Using principles of Whole Brain® Thinking to transform radiographic clinical practice: an action research study

by

Zanelle Kruger

Submitted in fulfilment of the requirements for the degree

Magister Education

(Curriculum and Instructional Design and Development)

in the

Department of Humanities Education

Faculty of Education

University of Pretoria

Supervisor: Prof. P.H. du Toit

January 2021

DECLARATION REGARDING AUTHENTICITY

i) I understand what plagiarism entails and am fully aware of the University's policy in this regard.
ii) I declare that the dissertation is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.
iii) Where other people's work has been used (either from a printed or electronic source), this has been properly acknowledged and referenced in accordance with departmental requirements.
iv) I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

Signature:

Z Kruger

Date: 4 January 2021

ETHICS CLEARANCE CERTIFICATE

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	CLEARANCE NUMBER: **HU 19/06/04**
DEGREE AND PROJECT	MEd Using principles of Whole Brain® Thinking to transform radiographic clinical practice: an action research study
INVESTIGATOR	Ms Zanelle Kruger
DEPARTMENT	Humanities
APPROVAL TO COMMENCE STUDY	17 September 2019
DATE OF CLEARANCE CERTIFICATE	17 December 2020

CHAIRPERSON OF ETHICS COMMITTEE: Prof Funke Omidire

CC Ms Bronwynne Swarts
Prof P.H du Toit

This Ethics Clearance Certificate should be read in conjunction with the Integrated Declaration Form (D08) which specifies details regarding:

- Compliance with approved research protocol,
- No significant changes,
- Informed consent/assent,
- Adverse experience or undue risk,
- Registered title, and
- Data storage requirements.

ABSTRACT

As an inexperienced facilitator with a passion for education, research, and the field of radiography I identified an innovative idea to transform my practice as part of my professional development and role as a lecturer. This research focuses on implementing a professional development intervention aimed at improving Radiographic Clinical Practice. Radiographic Clinical Practice is a subject specialising in radiographic techniques for the demonstration of specific anatomical structures and pathology. Constructive academic contributions on holistic Whole Brain® facilitating learning in South Africa abound but a void was identified in its implementation in Radiographic Clinical Practice. Whole Brain® thinking is in principle, the way in which I choose to execute the learning task. As I have my own thinking preference, known as my comfort zone, the goal throughout the project was to facilitate learning tasks in a holistic Whole Brain® manner. Developing Whole Brain®-focused radiographers is imperative for the industry to be effective and efficient, while improving or maintaining the well-being and heath of the patients in an era of rapidly advancing technology (Dos Reis, Pires-Jorge, York, Flaction, Johansen, & Maehle, 2018:61).

By using an action research design, I took responsibility for my own professional development in a self-regulated fashion – one's ability to understand and control one's own learning in practice. I improved the approach to my educational practice by facilitating the learning of radiography in a holistic Whole Brain® manner. A mixed methods approach was followed during data collection, analysis and interpretation.

The fieldwork consisted of different questionnaires, observations, observation sheets and a reflective field notebook. These different data collection methods were implemented by various sources (participants, peers and myself) to augment the validity and reliability of the data and the interpretation, as recommended by Zohrabi (2013:254).

Findings indicate that I did develop professionally and created learning opportunities for the participants to develop professionally.

KEY TERMS

Whole Brain® facilitating of learning; Whole Brain® thinking; holistic thinking, self-regulated learning; action research

PROOF OF EDITING

I HATE MISTEAKS

TK LANGUAGE SERVICE
EDITING | PROOFREADING | TRANSLATION
Prof. Dr. Tinus Kühn
+27 82 303 5415 | tinus.kuhn@gmail.com

27 December 2020

TO WHOM IT MAY CONCERN

I, the undersigned, hereby declare that the master's dissertation titled **Using principles of Whole Brain® thinking to transform Radiographic Clinical Practice: An action research study** by **Zanelle Kruger** has been edited.

It remains the responsibility of the candidate to effect the recommended changes.

Prof. Tinus Kühn

ACKNOWLEDGEMENTS

Foremost, I am grateful to the Almighty God who has given me the potential and strength to complete my studies.

I would like to extend my sincere appreciation, in no specific order, to the following institutions and individuals who have facilitated me in this endeavour:

i) I wish to express my sincere thanks to my loving husband for all the patience and support during the entire process. Without his support and encouragement this venture would not have been possible.
ii) I would like to thank my supervisor, Prof. P.H. du Toit for introducing me to the concept *Whole Brain® learning* and inspiring my interest in the field.
iii) The Department of Humanities Education, Faculty of Education, University of Pretoria. Thank you for the support sessions offered in cohort sessions and facilitating the process in a dynamic fashion.
iv) Education Library, Department of Library Services. Specifically, information specialist, Ms S. Delport, for her professionalism and constant assistance in sending information required.
v) Every participant who volunteered to be part of my study; without each one's co-operation this study would not have been possible.
vi) I would like to thank Dr W. Cordier for his advice and assistance throughout the process.
vii) Dr Mkhabele and Indunah private X-Ray department permitting me to conduct my research at their practice during a very difficult pandemic.

TABLE OF CONTENTS

DECLARATION REGARDING AUTHENTICITY i

ETHICS CLEARANCE CERTIFICATE ii

ABSTRACT iii

KEY TERMS iv

PROOF OF EDITING v

ACKNOWLEDGEMENTS vi

Chapter 1: Orientation 1

1.1 Background 1

1.1.1 Metaphor for my education practice 4

1.2 Innovative research idea 6

1.2.1 Research questions 7

1.2.1.1 Main research question 7

1.2.1.2 Secondary research question 7

1.3 Rationale for the study 7

1.4 Research premises 8

1.4.1 Ontological assumptions 8

1.4.2 Epistemological assumptions 9

1.5 Action research design 9

1.6 Overview of research methods 10

1.7 Chapter outline 12

1.8 Constructs 14

Chapter 2: Stage 1 of the study's life cycle 18

2.1 Introduction 18

2.2 My role as lecturer 20

2.3 Constructivism 22

2.4 Radiography as an industry 24

2.4.1 Radiographic Clinical Practice as a subject 25

2.4.2 Research on Radiographic Clinical Practice 27

2.5 Conceptual argument 28

2.5.1 Herrmann's Whole Brain® model 31

2.5.2 Whole Brain® thinking as background to Radiography 36

2.6 Conclusion 38

Chapter 3: Stage 2 of the study's life cycle (Research design and methodology) 39

3.1 Introduction 39

3.2 Research paradigm 39

3.3 Action research design 40

3.4 Mixed methods approach 44

3.5 Research methods 44

3.5.1 Questionnaires 45

3.5.1.1 Herrmann Brain Dominance Instrument® as baseline data 45

3.5.1.2 Participant feedback 45

3.5.2 Observations 46

3.5.2.1 Peer observation 46

3.5.2.2 Self-observation 46

3.6 Data collection 47

3.6.1 Cycle A - C: My action as visionary practitioner-researcher 49

3.6.1.1 Step 1: Acting to innovate and transform 49

3.6.1.2 Step 2: Reflecting on action 50

3.6.1.3 Step 3: Observing the effects of the new actions 50

3.6.1.4 Step 4: Reflecting on actions and data 52

3.6.1.5 Step 5: Evaluating the process 52

3.7 Data analysis 52

3.8 Ethical considerations 53

3.9 Conclusion 54

Chapter 4: Stage 3 in the study's life cycle (Empirical research findings and assumptions) 55

4.1 Introduction 55

4.2 Baseline data – My Whole Brain® profile 56

4.3 My action research cycles 61

4.3.1 Step 1: Planning innovative learning opportunities 61

4.3.2 Step 2: Action to transform 61

4.3.3 Step 3 and 4: Observing and reflecting on actions and data..... 65

4.3.3.1 Feedback from participants 65

4.3.3.2 Feedback from peers 88

4.3.3.3 Observing the participants..... 92

4.3.3.4 Self-observation..... 98

4.3.4 Step 5: Evaluating the process 101

Chapter 5: Stage 4 in the study's life cycle (Discussion, conclusion, recommendations)..... 102

5.1 Introduction..... 102

5.2 Addressing the research questions 102

5.2.1 First secondary research question..... 103

5.2.2 Second secondary-research question..... 104

5.2.3 Third secondary research question..... 104

5.2.4 Main research question..... 106

5.3 Contributions 106

5.4 Challenges 107

5.5 Recommendations for future research 107

5.6 Meta-reflection..... 107

List of references 113

List of figures

Figure 1.1: Metaphor for my educational practice 5

Figure 1.2: Visual representation of the outline of the research 12

Figure 2.1: Integrated metaphoric visual representation − the interrelatedness of applicable theories 28

Figure 2.2: Herrmann's metaphoric Whole Brain® model 31

Figure 2.3: John Doe Visual Profile 34

Figure 3.1: Adapted action research model 42

Figure 4.1: HBDI data summary of my preferences 56

Figure 4.2: My HBDI® profile 59

Figure 4.3: Participants executing learning task 1 62

Figure 4.4: Participants executing learning task 2 63

Figure 4.5: Participants executing learning task 3 64

Figure 4.6: I communicated clearly during the learning opportunity 65

Figure 4.7: I was well prepared 66

Figure 4.8: I managed time efficiently 66

Figure 4.9: I activated my interest in this subject by integrating tasks linked to diversity in thinking preferences 67

Figure 4.10: I was responsive to participant queries and concerns 67

Figure 4.11: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations 68

Figure 4.12: I effectively used an array of educational media 68

Figure 4.13: I developed holistic and relevant assessment tasks.....69

Figure 4.14: I provided constructive feedback in a realistic time frame 70

Figure 4.15: I enhanced effective and holistic learning 70

Figure 4.16: How would you rate my effectiveness of facilitator of learning 71

Figure 4.17 LT 2: I communicated clearly in the learning opportunity 74

Figure 4.18 LT 3: I communicated clearly in the learning opportunity 74

Figure 4.19 LT 1: I was well prepared 75

Figure 4.20 LT 2: I was well prepared 75

Figure 4.21 LT 2: I managed time efficiently 76

Figure 4.22 LT3: I managed time efficiently 76

Figure 4.23 LT 2: I displayed my interest in this subject by integrating tasks linked to diversity in thinking preferences 77

Figure 4.24 LT3: I displayed my interest in this subject by integrating tasks linked to diversity in thinking preferences 77

Figure 4.25 LT2: I was responsive to participant queries and concerns.....78

Figure 4.26 LT3: I was responsive to participant queries and concerns.....78

Figure 4.27 LT 2: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations 79

Figure 4.28 LT 3: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations 79

Figure 4.29 LT2: I effectively used an array of educational media 80

Figure 4.30 LT 3: I effectively used an array of educational media 80

Figure 4.31 LT 2: I developed holistic and relevant assessment tasks 81

Figure 4.32 LT 3: I developed holistic and relevant assessment tasks 81

Figure 4.33 LT 2: I provided constructive feedback in a realistic time frame 82

Figure 4.34 LT 3: I provided constructive feedback in a realistic time frame 82

Figure 4.35 LT 2: I enhanced effective and holistic learning 83

Figure 4.36 LT 3: I enhanced effective and holistic learning 83

Figure 4.37 LT 2: Effectiveness as facilitator of learning 84

Figure 4.38 LT 3: Effectiveness as facilitator of learning 84

Figure 4.39: Whole Brain® diagram provided by a peer 89

Figure 4.40: My contribution to participants' learning in the first category 97

Figure 4.41: My contribution to participants' learning in the second category 98

Figure 4.42: My contribution to participants' learning in the third category..... 99

Figure 5.1: Fact-based reading whenever the opportunity arose − during theatre nightshift.....107

Figure 5.2: Cohort session 4: Theoretical and conceptual framework learning opportunity 109

Figure 5.3: WhatsApp Video calls with critical friends 110

Figure 5.4: Butterflies in my stomach 111

List of tables

Table 1.1: Outline of the research methodology.....11

Table 1.2: Constructs used in dissertation 14

Table 3.1: Data collection process 47

Table 4.1: Qualitative feedback from respondents regarding their experience of the first learning opportunity 71

Table 4.2: Qualitative feedback from respondents regarding their experience of the second learning opportunity 85

Table 4.3: Qualitative feedback from respondents regarding their experience of the third learning opportunity.....86

Table 4.4: Observation of accommodating modes of thinking in the first learning task.....91

Table 4.5: Observation of accommodating modes of thinking in the second learning task.....94

Table 4.6: Observation of accommodating modes of thinking during the third learning task.....95

List op appendices

I. PGCHE invite

II. HBDI®

III. Participant feedback questionnaire

IV. Observation feedback sheets for peers

V. Self-assessment of teaching practice

VI. Written consent from participants

VII. Information leaflet

Chapter 1: Orientation

This chapter provides the background to the study. Action research is an enquiry into the self and one's professional development. In the context of my study, the focus is on my professional development as a lecturer in higher education. The nature of action research allows for personal reflection. Reflection forms an integral part of action research. As the focus is on me, I made writing in the first person my style of choice. In this chapter I explain my perception of action research and the importance of educational transformation; it includes the innovative research idea, traditionally known as the research problem and the rationale. I explain the research premises and provide an overview of the research design and methods. The chapter also provides a framework of what is presented in the successive chapters and is concluded with constructs used throughout the document.

1.1 Background

As a scholar of facilitating learning in higher education on a part-time basis for only three years, I continuously strive (on a day-today basis) to maximise my potential – a construct used by Slabbert, De Kock, and Hattingh (2009:49). In South Africa there are twenty-six public universities. I have been involved at two institutions, namely the University of Pretoria (UP) and the Tshwane University of Technology (TUT). The University of Pretoria and the Tshwane University of Technology are two of Africa's top universities and the largest contact universities in the country. After completing my Postgraduate Certificate in Higher Education (PGCHE) in 2016 at the University of Pretoria, I soon realised that I was extremely passionate about research, specifically in the field of teaching and learning in higher education. The PGCHE is a 120-credit programme that consists of nine modules offered to postgraduate students by the University of Pretoria. Each module has its own focus with different credits that count towards the final qualification. The programme is considered innovative in its design

as it includes a module on Community-based Learning, which is essential for the 21st century student; a module on Mentorship and one on Educational Entrepreneurship – three distinct modules that are not included in any of the PGCHE programmes offered by universities across the country, such as the University of Cape Town, the University of Stellenbosch, the University of the Free State and Rhodes University. The curriculum includes two fundamental modules −Mediating Learning and Professional Development; five core modules − Assessment Practice, Community-based Learning, Leadership and management, Curriculum Development, and Education Technology; two elective modules in which I did Entrepreneurship Practice and Mentorship. My enrolment in a Magister of Education (MEd) at the University of Pretoria, contributed not only to my professional development as a higher education practitioner, but also fulfilled my role as a lecturer (being a lifelong learner) as outlined in the *Norms and standards for educators (Norms and standards for educators, 2002)*.

In March 2014 I was approached by two public higher education institutions in South Africa, namely the University of Pretoria and the Tshwane University of Technology to substitute for lecturers on sabbatical leave. This was a golden opportunity to establish myself in the lecturing field, but after inception I soon realised that I would face more challenges than anticipated.

