.76	7.48	7.33	6.41	10.98	9.16	13.09	10.95
	92	52.00	54.26	59.31	60.23	60.59	59.67	56.68	7.77	6.53	8.55	8.95	9.87	12.31	12.07
CULT.	P-Value 1991-1992	0.23060	0.18892	0.06452	0.08700	0.15843	0.59245	0.64404							
	93	54.34	59.60	61.52	64.04	64.18	56.43	55.14	4.27	5.88	5.86	11.07	9.70	9.11	10.07
	P-Value 1992-1993	0.00009 *	0.00753 *	0.01083 *	0.66804	0.12173	0.14227	0.02217 *							

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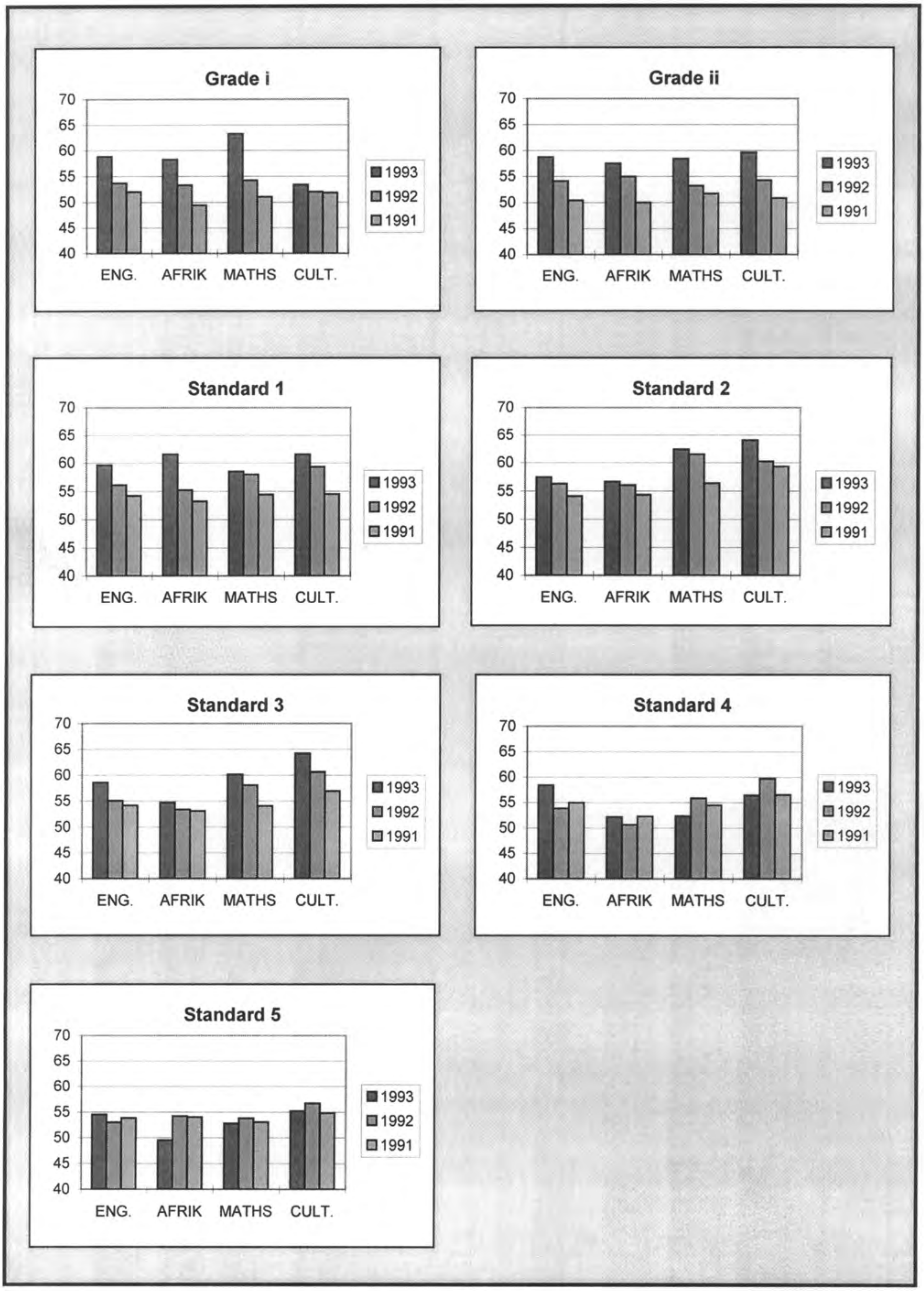


Figure 5.9 : A comparison of the trend of academic results per subject per standard : Results of mixture test of Wilcoxon Sum Ranks & Signed Ranks test

In standard one, the trends of all the academic results were positive between 1991 and 1992, with significantly positive changes being experienced in English, Afrikaans and cultural subjects in 1993. For Maths the positive trend was maintained but not improved in 1993.

The baseline trends of academic results in standard two were positive for all subjects and this positive trend was maintained in 1993. However, the difference between 1992 and 1993 was closer to significance than between 1991 and 1992. It can therefore be said that there was a slight improvement in 1993.

The trends of academic results in standard three were again positive, but it appears that the MMA methods only maintained as opposed to improving the natural trend.

In standard four, the positive trend in English was maintained in 1993. For Afrikaans the negative trend was reversed but not significantly. In Maths and cultural subjects the positive trend became non-significantly negative in 1993.

In standard five the negative trend in English was reversed in 1993, but not significantly. In Afrikaans and cultural subjects the positive trend became significantly negative in 1993. In Maths the positive trend became negative, but not significantly.

In summary, it can be seen that in grade one, grade two and standard one all the subjects showed positive trends that were improved significantly for all subjects - except for Afrikaans in grade one and two and Maths in standard one, where the positive trends were maintained. This confirms the results of the previous sections, which showed that the pupils in phase one consistently responded the best to the MMA methods.

The standard two and three the trends of the academic results were maintained for all subjects in 1993. However, in standards four and five, the trends worsened for all subjects except English, and Afrikaans in standard four. Therefore the subject of English consistently demonstrates the most favourable response to the MMA methods, and the subject of Afrikaans the least favourable.

5.3.4. GENERAL CONCLUSIONS REGARDING THE RESPONSE OF THE PUPILS

In evaluating the response of the pupils to the exposure to the MMA methods by the teachers and therapists, trends were initially identified and then compared to the performance in the experimental year. The overall result indicates a positive change in the pupils' performance, that is, the academic results improved in a statistically significant way in the experimental year with the introduction of the MMA methods.

The trends identified were the overall trend for the pupils of three learning disabled primary schools; the trend per phase; the trend per standard and the trend per subject. The overall trend for the pupils of three learning disabled primary schools was found to be positive implying that in general, the pupils' proficiency improves as they move through the standards. The introduction of the MMA methods resulted in a significant positive alteration of this trend implying that the positive trend can be enhanced.

Regarding the trend per phase, phase one and two had significant positive trends but phase three's trend was non-significantly positive. Phase one experienced a significant positive change in 1993, phase two's trend was maintained but not changed in 1993, and phase three's trend became significantly negative. Therefore, the academic results in phase one improved the most in response to the MMA methods, and phase three's academic results actually deteriorated.

Regarding the standards, grades one and two and standards one and three had positive trends that were significantly altered in 1993 in a positive way. Standard two had a positive trend that was maintained in 1993, and standard five had a positive trend which was significantly altered in a negative way in 1993.

All the general trends for the subjects were positive except for the subject of English in phase three which was negative. Examination of the trends of each subject per standard reveals a more realistic idea of the trends. All the subjects in grade's one, two and standards one had positive trends that were significantly altered in a positive way; the positive trends for standards two and three were maintained; the positive trends were altered negatively in standards four and five. This reflects the same patterns identified in the phase analyses.

The MMA methods appeared to influence the academic proficiency in the subject of English the most, but had the least effect on the subject of Afrikaans. Cultural subjects and the subject of Maths followed in second and third place respectively.

The results discussed above are based on the results obtained from dataset three which was a combination of datasets one and two, but with the dependency factor accounted for. However, a brief evaluation of the results of datasets one and two appears to confirm the findings of dataset three, and thus strengthen the conclusions reached. The ensuing paragraph provides a brief analysis of the results of dataset one and two.

It was realised that the general results of dataset one, which, as discussed earlier, were not accurate due to the dependency factor not being accounted for, would result in too many false positives. Evaluated in this light, however, the results confirm the findings for dataset three, in that they appear to reflect the same patterns, but are slightly more positive, as expected. The general results of dataset two, the longitudinal historical trend where the weighting was inaccurate, tend to indicate that the overall trend for learning disabled primary schools is negative. As an overall result, however, this is not accurate as 57% of this dataset were the results of pupils in phase three, which as seen above did experience negative effects. These negative effects outweighed the positive effects in the other phases. However, the phase analyses of this dataset appear to confirm that phase one responded the most effectively to the introduction of the MMA methods, and phase three the worst, and that phase two did not alter much, which results are consistent with dataset three.

It therefore appears that, overall, the MMA methods positively influenced the academic proficiency of pupils in a learning disabled primary school acting as subjects. This influence seems to be greater with younger pupils.

5.4. CONCLUSION

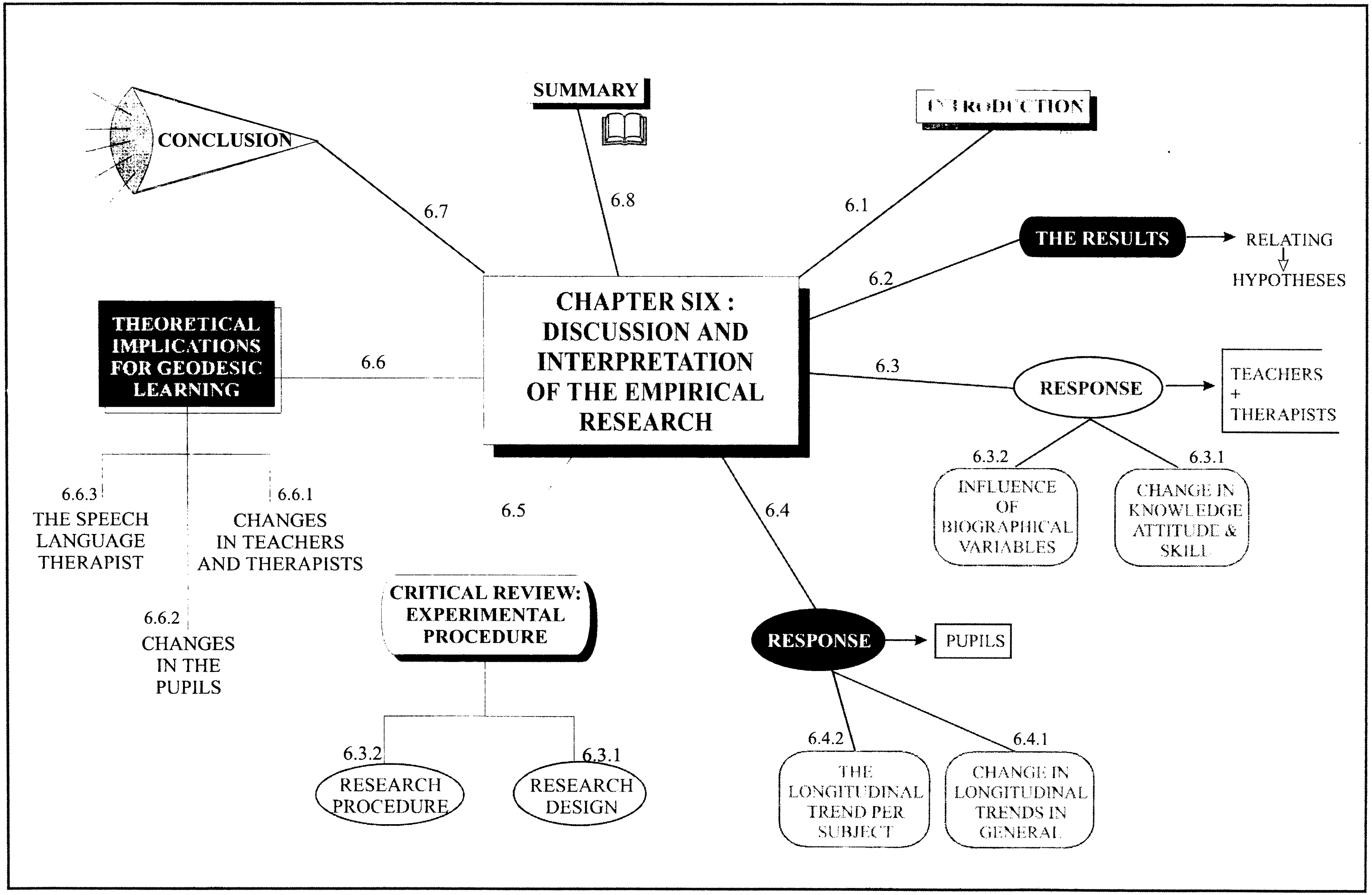
In synthesising and discussing the results of the current study, certain conclusions were reached: Firstly, it was found that the teachers' and therapists' knowledge, attitude and skills regarding the geodesic principles of the MMA did improve, but not to the extent predicted. It was felt that this was due to a "maintenance" effect resulting in the conditioning of attitudes towards learning. Secondly, the biographical variables of age, language and qualifications had a definite influence on the change experienced by the teachers and therapists. It was found that the younger age group, the English-speaking group and the other "professional" group experienced the most significant positive changes. Thirdly, a significant improvement in the academic results of the pupils was demonstrated after their exposure to the MMA methods, but also not to the extent predicted. Finally the MMA methods appeared to have the greatest effect on the subject of English.

5.5. SUMMARY

In this chapter, the results of the empirical study are presented. The results are organised into firstly, the responses of the teachers and therapists to the MMA geodesic methods, and then the responses of the pupils to the MMA methods introduced by the teachers and therapists subsequent to the training. The quantitative and qualitative analyses of the results are presented according to the aims of the study. The results form the basis upon which the interpretations and conclusions of the research are formulated in Chapter Six.

IF WE LEARNED TO USE OUR BRAIN
THE WAY IT WAS NATURALLY DESIGNED TO WORK,
WE WOULD ASTONISH OURSELVES EVERYDAY.

Jensen, 1995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6.1. INTRODUCTION

The present study was undertaken in view of the need to acknowledge that everyone learns in different ways, and that it is consequently necessary to explore alternative ways of facilitating learning that will allow individuals to realise their natural potential. Current learning systems, that propose to educate and re-educate the "whole" child, tend to favour predominantly linguistic and mathematical intelligences as opposed to a more pluralistic approach (Jensen, 1995). This is a consequence of the prevailing philosophy of current educational systems and therapeutic institutions which indicates that "intelligence" or "potential" is a single general capacity that enables the individual to achieve in all situations. This is an attractive philosophy as it is quantifiable and measurable allowing categorisation of the individual. Research has, however, indicated that this type of approach to developing learning potential, which is based on the I.Q., Piagetian and information processing approaches, is product versus process orientated, and does not develop the whole person in their full capacity (Iran-Nejad, 1990; Gardner, 1986; Jensen, 1995; Russell, 1986; Buzan, 1991). Many educators and philosophers concur that the most important goal of education and therapy is to facilitate thinking.

Consequently, an alternative approach that focuses on the dynamics of the thought processes and the pluralistic nature of the intelligences of the human mind has arisen, which can be termed the geodesic movement. The current study fits into this movement by proposing a framework that allows geodesic principles to be operationalised.

A number of questions were addressed in the study regarding the effectiveness of the MMA as a framework for the implementation of geodesic learning principles in teaching and therapy in order to better realise the learning potential of pupils. The results presented in Chapter 5 revealed a statistically significant improvement in the knowledge, attitude and skills of the teachers and therapists regarding geodesic learning principles, which was shown to be attributable to the MMA training. Furthermore, this changed knowledge, attitude and skills of the teachers and therapists also had a statistically significant positive effect on their pupils in terms of improved academic results.

6.2 THE RESULTS OF THE STUDY RELATING TO THE HYPOTHESES

This section summarises the results in terms of the hypotheses (see section 4.4) and determines which of the hypotheses can be accepted and which must be rejected.

- The results showed that overall the MMA training programme was effective in increasing, changing and improving the knowledge, attitude and skills of the teachers and therapists regarding geodesic learning principles. Furthermore, the application by the teachers and therapists of these principles in their educative and therapy environments led to a significant improvement in the academic performance of their pupils. The **first** and **second hypotheses**, that there would be a positive change both in the teachers and therapists and in the pupils as a result of the MMA programme, can therefore be accepted.

- The MMA training resulted in a positive improvement in the teachers' and therapists' **knowledge** of neuropsychological and metacognitive concepts, and therefore **hypothesis three** can be accepted.

- The MMA training resulted in a positive change in the **attitude** of the teachers and therapists towards neuropsychological concepts, but not towards metacognitive concepts. Therefore **hypothesis four** can only be partially accepted.

- There was a significant improvement in metacognitive and neuropsychological **skills** in the post-training phase, and therefore **hypothesis five** can be accepted.

- It was found that the teachers' and therapists' results did vary according to age, language and qualifications. Those in the middle age-group (aged 31-50) showed the most significant improvement; the Afrikaans-speaking as opposed to the English-speaking and bilingual groups demonstrated the most positive change; and those that had a teaching plus an extra qualification did better than the "professional" group and those with a teaching qualification only. The **sixth hypothesis**, namely that the biographical variables of age, language and qualifications would influence the change in knowledge, attitude and skills of the teachers and therapists, can therefore be accepted.

- The natural trend of academic results for the learning disabled pupils in this study was positive, that is, the academic results improved as pupils progressed to higher standards. Thus **hypothesis seven,** that the academic results of learning disabled pupils would worsen as they progressed to higher standards, must be rejected.

- With the introduction of the MMA principles during 1993 the natural upward trend of the academic results of the pupils over 1991 and 1992 was altered in a positive way in phase one, maintained in phase two, and altered negatively in phase three. **Hypothesis eight** can therefore only be partially accepted for phase one.

- The phase one pupils appeared to respond better to the introduction of the geodesic learning principles than the pupils in phase two or phase three. **Hypothesis nine,** that phase two would demonstrate the most benefit from exposure to the MMA learning principles, followed by phase three, and then phase one, must therefore be rejected.

- Regarding the subjects, the MMA methods worked the best with English, followed by cultural subjects and then Maths. The subject Afrikaans responded the least to the introduction of the methods. **Hypothesis ten**, which predicted that the greatest improvement would be demonstrated in cultural subjects, followed by English, Afrikaans and Maths, in that order, must therefore be rejected.

6.3 THE RESPONSE OF THE TEACHERS AND THERAPISTS TO THE MMA TRAINING PROGRAMME: THE FIRST MAIN AIM

6.3.1. THE CHANGE IN KNOWLEDGE, ATTITUDE AND SKILLS REGARDING THE GEODESIC PRINCIPLES OF THE MMA

6.3.1.1 The change in knowledge

The results showed that the teachers and therapists had more knowledge about the importance of neuropsychological concepts and learning than metacognitive concepts, and that neuropsychological knowledge in the pre-training phase was high. This result is predictable due to the amount of information in the media and books on the left and right hemispheres of the brain, and increased awareness that "whole-brain" learning requires alternative approaches.

The question can therefore be raised: if there is such widespread knowledge of how the brain works, why is this knowledge not being applied in learning environments? This is possibly because traditional behaviouristic approaches to learning do not consider the "how" of learning or a knowledge of the functioning of the brain to be a contributing factor to the improving and/or release of potential (Buzan, 1991; Jensen, 1995; Novak & Gowin, 1984). Iran-Nejad (1990) argues that traditional approaches undermine the creative and multimodal nature of learning, limiting its domain to the rote learning of facts and definitions. This is because traditional behaviouristic approaches to learning generally assume learning to be the internalisation of external knowledge controlled by a single central self-regulatory centre (Iran-Nejad, 1990; Derry, 1991).

According to surveys on the relationship between brain function and learning skills (Buzan, 1991; Russell, 1986, Jensen, 1995), little or no information is given to students about the function of the human brain and learning during the informative academic years. It appears then that traditional philosophies regarding learning principles persist even though the teachers and therapists "know better".

Confirmation of the persistence of traditional learning philosophies is gained from an examination of the responses to individual questions. For example, the high percentage of teachers and therapists that considered repeated reading through ones work to be "learning" is evidence that traditional behaviouristic philosophies still persist in current educational institutions, as well as being evidence of how entrenched these beliefs are. Furthermore, all the means in the Knowledge Neuropsychology category, although changed were still low in the post-training phase, which leads to speculation regarding the consistency of the changes that occurred. It appears that the teachers and therapists were not sufficiently convinced that they needed to change their entire approach, and continuing to use predominantly traditional methods, adopting only isolated components of the geodesic approach in a disjointed fashion. The other erroneous paradigms or beliefs relating to the issue of neuropsychological knowledge that continued to persist were as follows:

- *The human brain is not very creative* (**as opposed to** the human brain being exceptionally creative given the correct facilitation).
- *The left hemisphere is dominant for learning* (**as opposed to** a synergistic processing between the hemispheres being an essential requisite of effective learning).

- *Too much stimulation in the learning environment will decrease learning* (**as opposed to** the individual learning most effectively through multimodal multistimulation).
- *Visualisation is a fun activity but plays no real role in the learning environment* (**as opposed to** visualisation being the way information is stored in the brain, as well as being the activator of learning).
- *Intelligence is one-dimensional and is measurable by I.Q. testing* (**as opposed to** intelligence being multi-dimensional, and thus I.Q. testing giving an indication of mathematical and linguistic intelligence only).
- *The teacher or therapist is responsible for what students should learn, and how, when and if they have learned* (**as opposed to** the teacher or therapist being a process manager guiding self-directed content resourcefulness).

The significant improvement noted in the Knowledge Metacognition category indicates that there was a change in the status of the teachers' and therapists' knowledge of metacognitive concepts. However, the means for this category were even lower than for the Knowledge Neuropsychology category, which indicates that metacognition is a problem area.

Metacognition seems to be a difficult concept for teachers and therapists to grasp. This is not surprising considering the confusion in the literature regarding this topic. According to Brown and Palincsar (1982), the definition of metacognition needs considerable clarification. The low means in the Knowledge Metacognition category provide further support to the idea of entrenched traditional learning paradigms that were difficult to change. Erroneous ideas on metacognition still persisting in the post-training phase were:

- *Reading fast reduces comprehension of the material being read* (**as opposed to** increasing the comprehension due to the brain taking in whole units of meaning).
- *Using a pacer whilst reading reduces comprehension* (**as opposed to** increasing comprehension due to the pacer facilitating a more effective eye movement).
- *Linear monochromatic note-making techniques facilitate learning* (**as opposed to** inhibiting learning due to only a minimal amount of left-brain processing being activated).
- *Key words and key concepts are the same* (**as opposed to** being different, the concept being more important as the brain processes and stores units of meaning, which are concepts).

- *Factual recall is more important than creativity in the learning situation* (**as opposed to** creativity being the result of synergistic processing between the hemispheres and therefore vitally important to the learning process).
- *Learning is the internalisation of external facts, or the storage of facts for later reproduction* (**as opposed to** the view that a change will occur as a result of the creative reconceptualisation of knowledge).
- *The non-conscious plays only a very basic perceptual role in learning* (**as opposed to** controlling approximately 90% of the learning process).
- *Accelerated learning does not exist* (**as opposed to** accelerated learning being the norm, and traditional philosophies retarding what is normal).
- *A good teacher can get children to rote-learn and produce a good end-product, that is high academic results* (**as opposed to** a teacher having the function of process designer and manager, involving pupils in planning, linking to learning resources, and encouraging initiative).
- *Thinking skills should be taught as a subject* (**as opposed to** being an all encompassing structure guiding every interaction with pupils).
- *The highest level of thought is cognition* (**as opposed to** cognition being the result of conscious thought, which is in turn guided by metacognition, the highest level of thought).

In summary, the MMA training made a difference to the neuropsychological and metacognitive knowledge levels of the teachers and therapists but the means were lower than predicted. This leads to the speculation that the change experienced by the teachers and therapists was not large enough to overcome the entrenched traditional paradigms regarding learning principles. Thus, the teachers and therapists will probably only use the geodesic methods partially and inconsistently and eventually become demotivated and revert to predominantly traditional behaviours in teaching and therapy. The question arises: how should the MMA training be adapted in order to effect a change in paradigms in the long term? It is posited that the attitude of therapists and teachers plays an important role in effecting change. Researchers have long recognised the practical importance of attitude change, as this process has been the subject of careful study for several decades in organisational behaviour and adult education (Byron, 1986; Byron & Byrne, 1984; Rajecki, 1982; Knowles, 1990). In the next section, the attitude to neuropsychology and metacognition will be explored in order to investigate the possibility of a correlation between the results of these two pairs of categories.

6.3.1.2. The change in attitude

As reported in Chapter Five, the results in the Attitude Neuropsychology category showed a significant improvement in the post-training phase, whereas the Attitude Metacognition category showed a non-significant negative trend, indicating that the teachers' and therapists' attitude to metacognitive concepts was either poorer or more confused.

Examination of the overall means in the Attitude Neuropsychology category and of individual questions on the questionnaire indicated that the teachers and therapists believed in the potentially significant implications of the brain being involved in all aspects of the learning process, which is consistent with the results of the study thus far. Metacognition, however, once again presented as a problem, as the means for the Attitude Metacognition category were low. There was also an even spread of frequencies in the individual questions, indicating either a lack of understanding of the concept of metacognition, or just reflecting the entrenched belief that teachers and therapists transmit prescribed content, control the way students receive and use it, and then test if they have received it (Knowles, 1990). This tends to reduce learning to simple incremental internalisation as opposed to creative reconceptualisation, which can only really be facilitated by geodesic approaches. From the increase in the number of neutral "unsure" and "of some importance" responses in this category, it appears that even after training the teachers and therapists were confused or uncertain as to the significance of metacognition.

Furthermore, analysis of the responses to the section E questions (the definitions), for both neuropsychology as well as metacognition, reveals a lack of understanding of the implications of geodesic approaches to learning, which is either a reflection of entrenched beliefs, or is the result of inadequate training regarding this concept. In order to explain why this result occurred, attitude as an entity needs to be examined.

According to Byron (1986: 142), attitude can be defined as "relatively lasting clusters of feelings, beliefs and behaviour tendencies directed toward specific persons, ideas, objects or groups". Attitudes are assumed to comprise three basic parts: an affective component (feeling), a cognitive component (belief), and a behavioural or intentional component (Byron & Byrne, 1984; Knowles, 1990).

From the spread in the results and the significant positive trend in the Attitude Neuropsychology category, it would seem that the affective and cognitive components were influenced by the training, and to a certain extent, the behavioural or intentional component, which is needed to complete the cycle of change. However, in the Attitude Metacognition category, the spread was not even and the change was not significant, indicating that there was an imbalance between attitudes towards metacognitive concepts and attitudes towards neuropsychological concepts. It therefore appears that the teachers and therapists understood the need to change to more neuropsychological approaches, but did not fully comprehend the importance of the metacognitive non-conscious level in the learning process, which confirms their traditional cognitive conscious sequential approach to learning. In order to change to a completely new system of learning as in the MMA, the attitude to both neuropsychological and metacognitive concepts needs to change in a balanced way.

In an attempt to analyse the attitude of the teachers and therapists in more depth, the responses to the section D questions were used to ascertain whether there was in fact an imbalance between the three components of attitude in the sample of teachers and therapists in this study. For instance, for the statement "the learning environment must be quiet and serious" (question D1), there was a positive change in that the percentage of teachers who responded "of no importance" increased from 4,4% to 13,3% in the post-training phase, and those who responded "of very great importance" decreased from 20% to 15,6%. In order for this change to have taken place, the affective component must have been positive, as positive feelings result in a willingness to change the cognitive belief system (Byron, 1986). However, the majority of the teachers and therapists opted for the conservative "of some importance" option in both the pre- and post-training phases, indicating that the behavioural tendency will still be towards the "quiet and serious" option being applied in the classroom and therapy room.

In order to convince individuals to change their attitude, the affective, cognitive and behavioural components of attitude would need to change more or less equally, not in the imbalanced way as indicated in the results of the current study. Examination of the responses to the remaining attitude question revealed that this imbalance occurred repeatedly. The negative questions were not included for analysis because, according to Byron (1986), change will only be induced when feelings towards the ideas are positive, and not negative.

The criteria used to judge balance and imbalance in this respect were as follows. In order for balance to be considered to occur, responses to section D questions should show similar frequency percentages in category 1 ("of no importance") and category 4 ("of very great importance") in the pre-training phase, with the higher frequency percentages concentrated in category 2 ("of some importance"), then category 3 ("of great importance"), the latter two being the options usually selected by unsure or conservative respondents. In the post-training phase this spread of responses should change to majority either category 1 or 4, depending on whether the question was negatively or positively phrased.

By implication, if the majority of frequencies are clustered around the central options (2 and 3) in the post-training phase, and only a small positive change is demonstrated in either 1 or 4, then it can be assumed that the attitude components have not changed in a balanced way. The results of this study indicate an imbalance in the responses to all the questions related to attitude, particularly those pertaining to metacognitive concepts.

It can be concluded that it is easier to change the attitude of teachers and therapists towards neuropsychological concepts because the ideas invoked are logical and relate to the current philosophy propounded in many magazine articles and books, that consideration of brain research is imperative in education. However, consideration of the metacognitive non-conscious has many non-traditional implications, such as that the "teacher tell - pupil listen" paradigm is incorrect. This idea does not "fit" into the traditional mode of thought regarding teaching and learning, and is therefore more difficult to accept and implement. The implication is therefore to find ways of changing the three components of attitude of teachers and therapists to both neuropsychological and metacognitive concepts in a balanced way in order to effect total system changes.

In summary, it appears that the teachers and therapists agreed that changes in traditional systems are needed, and that neuropsychological approaches incorporating thinking skills are a necessary part of this change. However, it appears from the results of this study that the teachers and therapists were not convinced about a complete change in the system. This is possibly because traditional systems have been in place for so long and appear to be working. Alternatively, the teachers and therapists do not understand the implications of the change. It is postulated that this is one of the reasons that the teachers and therapists in this study are selecting only isolated components of the MMA in a disjointed fashion. According to the law of paradigms, however, past success guarantees nothing; in fact past so-called successful philosophies can block future vision (Barker, 1986). As Dewey indicated in 1896 (in Knowles, 1990), humans are in a constant state of change or flux, thus a static unchanging system, such as the current traditional educational system, will block human development. Knowles (1990) argues that perceptive observers of modern civilisation have long been asserting that the nineteenth century model of education is no longer functional in a world of accelerating change. He indicates that "contemporary educational enterprise is frozen into the nineteenth century model of education" (Knowles, 1990: 167). This unwillingness to change could also be the result of the elusiveness of the concept of learning, making a measurable, quantifiable and controllable system, as is the product of traditional behaviouristic and cognitive mechanistic theories, attractive. Alternative geodesic approaches, by contrast, may appear "uncontrollable", as they propose methodologies that are process oriented as opposed to product orientated. For instance, geodesic approaches propound co-operative learning (Johnson, Johnson & Holubec, 1986), where the teacher plays a facilitative background role, as opposed to an authoritative expert foreground role.

From the results discussed above, the following attitudes to learning still persisted after training in the majority of the teachers and therapists:

- *Learning is controlled by the teacher or therapist* (**as opposed to** being facilitated by the teacher and/or therapist, who requires the ability to convey respect, caring and support; provide data and feedback non-threateningly; ask probing questions while keeping the locus of responsibility in the pupil; use the pupil as a source for his own learning; and listen empathetically).
- *The learning environment is controlled and disciplined* (**as opposed to** fostering a healthy scepticism toward authority, a spirit of inquiry and intellectual curiosity being fostered).
- *Students learn from texts and from the teacher or therapist* (**as opposed to** having a knowledge of the resources available and how to use these resources, e.g. how to identify data available in printed materials using the table of contents, the index and so on; how to scan quickly).
- *Learning is the acquisition of isolated skills and techniques by drill, and therefore students need to listen uncritically, retain information, and predict exam questions* (**as opposed to** having the ability to solve problems, formulate questions answerable by data, analyse data to produce answers to questions, and test data against criteria of reliability and validity).

- *A competitive relationship with other pupils promotes learning* (**as opposed to** a co-operative relationship between pupils promoting learning).
- *Learning is a means to an end such as an exam* (**as opposed to** its being a lifelong skill).
- *The learning environment needs to be quiet and serious* (**as opposed to** its being fun, exciting, stimulating and non-threatening, that is, an environment of freedom within a structure).
- *Logical and ordered teaching is important to the learning process* (**as opposed to** multidimensional and collaborative teaching, which allows freedom of association, again within a structure).
- *Laughing, playing and joking serve as breaks from the tedium of learning* (**as opposed to** their being part of the whole learning process).

Hence, 65,7 % of the teachers and therapists in the current study were found to be reactive as opposed to proactive with regard to the facilitation of the learning process. Traditional philosophies of learning "condition the student to respond to the teacher's and therapist's stimuli; the initiative in the transaction is almost wholly in the teacher and therapist; the role of the student is to react" (Knowles, 1990: 209). This keeps the learner in a dependent role, limiting the learning to the paradigms set by the teacher. This study therefore lends support to the claim made by Iran-Nejad (1990) that traditional attitudes to learning limit the role of learning to the simple incremental internalisation of facts in a rote-learning fashion, and that this in turn fosters the achievement and motivational problems that children experience in schools.

