

**Two teachers are better than one: collaborative teaching as an approach to promote
whole brain learning**

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Authors' Statement

This article is the authors' own original work and has not been published or submitted for publication in any other journal. The order in which the authors are listed reflects their relative contribution to the article.

Abstract

Research on the thinking and learning processes of the brain has, amongst others, led to the development of a metaphoric four-quadrant whole brain model, used to determine and describe the thinking style and associated learning style preferences of humans. A challenge identified in classroom practices is that for effective learning, the diversity of learning styles of students should be accommodated by a single lecturer's teaching methods. In theory, two criteria specific lecturers, who teach jointly in a team and alternate their teaching, while

following a teaching style that reflects their own thinking preferences could be used as an approach to address this challenge. This could result in a better understanding of teaching content, higher energy levels in the classroom, higher student engagement and other indications of the promotion of whole brain learning. This article describes a case study of 288 third year accounting students at a South African University, examining the practical application of the theory identified. The results of this article seems to indicate that a collaborative teaching approach can be effective in meeting the diverse learning styles of students, promoting whole brain learning, although the initial adjustment from a single lecturer to two lecturers can be distracting for the students. These results may lead to new insight regarding the advantages and disadvantages of using collaborative teaching to promote whole brain learning.

Keywords: Collaborative teaching, whole brain learning, thinking preferences, learning styles.

Introduction

John Heywood famously stated, “Two heads are better than one”, but how effective can this quotation be transferred to the taxation education environment? The collaboration of different thinking preferences of individuals, as described in the Herrmann Whole Brain Model (Herrmann, 1995, 1996, 1998), may support John Heywood’s famous quote.

Herrmann (1995, 1996, 1998) describes the human brain in terms of a four-quadrant model, with the four quadrants distinguishing between the different thinking preferences of an individual. Contributing to this body of knowledge, Herrmann further identified learning styles associated with each quadrant of the model. This research largely contributed in

identifying the need for lecturers to teach differently in order to accommodate the various learning styles of students. Herrmann (1995) refers to this as whole brain teaching.

According to Bawaneh, Zain and Saleh (2009), a limitation in the practical application of whole brain teaching is the difficulty for a lecturer to adopt a teaching style different to his/her own preferred teaching style, with the result that not all the learning styles of students are accommodated. A reason for this difficulty can be found in Herrmann's research.

In terms of Herrmann (1989) the preferred teaching style of a lecturer directly relates to that lecturers' thinking preference. Therefore, for a lecturer to accommodate all the learning styles of students, the lecturer would have to adopt a teaching style that reflects all the thinking preferences.

In theory, if two lecturers who together represent the necessary teaching styles to address all the learning styles described by Herrmann, teach jointly in a team and alternate their teaching while following their preferred teaching style, the limitation identified could be addressed, resulting in a better understanding of teaching content by students, higher energy levels in the classroom, higher student engagement and other indications of the promotion of whole brain learning.

To examine the practical application of this theory, the results of a case study of two lecturers, who together represent a fairly equal distribution of the thinking preferences as described by Herrmann, using a collaborative teaching approach on a group of 288 third year accounting students at a South African University is reported on in this article. This was done to address the research question: Can two lecturers, who teach jointly in a team and alternate their teaching, while following a teaching style that reflects their own thinking preferences, be incorporated as an approach to promote whole brain learning amongst students in a third year taxation curriculum?

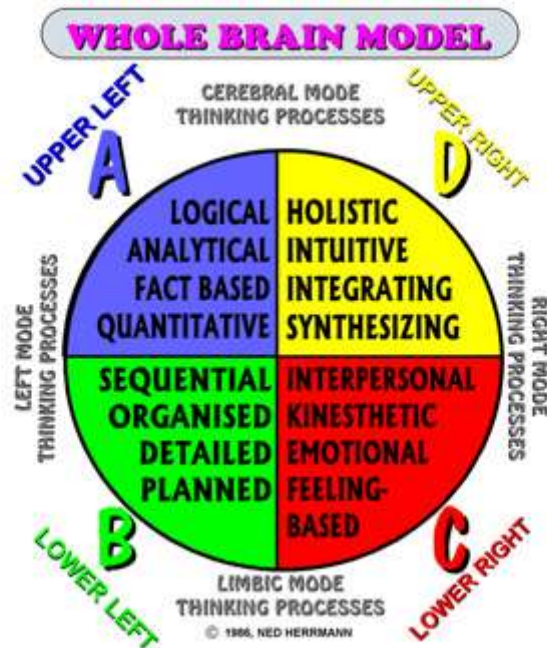
As an aspect of academic importance, the research reported offers new insight for lecturers into the possibility and outcome of a practical approach to whole brain teaching, being collaborative teaching, which could contribute to the optimisation of teaching and learning at a higher education level.

