A whole brain approach to teaching and learning in higher education

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ABSTRACT
Research on the human brain, and specifically on how we think and learn, has contributed to our understanding of the functioning of the brain. Insights gained from this research has, amongst others, led to the development of a metaphoric four quadrant whole brain model, by which human thinking style preferences can be described. The significance of this model and possible implications for teaching and learning in adult learner contexts have not been widely reported on. This article describes a research project in which the thinking preferences of a group of educators enrolled for the Diploma in Higher Education and Training Practice at the University of Pretoria were determined. The knowledge pertaining to the educators' preferred thinking styles was used as a point of departure to foster an awareness for the whole brain concept and the existence of diversity in thinking style preferences. This diversity poses challenges for all classroom practices.

INTRODUCTION
Programmes that focus on the development of higher education and training should reflect an educational approach that is appropriate for the participants and meaningful for the specific practice. In the new South Africa of the late 1990s, education and training are being transformed and reorganised with far reaching implications for all role players. In South Africa all policy documents on educational issues distinctly reflect that the learner and learning should be the point of focus (Olivier 1998). In the formal education of lecturers and trainers this aspect needs to be addressed in such a way that the students (educators-in-training) themselves are, on the one hand, the point of focus of the educational activities; on the other hand, the educators-in-training become aware that this focus should eventually be part of their own educational practices.

At the University of Pretoria a one-year part time programme, the Diploma in Higher Education and Training Practice, is presented with a view to enhancing the proficiency of educators who are engaged in higher education or post-school training. Students who enroll for the programme have not received formal training as educators in the field of adult learning. Anyone who has successfully completed three years of formal post-school education in his/her own field of specialisation may enroll for the course. The curriculum of the diploma focuses, inter alia, on issues regarding facilitating learning, learning theory, educational media, student orientation and teaching practices. In the student orientation and teaching practice components of the course, one of the aims is to sensitise students for and enhance their knowledge of the existence of the diversity in individuals' preferred thinking styles, as these give rise to preferred teaching and learning styles. This article reflects on promoting a whole brain approach to teaching and learning as the authors firmly believe that it provides for diversity regarding the participants in teaching and learning.

In 1999 a total of 17 students enrolled for the Diploma in Higher Education and Training Practice. They are tertiary educators or post-school trainers from different fields of specialisation, such as computer science, the medical field, mathematics, information technology, theology, business and military science. They are employed in a variety of institutions, namely universities, technical colleges and human resource development in corporate organisations.

The thinking style preferences of the educators were determined by means of the Herrmann Brain Dominance Instrument (HBDI). The knowledge regarding the educators' preferred thinking modes gained in this manner was used as point of departure for the activities of the student orientation and teaching practice components of the programme. Students are also introduced to a whole array of literature on learning styles and strategies and cognitive models as they form an integral part of the programme. Students are challenged to construct their own meaning on the principles of learning style differentiation in their practices. They are also encouraged to implement the principles in their practices.
The purpose of this article is not to critically compare different learning style theories/models. Different viewpoints are used to help students design innovative learning opportunities. The research outcome serves as an exemplar to students of how to cater for learning style diversity.

THE HERRMANN FOUR QUADRANT WHOLE BRAIN MODEL

Research done by MacLean, who proposed the triune brain theory, and Sperry’s left-brain right-brain model (Herrmann 1995; Ornstein 1997) gave impetus to the development of Herrmann’s whole brain model. This research eventually brought to light the specialised functions listed in Table 1 which are associated with the left and right hemisphere. The left hemisphere is logic, analytical, quantitative, rational and verbal, whereas the right hemisphere is conceptual, holistic, intuitive, imaginative and non-verbal.

Table 1

<table>
<thead>
<tr>
<th>Left hemisphere</th>
<th>Right hemisphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech / verbal</td>
<td>Spatial / music</td>
</tr>
<tr>
<td>Logical, mathematical</td>
<td>Holistic</td>
</tr>
<tr>
<td>Linear, detailed</td>
<td>Artistic, symbolic</td>
</tr>
<tr>
<td>Sequential</td>
<td>Simultaneous</td>
</tr>
<tr>
<td>Controlled</td>
<td>Emotional</td>
</tr>
<tr>
<td>Intellectual</td>
<td>Intuitive, creative</td>
</tr>
<tr>
<td>Dominant</td>
<td>Minor (quiet)</td>
</tr>
<tr>
<td>Wordly</td>
<td>Spiritual</td>
</tr>
<tr>
<td>Active</td>
<td>Receptive</td>
</tr>
<tr>
<td>Analytic</td>
<td>Synthetic, gestalt</td>
</tr>
<tr>
<td>Reading, writing, naming</td>
<td>Facial recognition</td>
</tr>
<tr>
<td>Sequential ordering</td>
<td>Simultaneous comprehension</td>
</tr>
<tr>
<td>Perception of significant order</td>
<td>Perception of abstract patterns</td>
</tr>
<tr>
<td>Complex motor sequences</td>
<td>Recognition of complex figures</td>
</tr>
</tbody>
</table>