Finally, the application of alternative geodesic approaches requires different types of skills and consequently roles from the teacher and therapist. This can be threatening as well as challenging for teachers and therapists, who find it easier, therefore, to revert to "comfort zone" levels of skill. The skill level of change is examined in the next sub-section.

6.3.1.3. The change in skills

As indicated in the results, scores in both the Skills Neuropsychology and Skills Metacognition categories showed significant improvement after training. Examination of the means of the scores before and after training for both categories indicates that although there was an improvement in teachers' and therapists' skills, the skill levels were initially low. This would seem to provide support for what has been postulated regarding the results of the study thus far, namely that traditional beliefs or paradigms are so entrenched or conditioned that even though the teachers or therapists are aware that a complete change to more geodesic approaches to learning is needed, they automatically revert to what they know, or are comfortable with. Alternatively, their conditioning or paradigms could be blocking their ability to understand and therefore apply more wholistic methods and consequently, they do not actually know what to do. Thus, their intentional, behavioural and actual skill application level of geodesic principles is low. These results confirm Knowles' (1990) postulation that contemporary educational enterprise is seemingly frozen into an outdated nineteenth century model.

Furthermore, even though change occurred during the post-training phase, traditional teaching and therapy methods were still being used, with only elements of the MMA methods being applied, which would account for the low means obtained for the skills levels. However, some improvement did occur, which indicates that benefit was derived by the teachers and therapists from the MMA training regarding skills. The effectiveness of this partial application can be judged in two ways: from an analysis of the results of section F of the questionnaire, where the teachers and therapists were given the opportunity to explain how they used the methods and the benefit, if any, they and their pupils derived from this exposure; and from the statistical analysis of the pupils' academic results, which is discussed in section 6.4 below.

With regards to the responses to the questions in section F (see Table 5.6), it appears that the majority of the teachers were using Mind-Mapping predominantly with cultural subjects and English, with very few using it with Afrikaans or Maths. Moreover, from the comments on the questionnaires, it appears that the teachers were using Mind-Mapping as a summary at the end of a lesson after "teaching" in the traditional format.

Thus the Mind-Mapping Approach was utilised as a supplementary aid and a way of summarising, not as a total system. The teachers and therapists did not use the co-operative teaching concept along with the Mind-Map, which is part of the presentation of information. It appears that they viewed the Mind-Map as a way of reinforcing the memorisation of facts, and of "getting the information into the pupils' heads for future reproduction", in other words, as a means to an end. The MMA was thus not viewed as a way of facilitating thinking and the creative expansion of thought, as a process of development. It is almost as if the geodesic methods of the MMA were changed into traditional "tools", and thus viewed as something "extra to do", and not as an alternative approach to turn the product of education into a lifelong learning experience.

For instance, music, which should be played throughout the lessons in order to facilitate concentration and increase the rate of learning, was used intermittently to relax the children, and only by 60% of the teachers and therapists; secondly, the relaxation exercises, which should be used at least daily to release the correct chemicals to facilitate the metacognitive and cognitive processes, were used sporadically by only 20% of the teachers; and, thirdly, the Mind-Map, which should be used continuously in exchanging information, solving problems, creating, memorising, organising thinking and information, and facilitating inquiry-directed research, was only really used as a summary "tool", and study method.

Furthermore, difficulty was experienced with the following skill applications of the MMA methods:

- Getting students to read faster using a pacer in order to improve comprehension
- Stopping students re-reading within a sentence, which reduces comprehension
- Using Mind-Mapping all the time, that is for planning lessons, presenting lesson content, discussions, studying - in other words, wherever there is an exchange of information
- Improving comprehension through the "jig-saw puzzle" method of the MMA, which applies an organised inductive and deductive approach to a text culminating in a Mind-Map (see Appendix IVA) as opposed to reading and rereading through work, underlining key words and making linear notes
- Differentiating between key words and key concepts, and facilitating this understanding in children
- Becoming a facilitator as opposed to a teacher, that is, moving away from the "teacher tell - pupil listen" paradigm
- Using co-operative teaching techniques
- Teaching pupils how to make Mind-Maps independently as well as assisting pupils in the use of the MMA as a study technique.

Few teachers or therapists used the MMA geodesic methods as an entire global cycle. Most of the teachers only adopted isolated components in a disjointed fashion. It appears that teachers and therapists did not know how to use the various procedures, and therefore selected those that they were comfortable with. Furthermore, the resistance to change by the therapists and teachers appears to be the result of being set in traditional paradigms.

6.3.1.4. General conclusion regarding the change in teachers' and therapists' knowledge, attitude and skills

Although the overall results of the current study indicate that a significant change did occur in the teachers' and therapists' knowledge, attitude and skills regarding the geodesic principles of the MMA, it is postulated that these changes were not sufficient to produce an attitude of complete change in the teachers that would be long-lasting. Thus in the post-training phase the teachers and therapists were not applying the MMA geodesic methodology as a an entire global cycle, they were adopting isolated components in a disjointed fashion. The results also indicated a persistence of traditional beliefs or paradigms regarding the learning process in the majority of the teachers and therapists. The speculation arises that this resistance to change is based on attitude, and that unless all three components of attitude (affective, cognitive, behavioural) are changed in a balanced way, long-lasting global changes will not be effected.

Therefore, it appears to be relatively easy to increase a person's knowledge and to improve a persons' skill under supervision, but unless there is a total change in all the components of attitude, this knowledge will not be utilised, and the skill levels regarding the use of the MMA will not increase sufficiently to allow effective autonomous and long-lasting application.

These findings support the literature dealing with the importance of attitude change (Byron, 1986; Rajecki, 1982; Byron & Byrne, 1984). This has important implications for the current research in that the MMA training needs to incorporate techniques that will facilitate a change in attitude towards alternative forms of education, and will therefore overcome existing traditional paradigms. This is discussed more fully in Chapter Seven.

6.3.2 THE INFLUENCE OF BIOGRAPHICAL VARIABLES ON BEHAVIOUR CHANGE

As reported in Chapter Five, it was the middle age group of teachers and therapists, the Afrikaans-speaking group, and those with a teaching qualification plus an extra qualification that showed the most improvement after the MMA training.

6.3.2.1. Age

In-depth analysis of the influence of age (Table 5.3a & b) revealed that the young and middle age groups had similar baseline levels (0,5 and 0,51) whilst the older age group had a higher mean of 0,54. The means of all three groups after the training were 0,57. The younger age group was significant on the 10% level possibly due to the smaller sample size. The scores of this younger group showed the greatest difference in the two phases. Therefore it appears that the capacity to change was easier for the younger and middle age groups of teachers and therapists, which is a predictable result in light of the fact that they are more recently qualified and thus are more likely to have been exposed to alternative methods. Furthermore, the younger the teachers and therapists are, the less likely they are to have established set teaching and therapy patterns and consequently the more open-minded they are likely to be towards alternatives. The older age group of teachers and therapists had a higher pre-training knowledge, but showed the least capacity for change, and were therefore the most resistant to new ideas. The older age group may have felt that their previous methods had worked in the past and were still working, and that they had the experience in education and therapy, and therefore may have been reluctant to change what appeared to be successful.

Analysis of the influence of age within the six individual categories revealed that the highest pre-training means were found to be in the Attitude Neuropsychology category for all three groups, and the lowest in both the skills categories, with the means in Skills Neuropsychology being lower than the means in Skills Metacognitive both before and after training. This would appear to indicate that the teachers and therapists in all three age groups realise the importance of neuropsychological concepts, but do not know how to apply this knowledge. Therefore their confidence in their ability to apply the concepts is not as strong as their confidence in their knowledge. Of the three age groups, the oldest had the most confidence in their skills, possibly due to their experience. The metacognitive aspect of all three categories, knowledge, attitude and skills, is definitely a problem area in all three age groups, and, once again, the older age group had the highest means, and thus knowledge, both before and after training. This appears to be more a lack of understanding of the concept of metacognition and its importance to learning, than a negativity towards it. It appears that it is easier to understand neuropsychological concepts as there are definite methods or exercises to enhance neuropsychological aspects of learning. Metacognition is more elusive, with less clearly defined parameters. This has implications for training, in that the model proposed in Chapter Three should possibly be included in the training of teachers and therapists in order to make the concept of metacognition more manageable. This would need to be co-ordinated with more practical exercises and demonstrations on the application level.

6.3.2.2. Language

An in-depth analysis of the influence of language (Table 5.4a & b) revealed that the bilingual group had the highest pre-training means, but demonstrated the least change, as opposed to the Afrikaans-speaking group which had the lowest pre-training means and the highest post-training means, therefore demonstrating the most change. The English-speaking group had a marginally higher pre-training means than the Afrikaans-speaking group, and demonstrated a significant change, but not as much change as the Afrikaans-speaking group. This would seem to imply that the Afrikaans-speaking group was the least resistant to change, and the English-speaking group the most resistant, with the bilingual group in the middle. All three groups had low means after the training, and the change was therefore marginal.

These results appear to be demonstrating the effect of "paradigms". According to Barker (1987), a paradigm can be defined as sets of rules and regulations which influence and guide thinking and hence decisions. A paradigm is the result of conditioning or sets of beliefs. In the case of the above results, it is possible that the conditioning in traditional education and therapy methods was too entrenched for the teachers and therapists to change their approaches radically. In other words, the MMA training was only partially successful, in that the teachers and therapists did not use the methods as an all-encompassing complementary teaching and therapy method. Traditional methods were still being used after training as the predominant form of facilitating learning, hence the low post-training means. With regard to the Afrikaans-speaking group being the most responsive to "new paradigms", it may be that the English-speaking and bilingual groups had already experimented with alternative methods to a certain extent. Due to either incorrect application of the "new methods", or proficiency with the older methods, or just coping with the curriculum or client load, the teachers and therapists reverted to their old methods, implying a weariness in the application of "more new methods". The Afrikaans-speaking group, on the other hand, may not have experimented with alternatives to the same extent, and may have been at the point where their need to change was greater. This is corroborated by the results of section F of the questionnaire, where the teachers and therapists were able to express their opinion of the MMA methods in an open-ended way. An element of scepticism and negativity was evident in the remarks of the English-speaking respondents, whereas the responses of the Afrikaans-speaking group were very enthusiastic and positive.

In terms of the six categories tapped by the questionnaire (Table 5.4b), similar patterns presented with all three language groups. That is, the attitude towards, and the knowledge of neuropsychological concepts had higher pre-training means, and greater post-training changes than the corresponding metacognitive categories in all three groups. The metacognitive skills, on the other hand, were higher both before and after training than the neuropsychological skills in all three groups. These patterns were the same as the patterns identified across the age groups. This implies that understanding the concept of metacognition and its link to learning is equally elusive for all three language groups. Therefore, even though the means were higher after training in the Skills Metacognition category, these means were still low, implying minimal change had occurred. It is also possible that metacognition was not explained or demonstrated clearly enough in the MMA training course, which would also account for the results obtained. This has clear implications for future training, as already mentioned.

6.3.2.3. Qualifications

An in-depth analysis of the influence of the teachers and therapists' qualifications (Table 5.5a & b), revealed that those teachers and therapists with a teaching qualification plus an extra qualification such as remedial or special education showed the most significant improvement in the post-training phase. However, the "professional" group, which also demonstrated a significant change although not as significant as the "teaching plus" group, showed the most difference between the pre- and post-training means. The lower significance of this result is probably attributable to the small sample size of the "professional" group (n = 9) as opposed to the "teaching plus" group (n = 24).

The results appear to indicate that higher qualifications make teachers and therapists more receptive to new ideas and change. The results of the "professional" group (which had the highest post-training means and smallest sample size, indicating that their knowledge, attitude and skills improved the most) indicate that the professional could play a supportive and consultative role in the classroom with regard to the implementation and carrying-over of geodesic principles. As the "professional" group in this study included speech-language therapists, this result supports the proposal by Gerber (1986), who suggests that the speech-language therapist is ideally qualified to act as a consultant in the classroom.

Analysis of the results in each of the six categories revealed that once again Attitude Neuropsychology had the highest means both before and after training in all three qualification groups. Furthermore, the skills categories demonstrated the most changes, but the means were once again low, especially in the Skills Neuropsychology category. This has important implications for the MMA training programme in that the trainer needs to provide more practical exercises in the form of demonstrations and practice of Mind Mapping in order to increase skill levels, which will in turn increase the application levels. This is necessary as it is becoming increasingly clear that all the teachers and therapists, regardless of age, language or qualifications, agree as to the importance of neuropsychological and metacognitive (geodesic) principles in learning situations, but are not sure how to integrate and apply this knowledge and belief with their current methodologies. The fact that the scores in the Attitude Metacognitive category were again low, and even lower after training, could also be due to inadequate training, as already mentioned.

6.4. THE RESPONSE OF THE PUPILS TO THE EXPOSURE TO THE MMA METHODS: THE SECOND MAIN AIM

In this section the effectiveness of the application of the MMA principles by the teachers and therapists on the academic performance of their pupils is discussed.

6.4.1. THE CHANGE IN LONGITUDINAL TRENDS OF ACADEMIC RESULTS IN GENERAL, PER PHASE, PER SUBJECT AND PER STANDARD

As reported in Chapter Five, the longitudinal trend of academic results showed a small but significant positive alteration in 1993. Therefore, it is concluded that overall the pupils benefited from the introduction of the MMA methods. However, these changes were limited which, considering the isolated componential use of the methods by the teachers and therapists discussed in the preceding section, is not surprising. It is postulated that, had the teachers used the entire system of the MMA as a new approach, much more significant change would have occurred.

Furthermore, the change that was measured in the pupils was academic results, a product. However, the MMA methods are process focused. Therefore, the question arises as to whether what was measured was actually what was facilitated. It could be that, had more process-oriented measures been used to evaluate success, a different type of result would have been obtained. The changes identified in the results are more likely to be a "side effect" rather than a direct effect of the geodesic training. Improved memory is one of the side effects of the MMA. In a product-orientated environment where predominantly facts are tested in exams, marks can improve for factual recall using the MMA. It is postulated that this is the change that was identified in the current study as opposed to a process change.

Stated within the parameters of the MMA model of geodesic information processing and thinking (as described in Chapter Two), traditional testing evaluates predominantly declarative knowledge, whereas geodesic training develops the interaction of declarative, procedural and conditional knowledge. This implies that alternative geodesic evaluation measures need to be used to evaluate geodesic processes.

A better indication of process improvement can be obtained from the responses to section F of the teacher/therapist questionnaire. For instance, F3 queried whether the teachers and therapists felt that their pupils had derived any benefit from the MMA, and if so what. Fifty-five per cent of the teachers and therapists indicated that their pupils had benefited in terms of improved memory, improved organisational skills in projects and essays, and improved problem-solving skills in terms of certain group assignments. However, these latter projects were not considered to be for exam purposes and the marks given to the pupils were not recorded in the promotional schedules. This reflects the traditional conditioning of the teachers and therapists to focus on the product-orientated factual regurgitation of photocopied notes as measures of potential - a "maintenance effect" of the traditional philosophy of education.

Comments were even made by the teachers and therapists to the effect that the marks received were the result of group collaboration and thus not reflective of an individual's potential and not used on reports; and that the marks were too high, the pupils were lucky. Therefore the academic marks measured in this research actually reflect the students' factual recall in a pressurised unnatural exam situation and not their true potential. What the results do confirm, however, is that memory definitely improves using MMA methods.

Examination of the remainder of the longitudinal trends reveals the emergence of a consistent pattern: the pupils in phase one responded better to the MMA methods than those in phase three, whose results tended to worsen when using the methods; the pupils in phase two appeared to maintain the positive trend. Likewise, the improvement in the subjects of English, Afrikaans, Maths and cultural subjects was greater in phase one than in phase two, whilst the results actually got worse in phase three.

The results of the analysis per standard confirms the above: grades one and two and standard one (= phase one) demonstrated significant improvements, whereas standards two and three (= phase two) maintained the same trend, and standards four and five (which span phase two and three) got significantly poorer marks. Therefore the younger children benefited the most from the MMA methods, and the older children benefited the least.

This pattern can be explained from various perspectives. Firstly, the younger pupils have not been in the traditional schooling environment long enough to have become over-reliant on active self-regulation and are thus still using predominantly dynamic self-regulation to learn, activating predominantly the metacognitive level. As they progress through to the higher standards, however, the executive controlling active self-regulation becomes progressively more involved at the expense of dynamic self-regulation. Learning consequently becomes encumbered by increasingly intentional rote and sequential one-thing-at-a-time learning; this learning is conscious, hence cognitively dominant. The pupils are going along the ineffective path of the effort to encode or memorise, thus making learning more difficult (Iran-Nejad, 1990).

The above finding is in contrast to what was hypothesised at the outset of the current study. It was predicted that the older pupils would have a greater need than the younger ones for a study method, and therefore would respond more favourably. It was also predicted that it would be easier to use the MMA methods with the more defined close-ended curriculum of the higher standards that have more specific product goals. It appears, however, that these selfsame paradigms served to limit rather than enhance the learning situation because pupils' marks worsened in the higher standards. Therefore, trying to slot geodesic methodology into a linear limiting traditional environment made matters worse rather than better. This could indicate that total system changes are needed in the higher standards, or that the higher standards need to go back to the methodology utilised in the lower grades in order to incur greater success.

The results of this study appear to confirm the results in the literature on learning (Lozanov, 1978; Dhority, 1991; van der Vyver, 1985; Iran-Nejad, 1990; Gardner, 1986; Jensen, 1995), namely that learning methodology has to have more of an emic perspective. The "teacher tell -

pupil listen" paradigm that becomes prominent in the higher standards does not allow for analytical, evaluative or creative thinking or for the application of knowledge in problem-solving (Adams & Wallace, 1991). Furthermore, "the content-overload of most syllabi prevents even the most skilled teacher from using time to develop pupils' active thinking rather than just memorisation in order to accrue marks" (Adams & Wallace, 1991: 105). This study underscores the seriousness of the situation in that incorrect facilitation of learning will actually inhibit the development of potential. Further confirmation of this trend of thought was found in the responses to section E and F of the questionnaire, where it appeared that the teachers and therapists who taught in phase three had more difficulty applying the concepts of the MMA than the teachers in phase one.

6.4.2. THE LONGITUDINAL TREND IN EACH SUBJECT PER PHASE AND PER STANDARD

Examination of the patterns that emerged from the phase and standard breakdowns of the results in each subject revealed that the subject of English responded the best to the introduction of the MMA methods, followed by the cultural subjects, then Maths, then Afrikaans. Furthermore, English was the only subject that consistently demonstrated significant improvement across all three phases.

The fact that the MMA methods had the most positive effect on the subject of English is possibly due to English generally being facilitated through more creative and wholistic means than the other subjects. The curriculum includes literature, poetry, plays, creative writing, debates. The mark in the subject of English is usually obtained from a factual grammar test and a creative writing test. It is possible that the marks on the creative writing test were higher after exposure to the MMA methods, and that the grammar marks also improved because they were taught thematically within a communication content. In contrast cultural subjects are normally taught in a very segmented factual way, with the objective being to learn the facts provided in the text book or the photocopied notes. In the higher standards exercises often comprise filling in the "missing word". Thus, traditionally there is limited creative thematic and wholistic methodology utilised with cultural subjects, and the improvement seen in cultural subjects in this study is probably due to the "side effect" of improved memory referred to earlier.

With regard to Maths, which is traditionally divided into units, and then sub-divided again into weekly and daily plans (Jensen, 1995; Knowles, 1990). This segmented approach provides unconnected bits of information out of context, and detracts from the wholistic overview required to understand Maths concepts. In order to use Mind-Mapping in the subject of Maths, the whole must first be presented thematically, followed by an analysis of how to get to the whole, and, most importantly, the information must be context related. This requires a different orientation to the traditional pedagogical approach and is thus harder to apply. In fact, only one teacher, a phase one teacher, out of the 45 teachers and therapists, actually used Mind-Mapping with the subject of Maths, whereas 38 of the teachers and therapists used the methods with English.

With regard to the subject of Afrikaans, only five of the teachers and therapists used the MMA methods. This may be due to the fact that the MMA training was in English, or because the subject of Afrikaans is still taught in a very traditional way in contrast to English, which made it very difficult to apply the MMA methods.

In conclusion, in order to adopt geodesic philosophy into the teaching environment, a wholistic multimodal thematic approach has to be adopted. This requires total systems changes rather than trying to slot geodesic methods into traditional formats. There appears to be more extensive use of the neuropsychological and metacognitive philosophy in the lower classes (grade 1 to standard 2). Furthermore, it appears that the subject of English is facilitated within these parameters to a certain extent in all the phases. However, the remainder of subjects are taught, or facilitated in therapy, in a fragmented piecemeal fashion, which is probably the result of conditioned traditional training.

6.5. A CRITICAL REVIEW OF THE EXPERIMENTAL PROCEDURE

Based on the preceding discussion of the results of this study, it is concluded that the efficacy objective of the research was reached. A critical evaluation of the experimental procedure takes into account the different aspects that must be considered during the evaluation of an experiment, and for the planning of future research. This section contains a critical review of the research design and research procedures.

6.5.1. RESEARCH DESIGN

The current research employed an adapted ABA experimental design due to the need to build in effective controls, as well as to deal with the complex layered design of the study. There were three forms of control involved in the study's tectonic structure, which served to strengthen the conclusions drawn. These were:

- The design, which comprised of two experiments, where the influence of the MMA philosophy was evaluated through the change in the teachers and therapists who received direct training, as well as through the change in the pupils who received indirect training
- A pre and post questionnaire so that each teacher or therapist served as their own control
- The establishment of longitudinal trends of pupils, who acted as subjects, academic results to serve as baseline measures and controls.

This combination of controls provided a sophisticated methodology for accounting for variability in behaviour, in that the changes in behaviour were evaluated in different ways (Leedy, 1989).

As control is fundamental to the experimental method, what was initially the study's weakness with regard to the subjects controls became its strength. It was impossible to create a matched control situation because all the pupils were exposed to the independent variable, the MMA methods, in the experimental year, and there were thus no pupils available who had not been exposed, to serve as a control. This led to the development of longitudinal trends which, due to the historical time factor, served not only as baselines but also as controls. Furthermore, these trends also provided important additional information regarding trends in remedial primary schools.

The development of the longitudinal trends led to the purification of the datasets used in the study. Initially there was one dataset of academic results, which consisted of a random sample of 790 sets of results over three years from the three remedial schools. However, the random sampling procedure, which normally adds validity to a study (Leedy, 1989), in this case resulted in dependent data - in that some pupils' results were used more than once over the period 1991 to 1993 - a situation which could lead to false positives being obtained. Therefore a second purer dataset was created of the results of those pupils whose results appeared for each of the three years. However, this dataset contained the results of only 75 pupils, the majority of whom were in phase three. This was unbalanced and moreover was actually only a subset of the first dataset.

The dependency factor was therefore accounted for by the creation of a third dataset, which combined the first two datasets, and in addition by the use of various statistical procedures. The results obtained from this third dataset were therefore more accurate and were hence used for the analyses.

Building these multiple controls into the design allowed for the exploration of the relationship between the independent variable (the MMA methods), and the dependent variables (the behaviour of the teachers and therapists and the academic results of the pupils).

Despite the above, there were, however, limiting factors in the tectonic design of this study that must be considered. These relate to the concept of bias which is an inherent part of any research. The sampling for the three datasets of pupils' results was carefully planned and statistically tested. Therefore, according to Leedy (1989), the conclusions drawn from the data should not be distorted or biased. The sample of teachers and therapists was homogenous in terms of their experience with learning disabled pupils, and one can thus assume that they all had similar experience regarding learning disabilities. However, 28,9% of the teachers and therapists in the study were in phase one, 19,9% were in phase two, and 8,9% were in phase three. Therefore, the weighting was in favour of the teachers in phase one.

The second possible area where bias must be acknowledged in this study is in the questionnaire. The questionnaire is a descriptive survey technique that was used in the current study in conjunction with the experimental method (Leedy, 1989). According to the literature, descriptive survey research is particularly susceptible to distortion through the introduction of bias (Kornhauser & Sheatsley, 1976). It is therefore imperative to bear bias in mind when interpreting the results of the questionnaire.

The MMA training for the teachers and therapists was not compulsory. All the teachers and therapists in the schools selected were briefed as to the contents of the course, and used this information to make their decision whether to come or not. They therefore had a general idea of what to expect. The high knowledge levels of neuropsychological concepts among the respondents, as well as the awareness of the need for change, may have been the result of the briefing; it may also be the case that those who chose to attend may have been more favourably inclined towards the principles put forward, a possible bias that needs acknowledgement.

6.5.2. RESEARCH PROCEDURES

This section evaluates the procedures employed in the research. As already reported, although overall the MMA proved to be effective as a vehicle for change, the results do indicate that the changes in both the teachers and the pupils were conservative.

The training of the teachers and therapists in the MMA could have been lengthened to include more practical work, allowing for more demonstration of the methods and for supervised application of the methods by the teachers and therapists in classrooms and therapy rooms.

Furthermore, in order to increase the external validity of the study, the experimental procedure could have been extended to provide a longer period of exposure for the pupils to the MMA methods. This could have been a controlled supervised situation in order to establish whether the improvements were maintained, and if periodic training of the teachers and therapists is needed to sustain the use of the alternative approach of the MMA.

Regarding the procedures used to measure changes in the pupils, this was done through an analysis of the academic marks according to the promotional schedules. As discussed previously, these are product orientated, whereas the MMA methods are process orientated. Thus, alternative measures of academic potential and thinking skills are needed in addition to straight academic marks. Improvement in the latter only really reflect memory improvements (Gardner, 1985).

A geodesic model such as the MMA would work more efficiently if used within a collaborative transdisciplinary approach. However, the study was carried out by the researcher alone and few collaborative techniques were used in training. The success factor of the MMA might well be increased within a collaborative transdisciplinary approach.

The study could therefore be lengthened to include a transdiciplinary team involved in the training as well as in the practical classroom and therapy room exercises, where consultative and collaborative techniques could be demonstrated and practised. This suggestion falls within the realms of a systems approach which would necessitate basic changes in the structure of the current research.

It appears, however, that the experimental method fulfilled the requirements of scientific research. Therefore, on the basis of the results, it is concluded that the MMA is an effective geodesic technique that is able to alter and improve the potential of teachers, therapists and pupils in remedial schools.

6.6. THEORETICAL IMPLICATIONS FOR GEODESIC LEARNING

The results of the current research indicated that the MMA training programme was effective in bringing about significant improvement in the teachers' and therapists' knowledge, attitude and skills regarding alternative geodesic principles. The results also indicated that the pupils that were exposed to these techniques benefited academically. The patterns emerging from the results revealed certain theoretical implications which will be discussed forthwith.

6.6.1 CHANGES IN THE TEACHERS AND THERAPISTS

The current research suggests that alternatives to the current traditional learning methods are essential if learning institutions are to provide people with effective life skills and enable them to be autonomous learners.

This suggestion is based on a body of literature on alternative learning which stresses the need for fundamental change in the perception of learning in order to cope with the world-wide information explosion (Lozanov, 1979; Gardner, 1985; Iran-Nejad, 1990; Knowles, 1986; Gould, 1973; Capra, 1982; Faure, 1972; Jensen, 1995; Slabbert, 1991; Novak & Gowin, 1984; Kline, 1988; Glasser, 1990; Palmer, 1985; de Capdevielle, 1986; de Andrade, 1986; Nummela & Rosengren, 1985; Wenger, 1985; Adams & Wallace, 1991). The alternative non-traditional approach proposed in this study is geodesic learning. Gould (1973) defines non-traditional learning as an attitude more than a fixed system, with delimited paradigms that can never be defined except tangentially. According to Gould (1973: xv), "this attitude puts the student first and the institution second, concentrates more on the former's needs than the latter's convenience, encourages diversity of individual opportunity rather than uniform prescription, and de-emphasises time, space and even course requirements in favour of competence and, where applicable, performance. It has concern for the learner of any age and circumstance, for the degree aspirant as well as the person who finds sufficient reward in enriching life through constant, periodic or occasional study."

Thus, alternative approaches to learning consider that learning how to learn and self-directed inquiry are essential life skills which enable systems as well as the people within the systems to bring about their own transformation in response to changing situations and requirements. Faure (1973) indicates that education and learning must be conceived of as an existential continuum as long as life, and not limited in time to "school age", or confined in space to "school buildings" and institutions.

The literature indicates that alternative non-traditional approaches to learning require an attitude change in order to deal with the flexibility of society and all of its institutions, which are in a continuing state of transformation (Schon, 1971; Iran-Nejad, 1990; Gardner, 1986; Jensen, 1995; Knowles, 1990; Okebukola, 1992). The results of the current study lend support to this contention in that attitude was found to be a fundamental criterion for effecting a change in perception towards learning. The results reflected a need in teachers and therapists to change to a more wholistic neuropsychological approach to learning. However, the attitude levels of the teachers and therapists were very low. This was presumed to be due to an imbalance in the components (affective, cognitive and behavioural) of the attitude phenomenon in the teachers and therapists. Furthermore, it is postulated that this imbalance increases the resistance to change. This in turn produces what is known as the "maintenance effect". Botkin, Elmandjra and Malitza (1979) indicate that "serious doubt must be raised as to whether conventional human learning processes are still adequate today". They state that traditional learning methods foster a pattern of "maintenance learning", where fixed methods, outlooks and rules - paradigms - are used to deal with known situations, which increases an individual's ability to cope with what is known but ignores what is not known. This can be compared to the Khunian effect where the unexpected is ignored and changed to fit into an existing paradigm (Khun, 1979, in Barker, 1986). Maintenance learning therefore maintains an existing system or way of life. This "maintenance" or "Khunian" effect was observed repeatedly in the current study where the MMA methods were adapted and changed by the teachers and therapists to fit into the traditional approach, as opposed to being adopted as a new entire global system different from the traditional system. Maintenance learning plays an indispensable role in the functioning of societies, but, for long-term survival, "learning that can bring change, renewal, restructuring, and problem reformulation" is essential (Elmandjra et al., 1979: 9). Hence, learning institutions need to develop innovative as well as maintenance learning, and not maintenance learning alone. The latter will create the paradigm effect where "past success can block future vision" (Barker, 1986). The results of current study emphasise the strong effect of maintenance learning and the need to foster innovative learning.

In summary, it is postulated that the "maintenance learning" and "Khunian effect" phenomena are the result of resistance to change, which is an accepted facet of human nature (Barker, 1986). Furthermore, resistance to change is only overcome when all the components of attitude are changed in a balanced way. Okebukola (1992) researched the attitudes of teachers, who are the key agents in the diffusion process of an educational innovation, towards the use of concept-mapping and "vee-diagramming" (Novak & Gowin, 1984). The underlying philosophy of these techniques is of a geodesic nature which requires a change in teachers to a new alternative approach. He found that, after a five-day training course which included practical application in the classroom, there was a favourable attitude in the teachers towards the use of the geodesic concepts - particularly concept-mapping which is similar to Mind-Mapping - in cultural subjects, but not in Maths. He also found that although the teachers' skill levels improved, they experienced difficulty in teaching the methods to the pupils. The current study confirms Okebukola's (1992) findings that attitudes and skills can be changed, and that teachers perceive geodesic methods as easier to apply with cultural subjects than with Maths. However, it is believed that the "favourable" attitude of Okebukola's (1992) study was the equivalent of a change in only the cognitive component of attitude and the knowledge levels of the current research, and not indicative of a permanent change in the teachers' philosophy. Furthermore, although the underlying philosophy of concept-mapping and vee-diagrams is geodesic, the methods themselves have remnants of traditional linear methodology in them.

This lends support to the proposition that, in order to effect a global and lasting change in the perception of learning, the three components of attitude have to be altered in a balanced way, which will in turn reduce the resistance to change and overcome the "maintenance effect". How to change the three components of attitude in order to overcome the resistance to change and to create innovative learning environments and innovative learners, provides speculation for future research (see Chapter Seven).

It is postulated that once the "maintenance effect" is reduced by influencing attitudes, then a paradigm shift will start to occur in accordance with the law of paradigms (Barker, 1986). This shifting of paradigms was evident in the current study, because, even though the means were low, significant positive changes occurred in four of the six categories measured (Knowledge Neuropsychology, Attitude Neuropsychology, Skills Neuropsychology and Skills Metacognition). The overall results also demonstrated a significant positive change. Furthermore, there is evidence that the pupils benefited significantly from the introduction of the geodesic principles, even though the principles were not used as a global system. It therefore appears that the componential use of the MMA methodology succeeded in altering positively the natural trend in the pupils' academic results. Furthermore, the teachers and therapists appeared to sense a substantial growth in themselves and their pupils, which is not always measurable on achievement tests.

This supports research by Palmer, Ellis and Alexander (1989), who did an in-depth case study of in-service training of an entire school staff in accelerative learning (Lozanov 1978) and teaching. According to Palmer et al. (1989: 56), the results of their study were both sobering and promising: "sobering in the realisation that a deeper examination must be made of what is required to produce universal implementation of any innovation by a school staff, and promising in terms of results seen in changes in attitudes, student achievement and aspirations".

6.6.2. CHANGES IN THE PUPILS

Borkowski, Schneider and Pressley (1989), who conducted researched on the challenges involved in teaching information processing to learning disabled pupils, found limited performance gains in pupils who received strategy instruction in information processing, and thinking and problem-solving skills. This was attributed to the fact that individual learning styles were not incorporated in the strategy training. Although the neurological deficiencies of the learning disabled pupil can undermine metacognitively-oriented training, and the special educator needs to confront realistically all the possible constraints, there is, however, considerable evidence from the current research, as well as from the literature, that it is possible to improve the learning potential of academically delayed as well as normal pupils. According to Scruggs and Brigham (1987) and Borkowski et al. (1989), wholistic education can do much to improve the functioning of pupils with learning disabilities and average achieving pupils by attempting to train information processing. It is proposed that the training of information processing can only occur within a geodesic system where students are allowed to explore at their own pace what their strengths and learning styles are, which is inhibited by the traditional system. There are countless “thinking skills” and metacognitive training programmes available (for example De Bono, 19; Adams & Wallace, 1991; Paris & Winograd, 1990; Kaniel & Reichenberg, 1990; Palmer, 1985; Derry, 1990) which all encourage the use of metacognitive strategy training to improve the performance of the learning disabled and normal population.