As a starting point to the theory on which the case study is based, the research conducted by Ned Herrmann in developing the Herrmann Four Quadrant Whole Brain Model and the thinking and learning preferences associated with each of the quadrant of this model is discussed.

The Herrmann Four Quadrant Whole Brain Model and Associated Learning Styles

The Nobel Prize winning research conducted by Sperry in developing the “Split Brain Theory” and the identification of the brain’s three sub-entities by MacLean in developing the “Triune Brain Theory” merged in the development of the Herrmann Four Quadrant Whole Brain Model (Herrmann, 1995; Ornstein, 1997). The four quadrants of this model represent cognitive predilections, resulting in different thinking preferences among individuals (Herrmann, 1995).

Figure 1 Illustration of Herrmann's Brain Model (Herrmann, 1998)



As illustrated in Figure 1, a diversity of thinking preferences is described within the different dominant quadrants of Herrmann's Brain Model. Based on these thinking preferences a student develops a preferred manner of learning, referred to as the students' learning style.

Figure 2 Learning styles based on thinking preferences (Herrmann, 1998)

<p>A</p> <p>Learns By:</p> <ul style="list-style-type: none"> ◆ Acquiring & Quantifying facts ◆ Analysis & Logic ◆ Thinking Through Ideas ◆ Building Cases ◆ Forming Theories 	<p>Learns By</p> <p>D</p> <ul style="list-style-type: none"> ◆ Taking Initiative ◆ Exploring hidden possibilities ◆ Relying on Intuition ◆ Constructing Concepts ◆ Sythesizing Content
<p>Learns By:</p> <ul style="list-style-type: none"> ◆ Organizing & Structuring content ◆ Evaluating & testing theories ◆ Practice ◆ Implementing content <p>B</p>	<p>Learns By:</p> <ul style="list-style-type: none"> ◆ Listening & Sharing ideas ◆ Integrating experiences w/self ◆ Moving & Feeling ◆ Emotional Involvement ◆ Harmonizing w/content <p>C</p>

When a lecturer facilitates learning in a manner that addresses all the learning styles presented by the four quadrants of the model (refer to Figure 2), such a lecturer facilitates whole brain learning. Each of the four quadrants is therefore involved in learning, resulting in a better understanding of content, higher energy levels in the classroom, an overall increase of learner engagement and numerous other indications of effective learning (Buzan, 1991; Jensen, 1996; Knowles, 1990; Ornstein, 1997).

If a lecturer were to accommodate the learning styles of their students, it stands to reason that the lecturer should have knowledge of those students' learning styles, associated with their thinking preferences. It is also suggested that lecturers should have knowledge of their own thinking preferences and the implications thereof for their teaching practices. These thinking preferences are measured using the Herrmann Brain Dominance Instrument (HBDI), a valid and reliable instrument for measuring human thinking preference (Bunderson, 1995), that provides an individual with a thinking preference profile (refer to Figure 3 and 4).

The thinking preference profiles results could be used to determine the need for change in teaching styles by lecturers.

Changing Teaching Styles

“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.” (Felder, 1996)

Based on the research of Herrmann, two factors could be used to determine the need for change in teaching style of a lecturer. Firstly the learning style preference of the students

and secondly, the thinking preference of that lecturer. Concerning the learning style preference of students:

“Every classroom represents a complete spectrum of learning style preference”
(Herrmann 1996:151)

Research conducted at the University of Pretoria agrees with this statement and found that irrespective of the module in which a group of students specialise, that group of students represent an equal distribution of thinking preferences (De Boer; Steyn & du Toit, 2001). A lecturer could therefore make a fair assumption that, for the optimisation of his/her teaching practice, a teaching style should be adopted that accommodates all the possible learning styles associated with the thinking preferences described by Herrmann (refer to Figure 2). The adoption of such a teaching style poses certain obstacles.