I was responsible for facilitating the radiographic practical module for the first- and second-year students. I facilitated the Radiographic Practice II module at the Tshwane University of Technology, and both the Radiographic Practice I and Radiographic Practice II modules at the University of Pretoria. Each programme offered by the respective universities is module-based with each module contributing different credits to the final degree.

The aim of all three subjects, in the Radiographic Clinical Practice module, is to offer students opportunities to develop as prospective professionals specialising in radiographic techniques to demonstrate specific anatomical structures and pathology optimally.

Working at the two different institutions I realised how differently radiographic clinical practice is facilitated. As proposed in Du Toit (2012:1219) I have to construct new meaning of the concepts with which I work as part of my living theory. My living/lived

theory (Du Toit, 2014:1219; McNiff & Whitehead, 2006:42) showcases how I have transformed my practice by making use of principles of professional learning. I want to have a positive effect on radiographic clinical practice and how demonstrations of different radiographic techniques are enacted. I offered students learning tasks with characteristics from all four brain quadrants (Consult Chapter 2, Section 2.5.1 for detailed information on the different quadrants of the brain). This ensured that Whole Brain® thinking occurred during the Radiographic Clinical Practice module. In the constant technological advancements in radiography whole-brained radiographers are imperative allowing them to produce optimal diagnostic images (radiographs) for the radiologist to interpret, diagnose and report (Raby, 2017:11)

A living theory links ideas with action and will change and develop as professional development occurs during the process of action research (McNiff & Whitehead, 2006:13). Over time I experienced that this is indeed the case as my living theory changed, based on my lived experiences.

I decided to register for the MEd at the University of Pretoria with a view to taking responsibility for my professional development as scholar and practitioner in the field of teaching and learning in radiographic clinical practice.

As an action researcher the expectation is to be a practitioner-researcher who conducts research in a scholarly fashion and who can offer evidence of the developmental process I followed to transform my education practice in radiographic clinical practice. The Radiography Skill Centre (RSC), a training facility with X-ray equipment and accessories at the Tshwane University of Technology was the ideal platform to conduct my action research. The Centre is one of a kind, and the only fully-equipped educational centre in the Gauteng region. However, due to the Covid-19 pandemic it was not possible to collect data at the Centre as originally planned. Dr Mkhabele and the Indunah X-Ray Department at the Louis Pasteur Private Hospital, situated in the centre of Pretoria, was the ideal alternative research site to conduct my action research during this pandemic.

1.1.1 Metaphor for my education practice

During our first PGCHE meeting all the lecturers enrolled in the programme introduced themselves and their modules to their peer students. Our programme coordinator, Prof. P. du Toit, invited us to the

"marriage between the scholarship of Teaching and Learning and Research scholarship" (Consult Appendix I). The hypothetical couple in the invitation implied that no money be offered as a gift; instead they wanted a personalised gift such as an artefact, piece of music or a poem that best represented or described us as individuals applicable to our teaching practice. This was the very first step in creating holistic individuals and took me out of my comfort zone.

Initially my practice metaphor was that of an emergency 911 dispatcher. The 911 dispatcher is the first voice one hears that assesses one's medical needs, encourages one that everything will be fine, coaches one through the first steps of response and sends the resources necessary to rescue one. My metaphor changed on a regular basis as I observed new characteristics manifesting during the learning opportunities – commonly known as lectures. This is a simple example of how my living theory has continuously changed.

The 911 dispatcher metaphor quickly (early in the research project) became lecturer-centred and a quick fix in my mind. Students [participants in my informal practice] are used to the traditional paradigm of "learning to know" (Slabbert *et al.*, 2009:64) the content and do not learn how to engage critically with the content and the related competencies to be mastered. Fundamentally, education should result in a change in the way students [my participants] think and engage with the world. To achieve this, learning should undergo the paradigm shift from "learning to know" to "learning to be" (Slabbert *et al.*, 2009:64).

My use of the current metaphor is based on certain factors. I had to understand how I viewed learning, skills and knowledge and what my role during facilitating of learning would be. Emphasis was placed on the *what* and the *how* acquiring knowledge and mastering competencies, while making meaning (Du Toit, 2012:1218) by using a constructivist approach. This is how one comes to know or understand through

interaction with the environment (Von Glasersfeld, 2001:165) and to facilitate learning (Slabbert *et al.*, 2009:10) in such a way that deep learning is promoted.

Next, in Figure 1.1 I visually represent my educational metaphor by means of a photograph.

Figure 1.1: Metaphor for my educational practice

The photograph shows a mountain landscape. There are multiple routes that can be taken to reach the summit; this is how I view meaning-making. Each route can be divided into sub-routes that can then be divided further into even smaller sub-routes – each of them connecting with one another. I am of the view that my role as a facilitator is to engage students [participants] in what is to be learnt and how it can be learnt, and engaging them in mastering of an array of competencies relevant to Radiography. By creating opportunities for self-empowerment students are allowed to take different directions as they explore different routes in constructing new meaning through principles of self-regulated learning.

No two students will take the same journey; they may even explore routes where I myself have not been. Metaphorically a facilitator facilitates student learning [participants as professionals] in such a way that all the connections between the different routes taken to reach the summit are not known by the facilitator. The facilitator must design learning opportunities to create self-regulated Whole Brain® students. Thus, the emphasis is shifted to the participant and what he or she does. In this student-centred approach participants become competent in monitoring their own

learning, as independent, self-regulating professionals (Du Toit, 2019b:54). As documented in Du Toit (2019b:40) effective learning takes place if the whole brain is involved in learning, requiring that all four brain quadrants are included in the learning opportunity (Consult Chapter 2, Section 2.5.1 for detailed information on the different quadrants of the brain). Metaphorically the participants must explore the different routes on their own without the process being facilitated by someone else but by themselves by means of Whole Brain® self-regulated professional learning (Du Toit, 2013:2).

The guide, who accompanies the travellers on the journey to the summit of the mountain, represents the facilitator who looks out for the best means of facilitating learning by planning learning opportunities consisting of a number of tasks, implementing the plan, taking action, observing in different ways and reflecting on the process. Students are challenged to take new routes with a view to taking control of their own learning through continuous self-development. As a lifelong learner I continuously follow the action research process as part of my personal and professional development.

A landscape with different routes changes continuously. Bushes and branches can close a pathway; it is like the ever-changing world in which we live. Moreover, there are many distractions, such as pollution, global warming, fires, droughts, natural disasters and so forth that may obstruct the landscape and necessitate taking different routes to reach the summit. But the facilitator and students alike should not allow these distractions to restrain their development. The awareness of these distractions should rather enhance the learning process by motivating one to embark on the quest for finding a way to reach the summit.

1.2 Innovative research idea

My research questions centre on two main ideas:

i) How can I transform what I am doing in terms of my teaching practice?

ii) What can I learn from my experience, as suggested by McNiff and Whitehead (2006:7) with a view to making new meaning against the background of constructivism as epistemological grounding of action research (Tekin & Kotaman, 2013:88).

The research questions that follow apply to my professional development. What should be kept in mind is that the study represents the double-layered dimension of my practice. This means that two dimensions of learning are implied − my professional learning on the one hand, and the participants' learning on the other.

1.2.1 Research questions

1.2.1.1 Main research question

How can my professional development and the learning of my students be developed in a synchronistic Whole Brain® manner through designing and implementing activities linked to Whole Brain® theory?

1.2.1.2 Secondary research question

To explore and clarify the main research question, I formulated the following secondary research questions:

i) What is my thinking preference according to the Herrmann Brain Dominance Instrument® (HBDI®)?
ii) How does my thinking preference inform my teaching practice?
iii) How can the radiographic clinical demonstration (in the Radiographic Clinical Practice module) be facilitated with a view to promoting Whole Brain® self-regulated learning?

The above-mentioned questions assisted me in remaining focused during the action research process.

1.3 Rationale for the study

Radiography as a profession is dependent on two different academic processes that are integrated, namely theory and clinical practice. Theoretical practice (theory) must

facilitate the process of learning, challenging the professionals who took part in my study until the highest quality of professional learning was reached. Radiography students enter the clinical environment to acquire and develop the necessary skills to produce the highest quality diagnostic radiographs and important prior knowledge, for example of each bone in the body, to become Whole Brain® (Ned Herrmann, 1999:1) self-regulated (Du Toit, 2013:3) professionals. The rationale for conducting this study was taking responsibility for my professional development as scholar and practitioner in the field of Radiographic Clinical Practice and to have a positive effect on it.

1.4 Research premises

1.4.1 Ontological assumptions

Understanding one's ontological perspective influences constructing of new knowledge and the multiple realities of the professionals in Action Research (Whitehead & McNiff, 2006:11). Relativism is the nature of the ontological assumptions used, indicating that there are multiple realities or truths that are shaped by the context (Killam, 2015:230). As ontology is the study of being and influences how one views oneself in relation to others, the following ontological commitments underpin action research (McNiff & Whitehead, 2006:23): action research is value laden, morally committed and one perceives oneself in relation to others in social contexts.

In the context of my study I was an "insider researcher" as indicated by McNiff and Whitehead (2006:8,10) and directly involved in the research. This means that I did regard myself in the centre of the process of transformation and in my development as a professional. I continuously asked: What am I doing? How do I describe and explain my actions? I kept records and produced regular written reports about what I was doing. McNiff and Whitehead (2006:12) state the following: "Sustainable change happens when people create and implement their own ideas rather than only accept and implement the ideas of others." The implementing of own ideas corresponds with my following an asset-based approach (Du Toit, 2012:1222) as reflected in Chapter 3, Section 3.4. One's ontological perspective dictates the epistemological assumptions

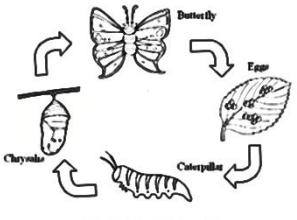
(Cohen, Manion, & Morrison, 2000:3) because the ontological underpinning cannot be separated from the epistemological view advocated (Du Toit, 2013:2).

1.4.2 Epistemological assumptions

Epistemologically I regarded my role as facilitator and the Whole Brain® Radiographic Clinical Practice transformation as inseparable. Cited in Rossouw (Rossouw, 2015:23) Bergman argues that "epistemology in a constructivist paradigm is the relationship between the researcher and what is being researched". Thus, I understood and acquired knowledge through a subjective and constructivist approach. This means that interaction was essential and known as an emic epistemology type (Killam, 2015:230). Emic epistemology is a subjective type of field research done from within where interaction is essential to obtain an in-depth understanding of what is going on. Action research is the perfect example of this emic epistemology type as viewed by (Maree, 2016:91). I was directly involved in the research to transform my practice in an innovative and accountable way.

1.5 Action research design

In this section I refer to my view of action research and the importance of educational transformation, based on McNiff's (2002:12) notion of what action research entails:



> *We live in a deeply unified universe, where all things are connected. The butterfly effect, where the bear of a butterfly's wings locally can have repercussions in far-flung global terms. All open-ended systems have the potential to transform themselves into richer versions of themselves*.

My view of action research can be compared with the butterfly effect and the stages in a butterfly's life cycle. The minute eggs represent identifying what to improve in everyday practice; identifying an aspect of one's practice represents the tiny worm-like creature hatching from the egg. The second stage is known as the caterpillar or larva. Each caterpillar is unique with different patches and stripes. The caterpillar grows rapidly and sheds its skin multiple times. This represents the aspect of transforming −

clear and defined plan of how to transform one's teaching practice. Stage three is the chrysalis or pupa. A chrysalis is the hard-shelled pupa of the butterfly. During this third stage all previous habits need to be addressed, critically reflected upon and changed.

In educational context it refers to the fact that as higher education practitioners we need to "unlearn" (Du Toit, 2018:17). When real transforming of teaching practice occurs the final stage – stage four – has been reached. The chrysalis opens and a butterfly emerges. A process of complete transformation, known as metamorphosis occurs. The main aim of action research is to generate real social change (McNiff & Whitehead, 2011:12), transforming how clinical radiographic practice is facilitated.

"Facilitation is not teaching, not telling, not lecturing, not preaching, and not direction [not guiding]. Facilitation is providing the resources and structures for [participants] to explore, learn and develop" (Slabbert *et al.*, 2009:99). Educational transformation is essential. To achieve the required transformation, learning should undergo a paradigm shift (Slabbert *et al.*, 2009:64) from the traditional lecture-centred to a student-centred approach.

Whole Brain® facilitating of learning (De Boer, Du Toit, Scheepers, & Bothma, 2013; De Boer, Du Toit, & Bothma, 2015; Du Toit, 2018; Ned Herrmann, 1998, 2013) is the perfect way to achieve the aim of educational transformation. As everyone has a different thinking preference for the way to execute a task, Whole Brain® facilitating of learning ensures that a heterogeneous group of participants as professional learners with different thinking preferences are accommodated. By integrating Whole Brain® facilitating of learning into Radiographic Clinical Practice, I aimed to challenge the participants to use less preferred thinking preferences and to accommodate their preferred mode of thinking.

1.6 Overview of research methods

In this section a summary of the research paradigm, research design, research approach, data collection, data documentation and how the data was analysed is

presented (Consult Table 1.1 below). An elaborated version is presented in Chapter 3, Section 3.5.

As illustrated in Table 1.1, a transformative constructivist paradigm guided the research. Transformative constructivism was utilised as I took responsibility for my professional development in a self-regulated fashion by using an action research design. Knowledge is not passively received either through the senses or by way of communication, but is actively constructed by the individual through interactions with the environment (Slabbert *et al.*, 2009:10). I adapted multiple action research models to my context, demonstrating the double-layered dimension of my practice. This means that two contexts of learning were implied: my professional learning on the one hand, and participant learning on the other. The study utilised a mixed methods approach. The justification for using both quantitative and qualitative data gathering lies in the fact that neither quantitative nor qualitative methods are adequate in themselves to capture the details and trends of a situation (Ivankova, Creswell, & Stick, 2006:3). Different data collection tools such as questionnaires and observation sheets were used to answer the research questions. Although there is no statistical value in the quantitative data I considered interpreting and analysing the questionnaires using descriptive statistics, such as visual graphics, pie-charts, diagrams, bar graphs and basic mathematics to describe the data as of value (Tomal, 2010:96). The video-recordings were analysed through behaviour logs. The observation strategy followed was a closed structure observation to focus on what mode of thinking was accommodated during each learning opportunity presented.

Table 1.1: Outline of the research methodology

Research methodology	
Paradigm	Constructivism and transformative procedure
Research design	Action research
Approach	Whole Brain® mixed methods using both quantitative and qualitative data

Data collection	• Questionnaires
	  ○ Herrmann Brain Dominance Instrument®
	  ○ Participant feedback questionnaires
	• Observations

	○ Peer observation feedback sheets ○ Self-observation
Data documentation	• Observation sheets – closed structure • Field notes • Reflective diary • Photos • Video recordings
Data analysis	• Questionnaires ○ Descriptive statistics • Video-recordings ○ Behaviour log
Ethical considerations	• Ethical clearance from the University of Pretoria • Information leaflet • Informed consent • Voluntary and anonymous participation • Documents stored for 15 years

1.7 Chapter outline

To explore and answer the innovative research idea as specified in the research questions (Section 2 above) the research is reported in five chapters as indicated in Figure 1.2. This figure is a visual representation of the outline of the research.