Herrmann (1996:42) points out, that although each hemisphere is specialised in a different way, physical connections secure integrated brain activity. According to Gazzaniga (1998:35) ongoing research has reaffirmed that “the two hemispheres control vastly different aspects of thought and action. Each half has its own specialisation and thus its own limitations and advantages”.

The four quadrants of the Herrmann model in Figure 1 represent the four thinking structures of the brain. The left and right hemispheres represent cerebral processes and the two halves of the limbic system represent the more visceral (feeling-based) processes. Each quarter has very distinct clusters of cognitive functions. According to Herrmann (1995, 1996 & 1998) preference for the A-quadrant (left cerebral mode) means that a person favours activities that involve logical, analytical and fact-based information. A preference for the B-quadrant (processes of the left limbic mode) implies a linear approach to activities. Individuals with a B-quadrant preference favour organized, sequential, planned and detailed information. They are conservative in their actions and like to keep things as they are. A preference for the C-quadrant (processes of the right limbic mode) indicates favouring information that is interpersonal, feeling-based and involves emotion. A preference for the D-quadrant (processes of the right cerebral mode) is mainly characterised by a holistic and conceptual approach in thinking. Although an individual may favour cognitive activities associated with a specific quadrant, “both hemispheres contribute to everything, but contribute differently” (Ornstein 1997:94).
cerebral mode is the more cognitive, intellectual part of man’s thinking processes and the limbic mode is the more structured, visceral and emotional part (Herrmann 1995). These specialised mental modes function together situationally and interactively making up a whole brain in which one or more parts become naturally dominant. The dominance between the paired structures oft he brain provides the basis for measuring the level of dominance. The Herrmann Brain Dominance Instrument (HBDI) is an assessment tool that quantifies the degree of a person’s preference for specific thinking modes.

THE HERRMANN BRAIN DOMINANCE INSTRUMENT

The HBDI is based on 20 years of extensive research on brain dominance and comprises a questionnaire consisting of 120 questions to be completed by an individual.

A thinking preference profile, resulting from the implementation of the HBDI, is displayed on a four-quadrant grid. Examples of thinking preference profiles are given in Figures 3 and 4. The score for each quadrant can range from under 10 to over 150. The higher the score in a quadrant, the stronger the preference for thinking in that quadrant. A preference code is determined by the magnitude of preference in each quadrant. The quadrant scores and preference codes are defined as follows:

- The preference code “1” or “primary” is indicated by a score of 67 or above. A score of 67–100 indicates a strong preference for thinking in that quadrant. A score of above 100 indicates a very strong preference.
- The preference code “2” or “secondary” is indicated by a score of 34–66. This indicates a secondary or intermediate preference representing thinking modes that are comfortable for the individual and available as necessary.
- The preference code “3” or “tertiary” is indicated by a score of less than 34. A tertiary or low preference indicates a lack of interest or even avoidance of that mode of thinking.

A validity study on the HBDI (Bunderson 1995) has indicated that the instrument provides a valid and reliable measure of human mental preferences when applied in a professional way, interpreted in conformity with the four quadrant model and scored with the approved scoring method. Since June 1999, more than one million HBDI profiles have been done world-wide (Herrmann-Nedhi 1999a). A database of profiles is kept at the headquarters of Herrmann International in the USA. Although the HBDI was originally developed for adult users in a corporate environment, it has been used successfully with tertiary students (Lumsdaine & Lumsdaine 1995b; Felder 1996; Herrmann 1996; Shelnutt, Middleton, Buch & Lumsdaine 1996; De Boer & Steyn 1999).

According to Herrmann-Nedhi (1999b) research is being done to adapt the instrument specifically for use with tertiary as well as middle school students.