Although through extensive planning and practice a lecturer could adjust their teaching style, there exist a direct relationship between the thinking preferences of a lecturer and the preferred teaching style of that lecturer (Herrmann, 1989) , meaning that lecturers prefer to teach content in the manner that they think about that content.

Trigwell, Prosser, and Waterhouse (1999), in their investigation of approaches to teaching, propose that there are two broad approaches to teaching. The first approach is an information transmission-/lecturer-focused approach. This approach is mainly preferred by lecturers with a preference to the A- and B-Quadrant of thinking. The second approach is a conceptual change/student-focused approach. This approach is mainly preferred by lecturers with a preference to the C- and D-Quadrant of thinking (de Boer & Bothma, 2003). Therefore, an obstacle for lecturers in accommodating all the learning styles of their students is to adjust their preferred teaching style to a teaching style that does not only reflect their own thinking preferences, but rather all the thinking preferences as described by Herrmann.

Although the need for a change in teaching style seems evident, the practical ability of lecturers to change their teaching styles remains a challenge. Most lecturers do not have the necessary teaching style to accommodate the learning styles of their students and need to be trained to adjust their current teaching style, do extensive lecture planning to implement this adjusted teaching style and practice this adjusted teaching style over an extended period of time (Hyman & Rosoff, 1984).

To reduce the challenges of adjusting lecturers' teaching styles the researchers propose a collaborative teaching approach to promote whole brain learning.

The Collaborative Teaching Approach

Collaborative teaching is an educational approach where lecturers work in a coactive and coordinated fashion to jointly teach academically (Gerber & Popp, 2000). "Two or more professionals jointly deliver substantive instruction to a diverse, or blended, group of students in a single physical space." (Cook & Friend, 1995:1)

For the purposes of using the collaborative teaching approach to promote whole brain learning the two or more professionals, as mentioned by Cook and Friend, needs to, together, accommodate all the learning styles of the group of students. Based on Herrmann's research, the preferred teaching style of each lecturer is directly related to the thinking preference of that lecturer. The preferred teaching style of a lecturer is, therefore, likely to be most accommodating to a student with a learning style associated with the thinking preference of that lecturer, i.e. a lecturer with a preference to the A and B quadrants' preferred teaching style would be most accommodating to a student with a learning style associated with the A and B quadrants. To address all the learning styles of the group of students, a combination of lecturers' thinking preference, that represents an equal distribution of the four quadrants,

could, therefore, in theory accommodate all the students' learning styles associated with those thinking preferences, resulting in whole brain learning.

To examine the practical application of this theory the researchers conducted a case study on a group of accounting students.

Research Strategy

“The case study is a research strategy which focuses on understanding the dynamics present within a single settings.” (Eisenhardt, 1989) Case studies is also used with the aim of testing theories (Pinfield, 1986; Anderson, 1983). Case studies typically combine data collection methods such as archives, interviews, questionnaires, and observations. The evidence may be qualitative (e.g., words), quantitative (e.g. numbers), or both.

For the purposes of the research reported on, a case study was conducted with the aim testing the collaborative teaching to promote whole brain learning theory. Data collection was done by means of a questionnaire, providing both qualitative and quantitative feedback, as well as recorded observations by the lecturers.

The research strategy is described in four phases. Phase I consists of the criteria's and processes involved in selecting the lecturers who implemented the collaborative teaching approach during the lectures. Phase II describes the criteria for selection and selection of the participants in the case study. Phase III describes the preparations of the chosen lecturers in preparing for these lectures. Phase IV discusses the structure and implementation of these lectures.

Phase I

The criteria for the selection of the lecturers to implement the collaborative teaching approach were largely based on the literature. To test the theory described, the thinking

preferences of the lecturers, together, had to represent an equal distribution of the four quadrants described by Herrmann. Further, the chosen lecturers had to be regarded as competent by students; it stands to reason that an incompetent, lecturer would not satisfactorily accommodate any learning style of students.