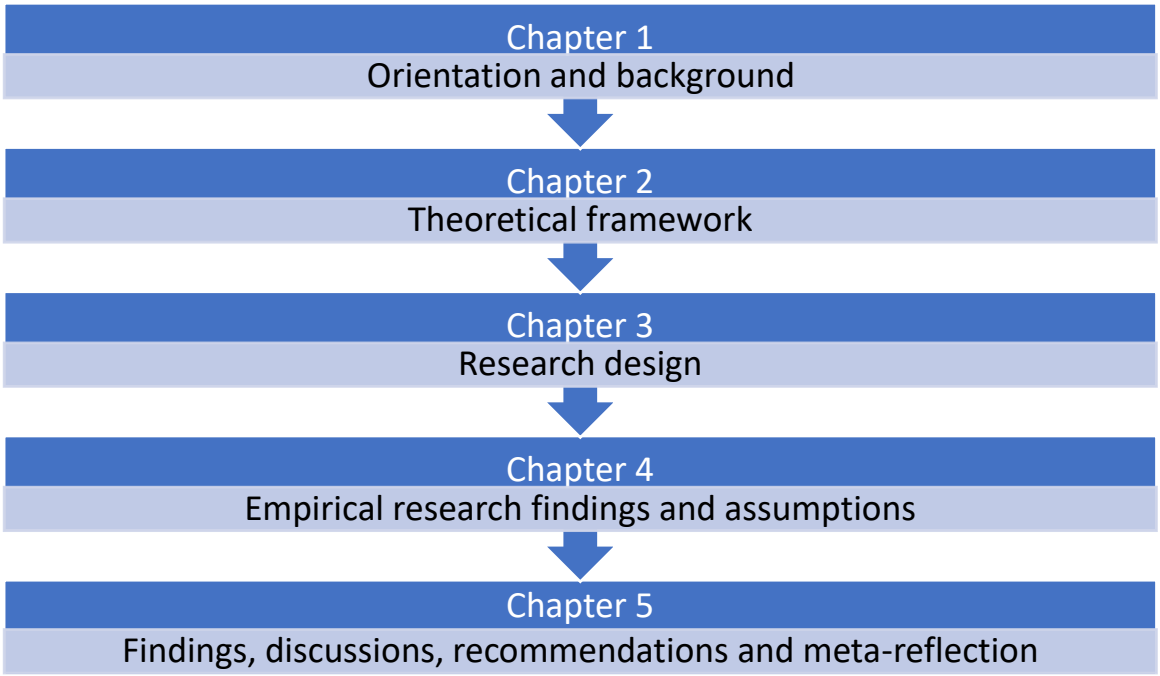


Figure 1.2: Visual representation of the outline of the research

Chapter 1: Orientation and background. The first chapter includes my background as the researcher with an accompanying metaphor for my education practice. It summarises the innovative research ideas, context rationale, research premises and provides an overview of the research methods.

Chapter 2: Theoretical framework. The chapter discusses the role of facilitators in outcomes-based education, and Radiography as an industry. A conceptual framework in the form of a metaphoric representation of the eye summarises the key theories and constructs used throughout the study. Thinking style preferences and Herrmann's Whole Brain® model are discussed in this chapter.

Chapter 3: In this chapter the research design (action research), research paradigm (constructivism), research approach (mixed methods) and data collection and analysis are discussed.

Chapter 4. Empirical research findings and assumptions. The results of the research are analysed and explained. These include the outcome of my completing the HBDI® profile. The visual of the profile is qualitative in nature. Quantitative data is indicated by means of an array of scores. I report my self-observation and the constructive feedback from the participants and peers on my facilitating of learning.

Chapter 5. Findings, discussions, recommendations and meta-reflection on the research process. In this chapter the empirical research findings are linked to the innovative research questions presented in Chapter 1. The contributions and challenges of the study are discussed, followed by recommendations for future research. The chapter is concluded with meta-reflection on the research process. As a self-regulated professional, I need to take responsibility for planning for innovation, monitoring and assessing my teaching practice, which I did by means of continuous scholarly reflection throughout my study as proposed by Wolvaardt and Du Toit (2012:1254).

The reflection on my reflections during the conducting of my research is known as meta-reflection (Hagström & Scheja, 2014:242). It demonstrates that the claims made on my professional development trajectory are integral to my lived experience.

This Chapter 1 is concluded with a table (Table 1.2 below) of constructs (commonly referred to as terminology) used throughout the study.

1.8 Constructs

Table 1.2: Constructs used in dissertation

Construct	Meaning-making
Action research	A mode of inquiry to investigate and evaluate one's teaching practice for the purpose of improving learning (Costello, 2003:3).
Authentic learning	Is concerned with learning quality and is a process of continual transformation (Slabbert *et al.*, 2009:70).
Bloom's taxonomy	Is a classification system used to define and distinguish different levels of human cognition, e.g. thinking, learning and understanding.
Brain profile	A formal summary or analysis of information regarding the brain from tests or questionnaires that have been administered, often in the form of a graph or table, representing distinctive features or characteristics (Slabbert *et al.*, 2009:7).
Cognition	The mental process of knowing, including aspects such as awareness, perception, reasoning and judgement (Slabbert *et al.*, 2009:8).
Community of practice	Groups of people in organisations that form to share what they know, to learn from one another regarding some aspects of their work and to provide a social context for this work; social learning resulting from the need to be connected (Slabbert *et al.*, 2009:10).
Competency	The ability to do something well or efficiently (Slabbert *et al.*, 2009:10).
Conceptual learning	A process of developing abstract rules or cognitive constructs based on sensory experience (Slabbert *et al.*, 2009:10).
Constructivism/Constructivist learning	Knowledge is not passively received either through the senses or by way of communication, but is actively constructed by the individual through interaction with the environment (Slabbert *et al.*, 2009:10).
Co-operative learning	Takes place when learners in small groups cooperate to learn with the exclusive purpose to increase the quality of one another's learning to

	maximise their individual and collaborative potential (Slabbert *et al.*, 2009:12).
Critical friends	Group of peers/specialists who engage with one another to share expertise and improve personal and professional development.
Critical reflection	A reasoning process to make meaning of an experience. Critical reflection is descriptive, analytical and can be articulated in several ways, such as in written form, orally or as an artistic expression.
Critical thinking	A concept similar but not identical to meta-cognition, critical thinking is an internally organised skill that selects and guides processes involved in assessing and solving problems (Beitz, 1996:164).
EMIC	A kind of research where the perspective is the perspective of the studied social group.
Facilitating learning	Facilitating learning is a deliberate, conscious intervention in the life of a human being caused by activating learning through challenging obstacles that necessitate exploration of the unknown and by ensuring the continuation of this learning that results in maximising the potential of the human through conquering the obstacles (Slabbert *et al.*, 2009:19).
Facilitator of learning (FOL)	For the purpose of this study the facilitator of learning is the lecturer that is responsible for guiding the instructional and learning processes. Someone that facilitates learning (Slabbert *et al.*, 2009:19).
Hermann Brain Dominance Instrument®	A scientifically validated instrument that quantifies the thinking preferences within a specific quadrant within the Whole Brain® model.
Learning	The activity by which knowledge, attitudes and or skills are acquired (Beitz, 1996:164).
Learning style	Different people have different preferences when it comes to learning. Some may refer and store visual input better, others may benefit from using memory aids (Slabbert *et al.*, 2009:30).
Learning task design (LTD)	The first function of facilitating during which a learning task is designed before it is operationalised (Slabbert *et al.*, 2009:30).
Learning task execution (LTE)	The fourth function of facilitating learning during which the learners are actively executing the learning task (Slabbert *et al.*, 2009:30).
Lifelong learning	A learner who is learning to learn and who is becoming increasingly competent up to the point where quality learning has become a lifelong pursuit (Slabbert *et al.*, 2009:31).
Living theory	A living theory is an explanation produced by an individual for their educational influence in their own learning, in the learning of others and in the learning of the social formation in which they live and work.
Longitudinal research	The subjects or cases analysed are the same, or at least comparable, from one period to the next (Miller & Brewer, 2003:181).

Meta-cognitive knowledge	Blooms taxonomy 2. Thinking about thinking. This comprises three types of knowledge, namely self-knowledge, task knowledge and strategy knowledge and refers to a learner's cognitive ability and skill to use these during learning.
Meta-cognition	Meta-cognition is the intra-personal communication process by which individuals know their personal cognitive processes and the use of critical thinking (Beitz, 1996:164).
Meta-learning	Meta-learning is ·the process of knowing one's personal learning behaviours (Beitz, 1996:159).
Multiple intelligence	One has more than one type of intelligence. The different types are verbal, logical, body, visual, spatial, musical, interpersonal, intrapersonal, naturalist, emotional and spiritual (Slabbert *et al.*, 2009:35).
Ontology	Ways of being (Slabbert *et al.*, 2009:35).
Outcomes-based education	Educational theory that bases each part of educational systems on goal or outcomes.
Paradigm	From the Greek *paradigma*, meaning pattern, is a theoretical structure or a framework of thought that acts as a template/example to be followed (Miller & Brewer, 2003:220).
Participants	Professionals – health science practitioners – taking part in the study.
Perceptual learning	Ability to interpret or become aware of something through the senses.
Radiographic Clinical Practice	Subject specialising in radiographic techniques for the demonstration of specific anatomical structures and pathology.
Sample	The sub-group of the target population that the researcher plans to study for generalising about the target population (Creswell, 2012:142).
Self-regulated practitioner	One's ability to understand and control one's own learning in practice.
Scholarly reflection	Involves thinking about and critically analysing one's actions with the goal of improving one's professional practice.
Target population	Also known as sampling frame. A group of individuals with some common defining characteristics that the researcher can identify and study (Creswell, 2012:142).
Triangulation	In social research the combination of different methods, methodological perspectives or theoretical viewpoints (Miller & Brewer, 2003:326). The type of triangulation most commonly found is some combination of quantitative and qualitative approaches. Proponents of this type of triangulation point out that the advantages of the quantitative approach correspond to the disadvantages of the qualitative approach and vice versa (Miller & Brewer, 2003:327).

Chapter 2: Stage 1 of the study's life cycle

As discussed in Chapter 1, Section 5 my view of action research can be compared to the butterfly effect and the stages during of a butterfly's life cycle. The minute eggs represent identifying what to improve in everyday practice. Identifying an aspect for improvement in my practice represents the tiny worm-like creature hatching from the egg. This is the main objective of this chapter: an extensive discussion of the literature indicates identifying what to transform in my practice and how to go about realising it.

2.1 Introduction

This chapter takes the form of a report on the literature I have consulted and on which the theoretical framework is based. To explore and clarify how the principles of Whole Brain® thinking may contribute to transforming Radiographic Clinical Practice, I critically reviewed all the relevant literature. During my search I came to realise that not many studies have been conducted on Whole Brain® learning in the field of Radiography in South Africa ; perhaps the only one on this topic is the work of Van der Watt (2008). In this chapter I report on investigating the need for professional development in the complex and ever-changing technology in Radiography. The work of the several experts was consulted in this regard (Cosson & Willis, 2012; Gee, 2008; McClanahan & McClanahan, 2002; Pascual, Chhem, Wang, & Vujnovic, 2011; Pieterse, Lawrence, & Friedrich-Nel, 2016; Raby, 2017). The main theoretical underpinnings are visualised by means of a metaphoric representation. The interrelatedness of the Herrmann Whole Brain® metaphoric model (Ned Herrmann, 1998:217) and Howard Gardner's multiple intelligence (Gardner, 1993) is indicated in this visual representation. As elaborated in Section 2.5.1 in terms of thinking preferences and Herrmann's Whole Brain® Model, it is important that there is a balance between the analytical, practical, relational and experimental quadrants (Ned Herrmann, 1999:2). This is aligned with Gardner (1993) view of Multiple Intelligence (MI) and the belief that everyone is made up of a range of unique characteristics. As

reported in (Du Toit, 2019b:15) the concept *intelligence,* known as mental intelligence (Slabbert *et al.*, 2009:74) or commonly referred to as IQ is multidimensional and cannot be reduced to a single number on paper.

Some other important theories and concepts to follow are those pertaining to learning, holistic thinking, critical thinking, reflection, reflective practice, professional development and self-regulated professional learning.

Furthermore, to understand the epicentre of my research topic holistically and facilitate Whole Brain® thinking, I consulted the work of several experts (De Boer *et al.*, 2013; Du Toit, 2018; Herrmann-Nehdi, 2009; Herrmann International, 2016; Ned Herrmann, 1998; Oosthuizen, 2001).

From the seminal work of Ned Herrmann (1996) and my conceptualising thinking preferences in the context of the private X-Ray department, I decided to use Whole Brain® thinking to take advantage of the preferences of each participant. These extend to other quadrants when required and take advantage of the preferences of fellow participants to improve results and performance. Closely linked to Whole Brain® thinking is Slabbert *et al.* (2009) ideas of creating a unique professionalism. The rest of the interrelated constructs, discussed in Chapter 1, Section 6, such as constructivism and self-regulated learning are integrated as part of my theoretical framework that informs the epistemology of the professional development process I followed.

The work of the following professional experts was consulted: (Biggs, 1996; Gardner, 1993; McNiff, 2002, 2014; McNiff & Whitehead, 2002; Piaget, 1976; Von Glasersfeld, 2001; Whitehead & McNiff, 2006; Zuber-Skerritt, 1992, 2001). All these interrelated constructs mentioned in the previous paragraph were used to construct new meaning as part of a constructivist (Von Glasersfeld, 2001) approach to my professional development.

The golden conceptual thread that is to be found throughout the study can be described as Whole Brain® self-regulated constructivism (Du Toit, 2019b). It should be kept in mind that the theoretical framework in the first place represents the double-layered dimension of my practice. This means that two contexts of learning are

involved. It is about my professional learning on the one hand, and student [participant] learning on the other. I distinguish between these two different contexts (Du Toit, 2014:258) by referring to the construct *learning* only when reference is made to the participants. When the construct *professional learning* is used, reference is made to my professional learning. Participants as professionals should learn with a view to being able to make a positive difference in the 21st century world of work. Although there are numerous attributes of the 21st century, my study focuses on leadership, being able to communicate, identifying and analysing real-life problems with a view to solving them and to being able to contribute as a member of a multidisciplinary healthcare team (Du Toit, 2019a:175).

2.2 My role as lecturer

As I have several roles to enact as a professional, such as being a lifelong learner, which is closely linked to what I refer to in the previous paragraph, I consequently focus on all the roles of a lecturer. There are seven roles of a lecturer that are outlined in the *Norms and standards for educators* (*Norms and standards for educators*, 2002). They are interrelated. In my action research project these roles were closely integrated. Apart from growing as a scholar and lifelong learner – a professional – I focused on facilitating learning, designing a learning programme and complementing study material, the role of a leader and assessor. I kept all these responsibilities in mind as my higher education practice is multidimensional in nature. It is multidimensional owing to all the facets that form part of it. For me, as a self-regulated professional, I need to take responsibility for planning for innovation, monitoring and assessing my teaching practice, which I did by means of continuous scholarly reflection throughout my study as proposed by Wolvaardt and Du Toit (2012:1254).