WHOLE BRAIN TEACHING AND LEARNING AND OTHER COGNITIVE MODELS

It has been documented (Knowles 1990; Buzan 1991; Jensen 1996; Ornstein 1997) that effective learning takes place if the whole brain is involved in learning. Interpreted in terms of Herrmann’s model, this presupposes that all four brain quadrants are included in teaching and learning activities.

Complementary to Herrmann’s model Lumsdaine and Lumsdaine (1995b) identify the following four modes of (tertiary) students’ learning:

- External learning is related to teaching from authority through lectures and text books. It is predominantly A-quadrant learning.
- Internal learning can be described as an insight, a visualisation, the synthesis of data or through the understanding of concepts holistically or intuitively. This is predominantly D-quadrant learning.
- Interactive learning is brought about by discussion, hands-on activities and sensory-based experiments where a student can try, fail, retry with an opportunity for verbal feedback and encouragement. Interactive learning is predominantly C-quadrant learning.
- Procedural learning is characterised by a methodical step-by-step testing of what is being taught, as well as practice and repetition to improve skills and competence. It is predominantly B-quadrant learning.

Cognitive functions are accommodated when teaching activities are constructed to comply with a learner’s preferred mode of thinking/learning (Steyn 1998). Steyn (1998) points out that cognitive functions are utilised when learning activities are constructed in such a way that the cognitive functions associated with all four quadrants of the Herrmann model are used. However, it should be borne in mind that teaching and learning are done within the context of the complexity as illustrated in the Herrmann extended model for teaching and learning (Figure 2).

In Figure 2 the learner/lecturer is represented in the centre as whole brained and within the broader cultural and social environment. The arrows in Figure 2 indicate the iterative nature of the activities as they correlate with the physiology of the interconnected brain. The left (structured) mode is categorised by processing dealing with logical, rational, critical, quantitative issues and activities. The procedural,
planned, sequential and organised elements of the learning/teaching activities are found in the structured left mode. The learning/teaching activities of the left mode are depicted in the cultural and social environment by achievements, fact-based knowledge and traditional ways. The experiential right mode is categorised by processing dealing with visual, conceptual, emotional and interpersonal activities. In the cultural and social environment the learning/teaching activities of the right mode can be described as participative and future orientated. The inclusion of all these modes in learning/teaching activities comprises a full range of activities.

In a study by Trigwell, Prosser and Waterhouse (1999) it was shown that qualitatively different approaches to teaching are associated with qualitatively different approaches to student learning. In their study they considered an information transmission/teacher-focused approach in comparison with a conceptual change/student-focused approach. This is also complementary to Herrmann’s model.

Viewed in terms of a whole brain approach to teaching and learning, the information transmission/teacher-focused approach represents an approach focusing only on cognitive modes associated with the A and B-quadrants in Herrmann’s model. However, the conceptual change/student-focused approach also includes cognitive modes associated with the C and D-quadrants of the Herrmann model.

According to Herrmann (1996) the model in Figure 2 serves as a strategy tool to design and deliver teaching and learning activities. Educational activities that implement all the modes of Herrmann’s model will ensure that learners’ preferred thinking styles are accommodated and less preferred thinking modes are utilised as well. An application of Herrmann’s extended model in teaching necessitates that educators become aware of their own thinking preferences and the implications thereof for their teaching practices.

The authors find themselves in agreement with Felder (1996:18) and find his observations fully applicable.
to the whole brain approach: "If professors teach exclusively in a manner that favours their students' less preferred learning style modes, the students' discomfort level may be great enough to interfere with their learning. On the other hand, if professors teach exclusively in their students' preferred modes, the students may not develop the mental dexterity they need to reach their potential for achievement in school and as professionals."

AIM OF THE RESEARCH PROJECT

The aim of the research project was to:

- give the educators of adult learners insight into their own thinking preferences;
- determine a possible diversity/homogeneity of preferred thinking styles of the group of educators;
- determine the distribution of thinking style preferences of the group, and
- introduce the concepts "whole brain teaching" and "whole brain learning" and the implications thereof for all educational activities.

METHOD

The project involved the 17 educators enrolled for the Diploma in Tertiary Instruction in 1999. The educators were introduced to the whole brain concept and they were given information pertaining to the Herrmann Brain Dominance Instrument (HBDI). It was emphasized that the instrument was not a test and that it does not measure cognitive abilities. An electronic version of the HBDI form was used and the students completed it on-line in the Gold Fields Computer Centre for Education at the University of Pretoria. The individual profiles were scored at the headquarters of Herrmann International, Lake Lure, USA and the reports were compiled locally. The students received a printout of their individual profiles representing their thinking style preferences as well as documentation enabling them to interpret profiles generated through the HBDI.