To meet these criteria the HBDI was completed by two lecturers, who based on their own opinion, significantly differed in teaching style. Based on their views, the first lecturer (also referred to as Lecturer 1) seemed to follow a transmission-/ lecturer-focused teaching style and the second lecturer (also referred to as Lecturer 2) a conceptual change-/student-focused teaching style. The student evaluations, forming part of the performance management of lecturers, was obtained from the lecturers affiliated universities statistics department. The lecturers met the required criteria (refer to Part I of the results section).

Phase II

In selecting the participants of the case study it was important for the researchers that firstly, the group of students follow a module in which both the chosen lecturers have extensive knowledge, as both lecturers had to be comfortable with the content of the lecture. Secondly, the participants had to represent a fairly equal distribution of thinking preferences as to ensure that the promotion of whole brain learning is indeed required for the selection of participants. Thirdly, to increase the validity of the results and decrease bias of the students to one lecturer, the participants should not have personally known or previously attended a lecture from either of the lecturers. Lastly, the selection of participants had to be large enough to provide valid results and increase the transferability of the results to all third year accounting students at the university (Krejcie & Morgan, 1970).

A group of participants consisting of 182 registered students within a taxation module presented to the third year English group of students studying towards specialisation in

accounting were selected. Both lecturers were completely comfortable with the content of the lecture, being exemptions and deductions of income tax.

Based on the literature, it would be a correct assumption by the researcher that the selected group would represent a fairly equal distribution of thinking preferences. Nevertheless, the thinking preferences of the 182 participants were determined with the use of a thinking preference questionnaire (TPQ), based on the HBDI. The TPQ is a shorter version compared to the full HBDI questionnaire and was used due to time and cost constraints. The questionnaire consists of 24 statements concerning thinking and learning preferences and students were required to state, by indicating on a 5 point Likert scale, to what extent (strongly disagree to strongly agree) they agree with each statement. In the same manner as the HBDI, the results of the questionnaire indicated each student's thinking preferences and associated learning styles in terms of the four quadrants described by Herrmann. The TPQ proved to be adequately accurate for its purpose within the scope and aim of the study (refer to Part II of the results section).

By means of a question in the data collection instrument it was ensured that none of the participants personally knew or previously attended a lecture from either of the lecturers.

The population out of which the participants were selected amounted to 288 accounting students and the amount of participants (182) was calculated to be sufficient at a 95% confidence level (Krejcie & Morgan, 1970).

Phase III

As discussed in the literature, the case study examines the theory that the combination of the preferred teaching styles of each of the lecturers could accommodate all the learning styles of the group of selected participants. It was therefore imported that both of the lecturers

teach in a manner that reflects their own preferred teaching style (the results seem to support this, refer to Part III). The lecturers' were required to each prepare individually in the same manner that they would for their usual lectures with the focus of only teaching in terms of their preferred teaching style. The content of the lecture to be prepared consisted of both revision of previously taught topics and new topics, not previously taught to the students.

The lecture was not rehearsed to eliminate the risk that the rehearsal could influence the teaching styles of the lecturers based on new knowledge or views gained on the content from hearing the other lecturer.

Phase IV

Before the commencement of the lecture the participants were required to complete the TPQ (refer to Phase II). During the lecture both the lecturers taught jointly in a team and alternated their teaching, while following their preferred teaching style to the best of their ability.

After the completion of the lecture the participants were required to complete the data collection questionnaire. The first part of the data collection questionnaire provided a student with statements concerning the lecture and the lecturers, requiring the student to indicate on a 5 point Likert scale (ranging from strongly disagree to strongly agree) to what extent they agree with each statement. The result from this part of the questionnaire was statistically analysed by a qualified statistician. To determine whether a relationship between a quadrant score of the participants (refer to Phase II), meaning a specific thinking preference, and any one of the options presented by the Likert scale exists, the Kruskal-Wallis one way analysis of variance test was used. A significant statistical result using this test indicates that the higher the score of a specific quadrant, the higher the inclination of that score is towards the

identified option presented by the Likert scale. This statistical test was deemed by the researchers and statistician to provide the most reliable results.

The second part of the questionnaire consisted of open-ended questions urging students to share general comments regarding their overall experience of the lecture. This data was processed by means of a content analysis using Atlas.ti.

The lecturers also recorded their observations of the lecture by completing a SWOT analysis of the collaborative teaching approach as experienced during the lecture.

The TPQ, data collection questionnaire and SWOT analysis all contribute to the results of the case study.