All these programmes report exciting but fairly conservative gains in potential. Analysis of the frameworks employed in the above programmes reveals an emphasis on behaviour modification and cognitive philosophies. Therefore, although wholistic skills were being trained by these programmes, they were being trained within traditional frameworks. As has been demonstrated in the current study, trying to incorporate geodesic methods into behaviouristic traditional philosophies does not work; it can in fact cause a lower performance in pupils. Entirely new systems have to be created that adopt the geodesic philosophy into which strategy training can fit, and it is believed that higher success rates will then be achieved.

There are some studies reported in the literature (Kaniel & Feuerstein, 1989; Derry, 1990; Erskine 1986; de Capdeveille, 1986; Van der Vyver, 1985; Van der Vyver & Capdeveille, 1990; Thembela, 1986; Schuster, 1983; Edwards, 1983; Dhority, 1984; Odendaal, 1986; Botha, 1985) which employ a more wholistic geodesic orientation, that are more in line with the philosophy of the current research, and that provide promising results. These studies report greater success in students’ process and product performance rates than in product performance alone. Currently in South Africa there is a project called the Upptrail trust that has been underway since the mid-eighties. Its inception was at the University of Stellenbosch, and it was designed to deal with the major problems inherent in black education. The Upptrail project is based on suggestopeadic philosophy, and employs a systems approach which suggests that there is a systematic relationship between social conditions and educational competence (Thembela, 1986).

The scientific monitoring of the Upptrail project, currently in progress, reveals that beneficial gains in terms of innovative lifeskill learning are being made. The current research falls in line with this research in that it promotes complete system changes that endeavour to place the benefits of knowledge and the development of potential at everyone’s disposal. Once the positive results of such research, as well as of the current research, are demonstrated to education departments, the private sector and institutions, wider implementation of similar in-service programmes may take place.

In conclusion, the speculation is made that, if the utilisation of isolated elements of geodesic approaches, as in the current study, is able to produce a positive change in teachers, therapists and pupils, how much more of an effect will utilisation of the entire global spectrum of geodesic learning produce.

6.6.3. THE SPEECH LANGUAGE THERAPIST

The discussion around teachers and therapists in section 6.6.1 applies to the speech-language therapist as well as other therapists and teachers. In this section, the changing role of the speech-language therapist in particular and the profession of Speech-Language Therapy and Audiology is elaborated on.

The paradigm shift that is occurring in the perception of learning is paralleled in the field of Speech-Language Therapy and Audiology, and has resulted in a paradigm shift in the professional self-concept of and role played by the speech-language therapist. This paradigm shift has emerged in response to the increasing awareness of the inefficiency of traditional approaches in meeting the needs of clients, with alternative service delivery models proposed to provide a more accountable service to clients (Paul-Brown, 1992; Simon, 1987; Leaf et al., 1990; Lewis, 1994; Lazar, 1992). The current study provides evidence of this paradigm shift as the speech-language therapists demonstrated a significant positive change in their knowledge, attitude and skills regarding geodesic concepts (see Table 5.5a & b). This indicates that they responded to the need to change in order to provide a more accountable service to pupils with learning disabilities.

The speech-language therapists in this study formed only a very small contingent of the sample (three out of 45) and for this reason were grouped with the remedial teachers, psychologists and occupational therapists for statistical purposes. However, the positive improvement demonstrated by the professional group, where the speech-language therapists numbered 3 out of 19, was significantly greater than that demonstrated by the teachers.

One of the communication needs stressed in the alternative service delivery literature, and which has particular bearing on the current study, is the need to integrate communication skills with academic material (Paul-Brown, 1992). Speech-language therapists need to broaden their role to be able to promote overall school success, and in this way, provide a more accountable service to clients. Speech-language therapists need to become more involved in facilitating the language and communication skills needed in the learning process in the classroom.

This change therefore implies an evolution. According to Johnson (1987: 225), "the evolution from 'speech-language therapist' to 'communication instructor' has been the result of adopting an educational model versus a medical model, through integrating communication instruction into the students natural learning environment, and through collaborating with other educators". This entails the use of classroom and curriculum based service delivery models where the basis for the content of treatment would be the concepts and vocabulary from the academic curriculum. This was one of the reasons for the development of the MMA training programme as a curriculum-based service delivery model to be utilised by both the teacher and the speech-language therapist. It was envisaged that the speech-language therapist would utilise the MMA methods in therapy, and in addition to this, would collaborate with the teachers regarding the pupils, and finally, would serve in a consulting role, assisting and facilitating the utilisation by the teachers of the MMA methods in the classroom.

The consultative role was identified for the speech-language therapist to allow for their background and abilities to be utilised to a greater extent. Not only can speech-language therapists provide direct therapy, but they can also provide input on the communication and social difficulties exhibited by the pupils as observed in the naturalistic learning environments, as well as about the process of language in general (Thurman & Widerstrom, 1990).

Section F of the questionnaire (see Table 5.6 and Appendix III) of the current study provided the opportunity to analyse whether the speech-language therapists' changed perception of themselves was actualised, and thus whether they saw themselves as becoming more involved in the classroom in a consultative and collaborative role. The comments revealed that the speech-language therapists used the MMA methods in 1:1 therapy, that more group therapy initiated, and that there was more collaboration with the teachers.

However, none of the three speech-language therapists who acted as respondents reported actually going into the classroom and working with the teacher and children in a consultative role. It appeared that three of the 12 remedial teachers, rather than the speech-language therapists, played more of a consultative role, and were the driving force regarding Mind-Mapping in the classroom.

These results need to be interpreted with caution as the sample size of speech-language therapists was extremely limited. However, certain theoretical implications can be deduced. It appears that, despite the awareness of the need for change, the sin the current study were not comfortable with the classroom environment and did not feel competent to deal with the curricular and language demands nor with the larger groups. The remedial teachers, on the other hand, had a better understanding of the academic environment due to their pedagogical background, and for this reason may have been more comfortable. Therefore, it appears that speech-language therapists need to be familiarised with the academic environment and the process of teaching in order to feel more comfortable in the classroom.

This supports research done by Gerber (1987) and Simon (1987), who indicate that some form of continuing education is essential if collaboration and consultation between teachers and therapists is to be successful. It would appear that the appropriate way forward would be to provide teachers with training about the nature of language and communication, and the dynamic nature of the learning process; likewise, speech-language therapists need training in the nature of classroom curriculum and its associated language demands. According to Tattershall (1987: 181), speech-language therapists need to "learn how a classroom works before its too late". Furthermore, the traditional training of speech-language therapists needs to include consultation skills as required competencies (Marvin, 1987).

Lastly, the results of this study indicate that teachers and therapists need training relating to the geodesic nature of metacognition and learning. The importance of the speech-language therapist as a collaborative consultant utilising alternative geodesic approaches is highlighted by Simon (1987), who postulates that well-meaning traditional speech-language therapists have actually ended up creating "educational casualties" as a consequence of segregating and labelling students, leading them to becoming addicted to 1:1 attention. This has contributed to the development of passive attitudes towards learning in so-called "learning disabled" students, who fall into patterns of "learned helplessness" due to their believing the label "disabled" (Altwerger & Bird, in Damico, 1987). The speech-language therapist can play an essential role in the creation of active, responsible and innovative learners specifically with those clients with learning disabilities who have long histories of attending 1:1 therapies.

6.7. CONCLUSION

The current study identifies the reasons why change in traditional perceptions of learning is needed by tracing the philosophies of contemporary traditional methods and their effect on the perception of learning, and proposes an alternative geodesic approach, the MMA model. Inherent in the model is the implication that traditional methods do not facilitate effective wholistic thinking and as a result, do not produce innovative life-long learners.

The broad topic of teaching and providing therapy to pupils with language, communication and learning disabilities consists of the distinctive domains of curriculum, instruction, management and assessment (Palmer et al., 1989). The MMA procedures lie within the domain of instruction and may be applied to any curriculum or therapy context and any age level. The MMA philosophy also provides an approach to curriculum, management and assessment. Therefore, extrapolated from the MMA model and its assumptions, is a practical framework, the MMA, that, when implemented within learning environments, will foster geodesic thinking which is in natural compliance with the functioning of the brain and therefore to be preferred.

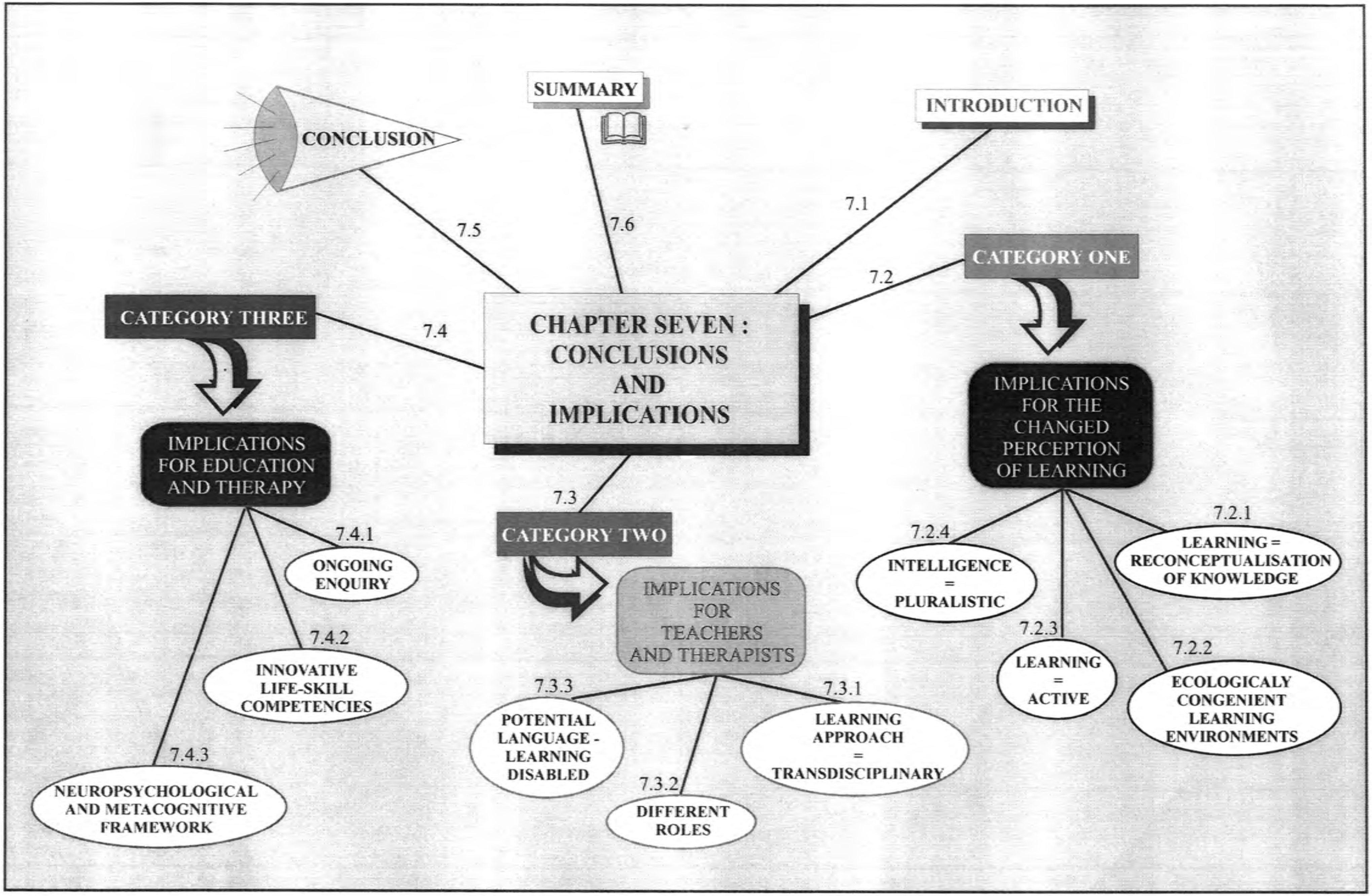
The study tested the validity of the above assumption by providing an alternative geodesic approach, the MMA, to a group of teachers and therapists that work with learning disabled pupils. In this way both the MMA as a geodesic framework, and the actual effectiveness of the MMA training programme in conveying geodesic principles, were evaluated. The results indicate that significant benefit was derived by the teachers and therapists from the MMA training. Furthermore, the overall longitudinal trends of the pupils' results indicated that a significant positive change was experienced by the pupils with the introduction of the MMA methods. Thus it can be said that the partial application of the MMA methods by the teachers and therapists did improve the performance of the pupils, and that this study was therefore successful.

However, the pupil improvement, as measured using academic results, was not as large as predicted. Analysis of the results for the teachers and therapists also revealed that the positive improvements were conservative. It is speculated that this conservative, although significantly positive, improvement in the teachers and therapists and in the pupils is attributed to the fact that the MMA methods are geodesic, facilitating improved thinking, problem-solving and research skills, and innovative learning. However, traditional methods of testing and marking do not evaluate these skills, as their emphasis is on the regurgitation of facts taught in the classroom using the "teacher tell - pupil listen" paradigm. Therefore, it is postulated that a different set of much more positive results would have been obtained had the pupils been evaluated in a way that matched their training, that is through using research projects, assignments, presentations and discussions.

It is possible that the results of this study simply reflect the "carry-over" effect of geodesic training, of which one of the "side effects" is improved memory. Improved memory results in better recall of facts and the resultant improved "product" - the academic percentage. The results obtained could be enhanced and valuable additional information provided if the pupils' metacognitive skills could be analysed through a parallel study where metacognitive thinking skills are evaluated before and after exposure to geodesic methods. The results of the study do, however, provide valuable information as to the effect of geodesic methods on traditional systems, which became an ad hoc additional objective of the current study.

6.8. SUMMARY

In this chapter, the empirical research, the results thereof and the MMA geodesic philosophy and training were critically examined in order to extrapolate the theoretical implications. The experimental and therapeutic criteria were invoked in order to examine and draw conclusions regarding the observed behaviour changes, that is, to determine whether the intervention had a reliable effect on behaviour under specific experimental conditions (Uys, 1989). The experimental criteria were met, indicating that the MMA training was effective in facilitating a change to more geodesic learning and learning environments. However, certain observations were made: the teachers and therapists only utilised the methods of the MMA componentially in an isolated fashion, and not as an entirely new system. It was surmised that this was a result of attitudes, which produce a "maintenance effect". Furthermore it was felt that the changes in the pupils' academic results were a "side effect" and not a direct effect of the application of the MMA methodology.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7.1. INTRODUCTION

The current research provides a model and framework for geodesic learning, the Mind-Mapping Approach, as an alternative approach to the realisation of the potential of pupils in learning environments. The central thesis of the current research is to change the perception of the traditional view of learning as a "mosaic of educational and therapeutic programmes conducted by a plethora of largely unconnected institutions" (Knowles, 1990:171), into a lifelong learning resource system or learning community. This implies that learning should be viewed as an internal construction process controlled by the learner, as opposed to the internalisation of external facts from an external source such as a teacher.

This alternative approach can be accomplished via the restructuring of learning environments so that they reflect the dynamic and spontaneous learning approaches that worked for children before school, and that follow the natural laws of brain functioning. This would entail: the eradication of memorizing isolated materials for an end result such as an exam - a product, and replacing it by the facilitation of meaningful and useful knowledge extension and understanding of concepts and their interrelations - a learning process; creating authentic learning opportunities in real world contexts. Therefore, learning intentions within a geodesic framework are changed from optimizing the conditions for encoding and retrieval under other-regulation, to optimizing the conditions for understanding and personal growth under self-regulation (Iran-Nejad, 1990; Gardner, 1985; Knowles, 1990; Jensen, 1995).

Geodesic methodologies are alternative systems as opposed to "methods" that can be componentially adopted ad lib into a traditional system. It is postulated that the ad lib componential adoption of geodesic methods will result in improved "side effects", as opposed to an improved thinking and processing system in an individual. It is proposed that this is what has happened in the current study. Initially it was predicted that geodesic methodologies could be adopted into traditional frameworks, and in this way, new systems could be created. However, the results of the study indicate otherwise. It would seem that the new system has first to be created and adopted by the teachers and therapists. Then, once the philosophy and methods of the new system have become implicit or conditioned, the positive aspects of the traditional system could be reintroduced in a componential fashion. In this way, the positive aspects of traditional systems could be utilised and the damaging negative aspects discarded.

This research then meets the current educational and therapy needs for transforming traditional approaches to education and therapy in South Africa which are in a process of review. The results of the study show that this change can be facilitated by using the geodesic approach which will be discussed further under clinical applications.

It has become evident that "merely increasing financial resources on a system which is incapable of providing human society with the enhanced human capabilities necessary to operate and contribute to a better society can be counterproductive" (LTFA, 1995). In 1974 a World Bank report concluded that the two previous decades of formal traditional educational systems had proved irrelevant to the needs of developing countries, as they tended to kill entrepreneurial and community interests (LTFA, 1996). Clearly new systems are needed to resolve the situation. A new system is a broad view which transcends technological problems and demands, and implies a basic reorientation in scientific thinking (Knowles, 1990), in other words, systems theory (von Bertalanaffy, 1968). It is into the systems theory that the geodesic approach fits as "systems theory is not a theory in the usual scientific sense of a discrete system of assumptions, constructs, and functional relationships which explains and predicts the behaviour of some particular phenomena. Systems theory is a set of principles, an orientation in thinking, a general body of knowledge applicable in a wide variety of circumstances" (Knowles, 1990). It applies in situations where "wholeness" is important, and this is usually the case when dealing with problems of education and learning (Hayman, 1975: 3).

The uniqueness of the MMA geodesic approach is specifically is that it offers an unified theoretical account, as well as a practical model, of a number of geodesic psychological phenomena that are discussed and evaluated in the literature, but have heretofore been unrelated into a unified theory and practical application. That is, the elements or procedures of the MMA are examples of what many teachers and therapists would recognize as basic as well as desirable tenets of a wholistic learning environment, and which have been used in isolation in learning environments before. The uniqueness of the MMA is the degree to which these components are integrated into a practical framework functional within daily therapist/teacher/pupil interactions. Therefore, the geodesic approach of the MMA not only provides a set of principles and an orientation in thinking, but also a practical framework enlisting geodesic philosophy and systems theory to be operationalised.

Arising out of the current research are various implications for education and therapy and the facilitation of learning in general. They are grouped into three categories, namely, implications for the changed perception of learning; implications for teachers and therapists; and implications for education and therapy. Each implication is outlined and then suggestions are made for implementation it and for future research.

7.2. CATEGORY ONE: IMPLICATIONS FOR THE CHANGED PERCEPTION OF LEARNING

7.2.1. LEARNING IS THE RECONCEPTUALISATION OF KNOWLEDGE AS OPPOSED TO THE INTERNAL INCREMENTALISATION OF FACTS

Discussion

Traditional philosophy limits the domain of learning to the simplistic internalization of externally available knowledge resulting in predominantly rote-type learning of facts and definitions (Iran-Nejad, 1990).

Most of the factual information taught within traditional environments has questionable value in terms of lifeskills, and therefore lacks in quality and usefulness (Glasser, 1986). Learning is an interactive multimodal process system, not a sequential accrual system - which is only a sub-function. It is thus limiting and inhibiting to design education around the simple behaviouristic one-thing-at-a-time stimulus response. This is not congruent with biological theories of brain functioning, which indicate that the genetic structure of the brain results in behaviour being the attempt to satisfy needs, and is thus proactive, not reactive and stimulus bound (Glasser, 1986).

Operationalisation and future research

If the alternative perception of learning really is adopted, then the emphasis will move from the memorising of facts, information and formulas, which are readily available in both books and computer software, to processes and skills.

For instance, preferred activities would be writing a play, as opposed to a grammatical writing lesson; or using co-operative groups to solve problems, or to understand a process as opposed to learning photostated notes off by heart for a test. The idea is to immerse learners in multimodal stimulation using as many varied learning opportunities as possible. The focus would then be on the process of how to learn, which is recreating knowledge, and would therefore avoid simple incrementalisation of existing facts. The reconceptualisation of knowledge would enable students and clients to develop their ability to use what is learned, not just to know what it is. A further consideration is that special education environments dealing with children with learning difficulties are usually characterised by a passive-acceptant approach (Kaniels & Feuerstein, 1989). Familiar simple subject matter is offered at a slower pace with emphasis on reproducing material - a simple incrementalisation of facts (Kaniels & Feuerstein, 1989; King & Goodman, 1990). This results in learning environments lacking any creativity, the facilitation of higher levels of thinking or the independant performance of higher level functions - the reconceptualisation of knowledge. In order to raise children with learning difficulties to higher levels of development, a passive-acceptant approach must be replaced by a proactive geodesic approach. According to this approach, the individual is an open system capable of mental and emotional modification (Kaniels & Feuerstein, 1989; Jensen, 1995). A proactive geodesic approach will encourage children with learning difficulties to be actively involved in normal education environments and society. This requires a process of integration facilitated by the professional in the learning environment, who needs to recognise that language, learning and communication do not exist in a vacuum (Paul-Brown, 1992; Marvin, 1987). Instruction to facilitate language, learning and communication skills should be presented in natural environments requiring communication (Johnson,1987). As school is normally the natural environment for most school-going children, communication skills need to be integrated with academic content. Thus, if the professional, specifically the speech-language therapist who has expertise in language and communication, works directly in the classroom where the problems occur, strategies can be provided for pupils to better understand academic material and classroom instructions (Paul-Brown, 1992). Viewed functionally, speech-language therapists are not “re-mediating” or “re-habilitating” communication, language and learning disabilities, but are attempting to proactively assist in the mediation of a school communication system for them. In this way, the passive reactive incrementalisation of existing facts can be replaced by the active recreation of knowledge.

As discussed previously, the findings of this research indicated high levels of awareness in the teachers and therapists of the need to change to a more neuropsychologically-based approach, as well as the indication that many of the above techniques are already being used in teaching and therapy. However, the use of the technique was componential, thus the question for future research becomes how to encourage global use of geodesic systems that will facilitate the reconceptualisation of knowledge as opposed to the incrementalisation of facts. This would possibly entail comparative studies of traditional versus geodesic evaluation procedures.

7.2.2. LEARNING ENVIRONMENTS NEED TO BE ECOLOGICALLY CONGRUENT AND AUTHENTIC WITH AN EMIC PERSPECTIVE, IN ORDER TO FACILITATE EFFECTIVE LANGUAGE, LEARNING AND COMMUNICATION

Discussion

The majority of learning needs to be contextually embedded as realistically as is possible (Johnson, 1987). This is because “the brain is actually very poor at learning large amounts of material from books. It is naturally good at learning in the locations and circumstances of everyday life” (Jensen, 1995: 333). Knowledge is more easily reconceptualised into useful knowledge that can be utilised when it is associated with a novel experience, or location or feeling, or some type of hook that will tie it in with the content. Therefore neither the traditional “stand and deliver” context of teaching nor the isolated 1:1 therapy model are authentic, ecologically congruent or emic as the focus is on the teacher and therapist delivering content or remediating an identified “deficit”. Rather, the learner needs to be guided to discover the meaning of the content. Furthermore, language, learning and communication are active creative processes. Whether the focus is on speaking, listening, reading, or writing, language and communication involve the creation of meaning and making sense (King & Goodman, 1990). A curriculum or therapeutic approach that fragments language, communication and learning into small, abstract pieces with the expectation that if the parts are mastered, the whole will eventually be mastered, inhibits learning and communication (Schory, 1990). The opposite perspective is a whole language perspective where the learning direction is from the whole to the parts, (King & Goodman, 1990; Schory, 1990), and therefore falls within the realms of a geodesic approach.

According to Miller and Sabatino (1978), children pass a crucial test, before school, suggesting that they are spontaneously proficient learners, because they master in a few years one of the most complex systems of rules known, their mother tongue. They also become quite proficient in the knowledge of the world around them (Iran-Nejad, 1990). By contrast, "only a few children in school ever become good at learning in the way we try to make them learn. Most of them get humiliated, frightened and discouraged. They use their mind, not to learn, but to get out of the things we tell them to do - to make them learn" (Holt, 1964: vii). Bereiter (1985) indicates that there is a complex relationship between the multisource nature of learning and the environment in which this learning is fostered. A young child's learning environment is multisource, creative and natural with the various sources that contribute, operating simultaneously. It facilitates a balance between active and dynamic self-regulation to occur.

This is in contrast to the less than authentic traditional learning environments of later life that foster a climate of encoding facts in an increasingly analytic and sequential way. This fosters an over-reliance on untrained or incorrectly-trained active self-regulation at the expense of dynamic self-regulation, which results in training children out of the natural way of learning (Holt, 1964). Therefore, the more wholistic, natural and meaningful the learning environment, is the more ecologically congruent and authentic it will be. This will ultimately result in more effective language, learning and communication skills.

Operationalisation and future research

Educationalists and therapists have a responsibility to change learning environments such that predominantly dynamic self-regulation operates with active self-regulation playing a minor role (Iran-Nejad, 1990; King & Goodman, 1990; Schory, 1990). This can be done by applying the principles of the philosophy of geodesic learning which have authentic ecological environments built into their methodology.

Geodesic approaches have to have authentic learning environments in order to work. By adopting geodesic approaches such as the MMA, authentic learning environments will automatically be created. Further research is needed to explore geodesic learning environments that foster a climate of authentic learning. In summary, transformation of learning in the in the schools of the future will need to consider the neuropsychological aspects that allow the interaction of dynamic and active self-regulation which will facilitate innovative learning.

7.2.3. LEARNING IS A PROCESS OF ACTIVE RESEARCH INITIATED AND CONTROLLED BY THE LEARNER

Discussion

Learning as a process of active research means that one's learning intentions need to be changed from those aimed at optimizing the conditions for encoding and retrieval under other-regulation to optimising the conditions for understanding and personal growth under self-regulation (Iran-Nejad, 1990). The latter implies that co-operation between teachers, therapists and pupils is required in the development of any course or therapy purporting to meet their needs. Thus the learners take responsibility for their learning and the quality of their work in co-operation with the facilitator (Glasser, 1986). This is in contrast to traditional philosophy of education and institution-based rehabilitation (IBR) which identifies the teacher and therapist as being solely responsible for what is learned, and how, when, why and if it is learned.

Currently, however, in the field of Speech-Language Pathology, there is a move away from institution-based rehabilitation to community-based rehabilitation as a result of the increasing awareness of the inefficiency of traditional approaches, and the recognition of the social interactive nature of language (Paul-Brown, 1992). This is evident in the whole body of literature on alternative service delivery models designed to meet more efficiently the needs of clients with communication, language and learning problems (Paul-Brown, 1992; Lewis, 1994; Schory, 1990; King & Goodman, 1992).

If learners are guided into taking responsibility for their learning, then this will lead to learning that is based on curiosity, need and relevance, and thus the motivation becomes intrinsic. Hence, the classroom and therapy room becomes focused on learning and not maintaining control. Teachers and therapists have authority, and are content specialists, but learners also have the right to be respected and given an opportunity to learn. According to Jensen (1995) and Iran-Nejad (1990), students in a fully-implemented geodesic learning environment will rarely have behavioural, motivational and learning problems because they are fully engaged, curious, engrossed, challenged and excited about learning.

Operationalisation and future research

Students need to play a major role in the decision about what they have to learn and how this can be done; that is, learners need to take a higher level of responsibility for their own learning

(Schory, 1990; King & Goodman, 1990). Thus the learner needs to self-monitor and self-evaluate with the facilitator, with the emphasis on teaching the student how to assess the process and not just the end result of the process, the product (Glasser, 1986). The learners and facilitators should engage in continual constructive examination of how to improve the process of learning. This can be done by the teacher and/or speech-language therapist orally making decisions and solving problems concerning her own reading, writing, communication or learning activity in order to demonstrate the problem-solving process (Schory, 1990). This is especially important for the language-learning disabled students who frequently experience difficulty solving problems related to language, learning and communication (Damico, 1987).

Finally, comparative studies should be conducted between self-regulated students in geodesic environments and other-regulated students in traditional environments in terms of problem-solving, research skills, thinking skills and general life skills in order to compare the differences in performance and learning potentials. There is research of this nature in the literature, but concerning predominantly suggestopaedic techniques (Dhority, 1990; Lozanov, 1978; Adams & Wallace, 1991). There are, however, relatively few programmes that offer the unique combination of the MMA, and it is felt that geodesic methods need to be used as wholistically as possible within a systems theory approach as opposed to componentially within a traditional approach to education. Thus, true geodesic systems need to be created and studied scientifically in order to create the body of evidence that is lacking in traditional learning approaches. Furthermore, this body of evidence will underscore the pitfalls of the traditional environments in education and therapy that were created, with relatively minimal scientific basis, (Gardner, 1985: Jensen, 1995; Iran-Nejad, 1990; Knowles, 1990), as well as supporting the intimation made by Gerber (1987) that traditional environments "de-educate" students turning them into rote-learning "junkies".

In addition, the speculation that behavioural, motivational and learning problems will decrease in fully operating geodesic systems (Jensen, 1995; Iran-Nejad, 1990) needs scientific and documented research as this has profound implications for students. This is because the ability to take a proactive role in initiating and controlling the learning process allows personal effort and ability to take on a determining role. According to Glasser, (1986) persons who see themselves in control of a given situation make a greater effort to achieve success then those who do not. Language-learning disabled pupils in particular need to be allowed to have a sense of control over their own learning processes in order to overcome the passive-acceptant and learned helplessness that comes from repeated failure and being continually guided (Kaniel & Feuerstein, 1989). When a teacher or therapist continually corrects and guides students' efforts, they prevent them from taking charge of their own learning. This leads to overdependency on others and decreased confidence in one's own abilities (Marvin, 1987). Thus, the language-learning disabled child needs to be shown how and allowed to take control of the language, learning and communication situation in and out of school.

7.2.4. INTELLIGENCE IS PLURALISTIC AND IN EVERY INDIVIDUAL THERE IS A UNIQUE BLEND THAT DETERMINES THEIR INDIVIDUALITY

Discussion

The multiple intelligence theory (Gardner, 1985) challenges the prevailing concept of intelligence as a single general capacity that enables individuals to perform in all situations. According to Gardner (1985) every normal human being is born with seven different intelligences. Of these, one will be dominant and one secondary and this contributes to individualistic learning styles. If this does not conform to the dominant traditional teaching style, which emphasises verbal and mathematical intelligence, then individuals are at a disadvantage.

Thus, learning environments and facilitators need to recognise that intelligence is made up of different capacities, not just mathematical and linguistic, which results in a diversity of learning styles requiring highly individualised programmes and consequently, "freedom within structure". Furthermore, I.Q. testing, which is based on the single unitary concept of intelligence, cannot predict or determine potential as these tests are based on mathematical and linguistic intelligences alone. I.Q. testing can only predict how well a student can play the "school game", and may erroneously label a student, limiting aspirations.

Opėrationalisation and future research

Successful teaching and therapy needs to reinforce and affirm the different ways in which individuals learn. Facilitators of learning need to incorporate situations where students have opportunities for the creative exploration of their individual interests and talents while also learning valued skills and concepts through multimodal means. Information needs to be presented in numerous ways offering students many opportunities to succeed. Therefore, manipulation and actual experience, moving, touching and doing should be part of the learning process. Learning environments need to help students to identify their areas of strength and to develop these so that they can become active contributors in society in their future. The more authentic the environment, the more effective the generalisation of skill mastery and problem-solving performance will be. In addition, learning is more effective if a process (for example: learning plan) and open-ended product structure (for example: therapy objectives, course outline) is applied, as opposed to a close-ended (traditional) product structure alone. Within the field of speech-language pathology, the whole-language approach (Schory, 1990) is evidence of this idea being practiced. The suggested geodesic methodology provides a broader framework enabling neuropsychological concepts to be incorporated into the whole-language approach, enhancing its effectiveness.

The practical application of facilitating the seven different intelligences in learning environments is currently available in the literature (Campbell et al., 1992). What is needed is scientific research incorporating these applications into geodesic frameworks such as the MMA, and into learning environments in order to demonstrate their success.

7.3. CATEGORY TWO: IMPLICATIONS FOR TEACHERS AND THERAPISTS

7.3.1. THE LEARNING APPROACH NEEDS TO BE TRANSDISCIPLINARY REQUIRING FACILITATORS, DIRECTORS AND THERAPISTS TO ASSUME INTERCHANGEABLE ROLES AND RESPONSIBILITIES FOLLOWING THE NEEDS OF THE CHILD, THE FAMILY AND THE COMMUNITY

Discussion

A geodesic approach requires pupils, therapists, teachers and parents to commit to teaching and learning from each other by working together. This approach involves a collaborative and consultative methodology and as such, can be considered transdisciplinary (Thurman & Widerstrom, 1990). A transdisciplinary approach falls within the realms of systems theory which allows any social system to be conceptualised as a system of learning resources, or an interdependent learning community (Knowles, 1990). A wholistic learning system is a complex of elements in mutual interaction (Griffiths, 1964).

Therefore, to account for wholism and interdependence, there has to be co-operative interaction between all the people within the system. The key issue, however, is the interchangeability of roles required and hence a transdisciplinary as opposed to interdisciplinary approach is essential for a truly geodesic learning environment to be created.