INTERPRETATION OF THE HBDI

It must be borne in mind that the HBDI does not test competencies but gives an indication of preferences and potential competencies. Herrmann (1995:76) points out that "profiles are neither good nor bad, right or wrong. The instrument measures preferences for a mental activity, which is entirely different from competence in performing it."

Examples of individual student's thinking preference profiles

The profiles in Figure 3 are those of four of the 17 educators who participated in the project. These profiles are examples to illustrate the tilt in a profile when a strong preference for the thinking mode associated with a specific quadrant is dominant.

Individual profile showing an A-quadrant thinking preference

The profile in Figure 3A (with preference code 1221) displays a strong preference for the thinking modes of the A-quadrant as well as an overall tilt towards the thinking preferences associated with cerebral functions. This profile indicates a strong preference for the analytical, rational and logical processes of the upper left A-quadrant, and a preference for the integrated, synthesizing, creative and holistic aspects of the upper right D-quadrant. The profile indicates a lesser preference for the controlled, structured and organised thinking modes associated with the lower left B-quadrant, and a low preference for the kinaesthetic thinking modes associated with the lower right C-quadrant.

Figure 3

Profiles showing the preference for a specific mode of thinking
Individual profile showing a B-quadrant thinking preference

The profile in Figure 3B (with preference code 2112) displays a strong preference for the thinking modes associated with the B-quadrant as well as an overall tilt towards the thinking preferences in the limbic mode. This implies a strong preference for the controlled, structured, and organised thinking modes associated with the lower left B-quadrant as well as for the interpersonal, feeling-based thinking modes of the lower right C-quadrant. The profile also shows a low preference for the analytical, rational and logical processes of the upper left A-quadrant as well as for the holistic thinking modes associated with the upper right D-quadrant.

Individual profile showing a C-quadrant thinking preference

The profile in Figure 3C (with preference code 2211) displays a strong preference for the thinking modes associated with the C-quadrant as well as an overall tilt towards the thinking styles in the right mode. This implies a strong preference for the interpersonal, feeling-based, emotional and spiritual thinking modes of the lower right C-quadrant, and also a strong preference for the holistic, imaginative, and conceptual thinking styles associated with the upper right D-quadrant. In this profile there is a low preference for the thinking modes associated with the lower left B-quadrant and a very low preference for the analytical, logical and rational thinking modes of the upper left A-quadrant. Overall, this profile indicates that the individual has a low preference for the thinking modes associated with the left brain hemisphere.

Individual profile showing a D-quadrant thinking preference

The profile in Figure 3D (with preference code 3211) displays a very strong preference for the thinking modes associated with the D-quadrant as well as an overall tilt towards the thinking preferences of the right brain hemisphere. In this case, the preferred thinking styles are characterised by the creative, holistic, and synthesising modes of the upper right D-quadrant in combination with the interpersonal, emotional, and spiritual processes of the lower right C-quadrant. This profile also indicates a low preference for the thinking modes associated with the left brain hemisphere and a very low preference for the thinking modes associated with the A-quadrant.

Diversity in thinking style preferences

The examples of the profiles displayed in Figure 3 are an indication of the diversity in the thinking style preferences of the educators in this group.

If the profiles of all 17 educators are superimposed, the composite profile indicates preferred modes of thinking in all four quadrants. The composite profile for this group is displayed in Figure 4A. It should be noted that although the composite group profile in Figure 4A is for a relatively small sample of individuals, it displays a composite whole of the diverse individual profiles representing thinking preferences in all four quadrants. This is in accordance with research findings pertaining to Herrmann’s model as pointed out by Knowles (1990:245) that ‘people are equally distributed throughout the teaching and

Figure 4

Distribution of thinking style preferences

Figure 4A
A composite profile of all the educators showing thinking preferences in all four quadrants

Figure 4B
Dominance map showing the distribution of the profiles of the educators

Figure 4C
Average profile of the educators
learning model in terms of their mental preferences”. Herrmann (1996:47) affirms that “the composite of individual profiles represents a highly diverse, but well balanced, distribution across the four quadrants of the whole brain model”. This is true for different groups of people in all parts of the world.