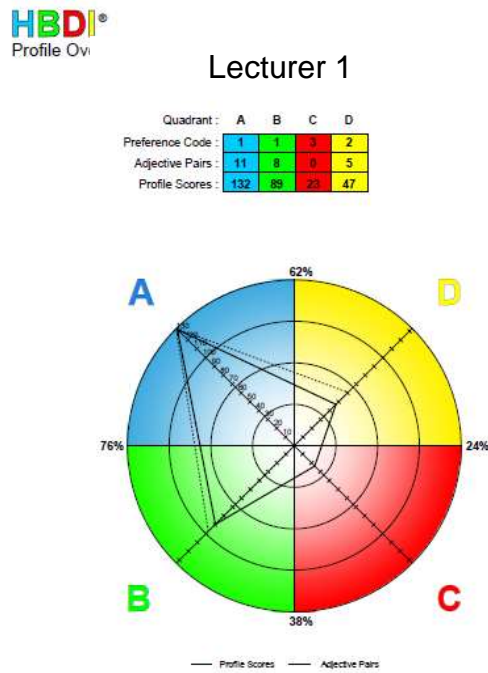
Results and discussion of results

The results section to this article consists of three parts. Part I provides the results relating to the lecturers and the selection criteria as described in Phase I of the research strategy. Part II provides the result relating to the TPQ (refer to Phase II of the research strategy). Part III provides the results of the data collection questionnaire completed by the students and also the SWOT analysis completed by the lecturers (refer to Phase IV of the research strategy).

Part I

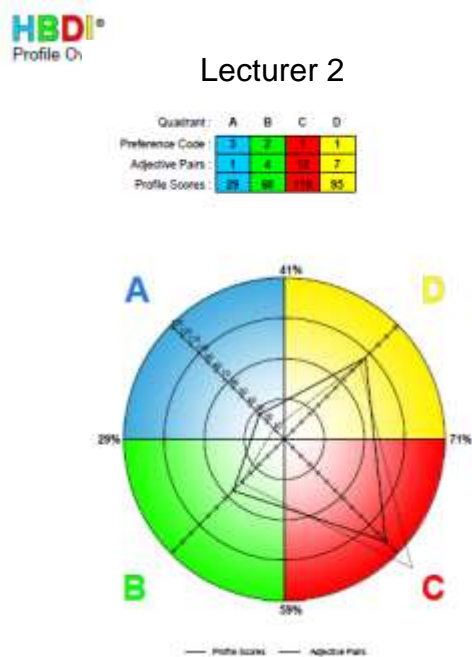
As discussed in Phase I of the research strategy, both of the chosen lecturers completed the HBDI rendering results provided by Herrmann International.

Figure 3 Results of the HBDIs completed by the first lecturer.



The profile of the first lecturer reflects the highest score in the A-quadrant and the second highest in the B-quadrant, meaning a preference towards the A-Quadrant and B-Quadrant of thinking.

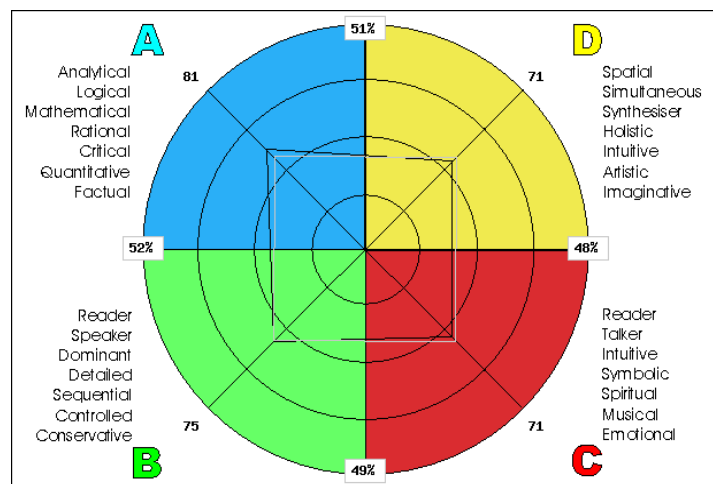
Figure 4 Results of the HBDIs completed by the second lecturer.