Operationalisation and future research

In order to operationalise the above implication, collaborative and consultative skills have to be included in any training of teachers and therapists (all types) (Simon, 1987; Damico, 1987). This would also include systems theory training which emphasises community-based learning systems. Future research needs to explore the benefits of transdisciplinary principles within wholistic geodesic learning environments such as those created when using the MMA, specifically the advantages of such an approach to the community as a whole. Resources are readily available in every environment, and thus a primary research focus is to identify these and introduce learners to them. Systems need to be put into effect where all resources within a community are explored and utilised in an organised interactive way within a geodesic framework. It is now recognised that services are most successful when teams of professionals and families collaborate forming partnerships. A transdisciplinary approach involves a collaborative consultative methodology involving both professionals and the community (Briggs, 1993).

7.3.2. TEACHERS AND THERAPISTS PLAY DIFFERENT ROLES IN A GEODESIC AS OPPOSED TO TRADITIONAL LEARNING ENVIRONMENTS

Discussion

Historically, the classroom teacher provided the student with the curriculum material to be learned, and the speech-language therapist provided the student with remediation strategies for specified communication difficulties (Shapiro et al., 1988). However, the most important objective of a geodesic model such as the MMA is adapting the child's academic instruction so that he can achieve to the best of his ability. Many students are not successful learners and the differences between the educational experiences of students from different racial, linguistic and socio-economic backgrounds has led to many revisionist movements, which fall within the realms of geodesic philosophy, and which share the common goal of changing what does not appear to work. One direct result of this change is the re-discovery of the role language-proficiency plays in the education process (Damico, 1987). Here, the speech-language therapist, who is a language expert, can be extremely effective in mainstreaming into the classroom. This implies changed roles for both the speech-language therapist and the teacher who would need to work together in a consultative and collaborative manner in order to take advantage of their combined expertise. This whole-language approach (Schory, 1990) would change the focus from the identification and fixing of deficits to the purpose and nature of learning.

A teacher or therapist in a geodesic learning environment is a facilitator of learning. This implies that teachers and therapists are managers of the process of learning as opposed to content-transmitters. Being a content resource or a content specialist should be a secondary role to that of being a facilitator of learning. According to Knowles (1990) and Glasser (1986), being a process manager as opposed to a content planner and transmitter requires relationship building, needs assessment, involvement of students in curricular planning, linking students to learning resources and encouraging student initiative. This idea is developed within the whole-language approach (Schory, 1990; King & Goodman, 1990) which provides a distinct philosophy as well as practical ideas on how to implement Glasser (1986) and Knowles (1910) postulations.

Operationalisation and future research

In order to operationalise the different roles of the teacher and therapist within the geodesic environment, classroom and curriculum-based models which utilise the concepts of collaboration and consultation have to be developed. Classroom-based language and communication intervention has the distinct advantage of allowing the speech-language therapist to use the pupils' academic programmes as the basis upon which to build language intervention because pupils can stay in their classrooms and thus be present when important content information is given (Schory, 1990). Under such a system, known as the whole-language approach (Schory, 1990), the speech-language therapist would be able to monitor the development of oral language skills within a more natural setting than a therapy room; there could be a more frequent exchange of information between the teacher and speech-language therapist regarding the specific needs of each language-learning disabled child resulting in improved language-learning experiences; there would also be the opportunity to provide teachers with suggestions for incorporating all the varied forms of oral language within their lessons; the speech-language therapist could mediate the communicative interaction between the teachers and pupils; and finally the speech-language therapist could assist in the implementation of the MMA methodology initially as an expert consultant, and thereafter as a partner in a collaborative process. In this way the teacher and therapist together become facilitators of language, communication and learning.

In summary, a facilitator of learning allows learners to work, learn and grow at their own pace, not according to the teachers' and therapists' preset time-table. The facilitator will allow for new and different ways to solve problems without the traditional limits. The facilitator will supply the resources that will enable the learner to find the meaning enabling them to focus on the process and not the product.

7.3.3. THE SO-CALLED "LANGUAGE-LEARNING DISABLED POPULATION" CAN BECOME INNOVATIVE THINKERS IF THEIR LEARNING IS FACILITATED WITHIN A GEODESIC ENVIRONMENT USING GEODESIC METHODOLOGY

Discussion

Recognising the possible neurological constraints of the language-learning disabled population, it is believed that within environments using geodesic frameworks such as the MMA many of the problems of the language-learning disabled pupil can be overcome enabling them to become innovative lifelong learners. Research (Jensen, 1995; Buzan, 1991; Dhority, 1991; Gardner, 1985) suggests that the brain thrives on novelty, challenge and enrichment, and therefore it is only logical and fair to put all types of learners into an environment that takes advantage of the natural functioning of the brain. According to Kaniel & Feuerstein (1989), restricting the level of requirements of the language-learning disabled child by simplifying the environment and reducing challenges, will lower levels of motivation, aspiration and achievement. Thus, in order to empower children with language-learning disabilities to reach higher levels of development, the traditional passive-acceptant approach must be replaced by an active approach to learning. According to this approach, the individual is an open system capable of mental and emotional modifiability. Therefore, low levels of achievement are reversible and it is possible to learn efficiently if the proper effort is invested in diverse and integrated ways (Kaniel & Feuerstein, 1989; Jensen, 1995; Gardner, 1985).

Operationalisation

In order to operationalise this implication, learning environments need to change, from being passive-acceptant to active-modification. Entire new global systems need to be created that will allow all learners, whether language-learning disabled or not, to develop their potential together. A geodesic system of learning will focus on individuals and developing them; and not on fitting the individual into a system. Separate schools for learning disabled students are not necessary, they are in fact making the situation worse. Individual help can be given when required, but within the system. Therefore the child with language-learning disabilities should be mainstreamed and not protected within isolated educational frameworks (Marvin, 1987). According to Kaniel and Feuerstein (1989: 166), "the ultimate purpose is to bring him satisfaction, not by isolating him and avoiding confrontation, but rather by providing tools for the daily struggle with a normal environment in which he may achieve satisfaction". The geodesic approach of the MMA, which is an active modification approach, has faith in the exceptional child's ability to change and grow, and accordingly great effort is invested in offering him many choices, as well as providing "tools" for change for example: the Mind-Map and the MMA strategies.

In addition, a system of "pull-out" programmes within the mainstream (Simon, 1987) could be created for students with special needs. Instead of the traditional approach which primarily teaches content more slowly, these should focus on the processes and values of learning, for instance, how to spell, rather than lists of rote spelling words; how to learn; Mind-Mapping; communication skills; and finally social skills (Jensen, 1995).

7.4. CATEGORY THREE: IMPLICATIONS FOR EDUCATION AND THERAPY

7.4.1. LEARNING IN A WORLD OF CONTINUING ACCELERATING CHANGE IS A PROCESS OF ONGOING ENQUIRY

Discussion

Within the field of Speech-Language Pathology and Audiology, the increased awareness of the inefficiency of traditional approaches has led to the emergence of alternative treatment approaches. The alternative service delivery models (Morvin, 1987; Paul-Brown, 1992) have been the result of speech-language therapists being required to serve a wider range of persons who present with a greater variety of communication disorders (Van Kleeck, 1992; Lewis, 1994). This has resulted in a paradigm shift in the professional self-concept of and role played by the speech-language therapist.

This necessitates the ability to learn to understand, guide, influence and manage these transformations or paradigm shifts. Learning activity should be deformalized and replaced by flexible diversified models, such as the MMA, in order to move learning into the twenty-first century (UNESCO, 1972, in LTFA, 1996). It therefore becomes an imperative task for individuals, institutions and society as a whole to learn about the process of learning. This is not complex, as has been demonstrated in the current study. Through the collaboration of teachers, therapists and pupils, significant improvement in the teachers' and therapists' knowledge, attitude and skills regarding geodesic principles and the process of learning, as well as significant improvement in the pupils' academic results was attained by the partial implementation of the alternative geodesic approach to learning, the MMA. Although the changes were smaller than predicted, due to the way the methods applied piecemeal by the therapists and teachers, what was evident in the study was the high levels of awareness and knowledge in the teachers and therapists of the need to change to more process-orientated learning environments.

Operationalisation and future research

In the attempt to overcome the maintenance effects of conditioned traditional paradigms, and to foster a climate of change, as well as to deal with the education and therapy crises, it is believed that the basic training of therapists and teachers needs to change to adopt a geodesic philosophy which allows for more flexible and diversified models to be created and implemented. The training of facilitators and pupils or learners within geodesic philosophies such as the MMA has to aim at changing attitudes in order to create global changes in traditional learning philosophies. This will have long-lasting effects on the skill level of application in teachers and therapists and their pupils and clients, and by implication, on the educational and therapeutic environments in which learning is facilitated.

The results of the current study confirm findings in the literature (Knowles, 1990; Byron, 1986) that attitudes are holding people back from going beyond the "awareness of the need to change" stage, to actually changing and operationalising the paradigm shift. Hence, the focus of future training should highlight the changing of attitudes, in particular the three components of attitude - cognitive, affective and intentional (Byron, 1989) - in a balanced way, as discussed in Chapter Six of the current study. On a practical level, this can be done by balancing theoretical input with practical application. For instance, the MMA training programme presented in the current study places more emphasis on theory than on practical application. It is believed that if the researcher had demonstrated classroom application of the entire system both on video and during the training for all subjects, a more global adoption of the geodesic philosophy would have been achieved. Therefore, expanded practical application is required. Furthermore, the conversion of the traditional curriculum to a geodesic alternative learning curriculum needs hands-on demonstration. Finally, the collaborative process between teacher and therapist needs facilitation to overcome the fear of crossing the boundaries of the 2 professions. It is therefore proposed that the creation of geodesic systems can be achieved through facilitators providing training inside classrooms and therapy rooms as opposed to teachers and therapists going to a venue to sit through, for example, a twelve-hour training programme as in the current study. The latter will increase knowledge and basic skills, and may even influence the cognitive component of attitude. However, the affective and intentional components of attitude will only change in an equivalent way when individuals internalise something that they see as being meaningful through practical application (Byron, 1986).

Furthermore the institution of training programmes to achieve the objective of creating global changes to geodesic systems for education and therapy needs to recognise the complex interrelationship between the diverse institutional learning environments in order to be successful. If the philosophy of systems theory (von Bertalanaffy, 1968), which visualises the complex interaction of systems and sub-systems, is adopted, then geodesic frameworks such as the MMA could be applied within the larger framework of lifelong learning. The systems theory could therefore provide the principles of creating infrastructures within which geodesic frameworks could be implemented for education and therapy on all levels of learning. For instance Knowles (1990) visualises an infrastructure for a lifelong learning resource system based on systems theory that emphasises the need to teach the community as a whole how to learn. The role of geodesic frameworks such as the MMA in such an infrastructure is that of providing the "how" of the implementation of facilitating geodesic learning environments.

Thus, the systems theory (von Bertalanaffy, 1968) provides the infrastructure for the creation of geodesic learning environments, and programmes such as the MMA provide the methods of training and facilitation within the geodesic learning environment. It is proposed that future research should concern itself with the interaction of the creation of geodesic infrastructures and the programmes providing the methods of facilitating geodesic learning. Therefore the results of this study, and those of other similar research, need to be integrated with systems theory to create long-term and long-lasting changes that will ultimately equip learners with innovative lifelong learning skills.

Further research regarding the manner in which the attitudes of teachers, therapists, parents, pupils, and all those conditioned in to the traditional system can be enlightened in order to change their perceptions of their roles as learners.

7.4.2. THE PURPOSE OF "EDUCATING" AND "REMEDIATING" IS TO FACILITATE INNOVATIVE LIFE SKILL LEARNING COMPETENCIES

Discussion

Students should be excited about learning as it is a natural neuropsychological law that the brain is designed to learn. In a geodesic environment, students learn about life, they learn from each other, they learn what is in the curriculum and in therapy objectives, and they are ready to become lifelong learners that can contribute to society.

Operationalisation and future research

By utilising geodesic methodologies such as the MMA of the current study, lifelong learning competencies can be developed. The MMA framework focuses on the learner, not the content. The organisation of lesson and therapy objectives is based around creating conditions optimal for learning. It allows immersion into an integrated, thematic and interdisciplinary curriculum. This is in contrast to traditional formats of education and institution type therapy that emphasize learning one thing at a time so that a subject is divided into small chunks, and then sub-divided again and again. Each day a micro chunk of the whole is presented out of context, for instance, "introduce unit A, learn it, take a test on it; now go to unit B" (Jensen, 1995: 301). Rather should one learn in an integrated thematic way. According to Jensen (1995: 303), "our brain is designed to learn multi-path, in order, out of order, on many levels, with many teachers, in many contexts and from many angles. We learn with themes, favourite subjects, issues, key concepts, questions, trial and error and application. The thematic approach urges you to follow threads that weave through your student's world instead of a single subject or text book". This is the philosophy adopted by the MMA, as the actual structure of the Mind-Map promotes this type of thinking because it creates patterns of meaning. The MMA provides a strategic approach that can assist in the facilitation of innovative learners with good life-skills.

Future research needs to concentrate on creating and planning entire new systems using geodesic approaches such as the MMA in drawing up the curriculum for lifelong learning. This is in contrast to fitting geodesic philosophy and methodology into traditional formats, as was done by the teachers and therapists trained in the current research.

7.4.3. GEODESIC LEARNING FRAMEWORKS NEED TO BE NEUROPSYCHOLOGICALLY AND METACOGNITIVELY ORIENTED

Discussion

The key issue in geodesic information processing model of the current research is the intimate interaction and interdependence of metacognition and neuropsychology. The model proposes that metacognition is the non-conscious level, elevating metacognition to the level where most learning (approximately 90 per cent) occurs. This is the highest level of thought, where thinking begins. The model then proposes that cognition is the next level of thought, the level of conscious thinking responsible for approximately 10 per cent of learning. Both levels need to be fully activated according to the ratio of their responsibility in order for learning to be effective and result in usefully reconceptualised knowledge. If methodologies and systems are used that are incompatible with natural neuropsychological laws, then the cognitive level will be predominantly activated, with limited intermittent involvement of the metacognitive non-conscious level. This will result in inefficient rote-type learning with a product orientation as opposed to a process orientation.

It is believed that geodesic methodologies such as the MMA are neuropsychologically based and will thus activate both metacognition and cognition in the correct way. In contrast, traditional methodologies stimulate predominantly cognitive processes with the concomitant learning limitations. Furthermore, the Mind-Map itself is viewed as the "tool" which directly accesses and trains the metacognitive non-conscious. The emphasis of the MMA is on the facilitation of improved language, learning and communication through a strategic versus skill-based approach. Communication, language and learning are seen as being controlled by metacognition, which will in turn influence information processing and thus the effectiveness of communication, language and learning - oral or written. In other words, strategies are being facilitated at the root level and once automatized, will have a more effective result in terms of generalisation than if fragmented skills are trained.

Operationalisation and future research

The global utilisation of geodesic frameworks such as the MMA allows geodesic principles to be operationalised. When geodesic environments are created and geodesic methodologies are utilised, then the under-utilised metacognitive non-conscious will be allowed to operate more effectively releasing potential.

The MMA needs to be expanded, developed and improved based on ongoing research in the fields of neuroscience, neurobiology, neuropsychology, metacognition, and the non-conscious. The Mind-Map itself needs to be explored as the "tool" of thought and intelligence and also as an assessment "tool".

7.5. CONCLUSION

The current research proposes a model of learning which parallels the way the brain is biologically designed to learn. If a learning environment is designed which is antagonistic to the natural and effortless way that the brain can learn, motivational, behavioural and learning problems will result with concomitant cost implications. Thus learning environments need to be designed around questions such as "how does the brain learn most effectively?" and "how do we create successful learning organisations?" The MMA employed in the current research offers a framework that designs effective geodesic learning organisations. The preceding chapters presented the theory of a geodesic model of learning and why it works, and identified the positive and negative aspects of the MMA training. The current study has the following to offer in terms of an alternative approach to the facilitation of improved language, communication and learning:

- ❑ It provides a motivation and rationale for changing to alternative geodesic approaches, highlighting the setbacks of maintaining the traditional systems.

- It explains the philosophy of alternative geodesic approaches.
- It provides the development of a theoretical model as a product of this research as to how information is processed within geodesic frameworks, as well as the construction of a framework for the implementation of geodesic training. It is assumed that this type of geodesic induced thinking is more effective than that produced by traditional formats due to being based on natural laws of neuropsychological functioning
- It provides a practical framework within which to operationalise geodesic principles, and as such is a vehicle of change from traditional learning systems
- It reveals that the prevailing attitude of teachers and therapists towards the concept of learning is one of awareness of the need for change to more neuropsychologically-based approaches
- It reveals that there are strong traditional maintenance effects in teachers and therapists that are the result of attitudes, which accounts for the mismatch between the high levels of neuropsychological knowledge and awareness of the need for change, and the actual application thereof.
- It reveals that even the partial introduction of the geodesic methods of the MMA made a significant difference to the performance of the pupils. However, the significant improvement of the pupils was a side-effect as opposed to direct effect of the geodesic methodology because what was being trained with the MMA methods is not what was tested in the end-of-year product-focused exams.
- It reveals the urgent need to create low-cost infrastructures that will facilitate the adoption of geodesic methodologies into neuropsychologically-based learning environments in order to create accountable and effective learning and therapy environments, that is, the need to link up systems theory with practical geodesic methodologies in the facilitation of the paradigm shift from traditional to geodesic methodology.
- It reveals the importance of training the speech-language therapist to be more actively involved in the learning environment in a collaborative and consultative role.
- Finally, this research provides evidence that the learning disabled population, given the chance in systems that create geodesic environments, and use geodesic methodology, have the potential to become active innovative thinkers that can make a contribution to society. Furthermore, if geodesic methodology can significantly improve performance in those with so-called "language-learning problems", what level of effect will it have on the so called "normal" population?

The central issue of the current research is that there is sufficient evidence for believing that a geodesic approach to learning, such as the MMA propagated by the current study, can achieve significant changes in the potential of pupils to benefit from their schooling, as well as in their ability to deal with the problems of daily existence in an effective way. Much will depend on the capacity of teachers, therapists, pupils and administrators to cope with the changes and paradigm shifts that will be required if geodesic approaches to learning are adopted.

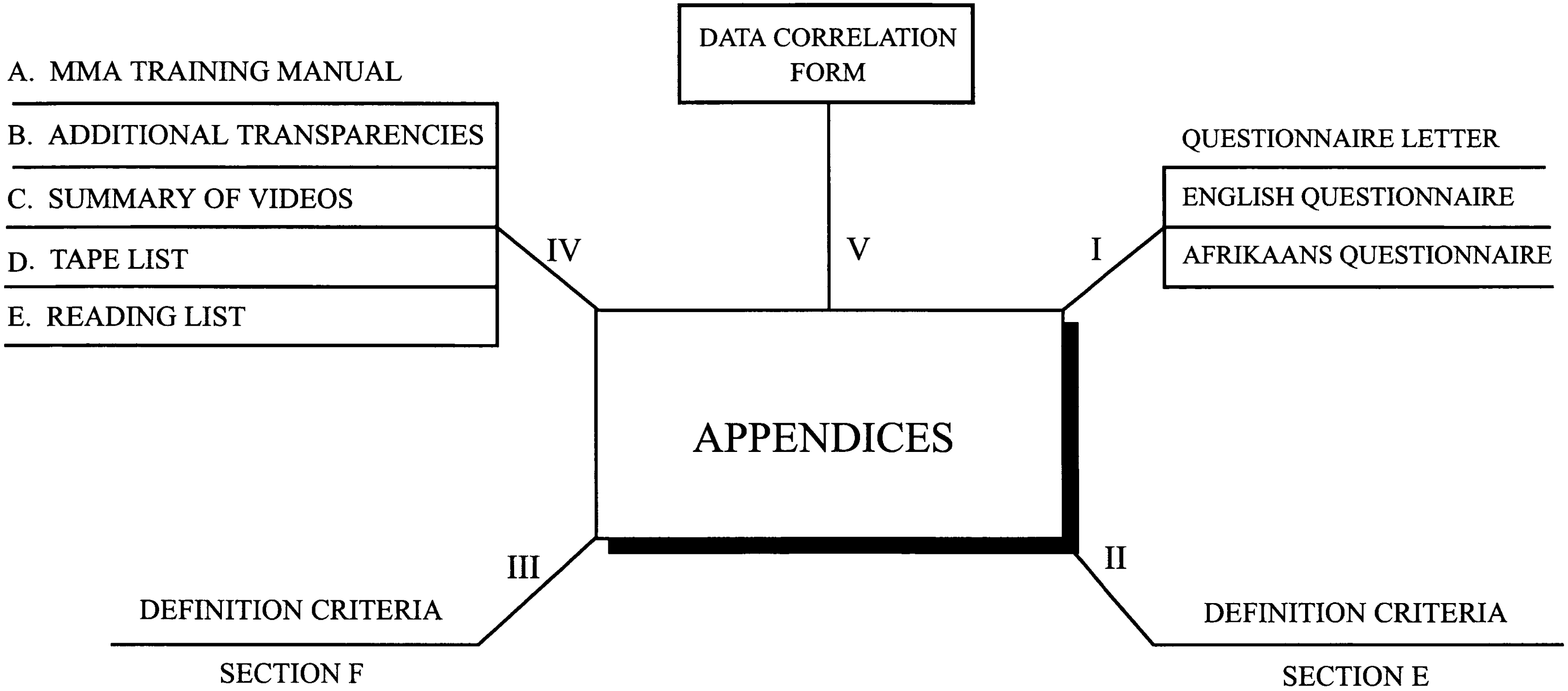
"Throughout history only a few people have benefited from the growing corpus of scientific knowledge which permits the development of human potential and development. Inequality of human beings was not determined genetically. They all have more or less the same potentiality, the same capacity to think" (Van der Vyver & Capdevielle, 1990: 61). Therefore, every effort should be made to develop this potential of individuals. Everyone should be allowed the opportunity to learn how to learn.

7.6. SUMMARY

Chapter Seven presents the general conclusions of the current research. Ten implications of the results of the study for the geodesic philosophy of learning are put forward and described. Each is then elaborated on in terms of how they can be put into practice and suggestions for future research are made. A general conclusion is reached that it is everyone's democratic right to be able to learn how to learn.

EVERY CREATIVE ACT INVOLVES ...
A NEW INNOCENCE OF PERCEPTION,
LIBERATED FROM THE CATARACT
OF ACCEPTED BELIEF.

Arthur Koestler
1989


DATA CORRELATION FORM
A. MMA TRAINING MANUAL
B. ADDITIONAL TRANSPARENCIES
C. SUMMARY OF VIDEOS
D. TAPE LIST
E. READING LIST
IV
V
I
QUESTIONNAIRE LETTER
ENGLISH QUESTIONNAIRE
AFRIKAANS QUESTIONNAIRE
APPENDICES
III
II
DEFINITION CRITERIA
SECTION F
DEFINITION CRITERIA
SECTION E

APPENDIX I :
QUESTIONNAIRE

Universiteit van Pretoria
PO Box 11103 0011 Brooklyn Telex 3-22723 SA Telegr PUNIV
Tel (012) 4202357/4202816 Fax: 43-2185

Department of Speech Pathology
and Audiology

27th March 1993

TO WHOM IT MAY CONCERN

THE MIND MAPPING APPROACH (MMA) TRAINING PROGRAMME: A CONSULTATIVE FRAMEWORK FOR TEACHERS AND THERAPISTS WITHIN THE SOUTH AFRICAN CONTEXT

As a doctorate student in Speech-Language Pathology, I am currently busy with a research project evaluating the effect of the MMA training programme in schools and therapeutic institutions.

The aim of the MMA training programme is to empower teachers and therapists to incorporate the whole-brain learning concept of the MMA into the classroom/therapy room, in this way reaching large sectors of the S A population.

It would be very much appreciated if you would fill in the attached questionnaire before the course begins. In return, I will statistically evaluate the effect the MMA programme has on your pupils/clients academic results providing you with a report thereof at the beginning of 1994.

With sincere appreciation for your co-operation.

Yours sincerely

CAROLINE LEAF

PROFESSOR I C UYS
HEAD: DEPARTMENT OF SPEECH PATHOLOGY AND AUDIOLOGY
UNIVERSITY OF PRETORIA

QUESTIONNAIRE

SECTION A: BIOGRAPHICAL DATA

NAME ______________________

AGE ______________________

SEX ______________________

QUALIFICATIONS ______________________

YEARS OF EXPERIENCE ______________________

PRESENT POST HELD ______________________

NAME OF SCHOOL/ INSTITUTION WHERE EMPLOYED

____

REPETION NUMBER______________________

OFFICE USE ONLY

V1	☐☐☐	1-3
V2	☐☐	4-5
V3	☐	6
V4	☐☐☐	7-9
V5	☐☐	10-11
V6	☐☐	12-13
V7	☐☐	14-15
V8	☐	16

SECTION B:

The following questions probe the academic learning process in school and therapy situations. There are no right or wrong answers. Please select what you feel to be the most appropriate answers according to your experience. Please mark an X in the selected column.

	YES	UN SURE	NO	OFFICE USE ONLY		
1. Is a knowledge of the structure of the brain and its functioning in relation to academic learning, important?				V9	☐	17
2. Is it necessary for students/ clients to know how their brains function, in order to improve their learning skills?				V10	☐	18
3. Is it necessary for students / clients to understand how memory works, in order to improve their memory?				V11	☐	19
4. Most students know a lot about how to think, create and formulate conclusions.				V12	☐	20
5. Succeeding academically takes a lot of extremely hard work.				V13	☐	21
6. Does one work better and achieve more under pressure?				V14	☐	22
7. Reading through one's work several times is memorising and learning.				V15	☐	23
8. All students have equal opportunity to succeed in all academic areas.				V16	☐	24
9. Would being relaxed enhance academic learning?				V17	☐	25
10. Is the average person, in your opinion, using limited brain potential for the academinc learning process ?				V18	☐	26

	YES	UN SURE	NO	OFFICE USE ONLY
11. Would music, in your opinion, influence the learning situation?				V19 ☐ 27
12. Would different types of music have different effects on the learning situation ?				V20 ☐ 28
13. Would a person's mental approach to reading and studying influence learning?				V21 ☐ 29
14. Would reading fast reduce the comprehension of the material being read?				V22 ☐ 30
15. Would rereading words within a sentence improve comprehension of the material being read?				V23 ☐ 31
16. Does following with one's finger while reading, improve comprehension of the material being read?				V24 ☐ 32
17. Is making notes while learning important to memory?				V25 ☐ 33
18. Do you think that the more creative right hemisphere plays a role in the academic learning process ?				V26 ☐ 34

SECTION C :

The following section also probes the academic learning process in schools and therapy situations. Please select what you feel in your opinion to be the most appropriate answer by marking an X in the selected column.

	KNOWLEDGE			
	Expert	Some	Little	
1. How much do you know about how your eyes move whilst reading and how this knowledge can be used to your advantage?				V27 ☐ 35
2. Do you know how to teach your eyes to take in more information than they normally do?				V28 ☐ 36
3. How aware are you of the chemical effects of certain foods on the learning process in the brain?				V29 ☐ 37
4. How much do you know about the nature of comprehension and how this can be improved?				V30 ☐ 38
5. How much do you know about note-making techniques that enable you to form "mental-pictures" of your thoughts?				V31 ☐ 39
6. How much do you know about the nature of key concepts as opposed to key words, and how they relate to note-making and imagination and learning?				V32 ☐ 40
7. How much do you know about creativity?				V33 ☐ 41
8. How much do you know about the potential of the average brain's creativity?				V34 ☐ 42
9. How much do you know about the differences between the functions of the left and right hemispheres of the brain ?				V35 ☐ 43

SECTION D:

The following is a list of characteristics of learning. According to your experience, how would you rate their relative importance in the teaching / learning environment?

1 = of no importance
2 = of some importance
3 = of great importance
4 = of very great importance

	1	2	3	4	OFFICE USE ONLY		
1. The learning environment must be quiet and serious					V36		44
2. Learning requires great effort and hard work.					V37		45
3. The good student must try his best and compete well.					V38		46
4. Some subjects / concepts are extremely difficult to learn.					V39		47
5. Concentration by sitting still in a quiet room with no distractions is important.					V40		48
6. Art and music aid the learning process.					V41		49
7. Imagination, intuition and playfulness are important in the class-room.					V42		50
8. Logical and ordered teaching and learning is important to the academic learning process.					V43		51
9. Feelings and random associations are part of teaching / learning.					V44		52
10. Laughing, playing and joking can be good breaks from difficult tedious lessons.					V45		53
11. Games, jokes, fun, are part of the class-room teaching process.					V46		54
12. Academic learning should be easy and fun.					V47		55
13. Learning comes more easily to some.					V48		56
14. The teacher is most important to the learning process.					V49		57
15. Co-operative learning between teacher/therapist and pupil / client is necessary.					V50		59
					V51	1	59

AFDELING D:

Die volgende is 'n lys leerkenmerke. Watter waarde sal u, op grond van u verworwe ervaring, aan hulle relatiewe belangrikheid in die onderrig-/leeromgewing toeken?

1 = van geen belang nie
2 = matig belangrik
3 = baie belangrik
4 = uiters belangrik

		1	2	3	4			
1	Die leeromgewing moet stil en stemmig wees.					V36		44
2	Leer verg baie inspanning en harde werk.					V37		45
3	Die goeie student moet sy bes probeer en goed meeding.					V38		46
4	Sommige vakke/begrippe is uiters moeilik om te bemeester.					V39		47
5	Konsentreer deur stil te sit in 'n stil kamer sonder enigiets wat 'n mens se aandag aftrek, is belangrik.					V40		48
6	Kuns en musiek help die leerproses aan.					V41		49
7	Verbeelding, intuïsie/aanvoeling en speleriǵheid binne die klaskamer is belangrik.					V42		50
8	Logiese en geordende onderrig en leer is belangrik vir die akademiese leerproses.					V43		51
9	Gevoelens en willekeurige assosiasies is deel van onderrig/leer.					V44		52
10	Gelag, spelery en grappe kan 'n welkome blaaskans tussen moeilike, vervelige lesse bied.					V45		53
11	Speletjies, grappies en pret is deel van die klaskameronderrig-situasie.					V46		54
12	Akademiese leerdery behoort maklik en prettig te wees.					V47		55
13	Sommige mense leer makliker as ander.					V48		56
14	Die onderwyser is baie belangrik vir die leersituasie.					V49		57
15	Koöperatiewe (samewerkende) leerwerk tussen onderwyser/terapeut en leerling/kliënt is noodsaaklik.					V50		59
						V51	1	59

SECTION E :

Please define or describe the following concepts according to your experience. V52 1-3

Learning V53-57 4-8

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Memory V58-62 9-13

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Visualisation V63-67 14-18

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Accelerated Learning V68-72 19-23

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Super teaching.. V73-77 24-28

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V78 2 59

SECTION F:

Please answer the following questions in as much detail as possible.

1. Have you managed to implement the concepts of the Mind-Mapping approach in your daily teaching curricula or therapy? If yes, indicate how e.g.:
   "Music - used daily
   Mind-Maps - teach Biology using these, etc."
   ....
   ....
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2. Have you experienced any difficulty using the concepts of the Mind-Mapping approach? If yes, specify which and how.
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   ....

3. Do you feel that your pupils/clients have benefitted from the concepts of the Mind-Mapping approach - how e.g.: *"using Mind-Maps as a study method - definate improvement in marks"* etc.
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4. Any additional comments.
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   ....
   ....
   ....

VRAELYS

SLEGS VIR KANTOORGEBRUIK

AFDELING A: BIOGRAFIESE GEGEWENS

NAAM ______________________ V1 ☐☐☐ 1-3

OUDERDOM ______________________ V2 ☐☐ 4-5

GESLAG ______________________ V3 ☐ 6

KWALIFIKASIES ______________________ V4 ☐☐☐ 7-9

JARE TOEPASLIKE ERVARING ______________________ V5 ☐☐ 10-11

HUIDIGE POS ______________________ V6 ☐☐ 12-13

NAAM VAN SKOOL/WERKGEWER/INSTELLING

WAAR WERKSAAM ______________________ V7 ☐☐ 14-15

HERHALINGSNOMMER ______________________ V8 ☐ 16

AFDELING B:

Die volgende vrae peil die akademiese leerproses in skool- en terapiesituasies. Daar is geen regte of verkeerde antwoorde nie. Kies, op grond van u verworwe ervaring, asseblief die antwoord wat na u mening die toepaslikste is deur 'n **X** in die toepaslike kolom te trek.