**Distribution of thinking style preferences**

The diagram in Figure 4B shows the distribution of the individual profiles for all 17 educators. The diagram clearly indicates a tilt in the distribution of profiles towards the lower right C-quadrant implying a preference for the interpersonal, feeling-based, kinesthetic and emotional thinking modes associated with the C-quadrant. The figures in Table 2 indicate that 76% of the educators have a strong preference and 12% have a very strong preference for the C-quadrant thinking modes. Furthermore, 47% of the educators have a strong preference and 35% have a very strong preference for the D-quadrant thinking modes.

The diagram in Figure 4B and the results in Table 2 also indicate that the group as a whole has a lesser preference for thinking modes associated with the A and B-quadrants. As many as 24% of the group have a very low preference for the A-quadrant thinking modes whilst only 8% have a very strong preference for the A and B-quadrant thinking modes.

*Table 2*

**Percentage of students with measured thinking preferences in different quadrants**

<table>
<thead>
<tr>
<th>In quadrant</th>
<th>Very low</th>
<th>Inter-mediate</th>
<th>Strong</th>
<th>Very strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24%</td>
<td>47%</td>
<td>24%</td>
<td>6%</td>
</tr>
<tr>
<td>B</td>
<td>None</td>
<td>41%</td>
<td>53%</td>
<td>6%</td>
</tr>
<tr>
<td>C</td>
<td>None</td>
<td>12%</td>
<td>76%</td>
<td>12%</td>
</tr>
<tr>
<td>D</td>
<td>None</td>
<td>18%</td>
<td>47%</td>
<td>35%</td>
</tr>
</tbody>
</table>

The profile in Figure 4C (with preference code 2111) is that of the group average of the educators. This profile shows a distinct tilt towards a preference for the thinking modes of the right hemisphere. On average, the dominant thinking preferences for this group of educators are for thinking modes associated with the upper right D-quadrant, followed by a preference for the thinking modes of the lower right C-quadrant, followed by a lesser preference for the thinking modes of the lower right B-quadrant and a (very) low preference for the thinking modes associated with the A-quadrant.

It is noteworthy that the average profile displayed in Figure 4C is typical of educators and trainers involved in adult education (Herrmann-Nedhi 1999a).

**WHOLE BRAIN DESIGN AND DELIVERY APPROACHES COMPLEMENTARY TO AN OUTCOMES-BASED APPROACH**

One of the twelve critical outcomes stated for all learning programmes offered in South Africa, has as focus the ability of learners to reflect on and use a variety of strategies to learn more effectively (Van der Horst & McDonald 1997:50). Complementary to this outcome the role of mediating learning as one of seven roles for all educators (South Africa 2000:15) implies that all educators be competent in “adjusting teaching strategies to cater for different learning styles and preferences”.

All lecturers and trainers, therefore, have to take their learners’ learning preferences into account when designing learning opportunities. Figure 5 shows the differences in the expectations of learners with preferences for a specific quadrant of the Herrmann model. A variation in design and delivery approaches would facilitate learning in all four the specialised quadrants. Structuring educational activities to incorporate the expectations of learners in all four quadrants would facilitate the development of the full potential of a learner. This will accommodate learners’ thinking preferences and areas of lesser preference and avoidance are activated. For example, if the learning content contains facts-based data and research results in a logical order, a learner with a thinking preference for the A-quadrant will feel comfortable if the content is presented in a lecture-type instruction. For a learner with a thinking preference for the C-quadrant, facilitation of learning pertaining to data and research results should be constructed to include group discussion and personal involvement.

Saroyan and Snell (1997) characterise lectures as content-driven, context-driven and pedagogy-driven. Ratings in their study indicate that the more pedagogical orientated lectures were better perceived by the students. Viewed in terms of the Herrmann model, any lecture-type of instruction focuses mainly on the cognitive modes in the A-quadrant. In Saroyan and Snell’s more pedagogical orientated lectures it seems as if the inclusion of cognitive modes from the other quadrants made it more whole brained in approach which may have contributed to it being better perceived by students.