As mentioned above, it is my responsibility as a facilitator to facilitate learning in a holistic Whole Brain® manner, which is aligned with the outcomes-based education (OBE) curriculum. The OBE's aim from the Department of Education is quoted next:

> *OBE aims to develop the full potential of each learner as a citizen of a democratic South Africa. It seeks to create a lifelong learner who is confident and independent, literate, numerate and multi-skilled, compassionate, with a*

> *respect for the environment and the ability to participate in society as a critical and active citizen* (*Norms and standards for educators*, 2002).

These attributes are commonly considered to be attributes of the 21st century that both my students as up-and-coming professionals and I as a professional should enact. An extensive list of these attributes is included in the work of Du Toit (2019b:180). The OBE curriculum indirectly links to the South African Qualifications Authority (SAQA) that has published critical cross-field outcomes (SAQA, 2012) that need to be achieved by students in higher education, in addition to the programme specific outcomes. One of the 12 critical cross-field outcomes, namely critical thinking, has not been researched by qualified diagnostic radiographers in the South Africa Radiography context (Pieterse *et al.*, 2016:382), strengthening the reasoning for the proposed project.

Slabbert et al. (2009:49) explain how facilitators should hold themselves accountable for the following:

> *The aim of education is to empower learners to maximise (completely develop and fully utilise) their human potential (fundamental human virtues) through facilitating lifelong authentic learning (resolving real-life challenges) in order to create a safe, sustainable and prosperous future for all.*

The goal of education has changed over the last two decades. It changed its focus from “learning to know”, acquisition of the basic literacy skills − reading, writing and calculating − to “learning to be”, critically engaging in all aspects to solve complex problems (Slabbert *et al.*, 2009:49). (Bransford, Brown, & Cocking, 2000) argue that the meaning of “knowing” has shifted from being able to remember and repeat information to being able to find and use it. I agree about the statement made by (Bransford *et al.*, 2000), in the rapidly advancing technological field of Radiology, I have to ensure students become self-regulated students, in such a way that they develop as holistic and whole-brained employees or even employers who take responsibility for maximising their full potential (Du Toit, 2013:1). These holistic independent radiographers will be leaders in the 21st century and will have developed the ability to think in an agile way (N Herrmann & Herrmann-Nehdi, 2015).

2.3 Constructivism

As early as the 17th century an Italian philosopher, Giambattista Vico, cited in Von Glasersfeld (2001:164) posit the following: "God knows the world because He created it; human beings can only know what they have made themselves". Constructivism is complex and consists of multiple theories (Biggs, 1996:347) but in essence all the theories have the same centrality, namely how we come to know or understand (Savery & Duffy, 1995:1), which is a learning or meaning-making theory (Richardson, 2005:3).

Constructivist epistemology accepts that individuals construct their own meaning and knowledge on the foundation of interaction with their situation in the environment (Van der Watt, 2008:35) through both social and individual activities (Biggs, 1996:348). The new experiences are incorporated into an already existing framework.

Constructivism is discussed above as a general theory. I used the principles of constructivism in the same way by facilitating learning opportunities that were participant-centred and where each participant had to create his or her own meaning.

An example of presenting a learning opportunity is by using an application known as Kahoot! A study conducted indicates that educational games can increase participants' academic achievement (Yazicioğlu & Cavuş-Güngören, 2019:391), motivate them to learn and have a positive effect on their attitude to learning (Urek, 2020:1067). Research supports Kahoot! as a successful tool for facilitators because it engages students in problem solving, critical thinking and the review of content knowledge (Dellos, 2015:49).

The Kahoot! App allowed live feed interaction among the participants. This created a competitive environment as the game centres on a leader board determined by the participants' answers. It results in a unique learning environment by immersing the participants in the learning opportunity.

Constructivism is one of the theories that oppose the traditional transmission models of teaching. The traditional transmission of learning modulates absorption of information. Absorption means that the participant passively "absorbs" information

compiled by others. Constructivism offers a sharp contrast to this traditional transmission and absorption model (Clements & Battista, 1990:34).

The traditional learning model, which most individuals are familiar with, inhibits any collaboration between new and prior knowledge; it prevents reflection and conversations that are essential for deep understanding, authentic learning and critical thinking (Richardson, 2005:3). A participant cannot passively receive knowledge; knowledge needs to be established and created actively (Clements & Battista, 1990:34) and applied, but moreover, needs to be created.

According to Von Glasersfeld (2001:165), Albert Einstein wrote the following seventy years ago:

> *Physical concepts are free creations of human thought, and are not, even if they seem to be, solely determined by the external world.*

Von Glasersfeld (2001:165) explains from a constructivist point of view that creating concepts is a form of constructing, and constructing involves reflection.

As a diagnostic radiographer having worked in health sciences for 10 years, radiographic positioning became a habit to me and is accomplished instinctively. As a student I had to make connections by means of continuous reflection. Essentially, constructivist learning transpires when individuals critically reflect, transform their opinions, views, ideas and paradigms as a result of such reflection, and creatively question concerns with the intention of indicating their solutions to problems of real-life challenges (Van der Watt, 2008:35). This approach of collaboration with critical friends can be described as socio-constructivism (Rossouw, 2015:76). Thus, knowledge from a socio-constructivist point of view is the result of active engagement, negotiation, communication and reflection (Slabbert *et al.*, 2009:57). The participants formulate their own views, ideas and conclusions based on this active engagement and reflection (Piaget, 1976; Von Glasersfeld, 1996:53). All the characteristics of constructivism are aligned with action research, which results in transformation within one's teaching practice (Rossouw, 2015:75). Consequently, it was my responsibility as the facilitator to facilitate the learning of participants in such a way that they became

self-regulated professionals who could take responsibility for their learning and development.

To ensure that holistic learning takes place, the participants need to, apart from a number of other factors such as a well-equipped laboratory, people skills and communication, recognise their thinking preference as well as their least preferred preference, know how to monitor their professional development process and how to adjust their thinking preferences to become holistic individuals. This is possible (Singh, 2015:45) through the process of self-regulated learning and a combination of Herrmann's (1996) and Gardner's (1993) theories.

2.4 Radiography as an industry

Since Wilhelm Conrad Roentgen invented X-Rays on 8 November 1895 in Würzburg, Germany (Curry, Dowdey, Murry, & Christensen, 1990) the radiographer's role has changed continuously and will constantly advance in parallel with the rapidly advancing technological field of Radiology. Radiographic Practice has grown into one of the largest allied health sciences in the world that focus on diagnostic imaging with radiation (Raby, 2017:1). It is extremely important that radiographers possess critical thinking skills, allowing them to produce optimal diagnostic images (radiographs) for the radiologist to interpret, diagnose and report (Raby, 2017:11).

Radiographic Practice plays a significant role in the health care services and cooperates in an inter-disciplinary and multi-disciplinary way with various professions (Oliveira, Geambastiani, Lopez, Cambui, Ubeda, & Mdletshe, 2019:205). There is an ongoing flux in the expectations of practitioners and students (Mc Inerney & Druva, 2019:1). Therefore, it is important to prepare participants as professionals to become self-regulated lifelong learners − professionals that take responsibility and accountability (Dos Reis *et al.*, 2018:61) for their own learning and who work autonomously, improving patient care through using a critical and reflective approach to decision-making (Cockbain, Blyth, Bovill, & Morss, 2009:243).

In the ever-changing field of radiology, education will fail if it continuous to be ordinary. Developing Whole Brain®-focused radiographers is imperative for the industry to be

effective and efficient, while improving or maintaining the well-being and heath of the patients in an era of rapidly advancing technology (Dos Reis *et al.*, 2018:61).

2.4.1 Radiographic Clinical Practice as a subject

The Health Professions Council of South Africa (HPCSA) regulates medical radiation practitioners in the country (Act 56 of 1974); students must be registered with the Board to practise. In 2020 all higher education institutions in South Africa were expected to introduce the new degree HEQSF (Higher Education Qualification Sub Framework) programme. The new degree is a four-year professional degree, 550 credit programme (SAQA, 2012) evolving from a three-year National Diploma (National Qualifications Framework (NQF) exit level 6 to NQF exit level 8. The Minister of Higher Education and Training in South Africa approved the NQF system. It is an all-inclusive system utilised for the registration, classification and publication of quality-assured and articulated national qualifications. The aim of the NQF is not only to promote the social and economic development of the nation at large, but also to ensure each learner reach his or her full potential (SAQA, 2012). The minimum radiographic clinical time until 31 December 2019 was 3 000 hours over a period of three years. It was regulated by the compulsory clinical hours part of the official university roster. Currently the focus is less on the number of hours spent in the Radiographic Clinical Practice and more on the quality of competency skills.

Radiography education across South Africa aims to graduate competent students who have a thorough foundation of knowledge and applicable skills (competencies) for the Diagnostic Radiography profession. These acquired self-constructed competencies need to be constructed and applied in a suitable clinical workplace context. The Bachelor of Diagnostic Radiography (programme code BPRA20) offered by Tshwane University of Technology in South Africa, empowers the student to construct a combination of theory, principles, proven techniques, practical experience and appropriate skills for the clarification of real-life challenges in the field of Diagnostic Radiography (SAQA, 2012). As mentioned in Chapter 1, South Africa's higher education landscape consists of public and private universities that are either contact or distance education institutions as well as colleges. Tshwane University of

Technology is a University of Technology and a public contact university. The young professional ought to develop in a self-regulated lifelong learner and a reflective practitioner in his or her profession, thereby advancing society and the community (SAQA, 2012). As discussed above, the radiographer's role will continue to change with technological advancements (Cronin, Fitzgerald, Gillard, Ghotra, Kieft, & Reynolds, 2018:100). This is true for the facilitator's role in Radiography education. Maintaining workforce competence, while responding to the most recent clinical requirements in terms of radiographic facilitation, is a vital duty of Radiography facilitators (England, Geers-van Gemeren, Henner, Kukkes, Pronk-Larive, Rainford, & McNulty, 2017:1). Although methods of facilitating learning differ in institutions in different countries, they all are multi-faceted, incorporating practical and theoretical components (Cronin *et al.*, 2018:100).

Even though Radiographic Practice incorporates theory and practice, it is of the utmost importance that students have all relevant theoretical and clinical knowledge before working clinically with patients, as diagnostic X-Rays use ionizing radiation that is hazardous for human health (Bushong, 2008:5). Radiographic Practice is therefore divided into two parts, namely the theoretical and clinical component. Additional clinical education is facilitated in a private or government hospital (England *et al.*, 2017:1). The practical or clinical education is a core component and plays an essential role in preparing radiography students to work with patients (Raby, 2017:11; Shanahan, 2016). The success of a clinical learning opportunity is paramount to ensure that student radiographers are prepared for the constantly changing clinical practice due to technology advancements (Cronin *et al.*, 2018:100). The facilitators in clinical education have an immense task facilitating radiographers to become autonomous (Wertz, Mickelsen, & Hobbs, 2014) and self-regulated Whole Brain® individuals who are competent in resolving problems encountered in this ever-changing world of work. Lorimer and Hilliard (2009:1) suggest that facilitators need to realign their facilitating of student learning in such a way that students become successful in the 21st century society. As discussed above, an extensive list of these attributes is included in the work of Du Toit (2019b:180). By facilitating Whole Brain® learning, the participants were accommodated and challenged.

Facilitating learning in the 21st century, according to (Slabbert *et al.*, 2009:102) is firstly initiating learning by means of learning task design (LTD) and learning task presentation (LTP); secondly, by authentic learning (AL) and thirdly, maintaining learning by means of learning task execution (LTE), learning task feedback (LTF) and learning task consolidation (LTC).

The major challenge the students [participants] in the 21st century are faced with is having to learn factual information while being facilitated how to interpret or decipher the information available to them, to reflect critically and problem solve in a specific clinical context (Spencer, 2008:89). Problem solving or real-life challenges as Slabbert *et al.* (2009:66) call them, are a vital skill for healthcare professionals in a constant evolving technology field (Pieterse, Lawrence, & Friedrich-Nel, 2014:33). Empowering students [participants] to problem solve inspires them to think critically, which in turn improves clinical competence (Pieterse *et al.*, 2014:33). Therefore, facilitating learning in such a way that participants become competent in solving real-life problems allows the facilitator to integrate theory and practice, develop and improve clinical interpretation and address the needs of the patient owing to better patient care and clinical competence (Pieterse *et al.*, 2014:33)

2.4.2 Research on Radiographic Clinical Practice

A study was conducted in Europe (Holmström & Ahonen, 2016:371) to describe research methodology and findings concerning Radiography students' learning. The phenomenon in the research concerning the learning of Radiography students focused on clinical or theoretical studies. The different learning methods such as peer-assessment, research-based learning and blended learning were studied to determine which learning methods were preferred by the students.

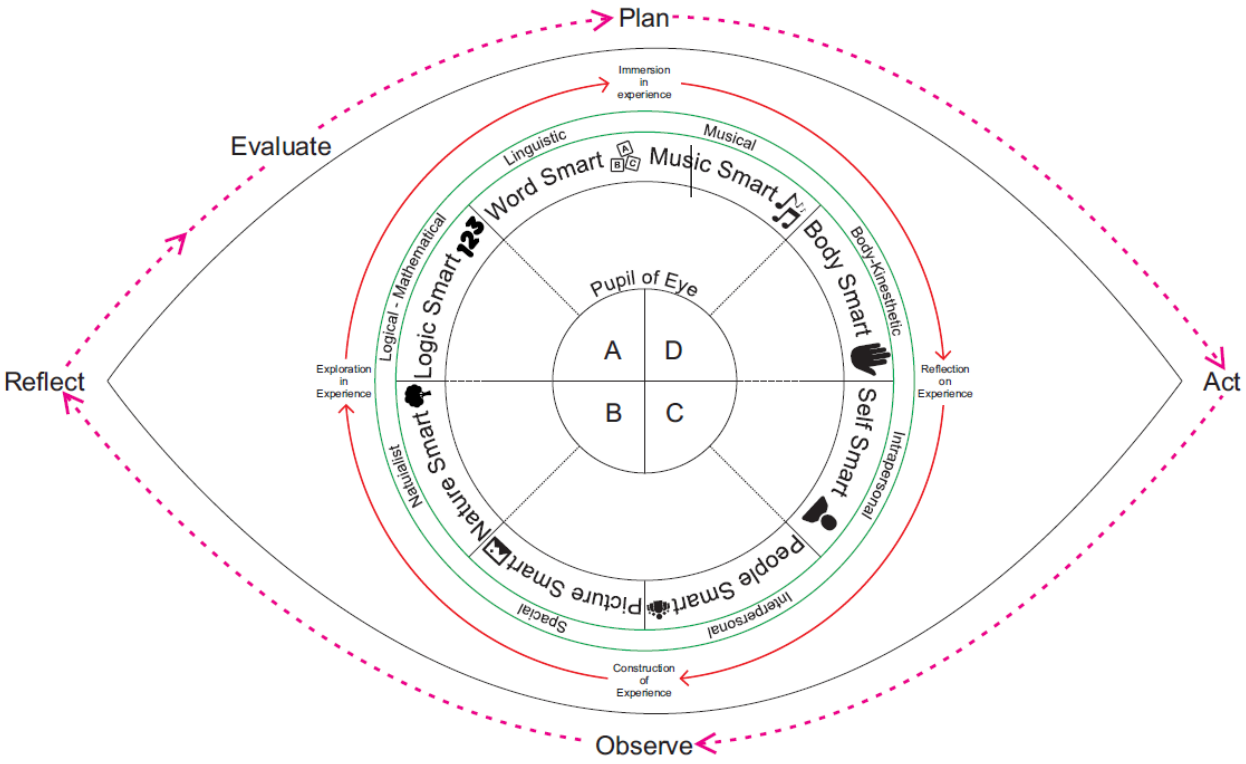
Holmström and Ahonen (2016:377) point out that most research is quantitative in nature. Unfortunately, there is a paucity of available qualitative literature in the field of Radiography education. The studies often apply the results from other fields of research, mainly nursing and education sciences as point of departure in quantitative studies.