		JA	ON-SEKER	NEE		
1	Is kennis van die breinstruktuur en -funksionering belangrik vir die akademiese leerproses?				V9 ☐	17
2	Is dit nodig dat studente/kliënte weet hoe geheue werk om hulle leervaardighede te kan verbeter?				V10 ☐	18
3	Is dit nodig dat studente/kliënte verstaan hoe geheue werk om hulle geheue te kan verbeter?				V11 ☐	19
4	Die meerderheid studente weet heelwat van hoe om te dink, te skep en gevolgtrekkings te formuleer.				V12 ☐	20
5	Akademiese sukses verg uiters harde werk.				V13 ☐	21
6	Werk en presteer 'n mens beter onder druk?				V14 ☐	22
7	Die herhaalde deurlees van mens se werk is memorisering en leer.				V15 ☐	23
8	Alle studente het op alle akademiese gebiede 'n gelyke kans op sukses.				V16 ☐	24
9	Sal ontspanne wees die akademiese leerproses bevorder?				V17 ☐	25
10	Benut die deursneepersoon, na u mening, beperkte breinpotensiaal vir die akademiese leerproses?				V18 ☐	26

		JA	ON-SEKER	NEE			
11	Sal musiek, na u mening, die leersituasie beïnvloed?				V19	☐	27
12	Sal verskillende tipes musiek verskillende uitwerkings op die leersituasie hê?				V20	☐	28
13	Sal 'n persoon se geestesingesteldheid jeens lees en leer die leerproses beïnvloed?				V21	☐	29
14	Sal vinnig lees die leser se begrip van die gelese materiaal verlaag?				V22	☐	30
15	Sal die herlees van woorde in 'n sin die leser se begrip van die gelese materiaal verhoog?				V23	☐	31
16	Verbeter volglees met 'n mens se vinger tydens lees die leser se begrip van die gelese materiaal?				V24	☐	32
17	Is aantekeninge maak terwyl 'n mens leer belangrik om te kan onthou?				V25	☐	33
18	Dink u dat die kreatiewer regterbrein-helfte 'n rol in die akademiese leerproses speel?				V26	☐	34

AFDELING C:

Die volgende vrae peil ook die akademiese leerproses in skool- en terapiesituasies. Daar is geen regte of verkeerde antwoorde nie. Kies die antwoord wat na u mening die toepaslikste is deur 'n **X** in die toepaslike kolom te trek.

		KENNIS					
		Deskundig	Gemiddeld	Beperk			
1	Hoeveel weet u van u oogbewegings terwyl u lees en hoe dié kennis tot u voordeel ingespan kan word?				V27	☐	35
2	Weet u hoe om u oë te leer om meer inligting in te neem as wat hulle normaalweg inneem?				V28	☐	36
3	Hoe bewus is u van sekere kosse se chemiese uitwerking op die leerproses binne die brein?				V29	☐	37
4	Hoeveel weet u van begrip se aard en hoe begrip verbeter kan word?				V30	☐	38
5	Hoeveel weet u van aantekening-tegnieke wat u in staat stel om "geestesprentjies" van u gedagtes te vorm?				V31	☐	39
6	Hoeveel weet u, in teenstelling met sleutel woorde,van sleutelbegrippe se aard en hoe hulle met aantekeninge maak, verbeelding en leer verband hou?				V32	☐	40
7	Hoeveel weet u van kreatiwiteit?				V33	☐	41
8	Hoeveel weet u van die deursneebrein se kreatiwiteitspotensiaal?				V34	☐	42
9	Hoeveel weet u van die linker- en regterhelftes van die brein se onderskeie/verskillende funksies?				V35	☐	43

AFDELING E:

Omskryf of beskryf asseblief die volgende begrippe aan die hand van u verworwe ervaring:

V52 [ ] 1-3

Leer ....
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....
....
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V53-57 [ ] 4-8

Geheue ....
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....
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....
....

V58-62 [ ] 9-13

Visualisering ....
....
....
....
....
....

V63-67 [ ] 14-18

Versnelde leer ....
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V68-72 [ ] 19-23

Superonderrig ....
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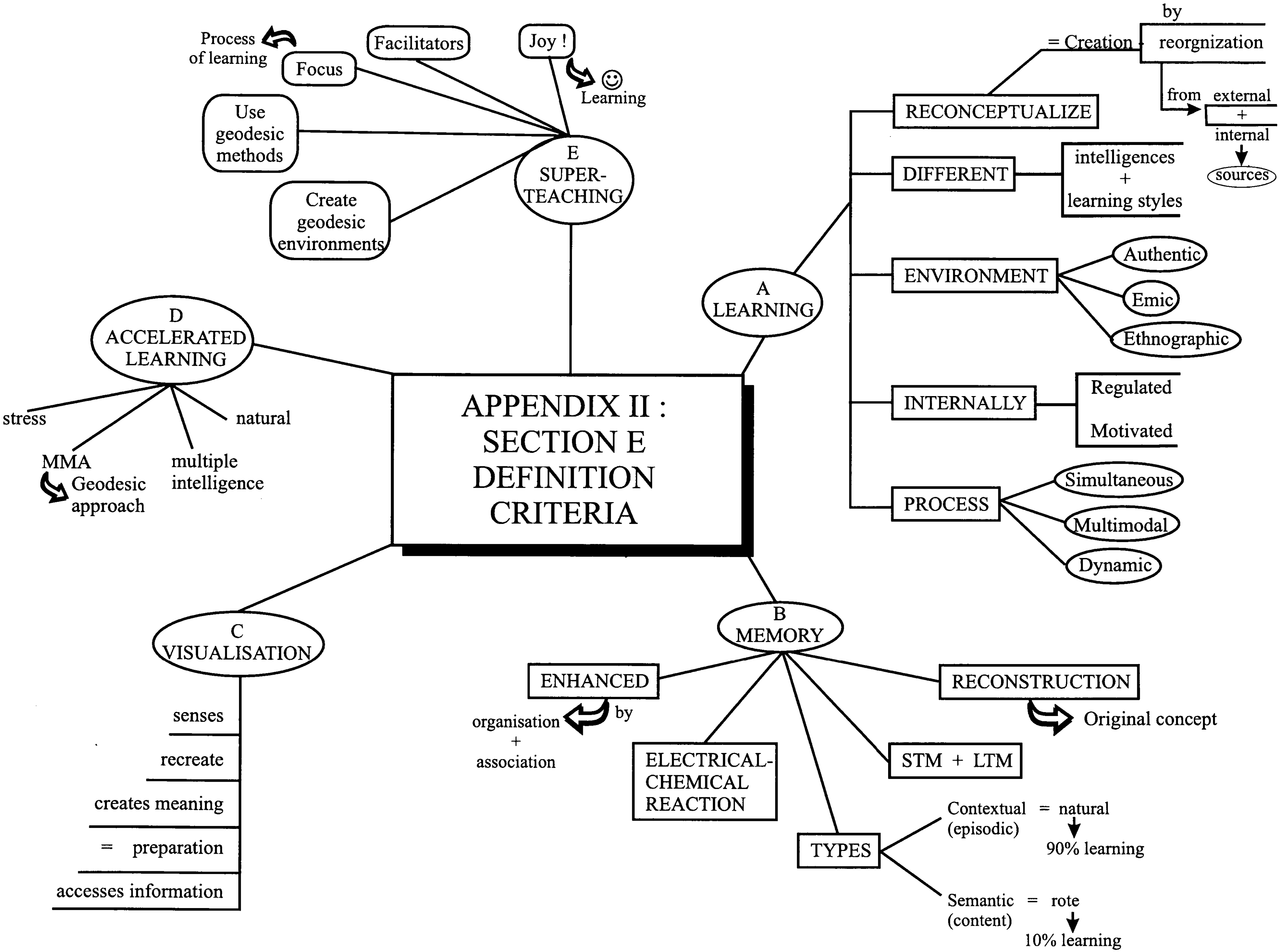
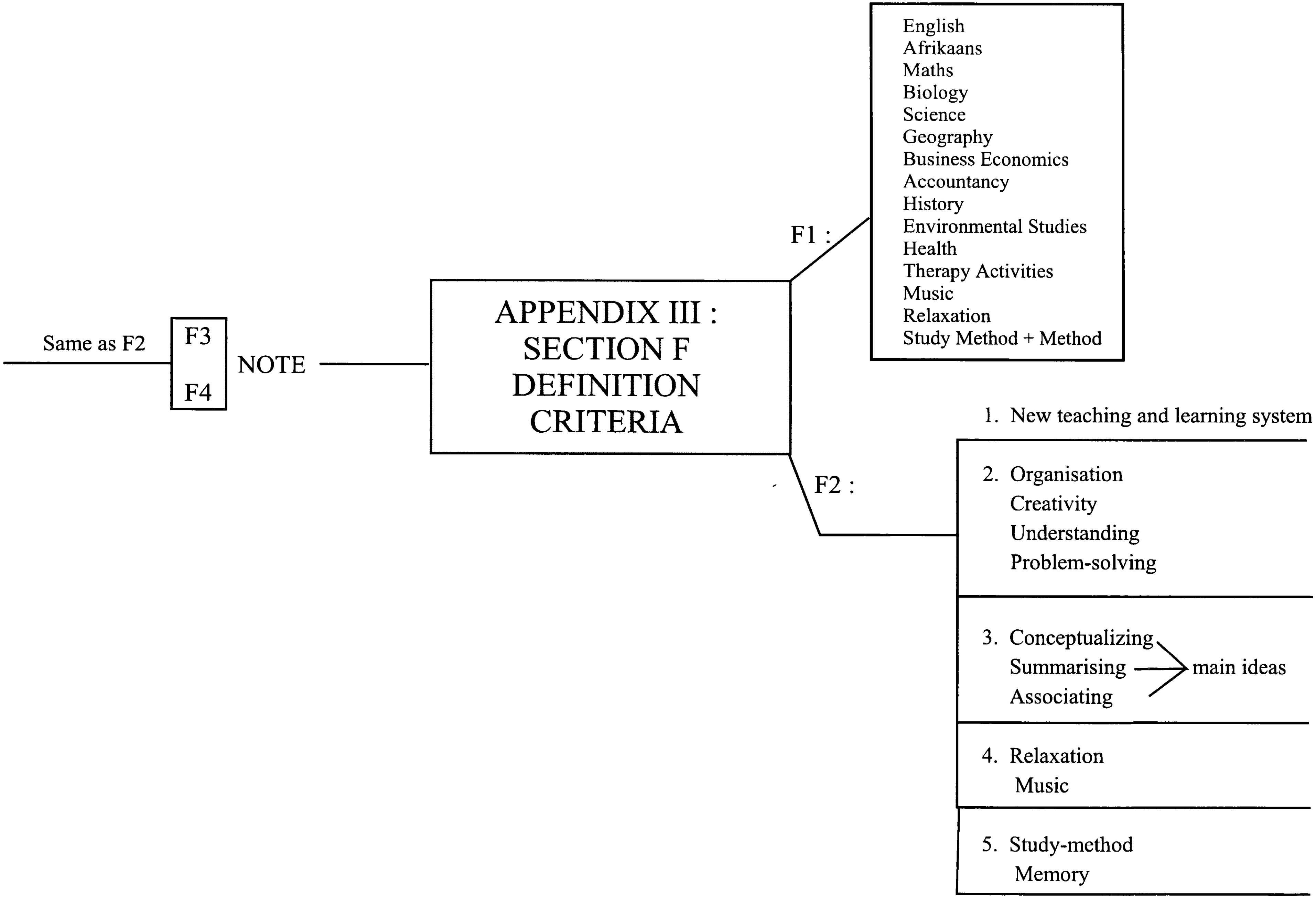
....

V73-77 [ ] 24-28

V78 [2] 59


APPENDIX II : SECTION E DEFINITION CRITERIA
A LEARNING
RECONCEPTUALIZE
= Creation
by
reorgnization
from
external
+
internal
sources
DIFFERENT
intelligences
+
learning styles
ENVIRONMENT
Authentic
Emic
Ethnographic
INTERNALLY
Regulated
Motivated
PROCESS
Simultaneous
Multimodal
Dynamic
B MEMORY
ENHANCED
by
organisation
+
association
ELECTRICAL-CHEMICAL REACTION
TYPES
Contextual (episodic)
= natural
90% learning
Semantic (content)
= rote
10% learning
STM + LTM
RECONSTRUCTION
Original concept
C VISUALISATION
senses
recreate
creates meaning
= preparation
accesses information
D ACCELERATED LEARNING
stress
natural
MMA
Geodesic approach
multiple intelligence
E SUPER-TEACHING
Process of learning
Focus
Facilitators
Joy !
Learning
Use geodesic methods
Create geodesic environments


APPENDIX III : SECTION F DEFINITION CRITERIA
F1 :
English
Afrikaans
Maths
Biology
Science
Geography
Business Economics
Accountancy
History
Environmental Studies
Health
Therapy Activities
Music
Relaxation
Study Method + Method
F2 :
1. New teaching and learning system
2. Organisation
Creativity
Understanding
Problem-solving
3. Conceptualizing
Summarising
Associating
main ideas
4. Relaxation
Music
5. Study-method
Memory
NOTE
F3
F4
Same as F2

APPENDIX IV

A : MMA MANUAL

B : ADDITIONAL TRANSPARENCIES

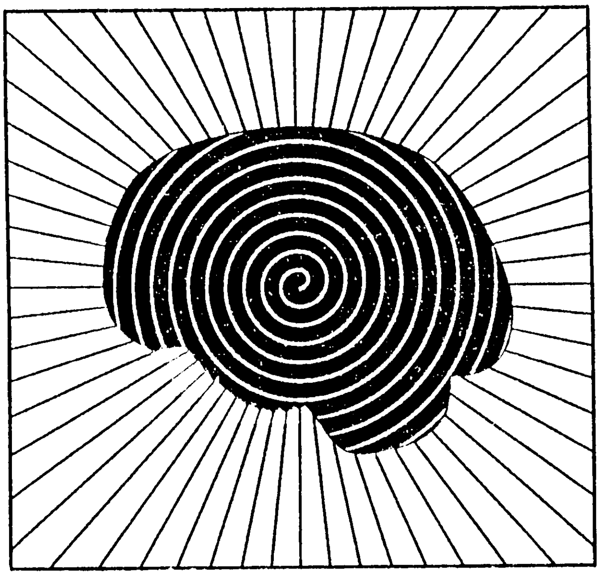
C : SUMMARY OF VIDEOS

D : LIST OF TAPES

E : READING LIST

APPENDIX IVA :

MMA MANUAL



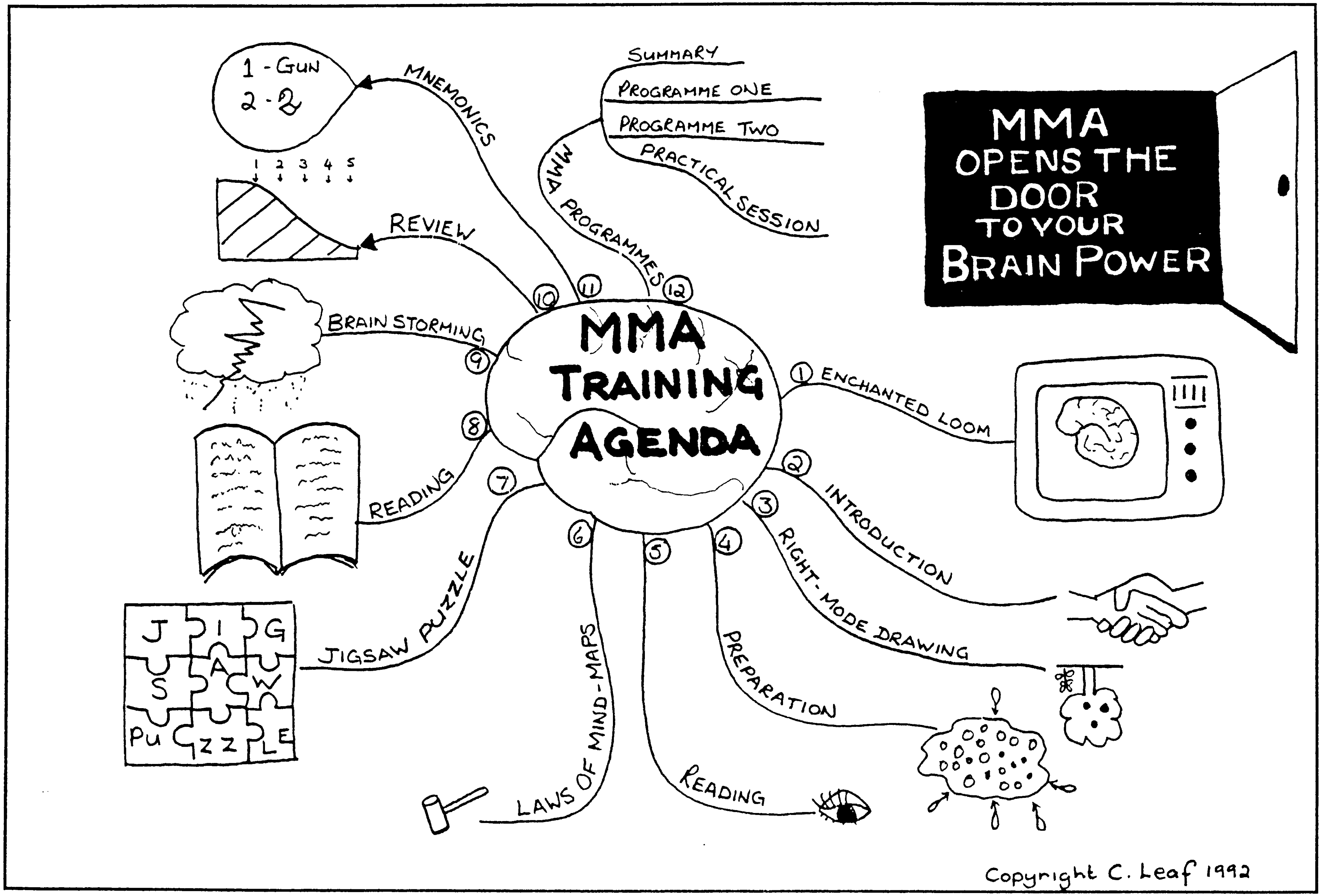
MIND MAPPING APPROACH

Researched, Designed, Presented

by

Caroline Leaf

Mind Dynamics


MMA
OPENS THE
DOOR
TO YOUR
BRAIN POWER
MMA
TRAINING
AGENDA
1 ENCHANTED LOOM
2 INTRODUCTION
3 RIGHT-MODE DRAWING
4 PREPARATION
5 READING
6 LAWS OF MIND-MAPS
7 JIGSAW PUZZLE
J I G S A W PU Z Z L E
8 READING
9 BRAIN STORMING
10 REVIEW
1 2 3 4 5
11 MNEMONICS
1 - GUN
2 -
12 MMA PROGRAMMES
SUMMARY
PROGRAMME ONE
PROGRAMME TWO
PRACTICAL SESSION
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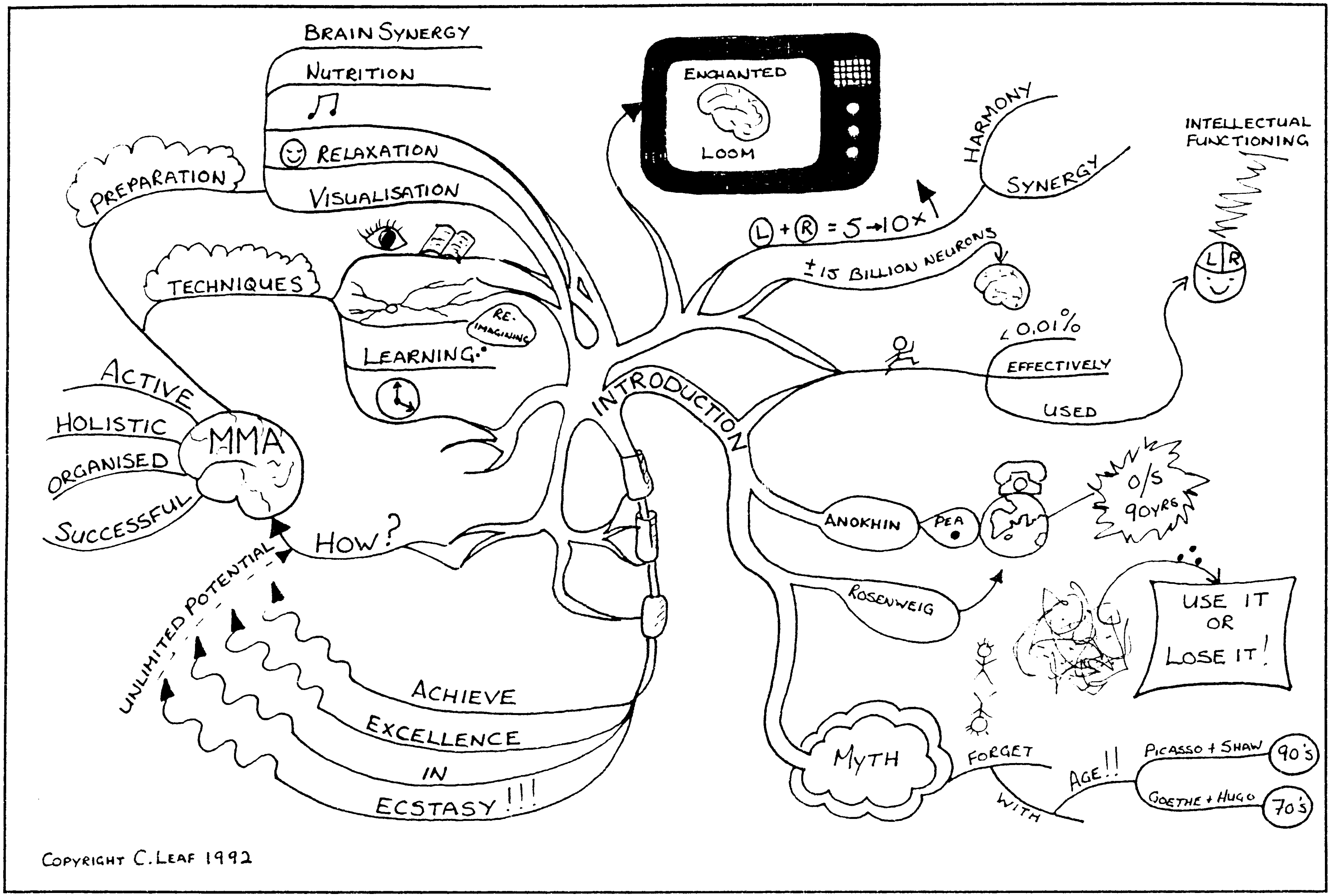
BRAIN SYNERGY
NUTRITION
RELAXATION
VISUALISATION
PREPARATION
TECHNIQUES
RE-IMAGINING
LEARNING
ACTIVE
HOLISTIC
ORGANISED
SUCCESSFUL
MMA
HOW?
UNLIMITED POTENTIAL
ACHIEVE
EXCELLENCE
IN
ECSTASY!!!
ENCHANTED
LOOM
INTRODUCTION
HARMONY
SYNERGY
INTELLECTUAL
FUNCTIONING
L + R = 5 → 10 x
± 15 BILLION NEURONS
L R
< 0,01 %
EFFECTIVELY
USED
ANOKHIN
PEA
O/S
90YRS
ROSENWEIG
USE IT
OR
LOSE IT!
MYTH
FORGET
WITH
AGE!!
PICASSO + SHAW
90's
GOETHE + HUGO
70's
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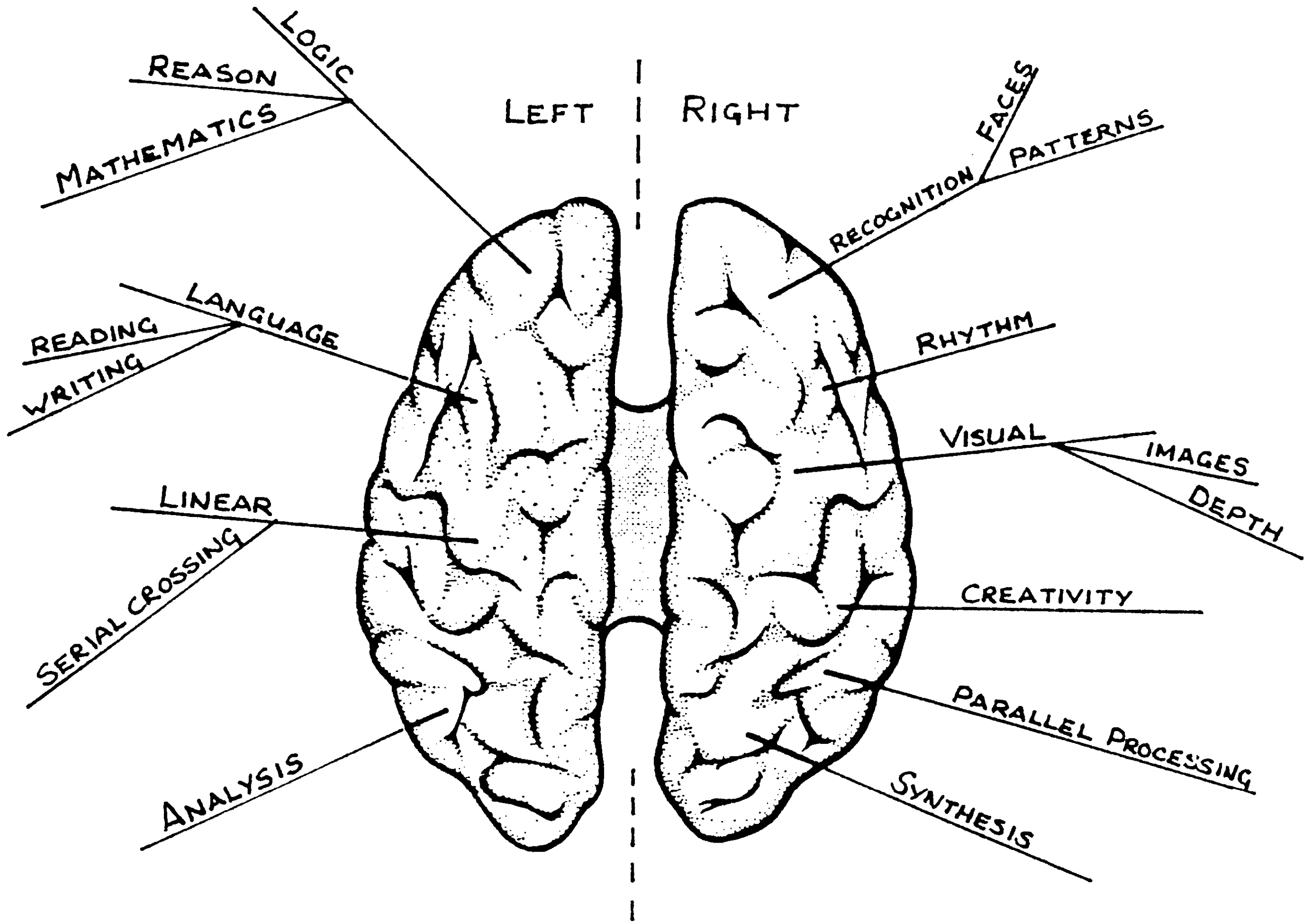


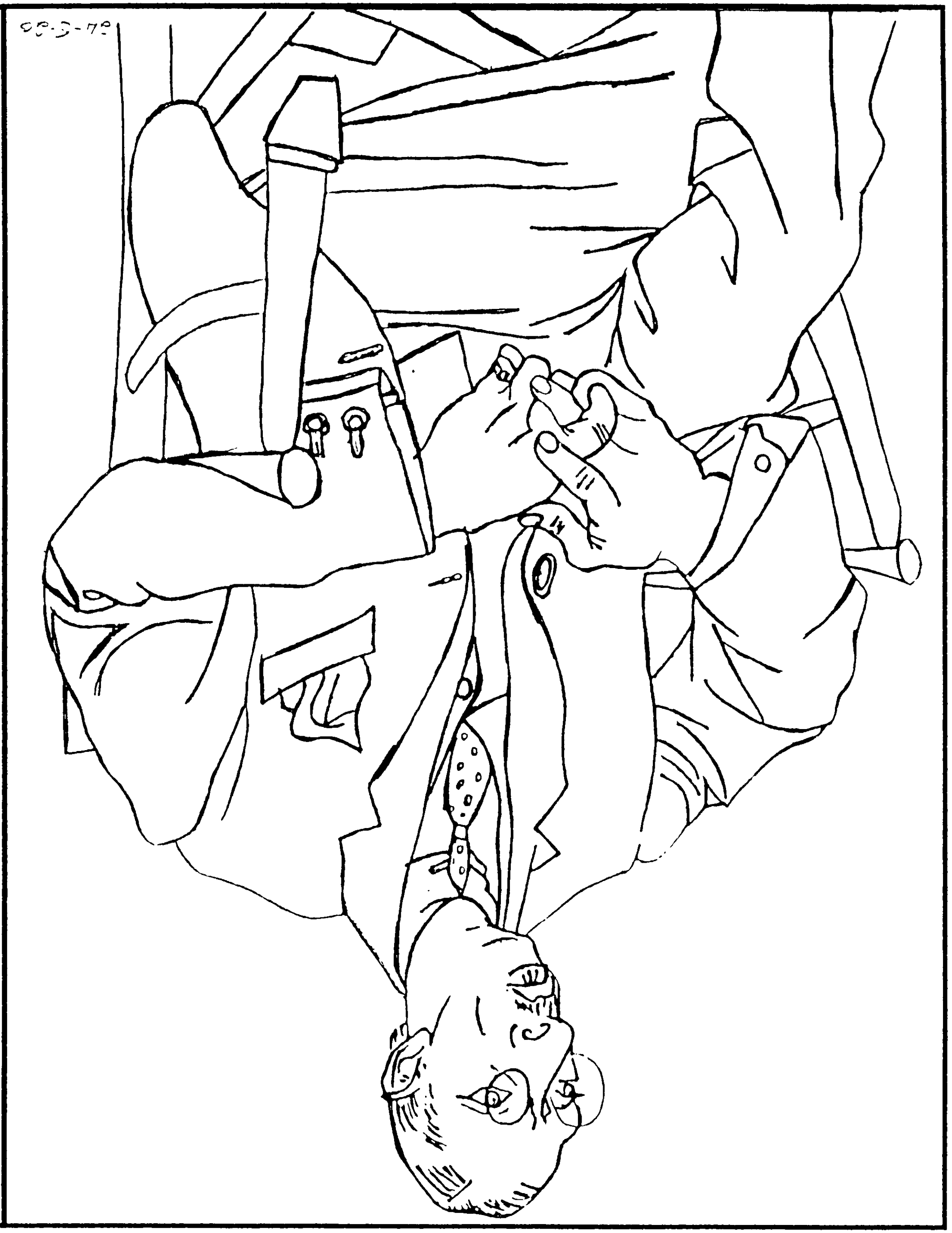
Specialisations of the Left and Right Brain

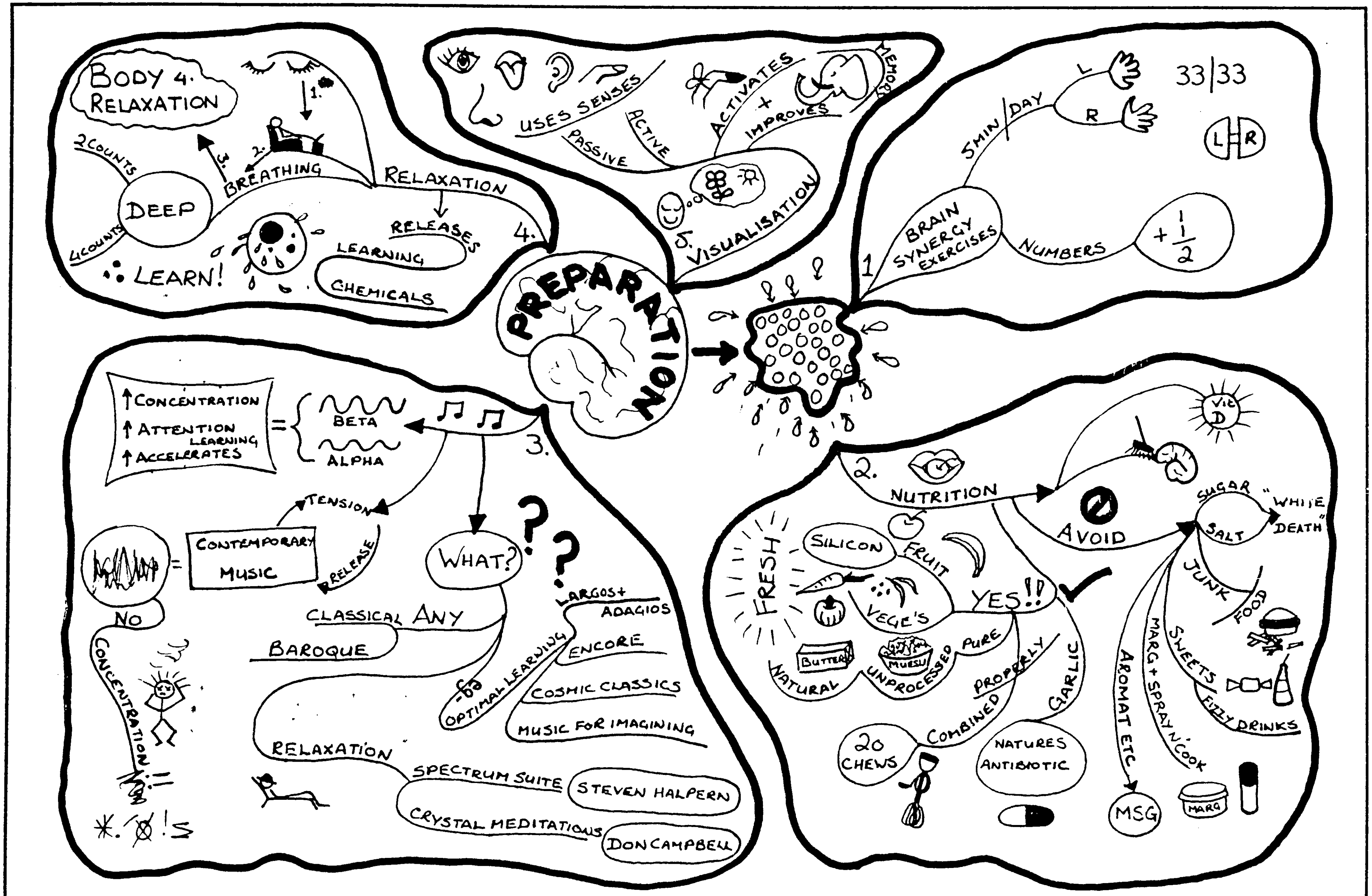
Upside-down Drawing

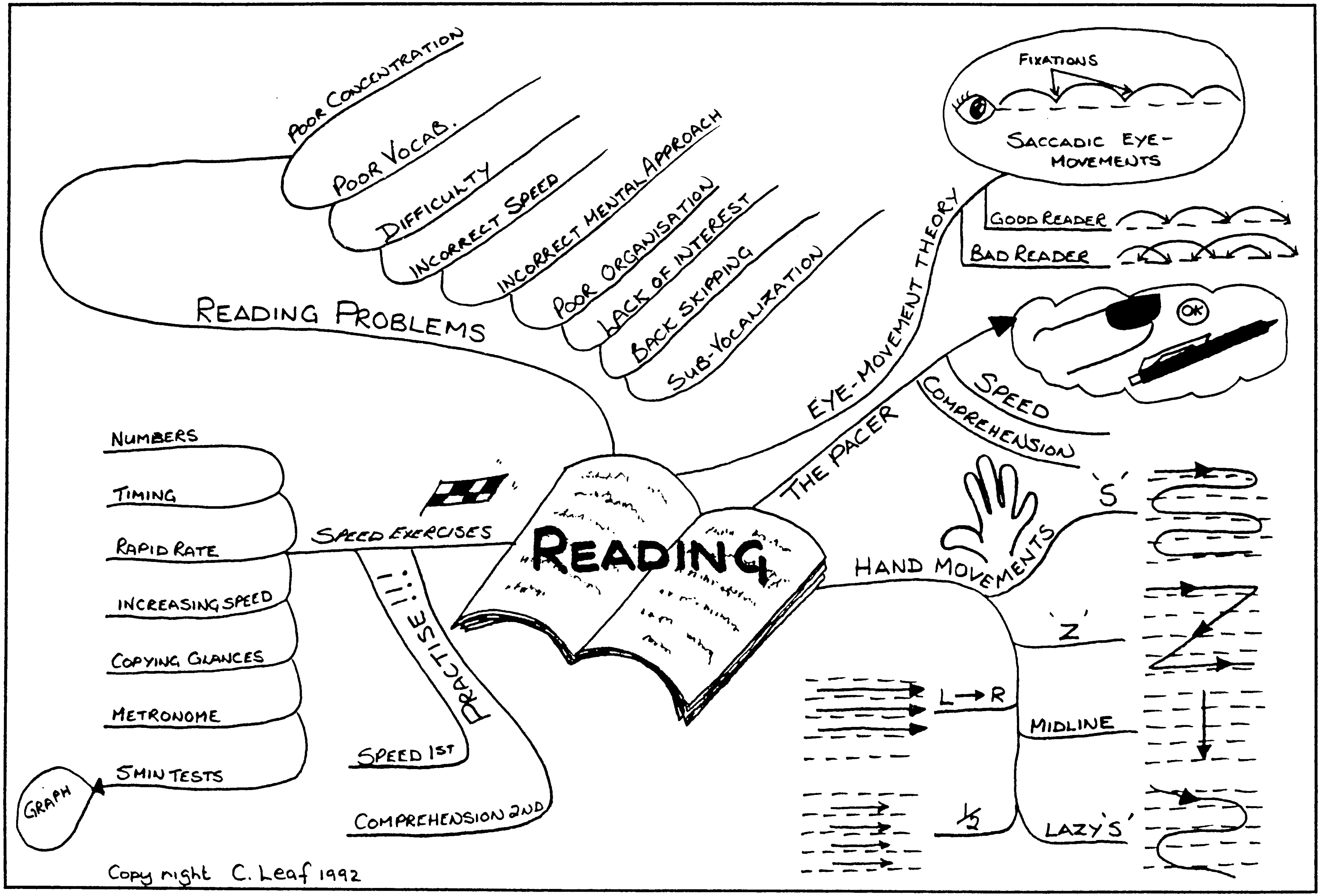
Learning To Experience The Right Mode

The figure is a reproduction of a line drawing by Picasso, of the composer Igor Stravinsky. The image is upside-down. You will be copying the upside-down image. Your drawing will therefore be upside-down.