Knowles (1990:241) remarks that “the assumptions about the learner must now be completely reconsidered. Intelligence is no longer one-dimensional, but rather includes the notion of multiple intelligences. Each individual is now being thought of as
Figure 5
Expectations of learners with thinking preferences in the four quadrants

The learner with an A-quadrant thinking preference expects:
- Precise, to the point, information
- Theory and logical rationales
- Proof of validity
- Research references
- Textbook readings
- Numbers, data

The learner with a B-quadrant thinking preference expects:
- Organised, consistent approach
- Staying on track, on time
- Complete subject chunks
- A beginning, middle & end
- Practice and evaluation
- Practical applications
- Examples
- Clear instructions/ expectations

The learner with a C-quadrant thinking preference expects:
- Group discussion
- Sharing, expressing ideas
- Kinesthetic, moving around
- Hands-on learning
- Personal connection
- Emotional involvement
- User-friendly learning
- Use of all senses

The learner with a D-quadrant thinking preference expects:
- Fun and spontaneity
- Playful approaches
- Pictures, metaphors, overviews
- Discovering and exploration
- Quick pace and variety in format
- Opportunity to experiment

with learning preferences and avoidances different from other learners.” According to Knowles (1990) the concept of whole brain teaching and learning provides the basis for bridging the gap between the unique individual learner and the design and delivery of the learning.

The restructuring of education and training in South Africa has as a core principle an “outcomes-based” approach. Olivier (1998:21) points out that the “outcomes-based learning approach intends to focus equally on knowledge, skills, the process of learning and the final outcome/result/product”. According to Olivier (1998) certain processes are identifiable as appropriate for learners to achieve the outcomes. In Table 3 these processes are interpreted and categorised according to those quadrants of the Herrmann model that predominantly represent the specific process. Combining the expectations of learners with thinking preferences in all four quadrants (as in Figure 5) with the data in Table 3, indicates that an outcomes-based approach and a whole brain approach to learning and teaching are complementary with regard to educational activities.

**FINDINGS AND CONCLUSIONS**

This project revealed a diversity of thinking style preferences among the individual educators in the group. Although the group size was relatively small, this finding is in accordance with research that “every classroom represents a complete spectrum of learning style preferences” (Herrmann 1996:151).

**Table 3**
Processes for an outcomes-based approach associated with a whole brain approach

<table>
<thead>
<tr>
<th>Process necessary to achieve outcomes</th>
<th>Associated quadrants in the Herrmann model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical thinking</td>
<td>A, B, C &amp; D</td>
</tr>
<tr>
<td>Problem solving</td>
<td>A, B, C &amp; D</td>
</tr>
<tr>
<td>Application</td>
<td>B</td>
</tr>
<tr>
<td>Appreciation</td>
<td>A, B, C &amp; D</td>
</tr>
<tr>
<td>Analysing</td>
<td>A</td>
</tr>
<tr>
<td>Synthesising</td>
<td>D</td>
</tr>
<tr>
<td>Evaluation of information</td>
<td>A, B, C &amp; D</td>
</tr>
<tr>
<td>Teamwork</td>
<td>C</td>
</tr>
<tr>
<td>Communication</td>
<td>A, B, C &amp; D</td>
</tr>
<tr>
<td>Socialising</td>
<td>C</td>
</tr>
</tbody>
</table>

The educators became aware of the fact that, for a group of learners, there is a composite array of learning style preferences distributed across the whole brain model. They also learned that there is an equal distribution of learning avoidances (non-preferred thinking modes) across the four quadrants and that “learning avoidances are even more significant than learning preferences because they turn people off – a turned-off learner is a waste of educational time and effort” (Herrmann 1996:152).
It is, therefore, imperative for an educator to be aware of his/her own thinking style preferences and the implication thereof for his/her teaching style preference and, on the other hand, to be aware of the diversity of thinking (learning) style preferences of learners. In order to develop one's full potential, educators and learners alike should develop whole brain cognitive skills. A whole brain approach (implying promoting and utilising the cognitive modes in all four quadrants of the whole brain model) will develop a learner's full potential and should form the basis of all teaching practice.

For the educators-in-training, as well as the lecturers involved in this project, it became apparent that traditional approaches to educational design and delivery could fail short of desired results when dealing with a composite group of learners with thinking style preferences distributed across all four quadrants of the whole brain model. Teaching activities should ideally be designed to move back and forth dynamically in its delivery of each key learning point to distribute learning equally across all four quadrants of the whole brain model. Experiences during 1998 and 1999 with tertiary educators-in-training have indicated that the four quadrant whole brain concept is a valuable principle to use as a guideline for designing and structuring (tertiary/post-school) education. These experiences affirm that "the whole brain concept, once understood, becomes irresistible" (Herrmann 1998).

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