Unfortunately, there is a lack of available relevant literature and it is evident that there is a marked absence of research done in the field of Radiography education. Research on radiographic clinical practice is a poorly known phenomenon in South Africa. My mixed method approach – elaborated on in Chapter 3, Section 3.4 – seems to be of significance as the qualitative aspect of my study is extremely important since it is the starting point of studying a poorly known phenomenon.

2.5 Conceptual argument

The interrelatedness of applicable theories is indicated by means of a metaphoric visual representation. The visual below (Figure 2.1) is followed by a brief discussion of its content.

The theoretical underpinning or research conducted in the field is presented in the following figure. Some important theories and concepts are those pertaining to learning, holistic thinking, critical thinking, reflection, reflective practice, professional development and self-regulated professional learning



Structures represent the following:

- Pupil – Whole Brain® individual
- Iris – Adapted Howard Gardner's multiple intelligence
- Sclera –The cycle of authentic learning in student and professional development
- Eyelid – Professional development and self-regulated learning propelled by action research.
    - NB: not part of theory, just to indicate professional development

Figure 2.1: Integrated metaphoric visual representation − the interrelatedness of applicable theories

Figure 2.1 above is a metaphoric visual representation of the human eye. Although the human eye is among the smallest organs in the entire body, it is one of the most important organs to all individuals, as sight is the sense that humans tend to rely on most. The pupil – the opening in the centre of the iris − of the eye represents the Whole Brain® individual. Whole Brain® thinking forms the epicentre or core theory of my study. To explain briefly, the A quadrant, also referred to as the rational self, represents mainly fact-based thinking; the B quadrant is sequential thinking – referred to as the safekeeping self; the C quadrant shows relational or emotive thinking – referred to as the feeling self, and the D quadrant experimental thinking – the experimental self (De Boer *et al.*, 2013; Du Toit, 2019a:180; Ned Herrmann, 1998). This is elaborated on in the next section.

The eyelid (thin skin that covers the eye) indicated in pink in the figure above represents the reflective practice and demonstrates my personal development. Consequently, the focus is on professional development and professional self-regulated learning, which is propelled by scholarly reflective practice. Although every individual has eyelids, this structure is most commonly used by females to express themselves by means of make-up. Through action research I continuously applied different colours and techniques (make-up) to my eyelid, demonstrating personal growth and development.

The iris, indicated in green in the figure above represents the adapted Howard Gardner's multiple intelligence (Gardner, 1993). Both Howard Gardner's model and the Whole Brain® model represent holistic thinking examples. Interpersonal intelligence relates to both the B and C quadrant, linguistic intelligence relates to both the A and B quadrant and logical intelligence relates to both quadrant A and B.

The different intelligences must be developed, ensuring that both my students and I as the lecturer become Whole Brain® partners (Du Toit, 2018:35). When we become Whole Brain® partners multiple intelligence can be nourished and developed. The sclera (white part) of the eye represents the cycle of authentic learning as well as my professional learning (the double-layered nature of my practice).

Authentic learning, indicated in red in the figure above, is concerned with the quality of learning and is a process of continual transformation. The characteristics of authentic learning are immersion; reflection; construction; exploration and holism (Slabbert *et al.*, 2009:72). I do not fully agree with scholar Har (2013:1) who states that authentic learning occurs when students practise the knowledge and skills that are relevant to workplace situations and learn at the same time. Authentic learning is more than just skills and knowledge aligned with a content-driven curriculum. Authentic learning should be process-driven (Du Toit, 2019a:178) through constructivist learning. As lecturer I should initiate learning through whole-brained, real-life challenges and keep on challenging students until the highest possible quality of learning is reached. This approach will ensure authentic learning (Slabbert et al., 2009). Reflection is a critical mental assessment of the actions involved; thus, constructivist learning occurs from the experience in resolving the real-life challenges.

2.5.1 Herrmann's Whole Brain® model

As a lecturer, I view myself as a role-model for my students (one of the attributes of the 21st century) and I am constantly aware of developing my full potential and encouraging the same mind-set in my students as young professionals. William Edward, "Ned" Herrmann, is known as the father of brain dominance technology. He is known for his research not only on creative thinking but also on Whole Brain® thinking preferences (Ned Herrmann, 1998). His daughter, Ann Herrmann-Nehdi, is currently the CEO of Herrmann International and does seminal work to promote a better understanding of how individuals and organisations think to become more effective (N Herrmann & Herrmann-Nehdi, 2015). Herrmann's research on brain dominance is documented in a number of publications (Ned Herrmann, 1995a, 1996, 1998). The essence of the research is to explain how the four different modes of thinking humans use can inform their practice; for example, processing information, communicating and solving problems. This, in principle, is the preferred way in which individuals choose to execute tasks. This choice is commonly referred to as one's comfort zone (De Boer *et al.*, 2013; Ned Herrmann, 1998; N Herrmann & Herrmann-Nehdi, 2015; Lothian, 2011).

Both my students and I have our own comfort zones as a point of departure when engaging tasks.

The Whole Brain® model (Consult Figure 2.2) illustrates that thinking preferences are determined not only by left or right brain dominance but consists of four different learning modes. Individuals have preferences for the way they understand information and construct new meaning, known as constructivism (Von Glasersfeld, 2001).

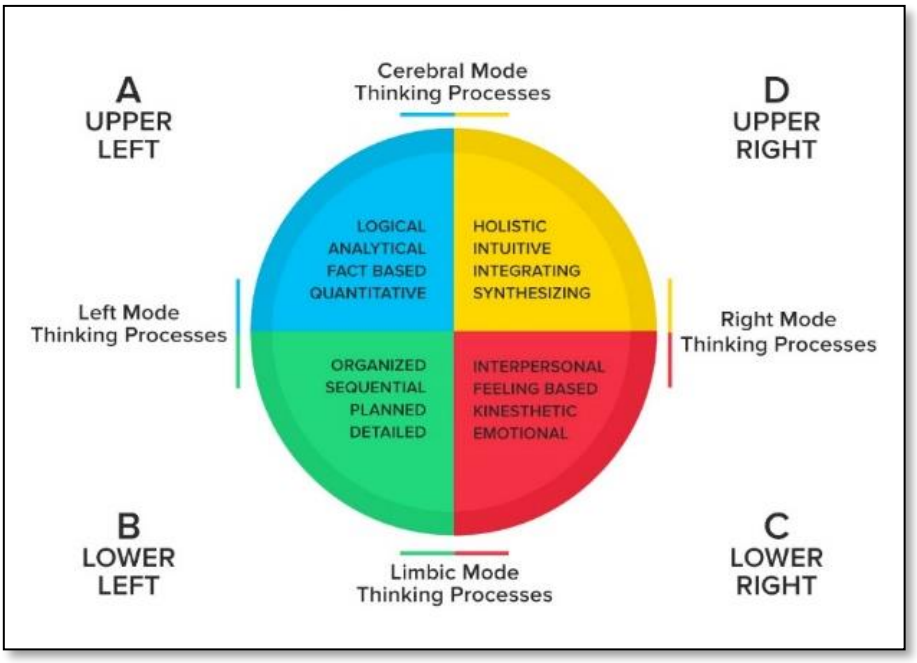


Figure 2.2: Herrmann's metaphoric Whole Brain® model (Herrmann, 1998)

Quadrant A (upper or cerebral left brain), known as the rational self, is described as the analytical quadrant where the thinking processes are associated with logical, analytical, fact-based and quantitative processes. Quadrant B (lower or limbic left brain), known as the safekeeping self, is described as the practical quadrant, where the thinking processes are associated with organised, sequential, planned and detailed processes. Quadrant C (lower or limbic right brain), known as the feeling self, is described as the relational quadrant, where the thinking processes are associated with interpersonal, feeling-based, kinesthetic and emotional processes. Quadrant D (upper or cerebral right brain), known as the experimental self, is associated with holistic, intuitive, integrating and creative processes (De Boer *et al.*, 2013; Ned Herrmann, 1998). I as lecturer must challenge students by motivating them to

approach the process at hand with a different mind-set that is not part of their thinking processes of choice. Students are therefore challenged out of their comfort zone; facilitating of learning has the responsibility of developing Whole Brain® individuals.

The assessment tool that Herrmann applies to profile one's thinking or learning style is known as the Herrmann Brain Dominance Instrument® [HBDI®] (N Herrmann & Herrmann-Nehdi, 2015:79; Singh, 2015:17).

Coffield, Moseley, Hall, and Ecclestone (2004:79) report on the validity of the instrument and refer to the fact that "it has good face, factorial and construct validity and is claimed to have catalytic validity when applied in the educational field". Du Toit (2013:5) explains that (Coffield *et al.*, 2004:79) link the good face validity to the reality that the HBDI® relates to one's real-life experiences; they thus deem the instrument authentic. Coffield *et al.* (2004:79) indicate that sound statistical analyses were conducted. The Coffield Report on thinking preferences concluded that the HBDI® and Whole Brain® Model are one of six suggested models in training and education (Goode, 2014:23).

The HBDI®, a popular instrument or assessment tool consisting of 120 questions (Consult Appendix II) is based on 30 years of extensive research and determines one's mental preference for a specific thinking mode (Scheepers, 2014:34). There are over two million respondents in the database from over 45 countries (Scherman, 2014:8). The instrument indicates how individuals choose to learn, what they pay attention to and what turns them off. It is important to understand that the HBDI® is not a test with right or wrong or good or bad answers; the concept deals with uniqueness and personal differences (Ned Herrmann, 1995b).

From the body of knowledge on brain research Herrmann constructed the metaphoric Whole Brain® model as demonstrated in Figure 2.3 (John Doe Visual profile) below. It is a model presenting how mental preferences are distributed in a four-quadrant profile. The model was established on the belief that there are four interconnected clusters of distinct thinking abilities and ways of "knowing" (Lumsdaine & Lumsdaine, 1995:193; Scherman, 2014:9).

The HBDI® profile results are depicted in a Whole Brain® manner, with a visual profile (Consult Figure 2.3 below), and a data summary sheet. The visual profile is a graphic displaying four quadrants that are quantified and marked on the axes intersecting the four quadrants (Herrmann International, 2009:10). As illustrated in the blue quadrant A in Figure 2.3 below, a score of zero starts in the middle where the axes of the quadrants intersect; it moves to 140 on the most outward area of the circle. The scores of an individual is a visual representation that synthesises his[1] responses into a global visual profile as presented below (Herrmann International, 2009:10). A low preference and potential avoidance is illustrated closer to the centre of the quadrants, with intermediate preference, preference and very strong preference radiating to the outward area of the circle (Herrmann International, 2009:1)

At the top of a visual profile is a preference code, adjective pairs and profile scores for easy reference (Herrmann International, 2009:10). The profiles and scores indicate thinking preferences in four different ways of thinking and "knowing" (Lumsdaine & Lumsdaine, 1995:193)

[1] To facilitate expression only the masculine pronoun is used henceforth.

Quadrant :	A	B	C	D
Preference Code :	1	1	3	2
Adjective Pairs :	9	6	3	6
Profile Scores :	111	75	33	53

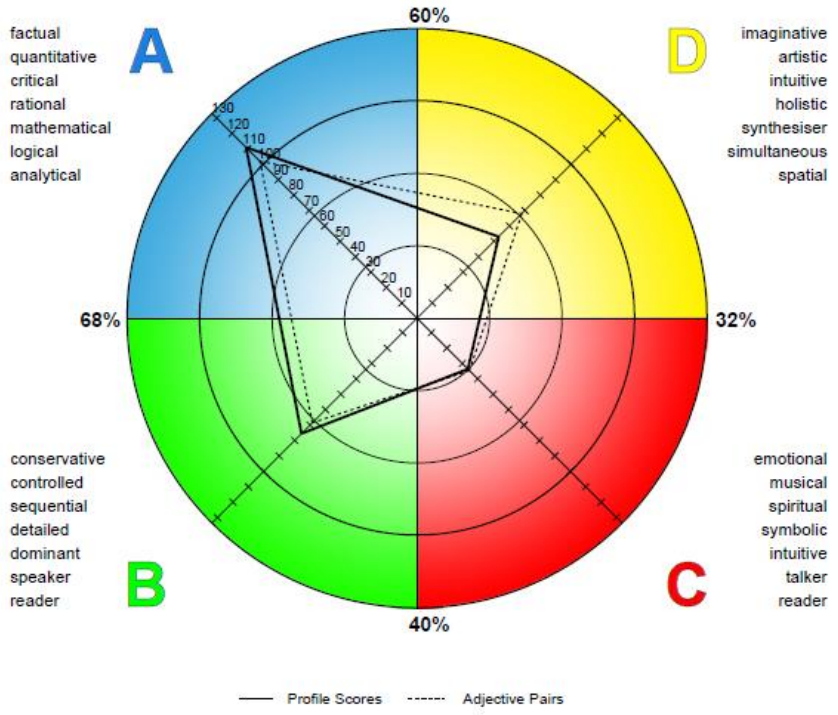


Figure 2.3: Joe Doe Visual Profile

Different profiles are to be found and are dependent on the answers of each individual respondent. HBDI® profiles are plotted along axes on a circular grid, as indicated in Figure 2.3 above.

The profile indicates the dominant quadrant(s) and the extent to which it is dominant. Dominancy may lie in one quadrant – single dominant profile; two quadrants – double dominant profile; three quadrants – triple dominant profile, or all four quadrants – quadruple dominant profile (Herrmann International, 2009:19-34). Single dominant profiles (where the preference code “1” occurs only once in a profile) represents 5% of the population, triple dominant profiles 34% (where the preference code “1” occurs three times) and 3% of the population represents a quadruple dominant (where the preference code “1” occurs four times). The remaining 60% represents double

dominant profiles – in the same hemisphere, in the cerebral or limbic or diagonal opposites – and preference code “1” appears twice (Herrmann International, 2009:19-34).

Preference code 1 indicates a strong thinking preference with a score of more than 67; code 2 indicates a lesser preference suggesting comfortable usage when the situation is neither preferred nor avoided, with a score between 34 and 66; code 3 indicates potential avoidance with a score between 0 and 33. This does not mean that it is impossible for a learner to use this thinking mode (Ned Herrmann, 1995b:70)

The adjective pair data comes from the forced choice pairings section on the HBDI® questionnaire; the individual must choose between opposing qualities (Herrmann International, 2009:12). The quantity (from 0 to more than 10) reveals which quadrants are most preferred (highest score) for learning in a stressful situation (Oosthuizen, 2001:71).