- ☐ You have ± 20 minutes in which to complete the drawing.
- ☐ Do not turn the drawing right side up until you are finished, this will cause you to shift back into the left mode.
- ☐ Look at the upside-down drawing for 1 minute.
- ☐ Now start drawing, begin at the top, copying each line, moving from line to line. Don't name things, ie hands etc. Just copy the lines.
- ☐ Once you have started drawing, you will find yourself becoming very interested in how the lines go together — your left hemisphere will switch off as the task is too slow and it is too hard to recognise anything. Your right mode will be working.




PREPARATION
BODY 4. RELAXATION
1.
2.
3.
BREATHING
DEEP
2 COUNTS
4 COUNTS
LEARN!
RELAXATION
RELEASES
LEARNING
CHEMICALS
4.
USES SENSES
PASSIVE
ACTIVE
ACTIVATES + IMPROVES
MEMORY
5. VISUALISATION
1
BRAIN SYNERGY EXERCISES
5 MIN / DAY
L
R
33/33
L R
NUMBERS
+ 1/2
2.
NUTRITION
AVOID
VIT D
SUGAR
SALT
"WHITE DEATH"
JUNK FOOD
SWEETS
FIZZY DRINKS
AROMAT ETC
MSG
MARG + SPRAY N' COOK
MARG
FRESH
SILICON
FRUIT
VEGE'S
YES!!
BUTTER
NATURAL
MUESLI
UNPROCESSED
PURE
PROPERLY
COMBINED
20 CHEWS
GARLIC
NATURES ANTIBIOTIC
3.
↑ CONCENTRATION
↑ ATTENTION
LEARNING
↑ ACCELERATES
BETA
ALPHA
TENSION
RELEASE
CONTEMPORARY MUSIC
NO CONCENTRATION!!
WHAT?
??
CLASSICAL ANY
BAROQUE
LARGOS + ADAGIOS
ENCORE
COSMIC CLASSICS
MUSIC FOR IMAGINING
eg. OPTIMAL LEARNING
RELAXATION
SPECTRUM SUITE
STEVEN HALPERN
CRYSTAL MEDITATIONS
DON CAMPBELL


READING
READING PROBLEMS
POOR CONCENTRATION
POOR VOCAB.
DIFFICULTY
INCORRECT SPEED
INCORRECT MENTAL APPROACH
POOR ORGANISATION
LACK OF INTEREST
BACK SKIPPING
SUB-VOCALIZATION
EYE-MOVEMENT THEORY
FIXATIONS
SACCADIC EYE-MOVEMENTS
GOOD READER
BAD READER
THE PACER
OK
SPEED
COMPREHENSION
HAND MOVEMENTS
'S'
'Z'
MIDLINE
LAZY 'S'
L → R
½
SPEED EXERCISES
NUMBERS
TIMING
RAPID RATE
INCREASING SPEED
COPYING GLANCES
METRONOME
5 MIN TESTS
GRAPH
PRACTISE !!!
SPEED 1ST
COMPREHENSION 2ND

SPEED READING EXERCISES

7401		2753	
8764		1172	
2876		4827	
7654		8566	
7601		9862	
8754		8421	
8110		46532	
8765		64321	
5492		98010	
3346		66254	
5443		65432	
4455		27548	
1877		86421	
7550		08435	
4466		18642	
7701		74322	
5420		52740	
6243		79284	
6421		29476	
4429		13654	
3327		29370	
8761		35726	
0185		64651	
8242		456095	
5530		825469	
9872		214193	
7049		475381	
7285		497624	
0423		950787	
4671		916365	
9014		260902	
4185		141601	

SPEED READING EXERCISES

516	615	516	893	625	847	782
827	827	651	825	837	653	445
745	873	754	745	755	432	891
653	763	563	566	653	365	871
874	198	235	471	874	236	714
654	564	445	645	654	348	251
843	256	345	761	918	843	348
118	881	818	453	116	118	342
822	522	782	282	882	822	768
845	352	764	238	845	458	326
874	187	874	784	237	453	267
187	234	118	553	178	187	456
465	345	564	456	465	234	265
876	456	345	234	237	876	678
781	871	765	187	465	781	118
123	132	123	546	781	432	234
567	543	234	567	765	576	891
562	562	265	256	786	198	234
776	667	676	891	776	453	234
765	664	678	765	654	367	918

TIME................

SPEED READING EXERCISES

572	256	762	572	527	653	862
782	278	872	782	433	574	276
330	303	430	330	030	764	332
319	193	391	193	319	491	339
445	545	554	445	675	465	234
354	543	334	354	345	554	435
213	231	123	213	331	112	238
435	543	334	554	434	435	534
221	112	221	321	121	212	124
736	673	376	376	673	763	736
241	241	412	214	412	240	112
567	765	567	675	657	577	651
021	210	021	102	110	201	121
227	727	772	272	722	277	227
646	664	646	661	464	446	466
189	189	918	891	981	198	819
771	117	771	717	711	171	177
926	629	962	626	966	369	926
202	022	020	202	220	210	201
356	365	563	356	765	536	635

TIME................

SPEED READING EXERCISES

75 941	________	82 457	________
84 307	________	49 562	________
18 592	________	94 165	________
89 062	________	14 830	________
56 107	________	93 724	________
02 733	________	64 190	________
75 916	________	93 076	________
07 825	________	23 196	________
81 943	________	36 741	________
28 921	________	94 566	________
42 105	________	56 029	________
63 429	________	93 575	________
90 472	________	38 470	________
65 917	________	21 349	________

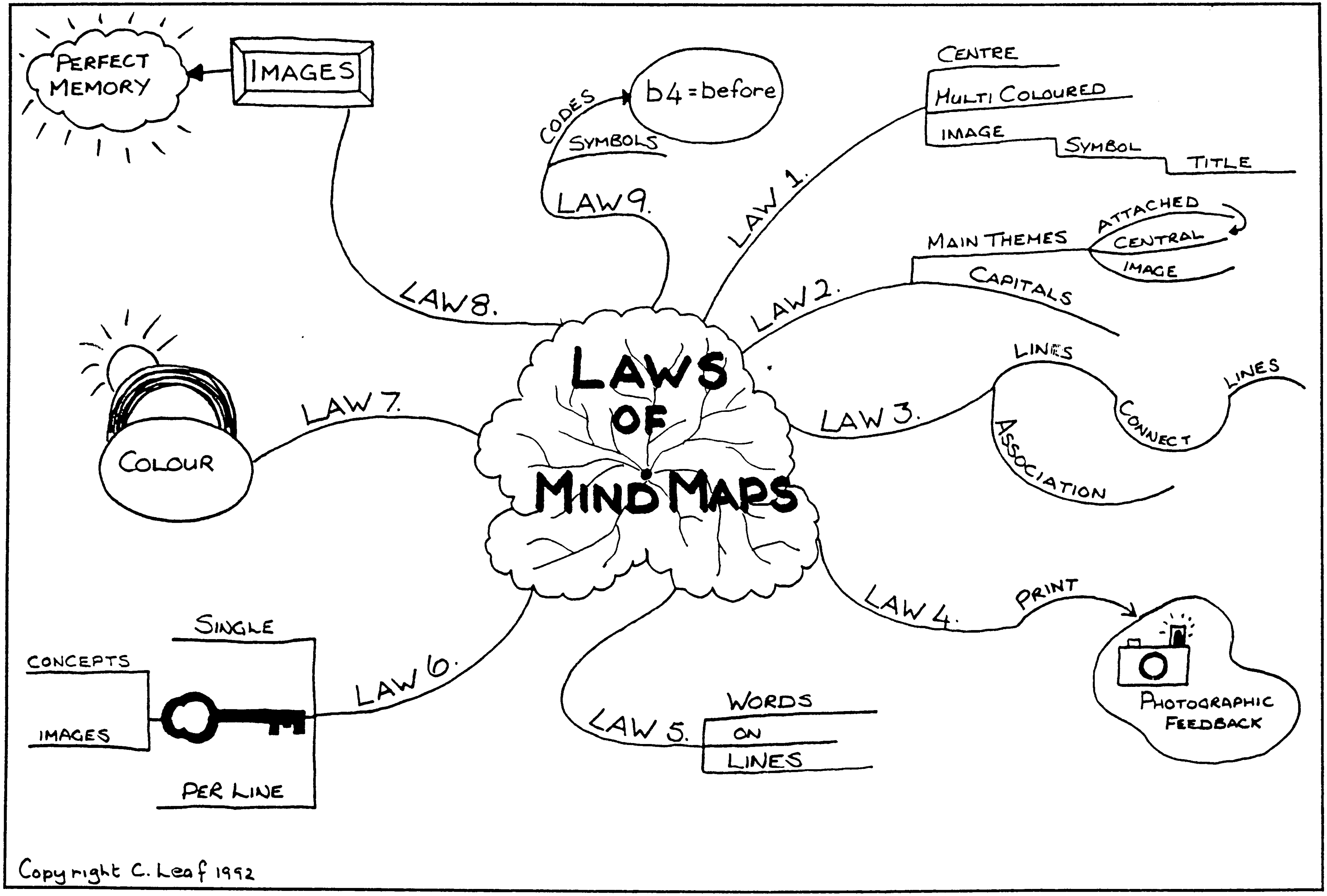
SPEED READING EXERCISES

93		31	
059	____________	280	____________
45		17	
298	____________	503	____________
36		94	
275	____________	705	____________
06		19	
329	____________	062	____________
12		29	
965	____________	410	____________
94		83	
562	____________	391	____________
51		77	
379	____________	152	____________
49		71	
063	____________	926	____________
10		62	
692	____________	831	____________
694		591	
801	____________	032	____________
937		152	
804	____________	407	____________
462		915	
591	____________	862	____________
905		105	
817	____________	762	____________
952		908	
831	____________	752	____________

RAPID READING PROGRESS CHART

GOAL

SPEED: wpm																COMPREHENSION
2000																100%
1900																
1800																90%
1700																
1600																80%
1500																
1400																70%
1300																
1200																60%
1100																
1000																50%
900																
800																40%
700																
600																30%
500																
400																20%
300																
200																10%
100																
DATE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	


LAWS OF MIND MAPS
LAW 1.
CENTRE
MULTI COLOURED
IMAGE
SYMBOL
TITLE
LAW 2.
MAIN THEMES
ATTACHED
CENTRAL
IMAGE
CAPITALS
LAW 3.
LINES
CONNECT
LINES
ASSOCIATION
LAW 4.
PRINT
PHOTOGRAPHIC FEEDBACK
LAW 5.
WORDS
ON
LINES
LAW 6.
SINGLE
CONCEPTS
IMAGES
PER LINE
LAW 7.
COLOUR
LAW 8.
IMAGES
PERFECT MEMORY
LAW 9.
CODES
SYMBOLS
b4 = before
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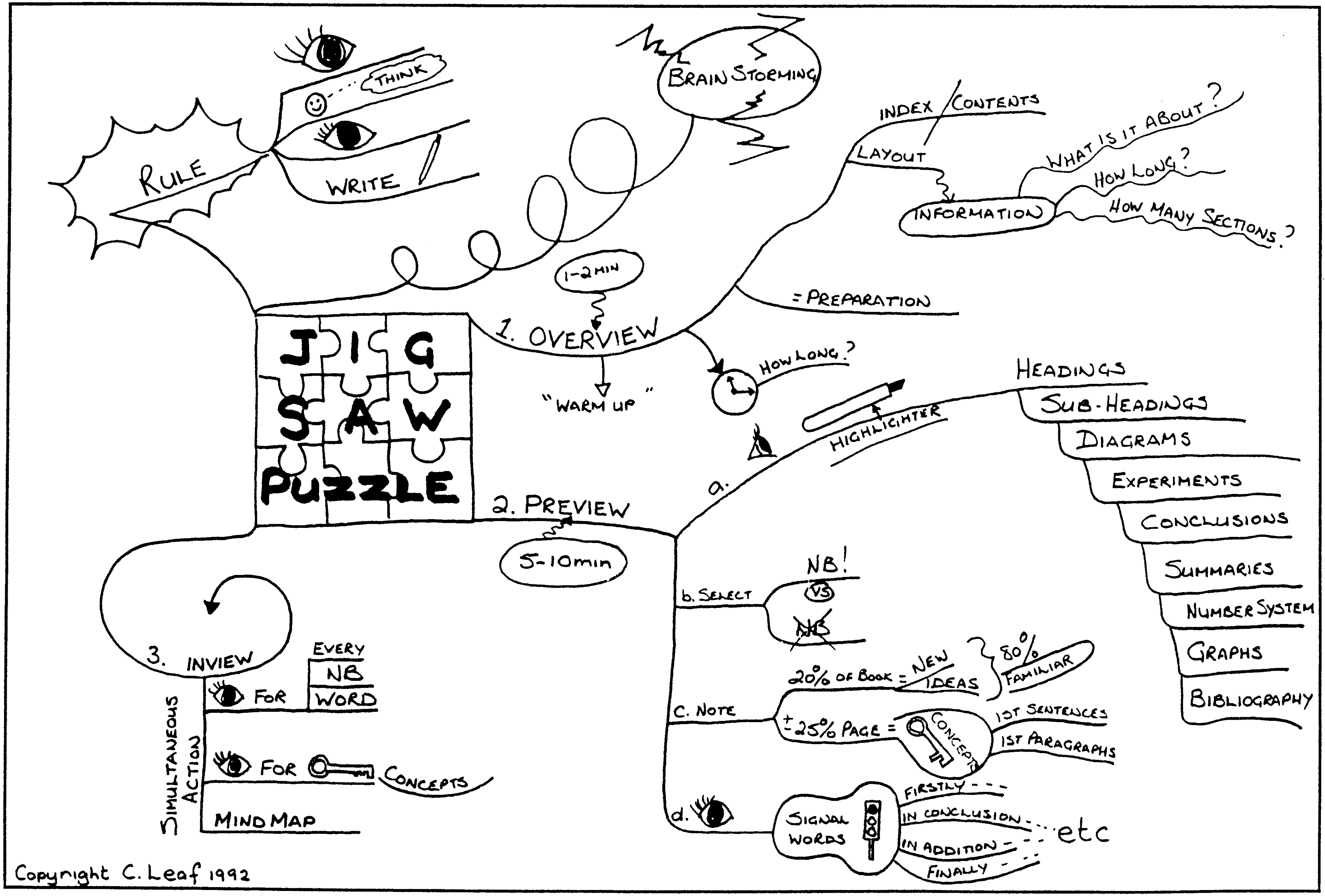

JIGSAW PUZZLE
RULE
THINK
WRITE
BRAIN STORMING
1. OVERVIEW
1-2 MIN
"WARM UP"
= PREPARATION
INDEX / CONTENTS
LAYOUT
INFORMATION
WHAT IS IT ABOUT?
HOW LONG?
HOW MANY SECTIONS?
HOW LONG?
2. PREVIEW
5-10min
a.
HIGHLIGHTER
HEADINGS
SUB-HEADINGS
DIAGRAMS
EXPERIMENTS
CONCLUSIONS
SUMMARIES
NUMBER SYSTEM
GRAPHS
BIBLIOGRAPHY
b. SELECT
NB!
VS
~~NB~~
c. NOTE
20% OF BOOK = NEW IDEAS
80% FAMILIAR
± 25% PAGE =
CONCEPTS
1ST SENTENCES
1ST PARAGRAPHS
d.
SIGNAL WORDS
FIRSTLY - - -
IN CONCLUSION - -
IN ADDITION - -
FINALLY - -
etc
3. INVIEW
FOR
EVERY NB WORD
FOR
CONCEPTS
MIND MAP
SIMULTANEOUS ACTION
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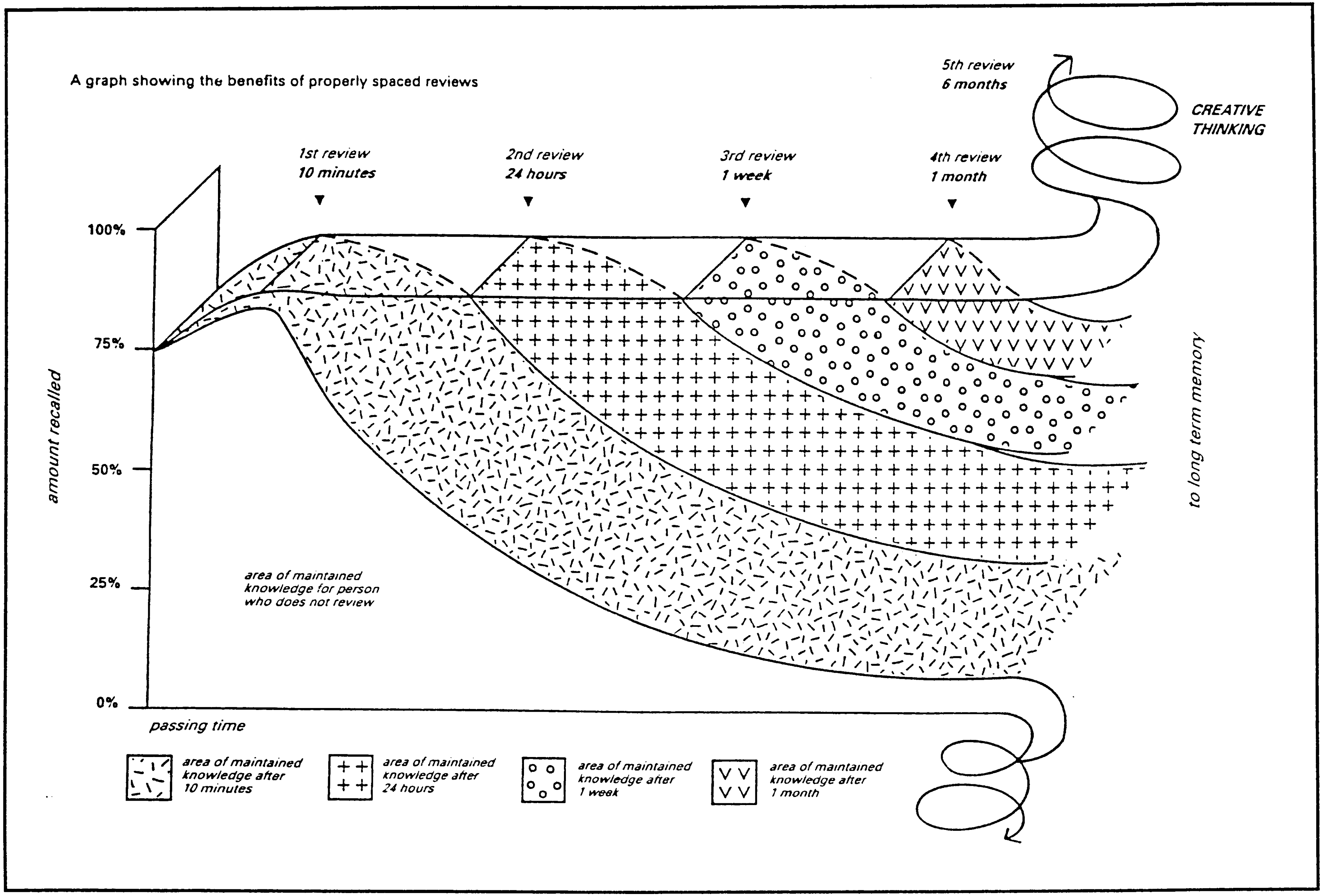
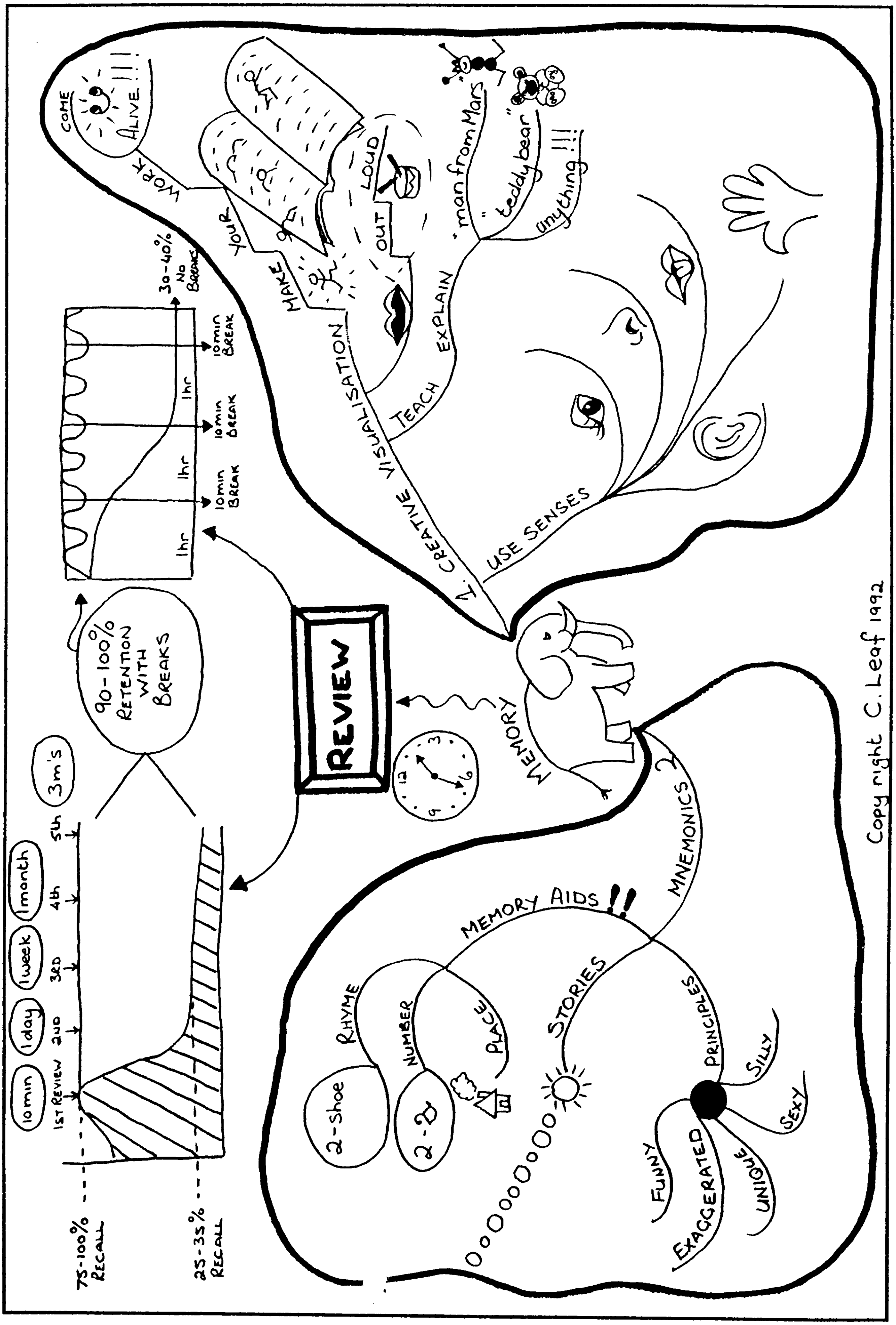

A graph showing the benefits of properly spaced reviews
1st review
10 minutes
2nd review
24 hours
3rd review
1 week
4th review
1 month
5th review
6 months
CREATIVE
THINKING
100%
75%
50%
25%
0%
amount recalled
to long term memory
passing time
area of maintained knowledge for person who does not review
area of maintained knowledge after 10 minutes
area of maintained knowledge after 24 hours
area of maintained knowledge after 1 week
area of maintained knowledge after 1 month