The profile of the second lecturer reflects the highest score in the C-quadrant and the second highest score in the D-quadrant, meaning a preference towards the C-quadrant and D-quadrant of thinking.

To determine whether the combined thinking preferences of the lecturers represent a strong inclination to all four quadrants the average combined scores (refer to figure 5) were also provided by Herrmann International.

Figure 5: Average combined results of the HBDIs completed by Lecturer 1 and Lecturer 2.



From the results of Figure 5 it is evident that the combination of the thinking preferences of the two lecturers would theoretically address all the learning styles of the students and the lecturers involved therefore meets this part of the selection criteria.

When considering whether both lecturers were perceived as competent by their students the results of the previous year's lecturers' evaluation by the students were obtained from the universities statistical department after being statistically analysed. During the previous academic year, the first lecturers' average evaluation rating was 4.61 out of 5 and the second lecturers' 4.64 out of 5. The lecturers therefore seem to be both regarded as competent by their students and meet this part of the selection criteria.

Part II

To establish whether the promotion of whole brain learning is indeed a requirement for the participant group the thinking preferences of that group had to be determined. This was done using the TPQ. Before the TPQ would be completed by the participants the researchers had to determine whether it is adequately accurate for its purpose within the scope and aim of the study. The results of the HBDI's completed by the lecturers were compared to the results if the same two lecturers completed the TPQ.

Table 1: Comparison of the results of the thinking preference questionnaire to the HBDI completed by the first lecturer

Lecturer 1	A-Quadrant	B-Quadrant	C-Quadrant	D-Quadrant
HBDI (score of 10 -150+)	132	89	23	47
Thinking preference questionnaire (score of 6-30)	28	22	12	18

Table 2: Comparison of the results of the thinking preference questionnaire to the HBDI completed by the second lecturer

Lecturer 2	A-Quadrant	B-Quadrant	C-Quadrant	D-Quadrant
HBDI (score of 10 -150+)	29	60	119	95
Thinking preference questionnaire (score of 6-30)	18	17	27	26

For the first lecturer the results of the HBDI and thinking preference test provided largely similar results. The same is applicable for the second lecturer, with the exception of the A-quadrant score. Based on these results the researchers concluded that the thinking preference questionnaire is adequately accurate for its purpose within the scope and aim of the study.

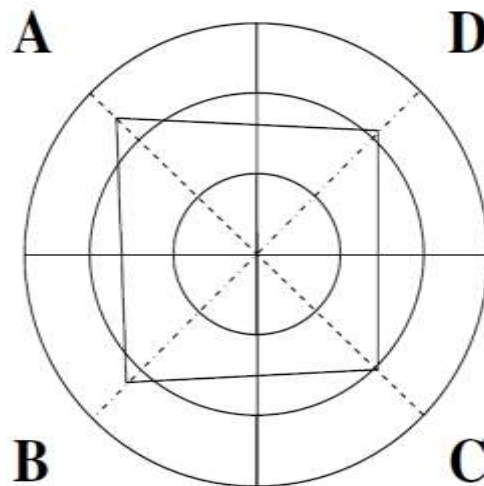
The TPQ was therefore completed by the group of participants before the commencement of the lecture.

Table 3: Results of the thinking preferences of the selected participants

Variable	Mean	Median	Standard Deviation
Quadrant A	24.1	24	3.0692
Quadrant B	23.2	23	3.1238
Quadrant C	20.1	20	3.6559
Quadrant D	21.6	22	3.3132

If these results, only taking the mean into consideration, are presented in the same manner as those of the HBDI it will be as follow:

Figure 6 Thinking preference profile of selected participants



It is evident that the selected participants represented a fairly equal distribution of thinking preferences indicating that the promotion of whole brain learning is indeed a need for the group. The distribution of thinking preferences is further in alignment with the research conducted by Herrmann (1996) and De Boer et al. (2001), providing further validation to the TPQ.