The HBDI® results make an individual attentive not to avoid his less preferred thinking preferences, forcing him to think out of the box; this is exceedingly important in the 21st century’s ever changing world of work.

In the light of the above, I endeavour to contribute to the literature on professional development, Whole Brain® learning and agile 21st century leader radiographers. I make my own professional learning clear and explore the validity of my knowledge claims by making these public as (Whitehead & McNiff, 2006) suggests.

2.5.2 Whole Brain® thinking as background to Radiography

Every group of students represent thinking style preferences in all four quadrants (De Boer & Van den Berg, 2001:124; Du Toit, de Boer, Bothma, & Scheepers, 2012:151; Ned Herrmann, 1996) but learning avoidance in a specific quadrant may also exist (De Boer & Van den Berg, 2001:124; Du Toit, Steyn, & De Boer, 2001; Scheepers, 2014:30). Developing a Whole Brain® model for radiographers is imperative in an era of rapidly advancing technology. Thus, using Whole Brain® learning in Radiography training is vital because it uses methods and tools that learners are already

accustomed with, which helps engage learners (Wertz *et al.*, 2014:23). But it also challenges the learners with new methods and tools that the learners are not familiar with, thinking preferences that have not been experimented with in the traditional school system. Authentic lifelong learning is facilitated and creates unity among the learners, facilitators and the course content material.

The motivation of learners plays an important role in success in the classroom. A study conducted concluded that students with a high level of motivation excelled in quizzes in a student-centred classroom setting (Chuang, Weng, & Chen, 2018:65). It is important for the facilitator to make it clear to the students that the success of the curriculum depends on their involvement and that they are accountable for their own learning (Raby, 2017:17). As students have become comfortable with traditional lecturing where the facilitator elevates himself, most of the times students are not comfortable with the concept of self-regulated learning. This in turn relates to the fact that students lack certain critical thinking skills (Raby, 2017:17), which are vital in an ever-changing world of work. An investigation done by Van der Watt (2008:1) revealed that critical reflection adds value to the effectiveness of learning. The ability to think critically is no longer a choice for radiographers. Radiographers are required by the Professional Board for Radiographers and Clinical Technologist (RCT board) to welcome a current and integrated conceptualisation of competence, including the capacity to think reflectively and critically to resolve clinical challenges (Mc Inerney & Baird, 2016:40).

Critical reflection is an active Whole Brain® integrated activity and fosters self-regulated learners. Research has proved that students are more partaking when a facilitator includes active hands-on learning strategies in their learning opportunities (Sedden & Clark, 2016:612). Another study reaffirmed that active learning strategies improve critical thinking and team cohesion (Carrasco, Behling, & Lopez, 2019:122).

Dahl and Smimou (2011:586) found that motivation creates the two exact concepts: “Higher levels of value motivate students; higher levels of interest and intrinsic motivation enable student performance”. Therefore, (Raby, 2017:18) came to the conclusion that if students notice that the outcome is worth the work, they tend to be more motivated. Motivation is cultured through active Whole Brain® learning

techniques such as interactive Whole Brain® learning instruction, co-operative learning that takes place when learners in small groups cooperate or work together to learn, and flipped classroom settings (Raby, 2017:18).

Active learning involves activities that motivate students to participate, and in return reflect, and construct their own meaning from their actions (Raby, 2017:18).A study conducted by Gainor, Bline, and Zheng (2014:200) concluded that active learning approaches are effective for three main reasons: "(1) They focus on the student's own personal experience resulting in the fact that the student can more easily relate to the examples created by his peers; (2) they empower the student, and (3) they create a competitive, active-learning environment". The techniques used for active learning include interaction with students during learning experiences, debriefing the learning activities, reflection, journaling, group activities, brainstorming, and eliminating some lecture material in exchange for time to incorporate active-learning activities (McClanahan & McClanahan, 2002:93-94).

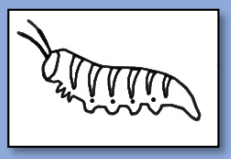
As a lecturer I view myself as a role model for my students, starting with action research, which is a perfect example of active learning; this is discussed in detail in Chapter 3, Section 3.3.

2.6 Conclusion

This chapter took the form of a literature review and provided the theoretical framework. Relevant concepts and theories addressed in the chapter clarify how important Whole Brain® learning is and why transforming clinical practice is important in the 21st century. The relevant literature was reviewed in a reflective manner; by engaging with the literature I constructed my own meaning. I use all the constructed information as I continue with Action Research in my practice.

This chapter provides the theoretical foundation for the action research design, which is discussed in the next chapter. All the methodological strategies that were adopted for the study are addressed in detail in the next chapter.

Chapter 3: Stage 2 of the study's life cycle (Research design and methodology)



As discussed in Chapter 1, Section 5, my perception of action research can be compared to the butterfly effect and the stages in a butterfly's life cycle. The second stage is known as the caterpillar or larva. Each caterpillar is unique, having different patches and stripes. The caterpillar grows rapidly and sheds its skin multiple times. This represents the aspect of transforming – a clear and defined plan of how to transform one's teaching practice, which is the main objective of this chapter.

3.1 Introduction

I conducted the study directed by the question, *How can my professional development and the learning of my students be developed in a synchronistic fashion?* As explained in Chapter 1, Section 6, this means that two contexts of learning were implied − my professional learning on the one hand, and student learning on the other. The research design, namely action research, was complemented by using a mixed methods approach. As previously discussed, the reason for using both qualitative and quantitative data in the research project was that the methods by themselves are not adequate to capture the details and trends of a situation (Ivankova *et al.*, 2006:3).

The purpose of this chapter is not only to discuss the data collection plan, data analysis strategy and ethical attentiveness, but also to provide the rationale for choosing these methods to answer the research question.

3.2 Research paradigm

As specified in Chapter 1, Section 1.6, the research paradigm that guided my research was a transformative constructivist approach by means of action research.

Transformative constructivism was utilised as I continuously take responsibility for my own professional development in a self-regulated fashion by using an action research design. Action research offers a valuable framework for critical and practical research studies in the education sector (Creswell & Guetterman, 2019; Du Toit, 2019b; McNiff & Whitehead, 2011; Nelson, 2013; Wolvaardt & Du Toit, 2012; Zuber-Skerritt, 1992). As Fringe (2013:101) explains, I do adhere to the action research paradigm on the grounds of its assumptions, since my aim and purpose is not only to comprehend the situation (Radiographic Clinical Practice being facilitated in a holistic manner), but primarily to go to action, which entails transforming my teaching practice.

3.3 Action research design

Action research is known for encouraging practitioners to be in control of their own lives and contexts (McNiff & Whitehead, 2002:4) and (Zuber-Skerritt, 1992:177). Tomal (2010:11) agrees by stating that one should take responsibility for one's own professional development in a self-regulated fashion by means of action research. In the light of the above, the construct *Whole Brain® action research* enhances one's understanding of what self-directed professional learning (Du Toit, 2014:263) entails.

Action research can be defined as a mode of inquiry to investigate and evaluate one's teaching practice for the purpose of improving learning (Whitehead & McNiff, 2006:6). The focus was constructing my own understanding of my higher education practice in a scholarly way (Du Toit, 2012:1216). As a self-regulated professional, I was in the field, building relationships – establishing a community of practice, collecting and analysing data, and revising research actions. I continued consulting relevant literature, learning about research methodologies and immersed myself in the research process so that constructivist learning, innovation and ultimately authentic learning were the result (Davis, 2004:3).

Action research takes place in a social context (Whitehead & McNiff, 2006:8;92). I consider my action research study an exploratory journey having distinct, but entwined phases: the action research fieldwork investigation, conducted by myself, for transforming Radiographic Clinical Practice, and a phase of analysis and reflection

based on the findings, where I developed my personal “living/ lived educational theory” (McNiff & Whitehead, 2002:20) about innovation and change.

Action research does not observe the actions of others objectively, but rather analyses one’s participation in the action and one’s knowledge creation via the experience of the action; it begins with an idea that is developed and open ended. Thus, action research does not begin with a fixed hypothesis (McNiff & Whitehead, 2002:6; Tomal, 2010:14).

McNiff (2002:15) states the following:

> *There is nothing sinister in the idea of influence, and everything to celebrate; most ideas that people have were influenced by someone else, somewhere else in time and space. This is the way that knowledge evolves, a process of learning from others and reworking existing knowledge in new ways.*

The foundation laid by leading research experts such as (Du Toit, 2013, 2019b; Du Toit *et al.*, 2012; Fringe, 2013; McNiff, 2002, 2008, 2014; McNiff & Whitehead, 2011; Whitehead & McNiff, 2006; Zuber-Skerritt, 1992, 2001).

After reviewing multiple action research models, I adapted and combined different parts of relevant models (Du Toit, 2018:19-24; Fringe, 2013:115; McNiff, 2014; Randewijk, 2019:18; Zuber-Skerritt, 2001) to my context as the approach promoted continual critical reflection and professional development. The main spiral in Figure 3.1 (adapted action research model) represents the action research process of my professional development and practice while the spin-off spirals represent the action learning of the students or participants’ professional development.

The figure illustrates that action research, represented by means of a spiral, consists of multiple cycles and is complex in nature. The de-routing spirals, consisting of different cycles – the action learning of the students or participants – indicate the complexity of the action research process. The action learning spirals followed the same process as the main cycle (Du Toit, 2018:18) that represents the process of my professional development. The process was cyclic in two ways: Firstly, it was a sequence of steps and relating actions within a cycle. Secondly, it was a series of

cycles. Hence it was a continuous and consistent flow of interrelated actions that had taken place over time (Davis, 2004). The process started with reflection on current practice (*context*), and proceeded to new actions which were, in themselves, researched. During each *personal reflective cycle* the following steps were followed (Du Toit, 2018:19-22):

i) Step 1: Planning for innovating/ transforming one's teaching practice
ii) Step 2: Acting to transform
iii) Step 3: Observation
iv) Step 4: Continuous critical reflection
v) Step 5: Evaluation

During the multiple individual reflective cycles (labelled cycle A to E) the same steps were followed. The *collaborative reflection* from the participants resulted in *strengthened practice*. This is depicted by the strong braided rope (Randewijk, 2019:18) that resulted in *a transformed practice (action).* The rope symbolises the scholarly community of practice that resulted in a *transformed practice (action).*

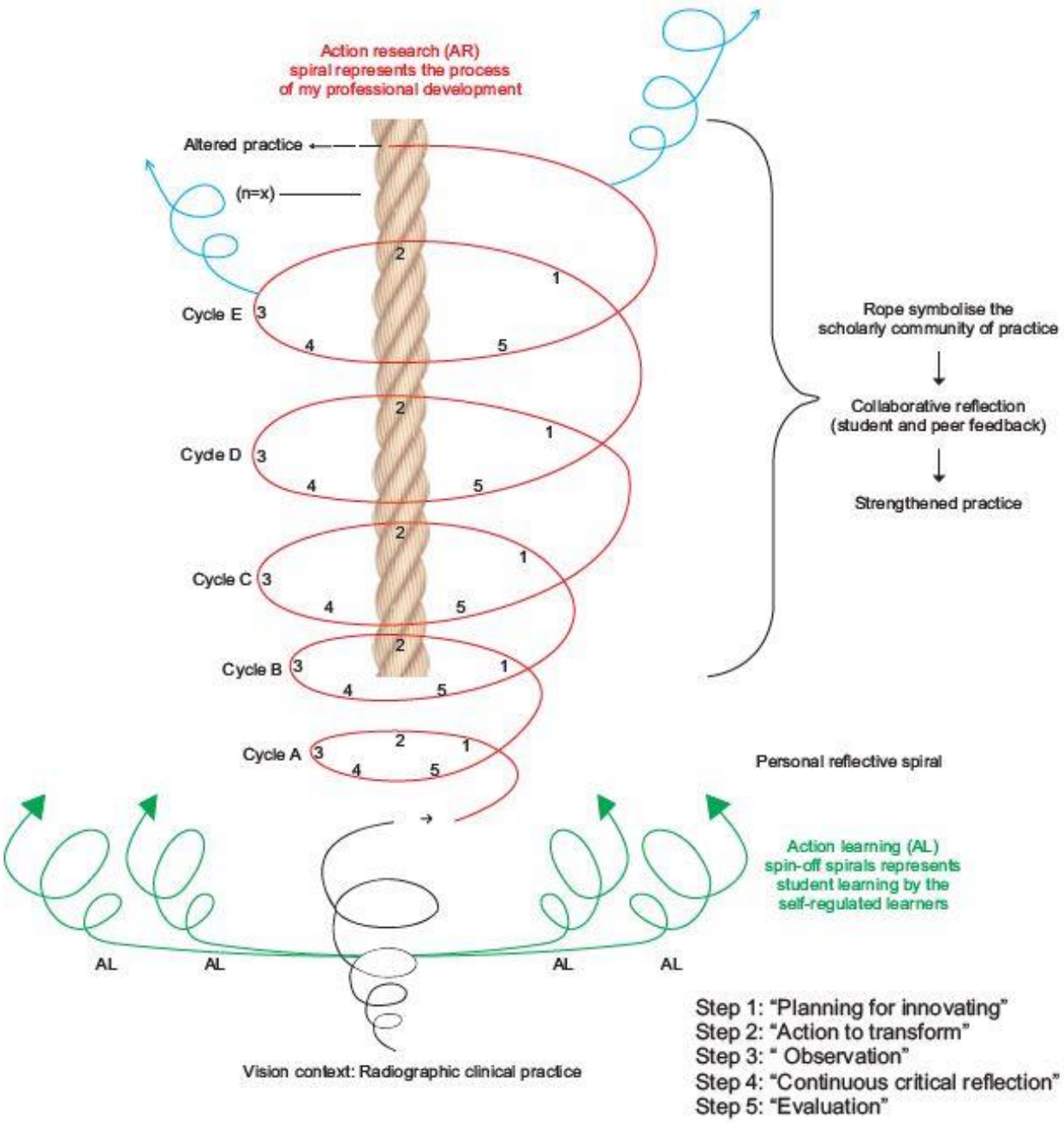


Figure 3.1: Adapted action research model (Du Toit, 2018; Fringe, 2013; McNiff, 2014; Randewijk, 2019; Zuber-Skerritt, 2001).

3.4 Mixed methods approach

I used a Whole Brain® angle of incidence. This implicates that I used a Whole Brain® mixed methods asset-based approach (Du Toit, 2012:1222) to complement my Action Research study. Du Toit (2012:1222) encourages using an asset-based approach instead of the traditional deficit-based approach. This means an innovative idea is used as point of departure in the research instead of waiting for a problem to occur.

The aim of the mixed methods approach is two-fold, firstly to benefit from the strengths of both quantitative and qualitative data, providing a better understanding of the research questions (Creswell, 2012:534). Secondly, as discussed by Wadsworth (cited in Goode (2014:62)," the use of mixed methods is less for triangulation but rather to explore multiple views and perspectives and utilise all thinking preferences in the four quadrants of the Whole Brain® Model".

The quantitative and qualitative methods were applied through a transformative procedure. Through this theoretical lens the data collection method involved a concurrent approach (Creswell, 2003:16); this means that the quantitative and qualitative data was collected and interpreted at the same time.