MAKE YOUR WORK COME ALIVE !!!!
LOUD OUT
"man from Mars"
"teddy bear"
anything !!!
EXPLAIN
TEACH
1. CREATIVE VISUALISATION
USE SENSES
30-40% NO BREAKS
10min BREAK
10min BREAK
10min BREAK
1hr
1hr
1hr
90-100% RETENTION WITH BREAKS
REVIEW
MEMORY
12
3
6
9
3m's
10min
1day
1week
1month
1ST REVIEW
2ND
3RD
4th
5th
75-100% RECALL
25-35% RECALL
2 MNEMONICS
MEMORY AIDS !!
RHYME
NUMBER
PLACE
2-Shoe
2-2
STORIES
PRINCIPLES
SILLY
SEXY
UNIQUE
EXAGGERATED
FUNNY
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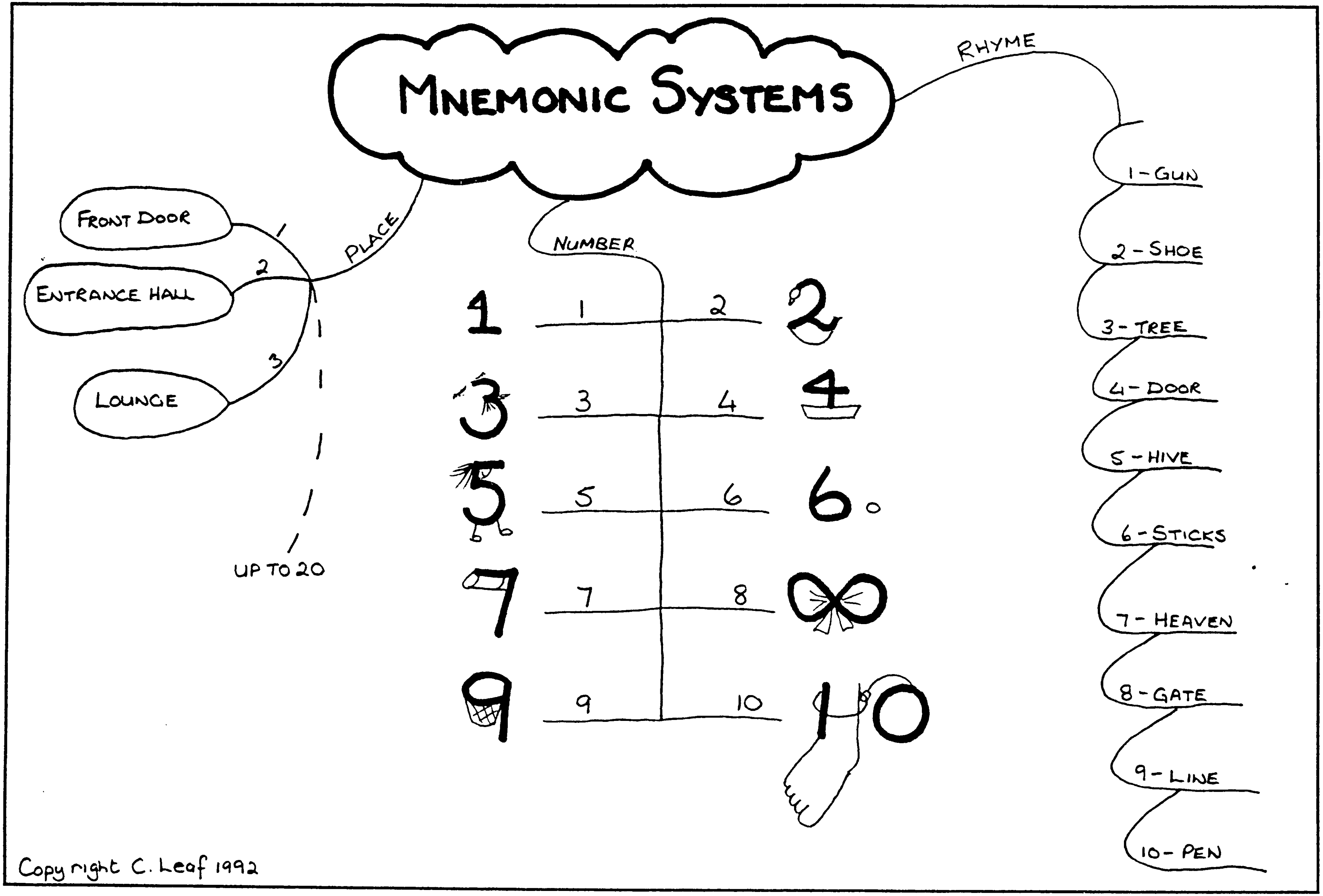
MNEMONIC SYSTEMS
PLACE
1
2
3
FRONT DOOR
ENTRANCE HALL
LOUNGE
UP TO 20
NUMBER
1
2
3
4
5
6
7
8
9
10
RHYME
1 - GUN
2 - SHOE
3 - TREE
4 - DOOR
5 - HIVE
6 - STICKS
7 - HEAVEN
8 - GATE
9 - LINE
10 - PEN
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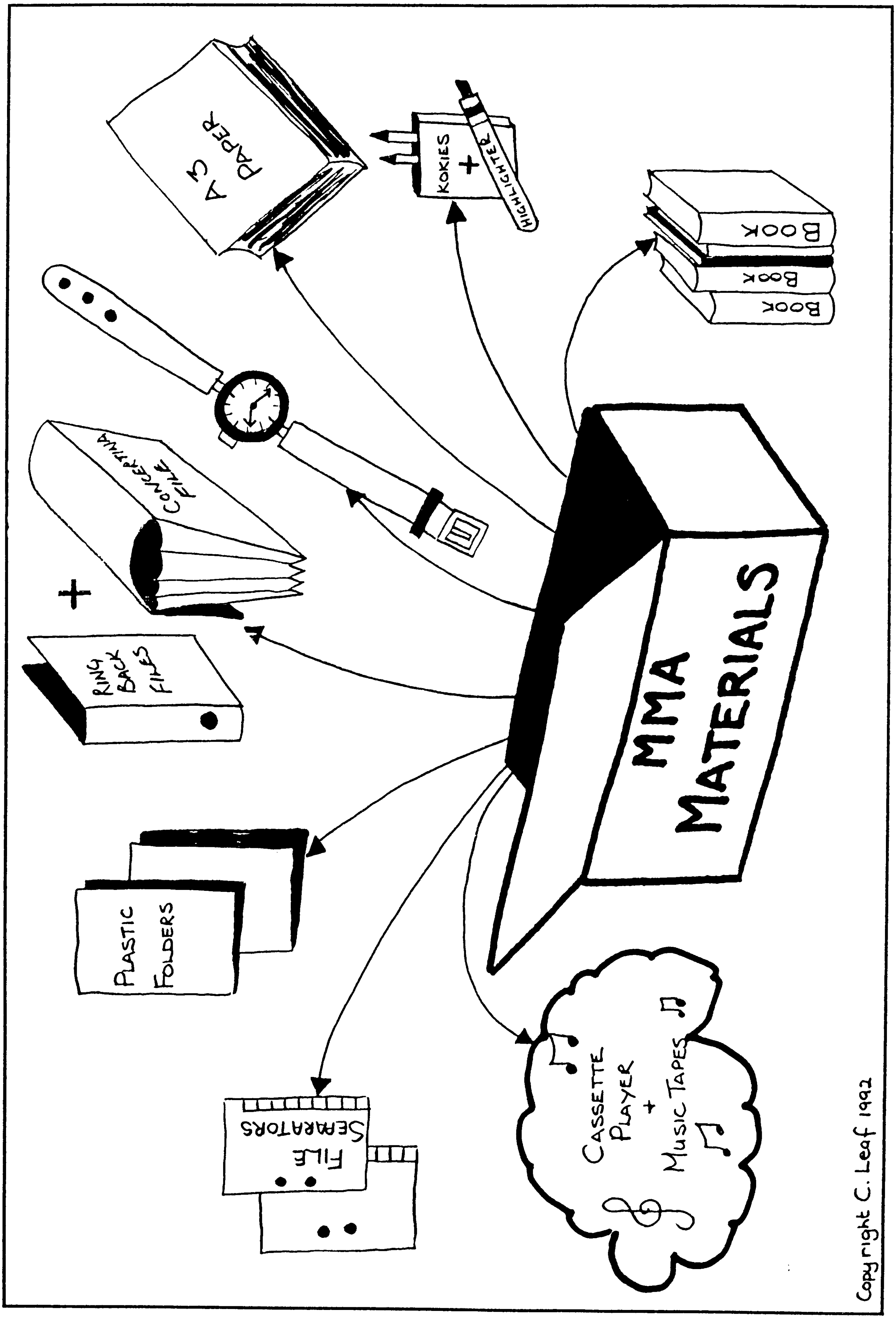
MMA MATERIALS
A3 PAPER
KOKIES + HIGHLIGHTER
BOOK
BOOK
BOOK
CONCERTINA FILE
+
RING BACK FILES
PLASTIC FOLDERS
FILE SEPARATORS
CASSETTE PLAYER + MUSIC TAPES
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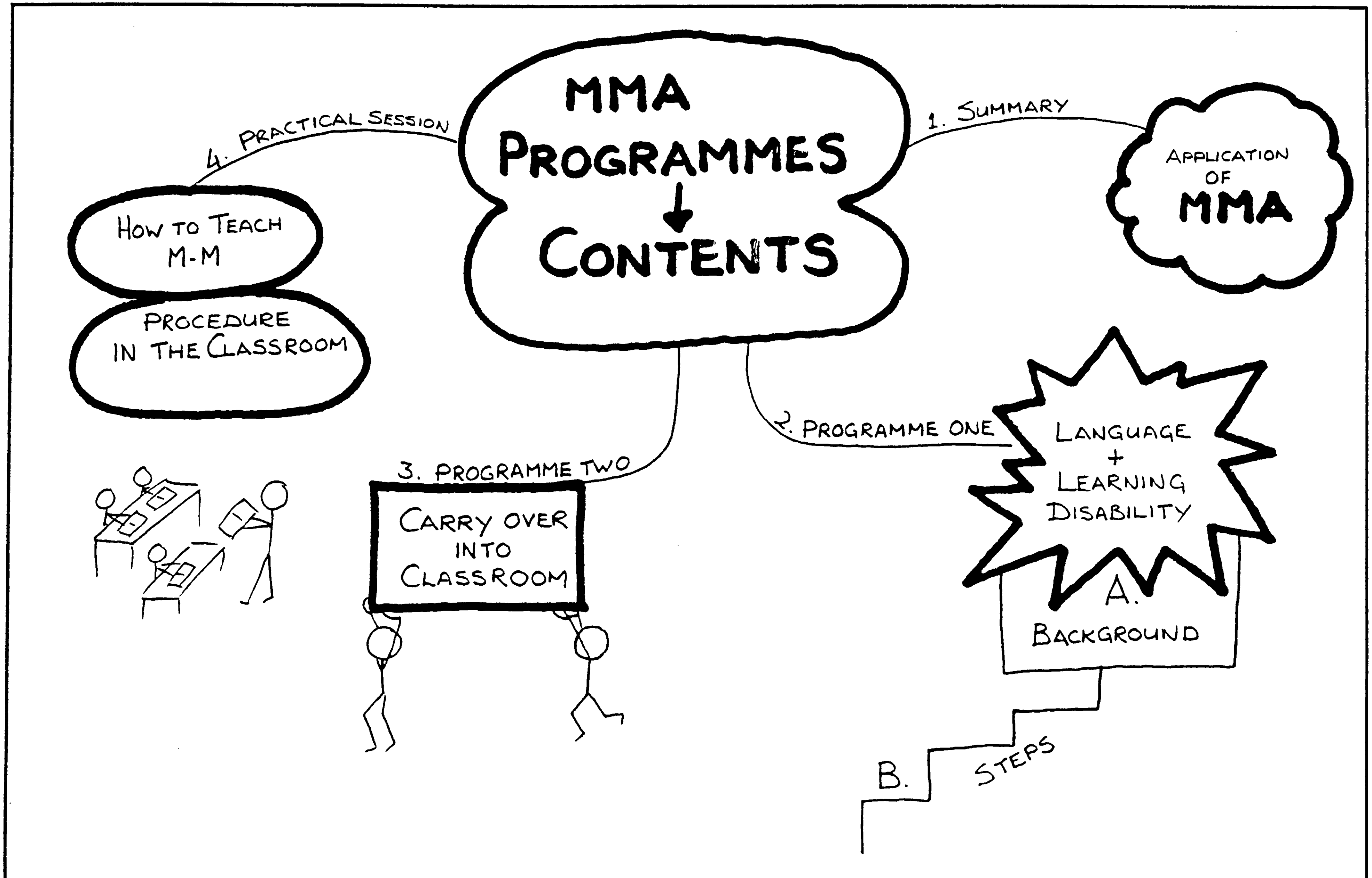
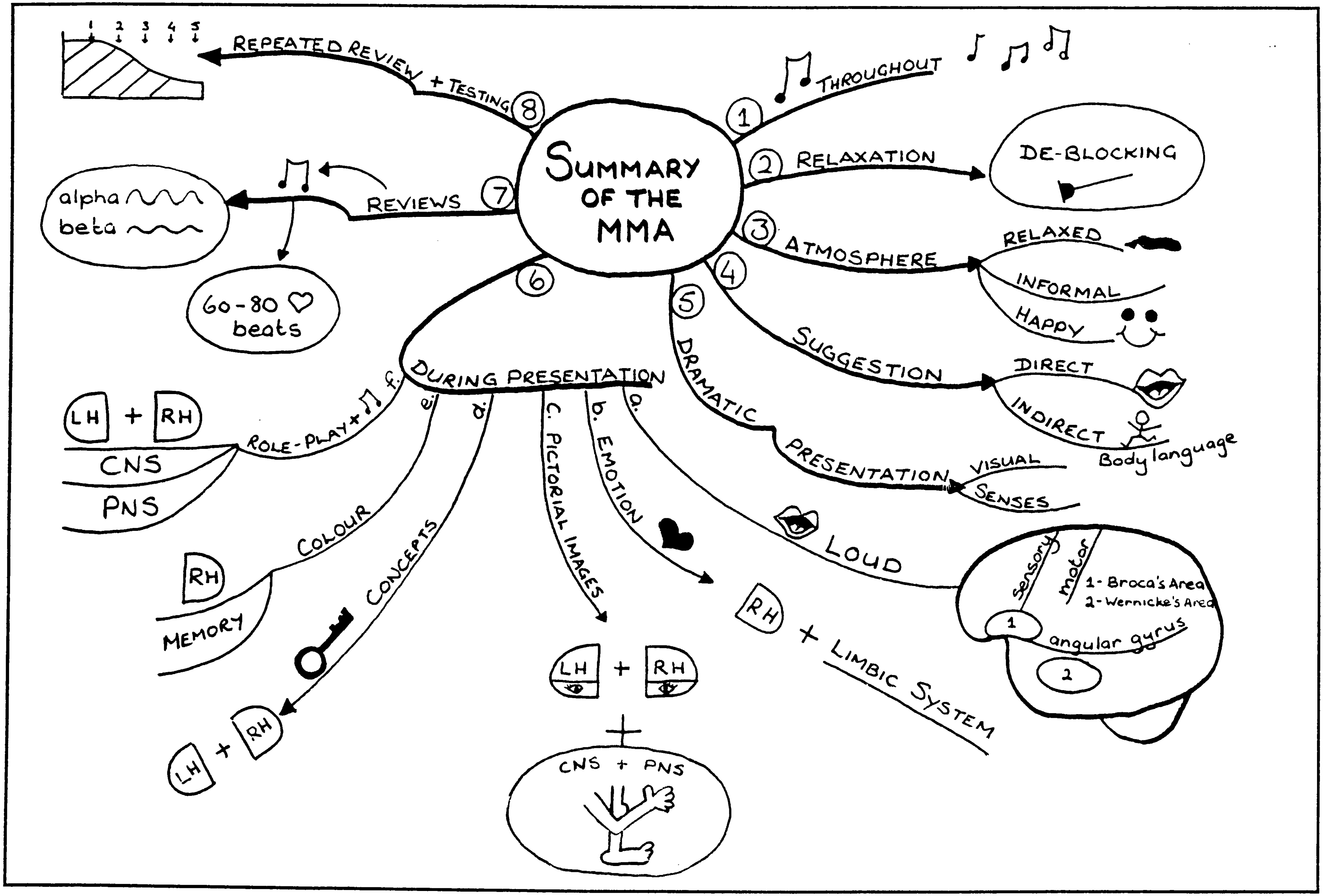
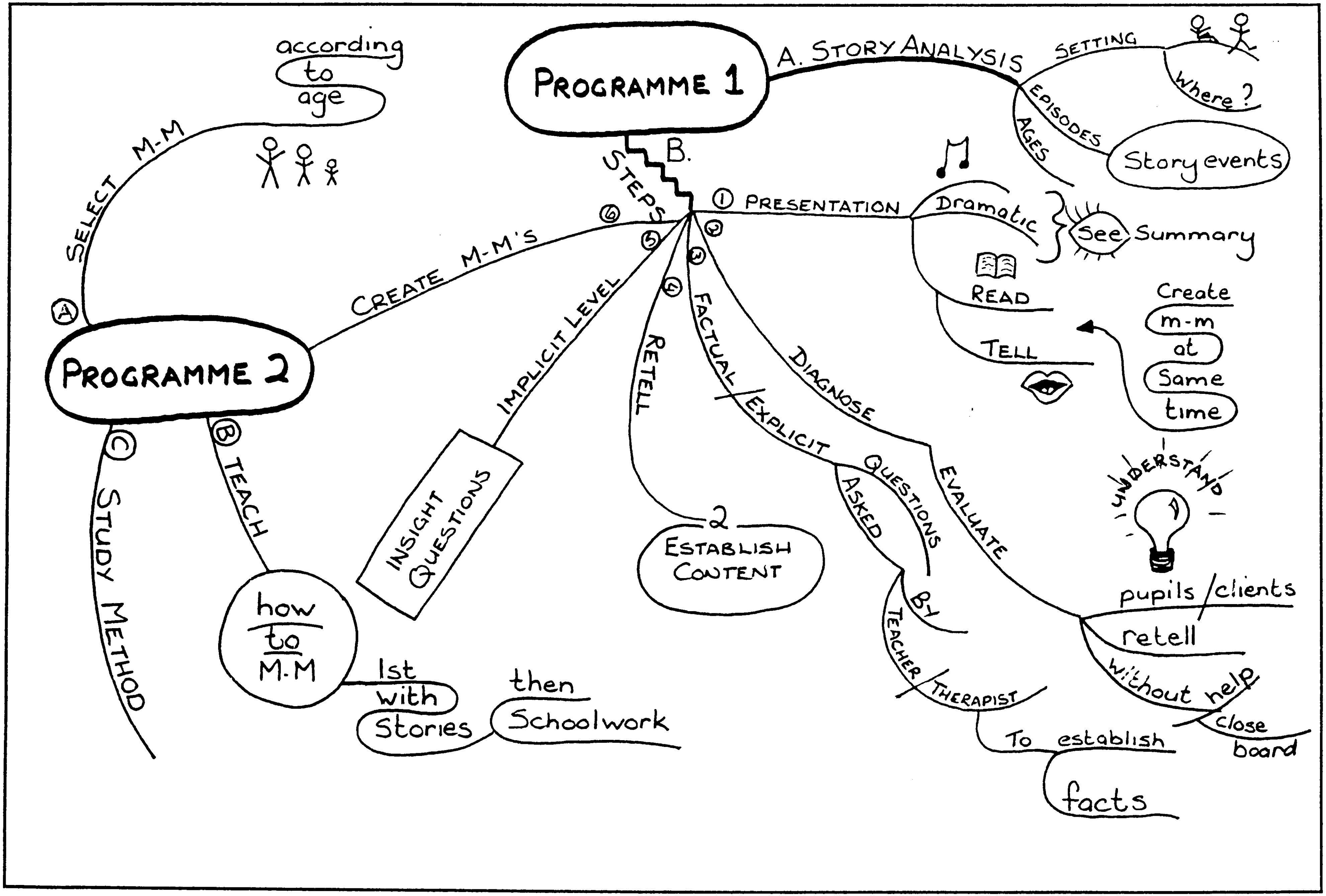

MMA
PROGRAMMES
CONTENTS
1. SUMMARY
APPLICATION OF MMA
2. PROGRAMME ONE
LANGUAGE + LEARNING DISABILITY
A.
BACKGROUND
B.
STEPS
3. PROGRAMME TWO
CARRY OVER INTO CLASSROOM
4. PRACTICAL SESSION
HOW TO TEACH M-M
PROCEDURE IN THE CLASSROOM


SUMMARY OF THE MMA
1 THROUGHOUT
2 RELAXATION
DE-BLOCKING
3 ATMOSPHERE
RELAXED
INFORMAL
HAPPY
4 SUGGESTION
DIRECT
INDIRECT
Body language
5 DRAMATIC
PRESENTATION
VISUAL
SENSES
6 DURING PRESENTATION
a. LOUD
Sensory
motor
1- Broca's Area
2- Wernicke's Area
angular gyrus
b. EMOTION
RH + LIMBIC SYSTEM
c. PICTORIAL IMAGES
LH + RH
+
CNS + PNS
d. CONCEPTS
LH + RH
e. COLOUR
RH
MEMORY
f. ROLE-PLAY +
LH + RH
CNS
PNS
7 REVIEWS
alpha
beta
60-80 beats
8 REPEATED REVIEW + TESTING
1 2 3 4 5


PROGRAMME 1
A. STORY ANALYSIS
SETTING
Where ?
EPISODES
Story events
AGES
B.
STEPS
① PRESENTATION
Dramatic
See
Summary
READ
TELL
Create m-m at same time
② DIAGNOSE
EVALUATE
UNDERSTAND
pupils / clients
retell
without help
close board
③ FACTUAL / EXPLICIT
QUESTIONS
ASKED
BY
TEACHER / THERAPIST
To establish
facts
④ RETELL
2
ESTABLISH CONTENT
⑤ IMPLICIT LEVEL
INSIGHT QUESTIONS
⑥ CREATE M-M'S
PROGRAMME 2
Ⓐ SELECT M-M
according to age
Ⓑ TEACH
how to M.M
1st with Stories
then Schoolwork
Ⓒ STUDY METHOD

SUMMARY OF THE APPLICATION OF THE MMA

1 Music is played throughout to create an optimimal learning situation.

2 Each session begins with physical and mental relaxation, to literally "deblock" the learning barrier.

3 A relaxed, informal, happy atmosphere is created.

4 The art of direct and indirect suggestion is used.

5 Whatever material is being worked on, is presented as dramatically as possible, using the senses and visual imagery.

6 During therapy/teaching/learning,

- words are read aloud. This activates Broca's area, Wernicke's area, the left hemisphere sensory and motor cortex, and the angular gyrus.
- text is read with emotion and inflection. This activates right hemisphere areas for prosodic functions, the right motor and sensory cortex, and the limbic system.
- pictorial images are developed and mind-maps used (see programmes). This involves a major portion of the primary visual cortex, the left and right motor sensory cortices and the central and peripheral nervous systems from the brain stem through the arms, hands and fingers.
- key words are used on mind-maps, encouraging the client to tie the words to a pictorial memory, thus activating the right hemisphere.
- colour-coding is used on mind-maps, allowing discrimination in the right visual cortex and to activate memory.
- role-play with music, is encouraged, to activate the left and right motor and sensory cortices, the brain stem and the central and peripheral nervous system.

7 Reviews are done using relaxation techniques, and also Baroque music, which, lowers beta rhythms 13.30 cycles per second within the left hemisphere, allows increased alpha rhythms (8-12 c.p.s) in both hemispheres, impacts the limbic system components controlling emotion and memory, and works to lower blood pressure, heart rate and respiratory rate.

8 Testing is done after a review, using mind-maps. This reinforces neuronal connections established during initial learning, leading to hypertrophy and/or branching of neuron dendrites, making recall easier.

The more vivid and active the impression of what is being learned, the stronger the memory trace. The spike of electrical activity in the brain increases markedly with novel, surprising or vivid stimuli. This activity signals the hippocampus and hypothalamus to produce increased levels of neurochemicals related to memory formation.

THE MMA PROGRAMME ONE: LANGUAGE AND LEARNING DISABILITY

SECTION A: BACKGROUND - STORY ANALYSIS

(Adapted from Wallach & Butler)

1 SETTING

Main Characters
Social, physical, temporal context

2 EPISODES

2.1 **Beginning** - the initiating event, which could be:-

- a natural occurrence. eg - a flood.
- an action. eg - three pigs leaving home.
- an internal physical state. eg - hunger, pain, sickness.
- a perception of an external event. eg - seeing a lion.

2.2 **Reaction** of the characters to the initiating event. This is normally the **internal response** that is determined by **cultural experience** and **personal attributes**. The internal response can be emotion (feeling or desire) or thinking (planning how to deal with a problem)

2.3 **Action** - The attempt (overt action) to deal with the initiating event.

2.4 **Consequence/outcome** -which could be:-

- a natural occurrence. eg - the rain stops.
- an end state. eg - marriage.
- an affective response. eg - They lived happily ever after.
- an idea. eg - has a new friend.
- an action. eg - riding off into the sunset.

2.5 **Ending**

3 WORLD KNOWLEDGE/VIEWS

The following concepts are needed in order to be able to tell and understand stories. They are the starting point.

linguistic knowledge
rhetorical knowledge (prosody, proverbs, poetic)
causal conceptual (lectures, expository)
intentional conceptual (narrative)
spatial knowledge
knowledge of
- ❖ objects
- ❖ personalities
- ❖ roles

equilibrium → transition → disequilibrium = sad stories
disequilibrium → transition → equilibrium = happy stories

4 IMPORTANT AGES IN STORY DEVELOPMENT

4.1	± 3 years	❖ recognise that a story is different from conversation.
4.2	± 4-5 years	❖ aware actions originate around events.
4.3	± 6 years	❖ expand the above idea to include mediating thoughts, actions, events.
4.4	± 11 years	❖ understand/use embedded episode.
4.5	± 12 years	❖ multiple embedded episodes.

SECTION B: STEPS

STEP 1 PRESENTATION LEVEL

1.1 Read story/section of work/newspaper article etc, to client. If the content is long, stop after each episode and ask a factual question (explicit level). eg "Who was that about?" or "What have we just read?"

NOTE: **If the client can't formulate an answer, summarise the content and ask the question again.**

Aim of Step 1
- ❖ listening skills
- ❖ attention
- ❖ comprehension
- ❖ memory

STEP 2 DIAGNOSTIC LEVEL

2.1 The client now retells the story/article/school-work etc.

NOTE: **Do not help via probes, questions etc, as this is on a diagnostic level.**

<u>For remedial therapeutic purposes</u>, record and transcribe content for analysis and comparison, as well as to get an indication of: language level, types of errors, recall/memory, sequencing abilities and logic.

Aim of step 2

- ❖ diagnostic
- ❖ assimilation and accommodation
- ❖ encoding and decoding

STEP 3 EXPLICIT LEVEL

3.1 Ask factual questions (explicit level), ie who?, what?, when?, in order to establish the factual content and sequence of the story/article etc, in the client.

NOTE: **No inference/insight questions are asked at this level.**

Explain meanings of new words - provide practice (semantics)

Aim of step 3

- ❖ sentence formation
- ❖ word finding - semantics
- ❖ vocabulary - semantics
- ❖ comprehension
- ❖ memory
- ❖ categorisation

STEP 4 RETELLING LEVEL/PRACTICE STAGE

4.1 The client retells the story for the second time.

NOTE: **<u>For remedial therapeutic purposes</u>, probes can be used but, note how many, as one aims to decrease the amount of probes used as a criteria for success in therapy.**

Make sure the patient has grasped the content of the story/article etc.

Aim of step 4

- ❖ memory
- ❖ sequencing
- ❖ sentence formation
- ❖ comprehension

STEP 5 IMPLICIT LEVEL

5.1 Now ask the insight/deep questions, ie Why?, how?, what for?, What do you think?, What does it mean?, What would happen if...?, What is another title for the story?, Give reasons for.....etc.

Aim of step 5

- ❖ cause/effect
- ❖ inference
- ❖ implications
- ❖ metalinguistics - identification and discussion of:-
  metaphor, simile, figurative language, use of expansion techniques, use of punctuation for effect etc.

- ❖ metacognition - thinking about thinking/internal plans eg:
  "Why did the author imply...?"
  "Why did the little girl tell stories?"
  "What were they feeling?"
  "What do you feel when you read this story?"

- ❖ reasoning, thinking, problem-solving, judgement:
  on a verbal level - later with mind-maps.

INDUCTIVE & DEDUCTIVE & ANALOGICAL REASONING
⇓
CONVERGENT & DIVERGENT THINKING
⇓
PROBLEM SOLVING & JUDGEMENT

NOTE: <u>For remedial and language therapy specifically:</u> **From steps 2-4 various grammatical errors should have been noted. At this level these errors can be worked on using the content of the story as the material for therapy. Extra practice of linguistic structure with additional material can be used as well, thus errors are noted as they occur and worked on throughout therapy.**

NOTE: <u>For auditory perceptual training:</u> **This is worked on simultaneously, directly or indirectly, as errors occur, throughout therapy.**

STEP 6 MIND-MAPPING

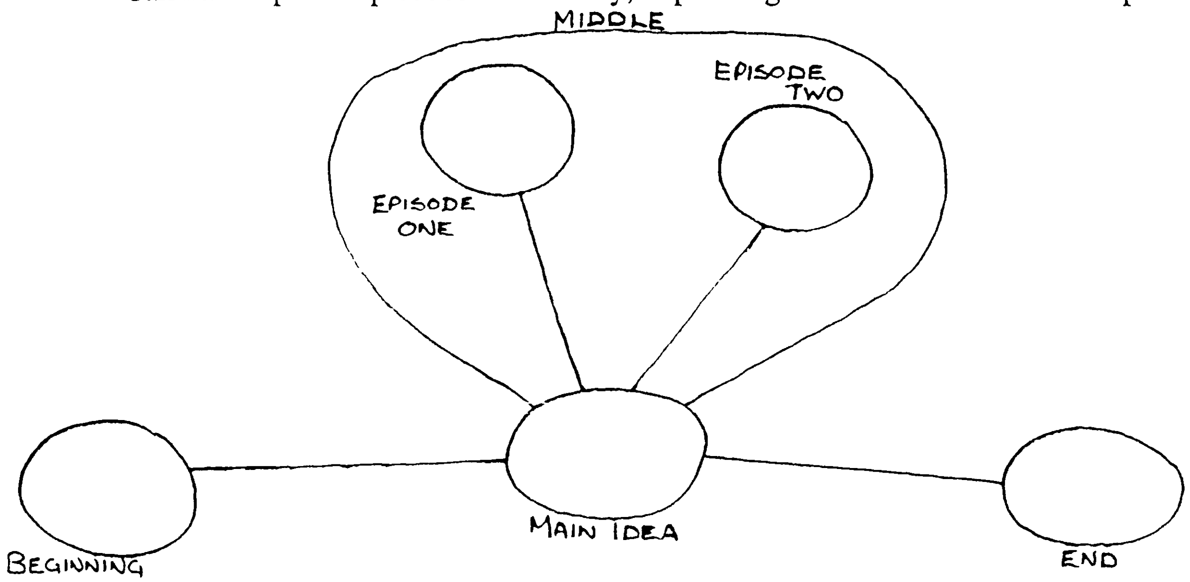
6.1 Only now is the client ready to mind-map the story. Select the type of mind-map to be done according to the age of the client.

THE MMA PROGRAMME TWO: CARRY OVER INTO THE CLASSROOM

TYPES OF MIND-MAPS

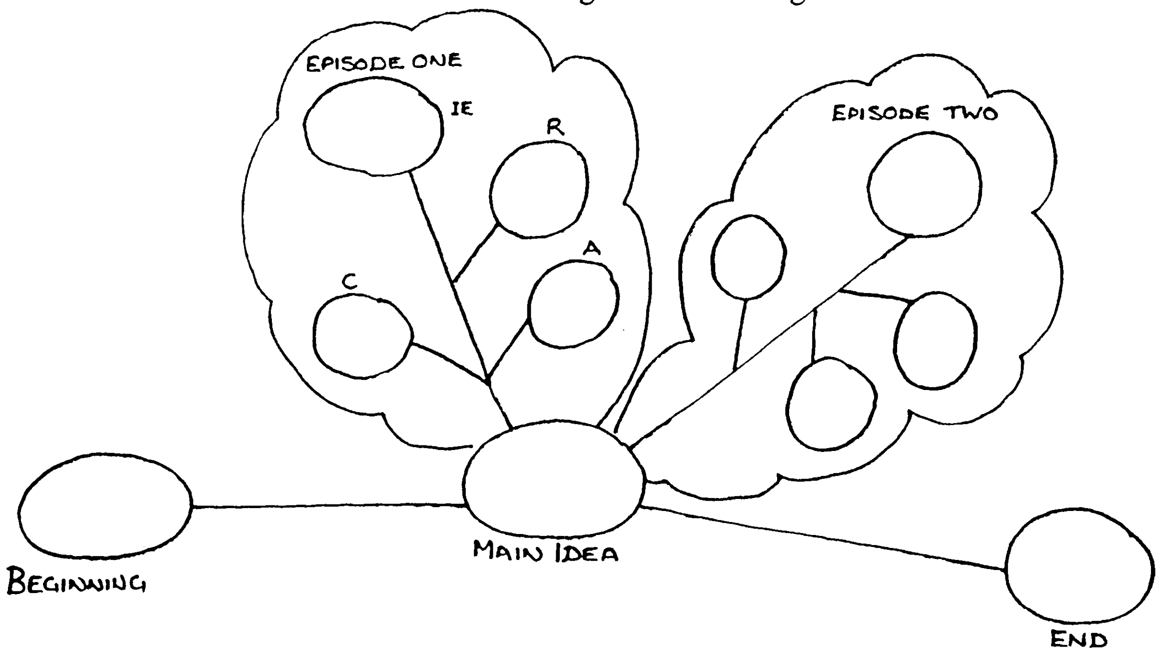
1 Pre-School, Grade One, Grade Two, 1st terms (± 5-8 years)

Can have up to 5 episodes in the body, depending on what the client can cope with.



2 Grade Two 2nd term (± 8-9 years)

There can be as many episodes as the client can cope with.
Words can be brought in at this stage.



3 Standard one onwards, mind-mapping proper is done.
See Jigsaw puzzle and Laws of Mind-maps overleaf.

HOW TO TEACH MIND-MAPPING

1 Show the client a few mind-maps, explaining the rules simultaneously.

2 Now do the first mind-map, with the client following on the story or article that is been worked on. While doing the mind-map discuss how you are fulfilling the rules. **Adjust the language used to the level of the client.**

3 Once the mind-map is completed, go through it cloud, by cloud.

4 Let the client retell the mind-map. Use probes if necessary.

5 The client must practice retelling until he/she can do it without help. This practice familiarises the client with the concept of mind-mapping.

6 Now let the client draw his/her own mind-map of the story, without copying the one you have done. Help with the memory of facts/content of the story, as the emphasis here is on the creation of a mind-map, and not memory.

(1-6 can be covered in 2-5 half hour sessions)

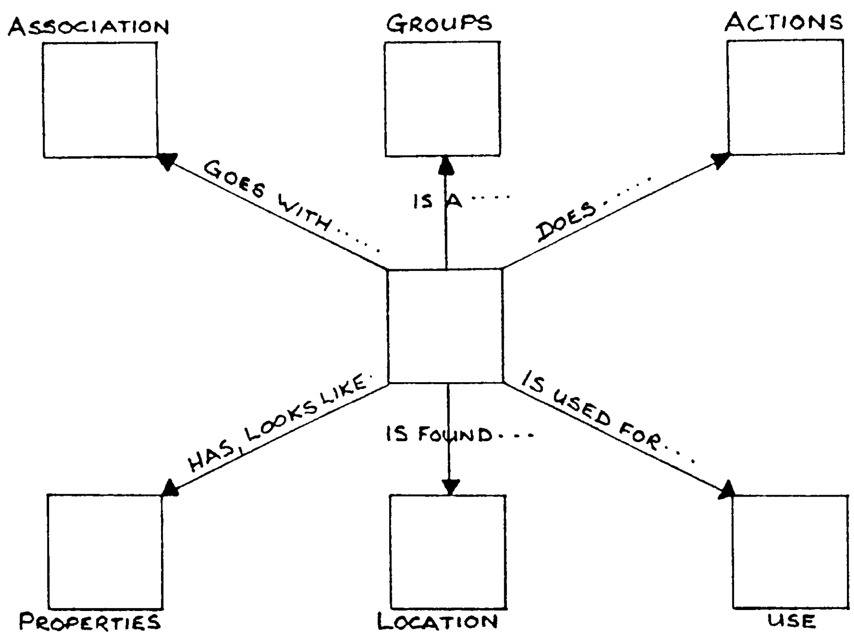
NOTE: Key concepts can pose a problem. If this appears to be the case, it is advisable to spend a few sessions working on key concept selection. When explaining what a key concept is, the following is often helpful:

Level one:	EVERY WORD ⇓	eg: The cat sat on the mat.
Level two:	KEY WORD ⇓	eg: cat sat on mat
Level three	KEY CONCEPT	eg: cat ⇒ mat

See overleaf - mind-maps for key concept practice.

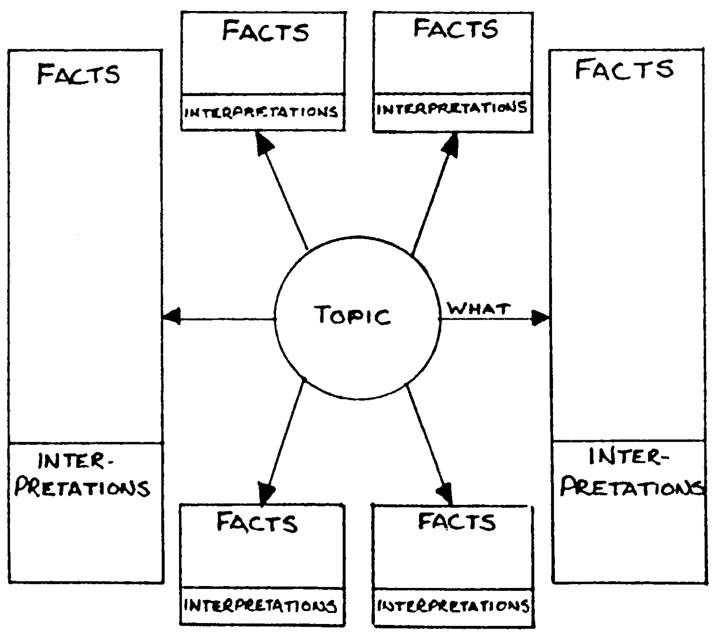
You can use the following mind-maps to do key concept practice:

1 FEATURE ANALYSIS GUIDE



This feature analysis guide not only improves key concept selection, but also categorisation, association, clustering and organisation (a cognitive skill).

2 SUN DIAGRAM



The Sun Diagram can also help with the analysis of the story, but the client must be encouraged to develop his/her own mind-map of the story, with his/her own creative structure as this one is still very linear and boring.

7 Using a new story, go through steps 1-7. Now get the client to create his/her own mind-map. Help where necessary.

> NB!
> As the client becomes more familiar with the method, decrease help gradually until the student can do a mind-map on his/her own. Once this is achieved, go onto a more complex story/article etc.

NOTE: IMPROVEMENT OF LANGUAGE USE:

This involves working on:

a) **Pragmatics** - dyad, turn-taking, topic-maintenance, listening, eye-contact.

b) **Transactional analysis** - the quality of what the patient is saying on a conversational level.

c) **Communicative functions** - informing, controlling, persuading, expressing, feelings, ritualising, imaging.