Part III

Table 4 Results pertaining to lecture

Statement	(SD)	(D)	(N)	(A)	(SA)
1. Difficult concepts were easier to understand than usual during the lecture	7.14	16.48	23.63	38.46	14.29
2. I have a better understanding of the revision topics that were dealt with in the lecture	3.85	12.64	28.57	38.46	16.48
3. I have a good understanding of the new topics that they did not have any prior knowledge of	3.3	7.69	27.47	45.60	15.93
4. I found the lecture to have a higher energy level than the usual lectures of the same module	3.3	10.44	18.13	35.71	32.42
5. I found it easy to concentrate during the lecture	13.74	25.82	18.13	29.67	12.64
6. I found the constant switch between lecturers to be distracting	13.74	24.73	20.88	20.33	20.33

The result of the Kruskal-Wallis test indicated that both the C- and D-quadrant score were more inclined to agree or strongly agree with the first statement at the 5% level (a 95% probability) and that the B-quadrant score were more inclined to agree or strongly agree with the fourth statement at the 5% level.

Table 5 Results pertaining to lecturers

Statement	SD	D	N	A	SA
7. I found that the first lecturer lectured in a manner that I prefer	6.6	12.6	23.6	29.7	27.5
8. I found that the second lecturer lectured in a manner that I prefer	7.1	18.7	25.8	31.3	17.0
9. I found the lecturing style of the first lecturer to be interesting	4.4	12.6	20.9	44.0	18.1
10. I found the lecturing style of the second lecturer to be interesting	2.8	9.3	28.0	42.3	17.6
11. I found that the lecturers made a good team	5.5	6.0	18.7	41.8	28.0
12. If I was unable to understand a topic after one lecturer explained it, the other lecturer assisted me in understanding the topic better	5.0	9.9	24.5	38.5	19.2
13. I would prefer to be lectured by two lecturers (jointly as in the current lecture) in future	30.7	15.9	22.5	15.9	14.8

The results of the Kruskal-Wallis test indicated that a relationship exists between the A-quadrant score and an agreement with the seventh and ninth statement on the 5% level. Further, a relationship exists between the C-quadrant score and an agreement with the tenth statement on the 5% level.

By analysing the qualitative data, themes were identified and the number of occurrences of that theme determined. The themes with ten or less occurrences are not provided.

Table 6 General comments regarding their overall experience of the lecture

Theme	Number of Occurrences
Found the lecture interesting	66
Different from usual lectures	42
Found the constant switch between lecturers distracting	33
It was a positive experience	26
Enjoyed the lecture	15
Found the lecture informative	12
Found it difficult to concentrate	12
Lecture had good energy	11
Better understanding of topics	11

Table 7 Results of SWOT analysis completed by lecturers

<p style="text-align: center;"><u>Strengths</u></p> <p style="text-align: center;">Constant change in energy Participants more engaged Combined knowledge</p>	<p style="text-align: center;"><u>Weaknesses</u></p> <p style="text-align: center;">Time consuming Wanting to talk at the same time Less amount of control over lecture</p>
<p style="text-align: center;"><u>Opportunity</u></p> <p style="text-align: center;">Good learning experience for lecturers Improved understanding of content by lecturers</p>	<p style="text-align: center;"><u>Threats</u></p> <p style="text-align: center;">Resource consumption Resistance to change from students Excessive knowledge transferred</p>

Supporting the statement of Herrmann regarding the relationship between thinking and teaching preferences, the results of Table 5 seem to indicate that a student prefer and find the teaching style of a lecturer with a similar thinking preference to him/her more interesting. This could further indicate that each lecturer taught in terms of his/her preferred teaching style, supporting the methodology (refer to Phase III).

From the literature it is suggested that the facilitation of whole brain learning would result in a better understanding of content. From the results it appears that students have a better understanding of difficult concepts, revision topics and new topics (statement 1-3 and Table 6). The Kruskal-Wallis test established that no relationship exists between any of the quadrants and a disagreement with statement 1 to 3. It therefore seems that any student, irrespective of his thinking preference and preferred learning style, was most likely to agree

or strongly agree with statements 1 to 3. Based on this, it is suggested that most of the learning styles of the participants were accommodated and consequently, whole brain learning was promoted.

The literature further suggests that the facilitation of whole brain learning would result in higher energy levels in the class room. The results of statement 4, Table 6 and Figure 7 seem to strongly agree that the lecture had a high energy level. The Kruskal-Wallis test did not indicate any relationship between a disagreement with statement 4 and any of the thinking preferences of the participants. This supports the suggestion made in the previous paragraph. The SWOT analysis (refer Figure 7) also indicates a higher engagement of students (compared to other lectures) and based on the literature, this also supports this suggestion.