Both quantitative and qualitative research methods have limitations, and by using a mixed methods approach, biases inherent in a single method could neutralise the biases of other research methods (Creswell, 2003:15). The multiple approaches to data collection complement one another, ensuring comprehensive analysis of the research (Ivankova *et al.*, 2006:3). Thus, a positive initiative was conducted to promote Whole Brain® learning in Radiographic Clinical Practice.

3.5 Research methods

The overarching research design executed was action research with a complementary mixed methods approach.

Two questionnaires with structured and open-ended questions were completed anonymously by participants after each learning opportunity, traditionally referred to

as a lecture. Thereafter, peer mentees observed my practice and completed a structured questionnaire with additional comments after each learning opportunity.

3.5.1 Questionnaires

In addition to help me gain insight into how I can use Whole Brain® learning to transform Radiographic Clinical Practice, I used qualitative and quantitative methods such as a participant feedback questionnaire (Consult Appendix III). I achieved triangulation by asking peer mentees (Consult Appendix IV) and by critical self-reflection (Consult Appendix V). I reviewed the observations and planned for improvements in the next action research cycle.

3.5.1.1 Herrmann Brain Dominance Instrument® as baseline data

The HBDI® consists of 120 items and is a scientifically validated instrument. In broad terms it identifies one's dominant thinking style preferences (Du Toit, 2013:5) but it also quantifies the thinking preferences in a specific quadrant in the Whole Brain® model (Consult Appendix II). The questions in the HBDI® use a quantitative approach to determine my thinking style. However, the outcome includes qualitative data in the form of narrative descriptions and a visual brain profile (Goode, 2014:63). This provides a holistic view with a visual representation of my profile score. The brain profile served as both a baseline study and point of departure for my professional development as suggested by Du Toit (2012:1222).

3.5.1.2 Participant feedback

Participant feedback or evaluation is referred to as higher order thinking (Du Toit, 2019a:22) that students should master to become self-regulated learners. The participating students were instructed to complete a questionnaire after each learning opportunity; the questionnaire related to the facilitating of learning that was used during the learning opportunities I offered (Consult Appendix III).

3.5.2 Observations

3.5.2.1 Peer observation

The observations by my community of practice is an important data gathering instrument. I asked two peers to observe different learning opportunities that I facilitated. An observation feedback sheet with rating scales as proposed by Du Toit (2018:30) was used to determine to what extent Whole Brain® facilitating of learning had been achieved (Consult Appendix IV). The collaboration with critical friends, fellow PGCHE graduates, was extremely important evidence for any research claims made (McNiff, 2014:81). I discussed my research with the two critical friends, who in turn provided criticism, recommended a fresh perspective and challenged my thinking process. As discussed in Foulger (2010:140) researchers are more successful if they use critical friends throughout the process.

3.5.2.2 Self-observation

To confirm that I had learnt something new, I had to observe myself in relation to the participants. I observed my practice by keeping a reflective journal (McNiff & Whitehead, 2006:55) during the entire process; I used direct observation by using a personal and field notebook as suggested by McNiff and Whitehead (2006:139) and Zuber-Skerritt (1992:141), and indirect observations by using video-recordings and photographs as suggested by McNiff and Whitehead (2011:144) and Zuber-Skerritt (1992:179). After each learning opportunity and observation, I completed a self-assessment form on my contribution to learning as the facilitator (Consult Appendix V). The observation ensured higher order thinking by demonstrating active participation in monitoring my learning.

Triangulation of data increases qualitative rigour according to Melrose (2001:164). By collecting data from multiple sources, a trend was established in the data that was checked for patterns or themes.

3.6 Data collection

The data collection process was initiated in July 2020 and lasted one month after the issuing of the ethical clearance certificate by the Ethics Committee of the University of Pretoria (ethical clearance number HU 19/06/04). Data collection would have commenced in March 2020 after receiving ethical clearance but due to the Covid-19 pandemic and the resulting lockdown I could not complete the data collection as planned.

Table 3.1 summarises the applied data collection process regarding the procedure and is accompanied by a timeline.

Table 3.1: Data collection process

Participants	Data Collection Method	Procedure	Timeline
I as the researcher	• Observation through video-recordings and photographs • Reflective journal	**Before initiative** The HBDI® instrument results were used as both a baseline study and point of departure for my professional development as the researcher. My profile is reported in Chapter 4, Section 4.2 where the quantitative data set is discussed. **During initiative** • A self-assessment questionnaire on my contribution as facilitator. • Reflective field notebook and personal notebook. **After initiative** Critical reflection.	Three months
Participating students	• Feedback questionnaires	**During initiative** Feedback questionnaire on participating students' own learning and my facilitating of learning.	One month Three learning opportunities
Two adult independent experienced interviewers	• Observation with feedback questionnaires	**During initiative** Observation feedback questionnaire on my facilitating of learning	

Applying the principles of action research in the Dr Mkhabele and Indunah X-Ray Department

Three action research cycles labelled cycle A to C were followed in the adapted action research model in Figure 3.1, Section 3.3. The spiral represents each learning opportunity that was facilitated by me.

3.6.1 Cycle A - C: My action as visionary practitioner-researcher

3.6.1.1 Step 1: Acting to innovate and transform

I designed and implemented Whole Brain® holistic learning opportunities. The holistic learning opportunities challenged all the participating students not only to use their preferred mode of thinking but also to use their less preferred thinking preferences in the learning opportunity. A summary of the three activities will be discussed next (Consult Chapter 4, Section 4.3.2 for detailed information on the different activities).

Learning task 1: The Kahoot! quiz

The application Kahoot! with specific formulated questions were presented to the students. The live feed interaction encouraged the participants to engage during the learning task. The student-centred activities were linked to professional development and self-regulated professional learning, which is discussed in Chapter 2, Section 2.5.

Learning task 2: 3D coronary tree and blue heart puzzle

During this second learning task, co-operative learning (group work) was encouraged. Multiple puzzle pieces in random order were given to the participants. The participants had to produce a 3D coronary tree and blue heart with the different steps presented.

Learning task 3: Coronary arteries on a 3D clay model

In the final learning task, the participants were instructed to produce a 3D model of the heart and indicate all the coronary structures involved. Throughout the learning task the participants constructed meaning in a self-regulated manner, using all the different materials (textbooks, phantoms, practical cases) to their advantage.

3.6.1.2 Step 2: Reflecting on action

I gathered data about my professional learning through both “reflection in action” and “reflection on action” as suggested by Schön (1987:31). It is important to gather data about my learning while it is happening, but it is extremely important to step back from the action to make sense of it through critical reflection to move in a new direction (McNiff & Whitehead, 2006:144; Zuber-Skerritt, 1992:141). I reflected on the tasks completed by the participants through the observations made; for example, reflection in action through field notes, reflection on action through a personal journal, video-recordings and photographs.

I recorded the details related to my observations in a field notebook to document my own feelings, thinking, experiences and perceptions throughout the research process (Creswell, 2003:202; McNiff & Whitehead, 2006:142). I distinguished the events of action from the events of learning by using a different font and colour as suggested by McNiff and Whitehead (2006:142).

3.6.1.3 Step 3: Observing the effects of the new actions

Participant feedback

Appendix III contains the Participant feedback questionnaire concerning my facilitating of learning. The questionnaire consists of eleven questions that relate to my facilitating of learning. The questionnaire was compiled on a group basis so that the participants could stay anonymous. Each question has five responses based on a Likert-scale (Efron, 2013:116), namely 5 = Strongly agree; 4 = Agree; 3 = Neutral; 2 = Disagree and 1 = Strongly disagree. Interpreting the data assisted in assessing and improving the quality of my innovative teaching practice as suggested by Singh (2015:99).

Data refers to all the new information – primary data gathered during the data collection period. The evidence refers to the special pieces of data that indicate transformation only (McNiff & Whitehead, 2006:95).

Peer assessment

I asked peers from the University of Pretoria who were familiar with action research and Whole Brain® learning to attend the different learning opportunity sessions and presented them with an observation feedback sheet (Consult Appendix IV) to record their observation of my facilitating learning during the Whole Brain® learning opportunities.

Through peer-assessment I took responsibility for my own professional learning and transformation. I expected exchanging of ideas after the learning opportunity, resulting in collaborative professional learning. The peers ensured that any conclusion I drew was reasonably accurate and fair (McNiff & Whitehead, 2006:82). The constructive feedback helped produce evidence to prove that Radiographic Clinical Practice was facilitated in a Whole Brain® manner. Appendix IV contains the peer and colleague observation feedback sheet. The observation sheet consisted of nine questions. All the questions related to my facilitating of learning. Each question had four responses, namely: 1 = Not at all; 2 = To some extent; 3 = To a large extent, and 4 = Great extent. The tenth question was a general comment section. The data obtained from the questionnaire helped me to assess and monitor the quality of my transformed teaching practice by comparing the data with the responses to items in the questionnaire used for the previous session.

Self-observation

To monitor my professional development, I completed a self-assessment questionnaire on my contribution as a facilitator. The questionnaire was based on the work of Du Toit (2018:28;29). It is compliant with the seven roles of educators as outlined by the Norms and Standards for Educators (*Norms and standards for educators*, 2002).

Appendix V contains a self-assessment questionnaire that contains three categories. Category 1 includes the questions on how I inspired the participants; Category 2 includes questions on how I as facilitator-initiated learning. Category 3 includes questions on how I as facilitator maintained learning during the learning opportunity. There was also a box for general comments on the session.

3.6.1.4 Step 4: Reflecting on actions and data

Reflective writing is evidence of reflective thinking. In my context, reflective thinking involved looking back at the facilitating of learning during the session. I analysed the learning opportunity in depth using all the different data sets and perspectives. I considered aspects of the learning opportunity that would contribute to my professional development with reference to facilitating Whole Brain® sessions. The structure of my reflection included a *description* of what happened, an *interpretation* of what was most important and an *outcome* of what I had learned and what this meant for the planning of the following learning opportunity.

3.6.1.5 Step 5: Evaluating the process

The analysed data sets from the reflection discussed above, were evaluated. The successes, strengths, errors and weaknesses were revealed, followed by an explanation of how I planned improving future learning opportunities with a view to transforming my entire practice.

3.7 Data analysis

I analysed the data. The main advantage of analysing own data, according to Litosseliti cited in (Scheepers, 2014:57) is that I can link the research question with the data. I found different themes, trends and patterns that related to the research question. My data archive was sorted systematically as suggested by McNiff and Whitehead (McNiff & Whitehead, 2006:146). Data was stored in electronic format and the physical artefacts in a box. I categorised the data into two broad categories, namely data that reflected my learning (File 1) and data that indicated the participants' learning (File 2). These categories were instrumental in keeping the data analysis controllable.

The outcome of the HBDI® was used as baseline data. The questionnaire was analysed using descriptive statistics, such as visual graphics, diagrams, bar graphs and basic mathematics to describe the data (Tomal, 2010:96). The video-recordings were analysed with a closed-ended behaviour log followed by a discussion.

3.8 Ethical considerations

A researcher has the obligation to conduct research in an ethical manner since it often involves human beings or animals. Failure to do so weakens the scientific process with possible negative consequences (Brink, Van der Walt, & Van Rensburg, 2007). Human rights violations during research studies in earlier decades led to the development of various codes of ethics. The most recognised of these codes is the *Belmont Report* (published in 1974) that not only provides a standard for many of the guidelines adopted by disciplinary organisations, but also serves as the basis for regulations affecting research (Polit & Beck, 2007).

The current study adheres to the guidelines set by the University of Pretoria (UP). As a registered student at the University of Pretoria, an application was submitted to the Ethics Committee of the Faculty of Education, University of Pretoria applying for clearance to conduct my action research project (Ethical clearance number HU 19/06/04). I adhered to all ethical considerations at institutional level. A declaration was signed regarding copyright and plagiarism; in-text referencing was done right through the dissertation followed by a comprehensive list of references of all the sources consulted in the writing of this dissertation.

Written consent (Consult Appendix VI) was obtained from all participants after an explanation, with an accompanied information leaflet (Consult Appendix VII) stating that I was a volunteer conducting an action research project. I emphasised that it was anonymous, voluntary participation, and there was no obligation to participate. Respondent numbers were allocated to each learner to ensure anonymity. The aim of the study was explained as well as exactly what participant involvement would be. The data collected would not harm them and would be used for the improvement of my teaching practice and professional development. The outcome of this study may be published in a scientific journal and/or presented at relevant summits without revealing the identities of participants as stated in the written consent form.

All documents used to perform the study, including the raw data, articles used in the literature review, informed consent, proposal and ethics documents will be stored as hard copies and electronically, and kept for a minimum of 15 years.

3.9 Conclusion

This chapter outlines the methodology and the research design used. The features of the action research design adopted are explained and outlined visually, indicating my professional learning on the one hand, and the participants' learning on the other.

The aim of the next chapter is to explain the findings from the empirical data that emerged from the data collection strategies and their analysis.

Chapter 4: Stage 3 in the study's life cycle (Empirical research findings and assumptions)

As discussed in Chapter 1, Section 1.5 my perception of action research can be compared to the butterfly effect and the stages in the butterfly's life cycle. Stage 3 is the chrysalis or pupa. A chrysalis is the hard-shelled pupa of the butterfly. During this stage all previous habits need to be addressed, critically reflected on and changed. This is the core of this chapter where the empirical data sets are discussed and reflected on.

4.1 Introduction

In this chapter I present and discuss the emperical data collected during the action research process. As discussed in each chapter, the study was driven by the question, *How can my professional development and the learning of my students be developed in a synchronistic fashion?* Different data sources were used to answer the main and secondary research questions and facilitated the triangulation process.

Triangulation is the process of validating the empirical data by different individuals (e.g. the researcher, participants and two peers), type of data (questionnaires, observations and field notes), or methods of data collection (e.g. documents and videos) Creswell (2012:259).

According to Creswell (2012:259) triangulation ensures that:

> *the study will be accurate because the information draws on multiple sources of information, individuals, or processes. In this way, it encourages the researcher to develop a report that is both accurate and credible.*

The chapter commences with a reflection on my Herrmann Brain Dominance Instrument® results or Whole Brain® profile (Herrmann International, 2009). Thereafter

my three action research cycles (A, B and C) are discussed in depth. There are five different steps in each cycle. Step 1 is where I planned an innovative Whole Brain® learning opportunity. In the second step I executed the plan and facilitated the Whole Brain® learning opportunity. Thirdly, I observed the effects of the new actions through participant feedback, peer assessment and self-observation. Next, I reflected on the actions and empirical data and finally I evaluated the process.

4.2 Baseline data – My Whole Brain® profile

In 2016 I completed the 120-item questionnaire online. The HBDI® results can be interpreted in a Whole Brain® manner that includes a visual profile, an explanation page – a narrative of the interpretation of my profile as interpreted by Herrmann International (2009), and a data summary sheet (Consult Chapter 2, Section 5.2). The results revealed what I pay attention to, how I prefer to learn and how my mode of thinking (preferences) change when I am under pressure.

My profile scores or preference code is discussed in conjunction with the data summary sheet in Figure 4.1.