All these can be assessed and analysed constantly, throughout, as mind-mapping therapy uses functional discourse, ie narration, conversation and procedure, as its basic material. Mind-mapping therapy also works extremely well in group set ups, providing the ideal environment for assessing and remediating a,b,c.

THE SUGGESTED MMA PROCEDURE IN THE CLASS-ROOM

1. Baroque music and relaxed atmosphere.
2. Physical relaxation exercises.
3. Mental relaxation exercises (visualisation).
4. Presentation of lesson using as much of a story text as possible.
5. While presenting story, do mind-map on blackboard - simultaneous presentation.
6. Go through mind-map.
7. Get the students to retell mind-map, taking turns.
8. Remove mind map from the board, write down lesson information on the board in point form - or present on an overhead projector. Help the students select the correct key words.
9. Now for the classwork activity, they must each make their own mind-maps.
10. Homework: students must rehearse mind-maps for next lesson.
11. Next lesson begins with going over mind-maps, using quiz games etc.

NOTE: Present the techniques of mind-mapping in a story form first, before applying to school lessons.

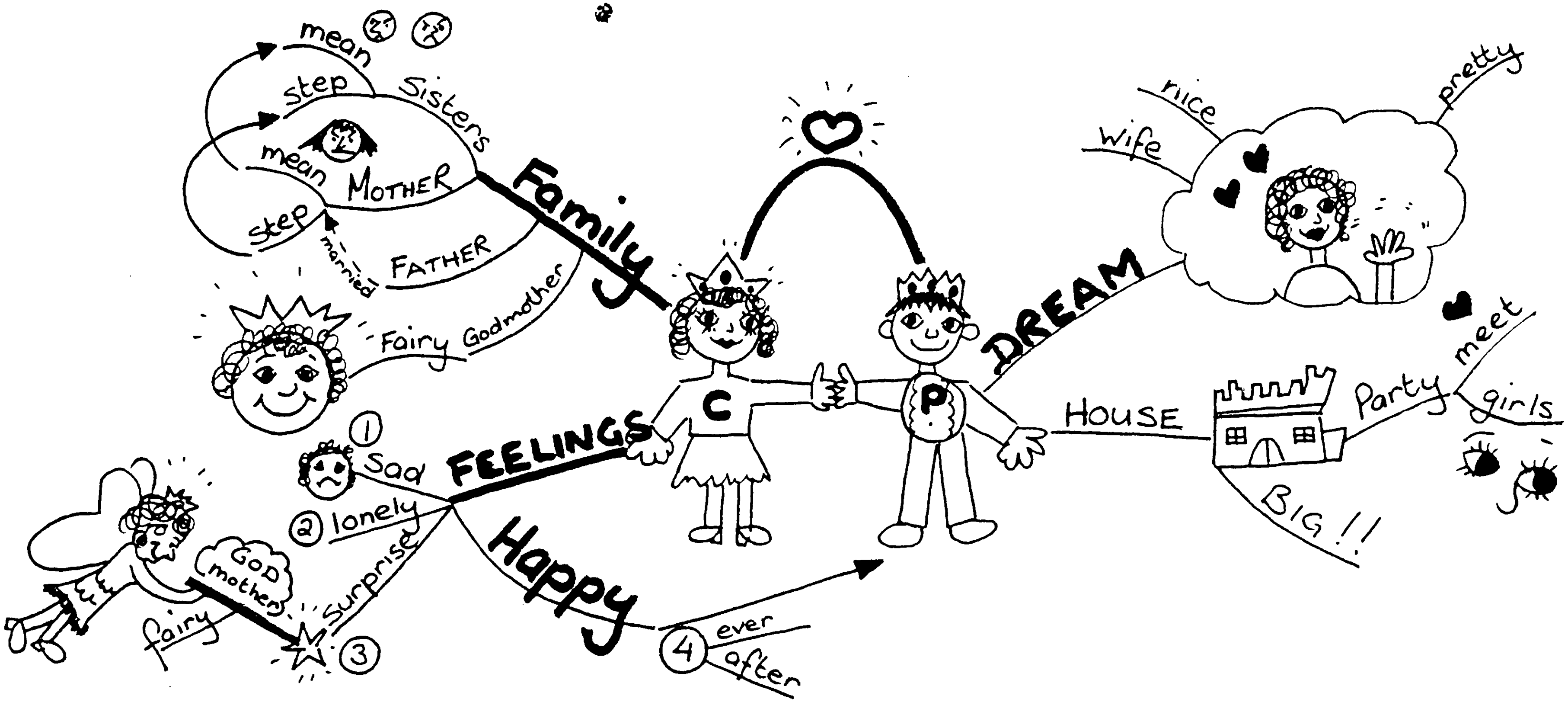
Teach Jigsaw puzzle to students as a lesson in guidance.

SAMPLE MIND-MAP

Cinderella

adapted from Tony Buzan

Here is how a child might envision the classic story of Cinderella.



This is an example of how Mind-Maps can be used by all ages and occupations, to describe an infinite variety of subjects.

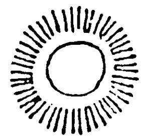
Summary

1. *Habitat:* Most frogs are land animals, but some kinds never leave the water. The eggs are laid in the water and the tadpole is aquatic.
2. *Body division:* Head and trunk.
   (a) *Head* with:
   - wide mouth; row of teeth in the upper jaw; long, sticky tongue attached to the front of the mouth;
   - two protruding eyes with nictitating membrane;
   - two nostrils for smelling and breathing;
   - two round eardrums for hearing and balance.

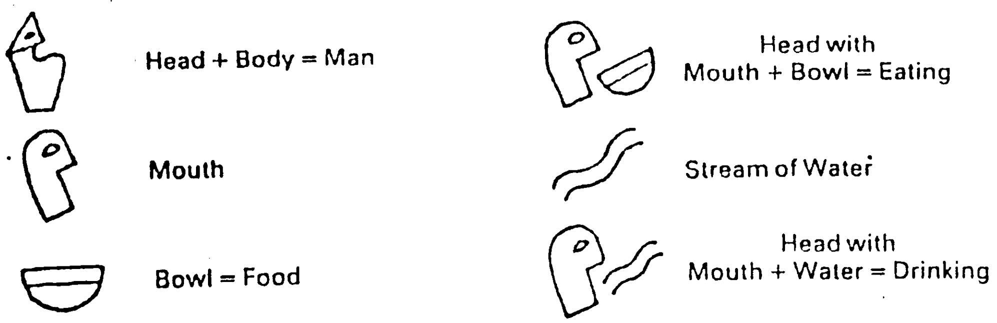
   (b) *Trunk* with two short forelegs and two large hindlegs with webbed toes.
3. *Body shape:* Short, flattened from top to bottom; no neck and a hump on the back.
4. *Body covering:* Moist, naked skin with mucous glands and pigment-cells.
5. *Locomotion:*
   (a) Jumps with hindlegs on land.
   (b) Swims in water with hindlegs and webbed toes.
6. *Breathing:* The adult frog breathes through his lungs, mouth and skin.
7. *Reproduction:* Oviparous. Lays eggs in water where they are fertilised externally. Tadpoles with suckers and external gills hatched by means of the heat of the sun. They develop into tadpoles with a mouth, eyes and internal gills. Hindlegs appear later and then the lungs develop. The front legs appear and the tail disappears. This change of shape is called metamorphosis.

THE ART OF WRITING (Egyptians)

As long ago as 3000 B.C. the Egyptians developed a form of writing by drawing pictures to represent objects. The great disadvantage of picture-writing is that it is usually clumsy and takes a long time to write. Eg. this mountain and sun

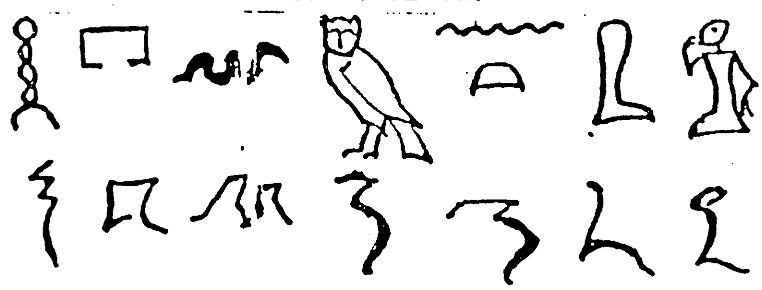


However, it was often necessary to refer not to a thing but to an idea, and so conventional signs were used to convey ideas: called Ideograms.



A later development was the use of signs with certain sounds to form words. These we may call Phonograms, eg. the picture of a bee and a leaf could be used to convey the idea of a "belief". This was phonetic writing and became very difficult to interpret when the meaning of the picture was lost.

Egyptian writing had over 600 signs. This writing in its earliest form was called "hieroglyphics" which means "holy writing" because it remained the secret of the priests who used the symbols on tombs and monuments and in the temples. Later a simplified form was developed - called "demotic". Finally an abbreviated form called "hieratic" evolved.

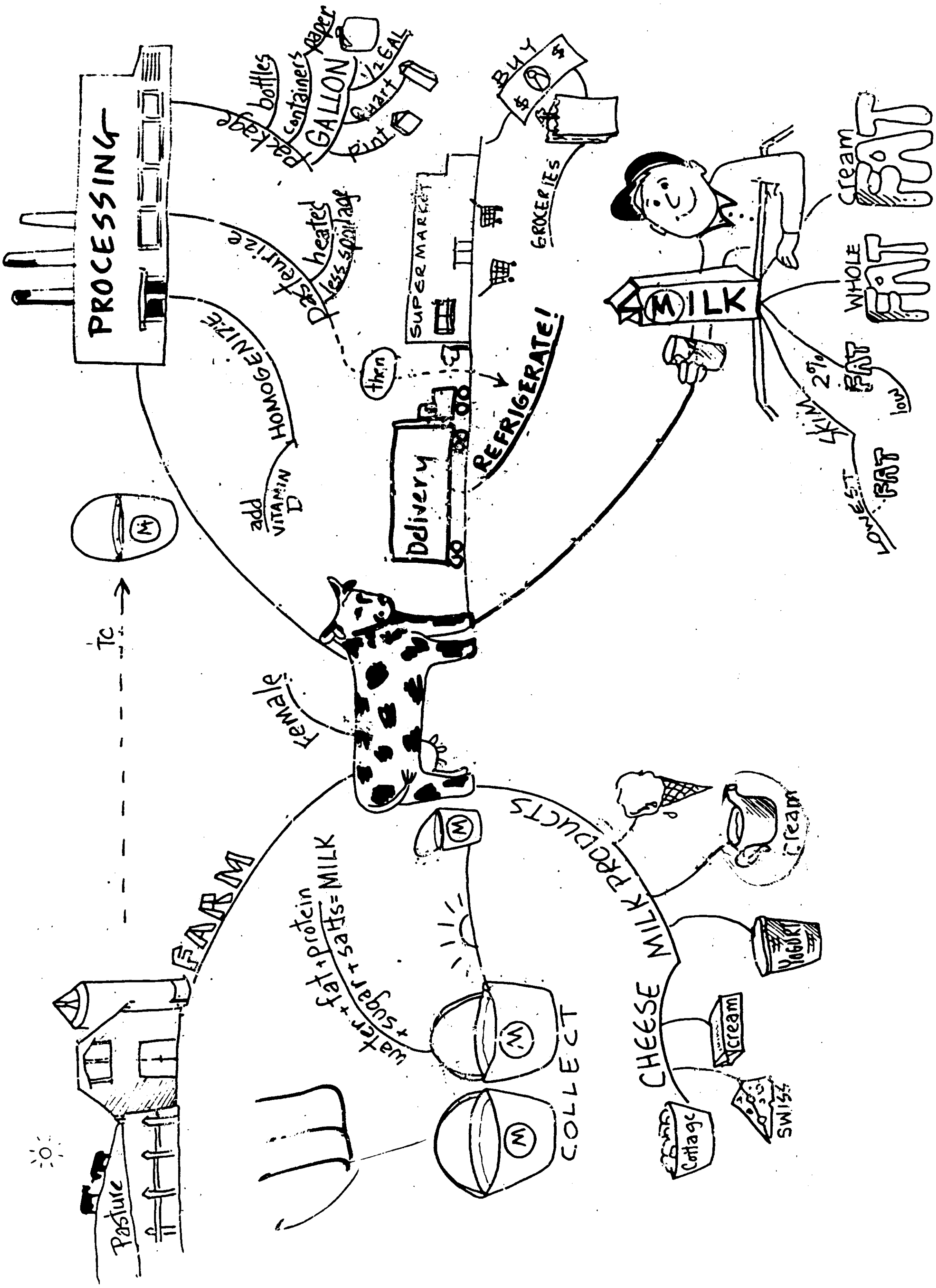


Upper line: Hieroglyphics — picture-writing
Lower line: Demotic writing — a running hand

The writing materials first used were surfaces, pieces of pottery and bone, but later they discovered they could make paper by splitting a river-reed, called papyrus, into thin strips which were pasted together to form large sheets. They made ink by mixing soot and water. A pointed reed was used as a pen.

APPENDIX IVB :

ADDITIONAL TRANSPARENCIES


PROCESSING
package
bottles
containers
paper
GALLON
1/2 GAL
Quart
Pint
pasteurize
heated
less spoilage
HOMOGENIZE
add
VITAMIN D
then
SUPERMARKET
GROCERIES
BUY
REFRIGERATE!
Delivery
MILK
cream
FAT
WHOLE
FAT
2%
FAT
low
SKIM
LOWEST
FAT
Tc
Female
FARM
Pasture
water + fat + protein + sugar + salts = MILK
COLLECT
MILK PRODUCTS
cream
YOGURT
CHEESE
cream
Cottage
SWISS

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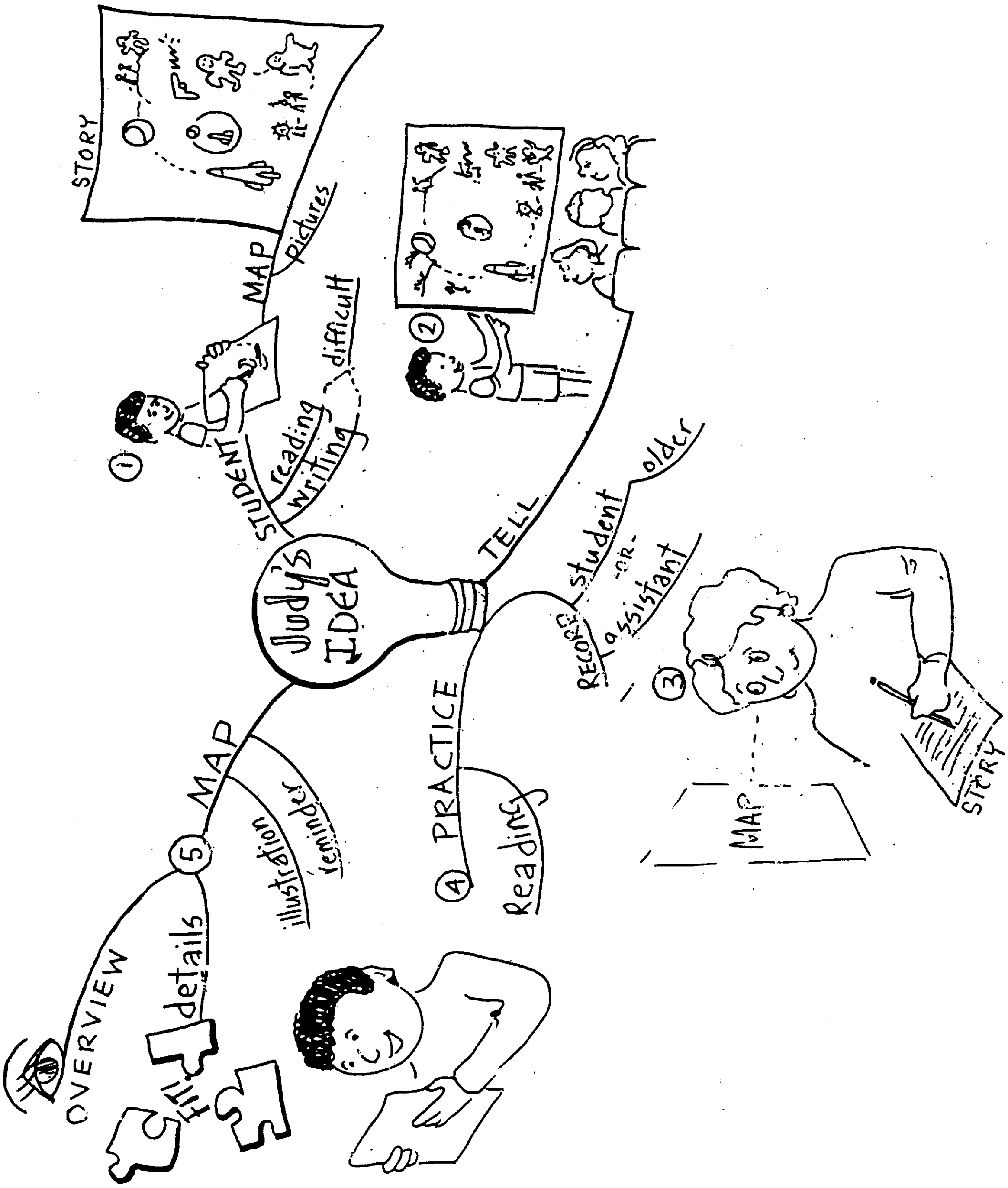
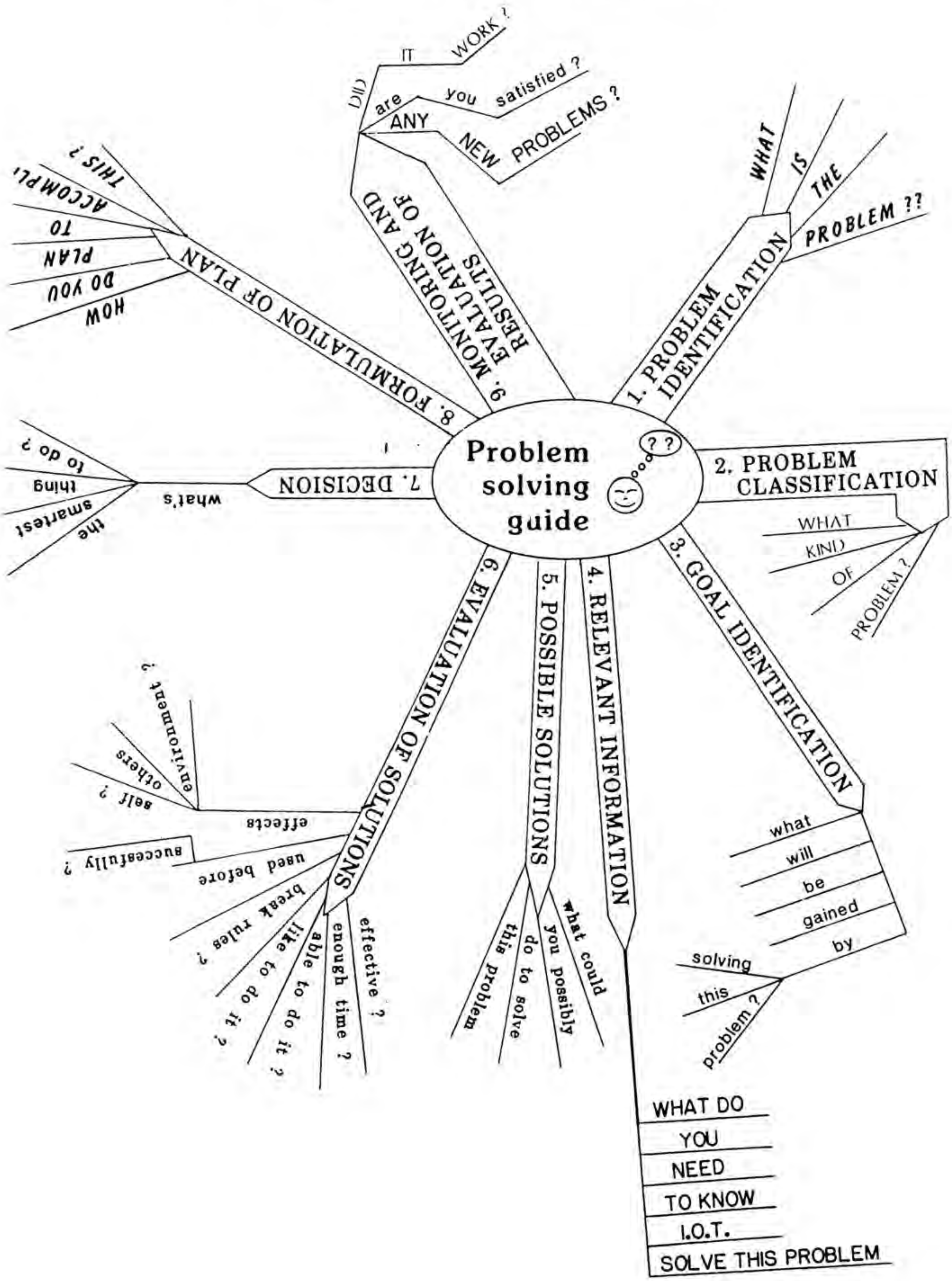
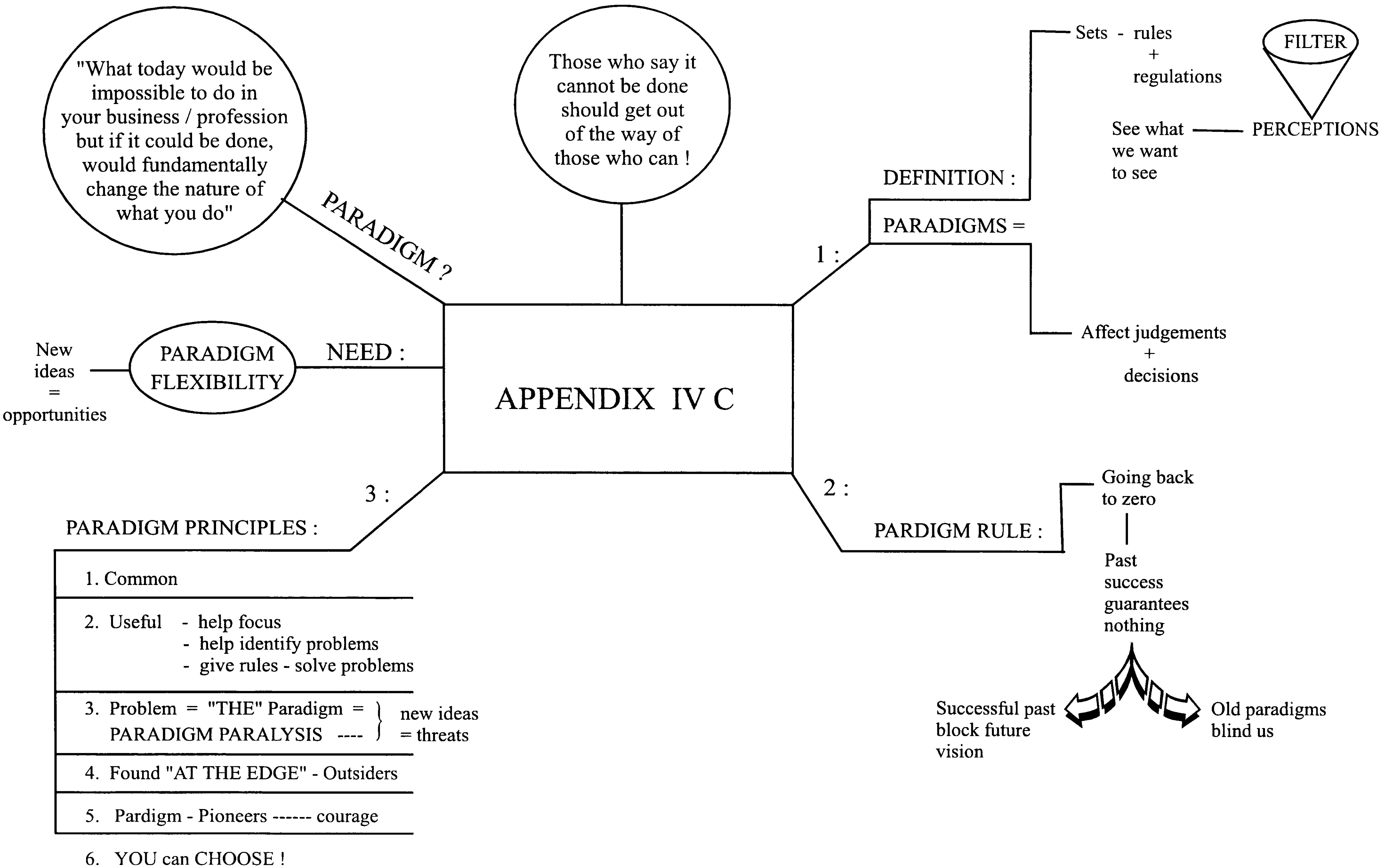
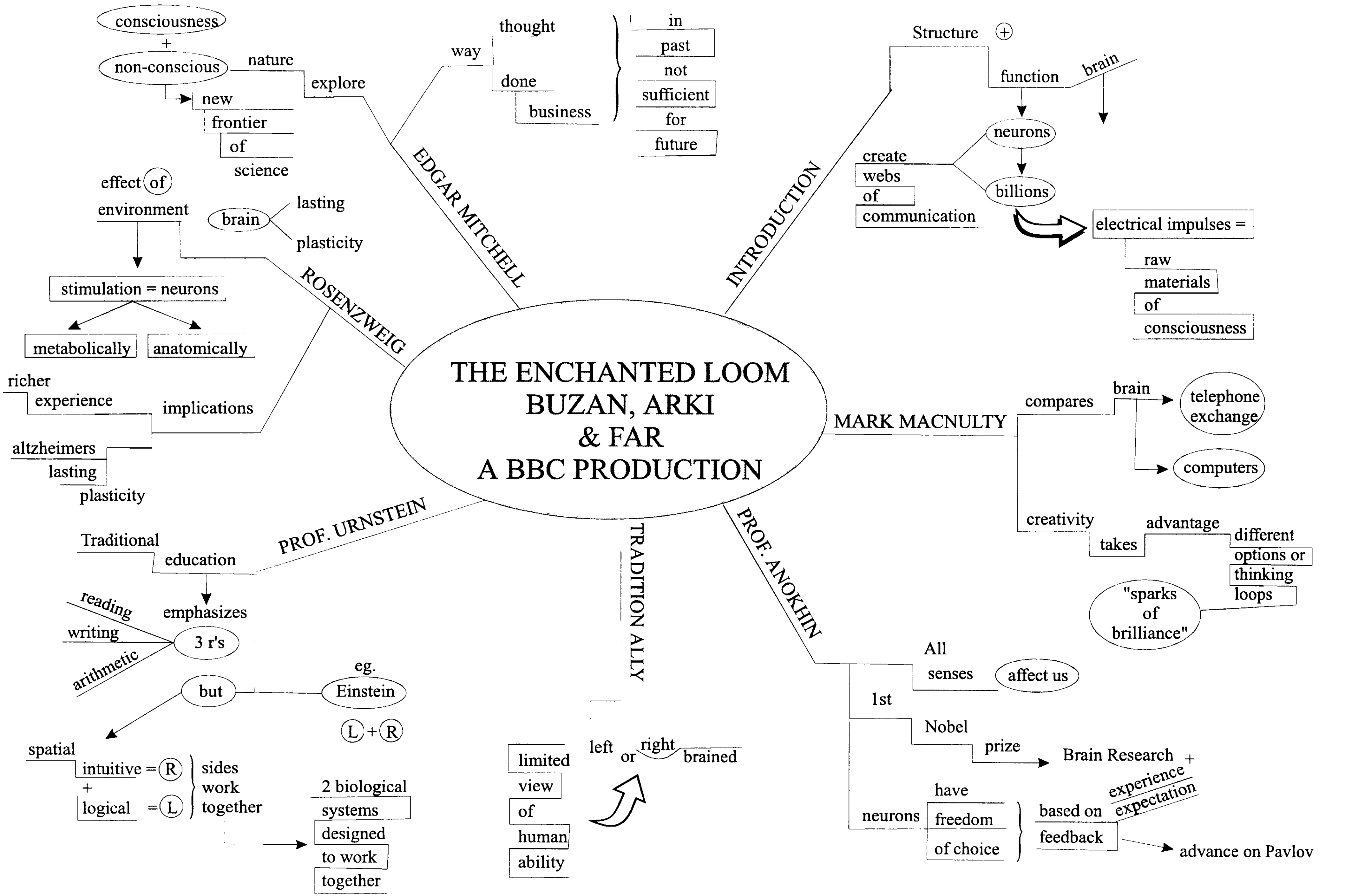

Judy's IDEA
1
STUDENT
reading
writing
difficult
MAP
pictures
STORY
2
TELL
student
-OR-
assistant
older
RECORD
3
STORY
MAP
4
PRACTICE
Reading
5
MAP
illustration
reminders
OVERVIEW
details
FILL

FIGURE 1 : Problem solving guide




APPENDIX IV C
"What today would be impossible to do in your business / profession but if it could be done, would fundamentally change the nature of what you do"
PARADIGM ?
Those who say it cannot be done should get out of the way of those who can !
1 :
DEFINITION :
PARADIGMS =
Sets - rules + regulations
FILTER
See what we want to see
PERCEPTIONS
Affect judgements + decisions
NEED :
PARADIGM FLEXIBILITY
New ideas = opportunities
2 :
PARDIGM RULE :
Going back to zero
Past success guarantees nothing
Successful past block future vision
Old paradigms blind us
3 :
PARADIGM PRINCIPLES :
1. Common
2. Useful - help focus
- help identify problems
- give rules - solve problems
3. Problem = "THE" Paradigm = new ideas
PARADIGM PARALYSIS ---- = threats
4. Found "AT THE EDGE" - Outsiders
5. Pardigm - Pioneers ------ courage
6. YOU can CHOOSE !


THE ENCHANTED LOOM
BUZAN, ARKI
& FAR
A BBC PRODUCTION
EDGAR MITCHELL
consciousness
+
non-conscious
nature
explore
new
frontier
of
science
way
thought
done
business
in
past
not
sufficient
for
future
INTRODUCTION
Structure ⊕
function
brain
neurons
billions
create
webs
of
communication
electrical impulses =
raw
materials
of
consciousness
ROSENZWEIG
effect of
environment
brain
lasting
plasticity
stimulation = neurons
metabolically
anatomically
richer
experience
implications
altzheimers
lasting
plasticity
MARK MACNULTY
compares
brain
telephone exchange
computers
creativity
takes
advantage
different
options or
thinking
loops
"sparks of brilliance"
PROF. URNSTEIN
Traditional
education
emphasizes
3 r's
reading
writing
arithmetic
but
eg.
Einstein
L + R
spatial
intuitive = R
+
logical = L
sides
work
together
2 biological
systems
designed
to work
together
TRADITION ALLY
limited
view
of
human
ability
left or right brained
PROF. ANOKHIN
All
senses
affect us
1st
Nobel
prize
Brain Research +
neurons
have
freedom
of choice
based on
experience
expectation
feedback
advance on Pavlov

APPENDIX IVD : MUSIC TAPE CATALOGUE

A General Relaxation and Imagery

Crystal Meditations	-	Don Campbell	________
Crystal Rainbows	-	Don Campbell	________

B Deep Relaxation

Eventide	-	Steven Halpern	________
Dawn	-	Steven Halpern	________
Spectrum Suite	-	Steven Halpern	________
Angelic Harp	-	Steven Halpern	________

C Awakening / Stimulation

Sun Singer	-	Paul Winter	________
Shadowdance	-	Shadow Fax	________

D Learning & Listening

Cosmic Classics	-	Don Campbell	________

E Baroque Music for Accelerated Learning & Relaxation

Music for Imaging	-	Lind Institute	________
Romantic Interlude	-	Lind Institute	________
Encore	-	Lind Institute	________
Relaxing with the Classics Vol I	-	Lind Institute	________
Relaxing with the Classics Voll II	-	Lind Institute	________
Largos & Adagios	-	Lind Institute	________
Andante	-	Lind Institute	________

F Music for Kinesthetic Imagery

Lightening on the Moon	-	Don Campbell	________
Symphony for the Inner Self	-	Don Campbell	________

APPENDIX IVE : READING LIST

ACCELERATED LEARNING	C. Rose, 1985 Accelerated Learning Systems
MAKE THE MOST OF YOUR MIND	T. Buzon, 1977 Cox & Wyman, Reading
THANK YOU BRAIN	S. Grove, 1990 Sigma Press, Pretoria
USE BOTH SIDES OF YOUR BRAIN	T. Buzon, 1989 Penguin
THE BRAIN BOOK	P. Russell, 1986 Routledge & Kegan, London
TEACHING AND LEARNING THROUGH THE MULTIPLE INTELLIGENCES	B. Campbell, L. Campbell & D. Dickinson New Horizons for Learning, Seattle
SUPER-TEACHING	E. Jensen, 1988 USA
THE MIND-MAPPING APPROACH (MMA) : A CULTURE AND LANGUAGE-FREE TECHNIQUE	C. Leaf, 1993 S.A. Journal of Communication Disorders

APPENDIX V :

DATA CORRELATION FORMS

YEAR	SCHOOL	TEACHER	STD	PUPILS	SUBJECTS														
					ENGLISH 1	AFR. 2	MATHS 3	BIOLOGY 4	SCIENCE 5	GEOG. 6	B.E. 7	ACC. 8	HISTORY 9	ENV. STUDIES 10	HEALTH 11				

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