Although it seems that the collaborative teaching approach was positively received by the students, the results present concerns. Statement 5 and 6 and the results of Table 6 indicate that a large percentage of the class found the constant switch between the lecturers distracting and also found it difficult to concentrate during the lecture. It is suggested that these results reflect negatively on the use of a collaborative teaching approach. Further research is needed to determine whether an adjustment period for students to the collaborative teaching approach could influence these results.

From the results in this part it is suggested that the collaborative teaching approach was firstly, effectively applied by the lecturers, secondly, promoted whole brain learning among the students and lastly, poses a challenge for the student in respect of concentration during the lecture.

Conclusion

Changing teaching styles to accommodate the ever present learning styles of students presents a great challenge to lecturers. Theoretically, if two lecturers' teaching styles could

jointly accommodate the learning styles of students, those lecturers would effectively promote whole brain learning. As the teaching styles of lecturers are directly in relation to their thinking preferences, the combined thinking preferences of two lecturers were examined and found to be nearly ideal for implementing the collaborative teaching approach to a group of participants with a fairly equal distribution of thinking preferences.

From the results it is suggested that the collaborative teaching approach promoted whole brain learning among the participants, but the constant switch between lecturers could be distracting. Further research needs to be done to establish the consequences of implementing the collaborative teaching approach on a permanent basis.

References

Anderson, P. (1983). Decision making by objection and the Cuban missile crisis. *Administrative Science Quarterly*, 28, 201-222.

Bawaneh, A.K., Zain, A.N., & Saleh, S. (2010). Investigating tenth grade Jordanian Students' thinking styles based on Herrmann's Whole Brain Model for the purpose of developing new teaching method in modifying science misconceptions. *Educational research*, 1(9), 363-372.

Bunderson, C. V. (1995). The validity of the Herrmann Brain Dominance Instrument. In N. Herrmann (Ed), *The creative brain. (2nd edition)*. USA: Quebecor Printing Book Group.

Buzan, T. (1991). *Use both sides of your brain. (3rd edition)*. USA: Plume Books.

Cook, L., & Friend, M. (1995). Co-teaching: Guidelines for creating effective practices. *Focus on Exceptional Children*, 28(3), 1–16.

de Boer, A., & Bothma, T. (2003, June). *Thinking styles and their role in teaching and learning*. Paper presented at the 24th IATUL Conference, Ankara, Turkey.

de Boer, A., Steyn, T., & du Toit, P.H. (2001). A whole brain approach to teaching and learning in higher education. *South African Journal of Higher Education*, 15(3), 185-193.

- Eisenhardt, K. (1989). Building theories from case study research. *Building Theories from Case Study Research*, 14(4), 532-550.
- Felder, R. (1996). Matters of style. *American Society for Engineering Education Prism*, 6(4), 18-23.
- Gerber, P.J., & Popp, P.A. (2000). Making collaborative teaching more effective for academically able students. *Recommendations for Implementation and Training. Learning Disability Quarterly*, 23(3), 229-233
- Herrmann, N. (1989). *The creative brain*. North Carolina: Brain Books, The Ned Hermann Group.
- Herrmann, N. (1995). *The creative brain. (2nd edition)*. USA: Quebecor Printing Book Group.
- Herrmann, N. (1996). *The whole brain business book*. New York: McGraw Hill.
- Herrmann, N. (1998). *Twenty years of thinking about the thinking brain: A special summary of learning outcomes*. Unpublished document, Herrmann International. Lake Lure. USA.
- Hyman, R., Rosoff, B.(1984). Matching learning and teaching styles: The jug and what's in it. *Theory into Practice*, 23(1), 35-43.
- Jensen, E. (1996). *Brain-based learning*. Del Mar: Turning Point Publishing.
- Knowles, M. (1990). *The adult learner : A neglected species (4th edition)*. USA: Gulf Publishing Company.
- Krejcie, R.V., & Morgan, D.W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30, 607-610
- Ornstein, R. (1997). *The right mind: Making sense of the hemispheres*. New York: Harcourt Brace & Company.
- Pinfield, L. (1986). A field evaluation of perspectives on organizational decision making. *Administrative Science Quarterly*, 31, 365-388.
- Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. *Higher Education*, 37(1), 57-70.