HERRMANN BRAIN DOMINANCE INSTRUMENT
DATA SUMMARY

id: HNTV4624

NAME	ZANELLE KRUGER	GENDER	F	GROUP	172997
OCCUPATION	Diagnostic radiographer			DATE	29 07 2016

	COLUMN A UPPER LEFT	COLUMN B LOWER LEFT	COLUMN C LOWER RIGHT	COLUMN D UPPER RIGHT
PROFILE SCORES	72	96	75	63
PREFERENCE CODE	1	1	1	2
ADJECTIVE PAIRS	5	8	10	1
KEY DESCRIPTORS (*MOST DESCRIPTIVE)	factual x quantitative critical x rational mathematical logical analytical	conservative controlled sequential x detailed x dominant x speaker reader	emotional * musical spiritual symbolic intuitive x talker reader	imaginative artistic intuitive x holistic synthesiser simultaneous x spatial
WORK ELEMENTS	analytical 2 technical 1 problem solving 4 financial 5	organisation 5 planning 5 administrative 4 implementation 4	teaching 4 writing 2 expressing 3 interpersonal 5	integration 3 conceptualising 2 creative 2 innovating 3
ADOLESCENT EDUCATION EDUCATIONAL FOCUS OCCUPATION HOBBIES				

	primarily right	right some left	mixed	left some right	primarily left
HAND DOMINANCE	X				

	day		equal		night
ENERGY LEVEL			X		

	none		some		frequent
MOTION SICKNESS					X

	introverted								extroverted
INTROVERT/EXTROVERT							X		

Figure 4.1: HBDI data summary of my preferences

According to the HBDI® data summary sheet, my profile scores or preference code reveals a triple dominance of 1112. As discussed in Chapter 2, Section 2.5.1 a preference code 1 indicates a strong thinking preference, code 2 indicates a lesser preference suggesting comfortable usage when the situation requires it (neither

preferred nor avoided). The data revealed a majority brain dominance in quadrant B, followed by quadrants C and A respectively. The profile features two primaries (Preference code 1 above in Figure 4.1) in the left mode, both upper left A and lower left B quadrants, and a third primary in lower right C. The secondary (preference code 2 above in Figure 4.1) is the upper right D quadrant (Herrmann International, 2009:31).

The triple dominant profile (dominancy lies in three quadrants) represents 34% of the database with my preference code being one of three codes that represent 81% of triple dominant profiles (Herrmann International, 2009:31). I have access to a certain thinking flexibility that comes from the multi-dominant nature of my thinking process that enables me to use three different quadrants. This allows me to move through my three dominant modes somewhat effortlessly, looking at all the angles before deciding how to approach tasks that require, for example, effective problem solving and communication (Herrmann International, 2009:31). This also facilitates easy collaboration with others due to the triple dominant profile – I am likely to share at least one preference with other people. This access to multiple preferences can, however, decelerate the decision-making process as I feel the need to evaluate all possible alternatives properly (Hermann, 2009:31).

The narrative report describes each of the quadrants of my preference, namely B > C > A > D (Herrmann International, 2016:1). My most preferred thinking preference is the B quadrant. Descriptors that I prefer in day-to-day life settings are *sequential*, *detailed* and *dominant*. Work elements I strongly relate to in this quadrant include *organisation*, *planning*, *administrative* and *implementation*. These elements reflect my mental preferences at work but could also align with my general preferences.

My next preferred thinking preference is the C quadrant. I selected *intuitive* and *emotional* as descriptors with *emotional* representing my key descriptor – the most descriptive of me. I identified *teaching* and *interpersonal* as work elements relating to Quadrant C. My next preferred quadrant by a slight margin from the C quadrant is the A quadrant. The descriptors that I chose *are critical* and *factual*. I identified *problem solving* and *financial* as work elements. My least preferred quadrant is the D quadrant. For this quadrant I selected *intuitive* and *simultaneous* as my main characteristics (Herrmann International, 2016:1).

Another consideration is the adjective pairs that specify my thinking preferences when under pressure. There are 24 questions and points between the four quadrants. This allocation is distinctively different from my normal profile that reveals that I respond quite differently when under pressure. This was evident during conducting my research project as the unplanned Covid-19 pandemic created an internal negative emotional response due to the uncertain time constraints it created. My second-preferred quadrant (quadrant C) became extremely dominant (C: 10), with my being emotional. Quadrant D was almost non-existent (D: 1), indicating an avoidance. I had to remind myself constantly to think creatively during the project.

The data summary in Figure 4.1 is elucidated in a detailed representation shown in the visual profile in Figure 4.2, which is a graphic representation of my profile. The figure displays four diagonal axes with a graphic visualisation that synthesises my responses into a global visual profile. This is a visual of my metaphor illustrating my thinking preference. The profile score is used to plot the graphic along the diagonal axes. A score of zero starts in the middle of the circular display and moves to more than 140 on the outward circle area. The adjective pair is the second graphic visualised through the dotted line. This measurement (from 0 to 10) reveals which quadrants are most preferred (highest score) for learning when I am under pressure.

An indication of my preference code adjective pairs and profile scores when I am under pressure is tabled below.

Quadrant :	A	B	C	D
Preference Code :	1	1	1	2
Adjective Pairs :	5	8	10	1
Profile Scores :	72	96	75	63

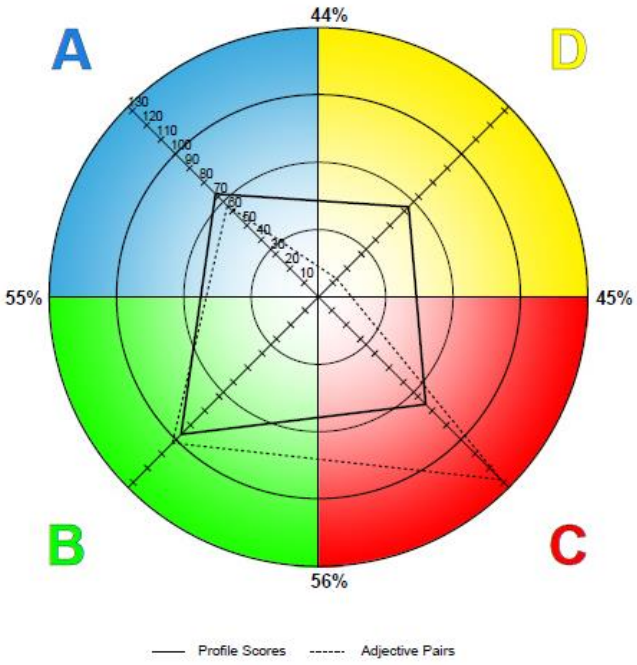


Figure 4.2: My HBDI® profile

The percentage scores indicated on the diagram reflect the preferred modes of thinking between left and right, and upper and lower modes of thinking. The split between the right and left is 55% and 45%. The right mode (combining the C and D quadrants) prefers an intuitive, idealistic, emotional, and expressive thinking style. The left mode (combining A and B quadrants) functions as a concise and efficient process with realistic, disciplined and orderly approaches according to Herrmann International (2009:11). The split between the upper and lower modes is 44% and 56%. The upper mode (combining A and D quadrants) is more cognitive and intellectual that prefers thinking in conceptual and abstract mode. The lower mode (combining B and C quadrants) is grounded and emotional in nature. This mode prefers a concrete approach and visceral gut feeling (Herrmann International, 2009:11).

Next I explain how I conducted my action research and the role Whole Brain® thinking played in the designing of my learning opportunities. This is outlined by explaining each of the action research cycles I planned and executed.

4.3 My action research cycles

4.3.1 Step 1: Planning innovative learning opportunities

The planning phase required multiple activities. Firstly, I had to reflect on how I would facilitate the session in an innovative fashion, with the Covid-19 pandemic as a major challenging factor. Due to Covid-19 regulations, the participants worked in shifts on different days; thus I had multiple sessions of the same learning opportunity with different participants. This enabled me to modify what was necessary to improve in the next learning opportunity.

Next, I had to observe coronary angiograms done in practice by only the head radiographer as this was a new advanced procedure that I had not been exposed to before. At the same time, I researched relevant literature.

Finally, I designed three holistic learning tasks (Consult Chapter 2, Section 2.3) as proposed by Slabbert *et al.* (2009:102).The holistic learning tasks were designed to accommodate the different thinking preferences and to challenge the participants to use their less preferred modes of thinking.

4.3.2 Step 2: Action to transform

The learning tasks were presented in verbal and written format as advised by Slabbert *et al.* (2009:102). They were video-recorded and photographed during the learning task execution (LTE) as part of my data collection. Through a process known as photo voice I could record and reflect on the strengths, weaknesses and concerns in relation to the learning opportunities (Wang & Burris, 1997:369); this is discussed in Step 4 and 5 below. Since I followed an asset-based approach, I used photo voice to reflect on. In three of the learning opportunity sessions I was observed by my peers who completed the PGCHE (Consult Chapter 1, Section 1.1) course and had experience in action research and Whole Brain® learning. McNiff (2002:21) recommends this

critical scrutiny that ensures that the judgement of my work is not only my opinion. Critical friends, also called a learning partner or a critical colleague, are professionals whose opinion I value. Their critique provided alternative perspectives and advice on how I could improve the upcoming sessions and is discussed in Section 4.4.3.2.

Learning task 1

The participants connected to my Wi-Fi modem and downloaded the application Kahoot! to their mobile devices. A game pin was provided to the participants (Consult Figure 4.3 below). Ideally a projector should have been be used but I had to improvise in the hospital boardroom. The Kahoot! App allowed live feed interaction among the participants. This created a competitive environment as the game created a leader board determined by the participants' answers. A total of 28 questions were presented. The participants used their mobile devices to answer each question. The device displayed four different colour blocks as answers. In the first learning opportunity the time allocated for answering the question was 10 seconds. All 28 questions were answered before the process of learning task feedback (LTF) began. This process was modified in the second and third learning opportunity. The time allocation was altered to 30 seconds, allowing metalearning and co-operative learning to take place. The process of LTF did not only occur at the end of the session as with the first learning opportunity, but throughout the learning opportunity. This ensured that the participants remained engaged during the learning process.

Next some of the photographs taken were displayed. They offered evidence of how the participants were engaged in answering the questions included in the Kahoot! quiz. What is to be observed is the practical approach taken to the designing of the questions. Participants were expected to respond to the questions asked using the visual material that was made available for own interpretation (Visualised in photograph 1 to photograph 3). These visuals represented hypothetical real-life examples. In photograph 4 student-centred group work is visualised. The participants were instructed to construct their own meaning; in this way it was ensured that the questions were authentic and not focused on theory only. These student-centred activities were linked to professional development and self-regulated professional learning, which is discussed in Chapter 2, Section 2.5.

Figure 4.3: Participants executing learning task 1

Learning task 2

As discussed in Chapter 2, Section 2.5.1 both the participants and I had our own thinking preferences and comfort zones as point of departure when engaging in learning tasks. When these participants worked together in a group it resulted in a Whole Brain® group, where the participants could take advantage of one another's strengths. Being able to communicate and contribute as a member of the healthcare team is an important attribute of the 21st century (Du Toit, 2019a:175). These attributes of the 21st century require a Whole Brain® thinking process with a view to becoming a holistic individual. Group work (co-operative learning) has many benefits for a healthcare team. Firstly, the members become independent, which is important for self-regulated learning. Evident in photographs 1 to 6 (in Figure 4.4 below) is that each participant was engaged in the learning task and eager to develop professionally.

In the learning task presentation the participants received a file with multiple puzzle pieces in random order, an A3 format carton paper, and Bostik Prestik pliant adhesive and coloured pens. The pieces represented a 3D coronary tree and a blue heart at the advanced working station, where they would complete the task. Different steps needed

to be followed to construct the models. The different steps included incorrect steps to ensure the participants considered all the possibilities. The participants completed the puzzle independently, using the advanced workstation to guide the process as depicted in Figure 4.4.

Figure 4.4: Participants executing learning task 2

Learning task 3

During the presentation of learning task 3 the participants were instructed to build a heart-shaped structure with the clay provided and indicate, with different materials available, all the coronary arteries on the 3D model. Consult Figure 4.5 below for an example of the execution of the task. In photograph 1, 2, 3 and 5 (in Figure 4.5 below) it is evident that the participants were engaged and enjoyed the learning task. In photograph 1 the participants were constructing meaning in a self-regulated manner. A participant asked me to assist in the placement of the right coronary artery, when I

proceeded asking a question to show me on the anatomy model what structures the right coronary artery supplies (Consult Figure 4.5 below, photograph marked 2).

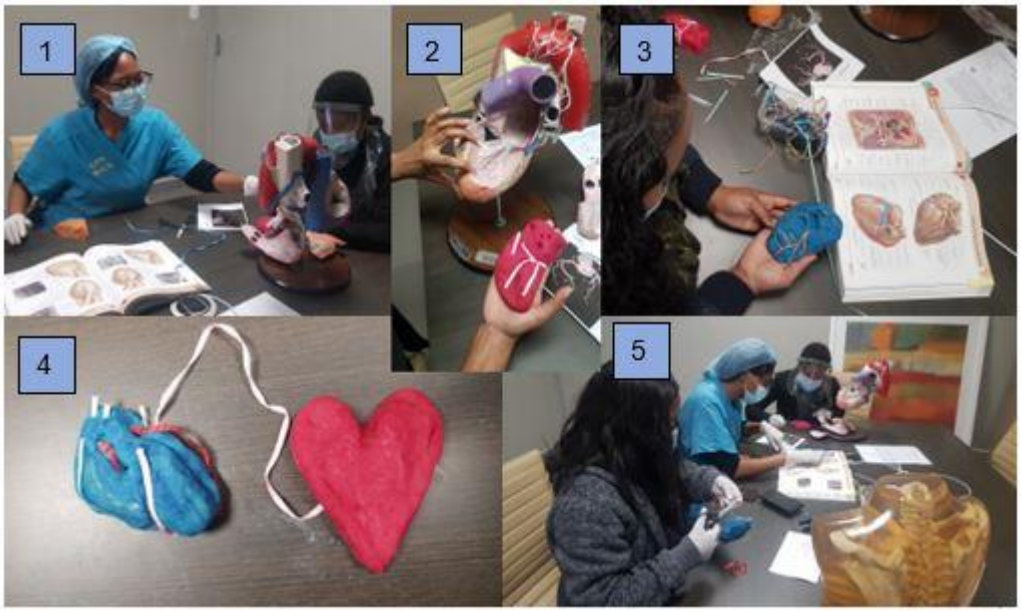


Figure 4.5: Participants executing learning task 3

After the execution of the three learning tasks the participants were requested to complete a participant feedback questionnaire. The questionnaire consisted of 11 closed-ended questions with an additional comment section. The time used for the completion of the questionnaire was used by me to complete my field diary in which I recorded any observations made and my own feelings and perceptions.

4.3.3 Step 3 and 4: Observing and reflecting on actions and data

Feedback from the participants and my critical friends is discussed next, followed by a closed-structure behaviour log in which I recorded my observations.

4.3.3.1 Feedback from participants

Learning task 1

Figure 4.6 indicates that all the students gave positive feedback regarding my communication ability. This suggests that my facilitating of learning initiated the

learning process by presenting the learning task effectively. Learning task presentation is critical for the success of the learning task operation, and for authentic learning to take place (Slabbert *et al.*, 2009:106).

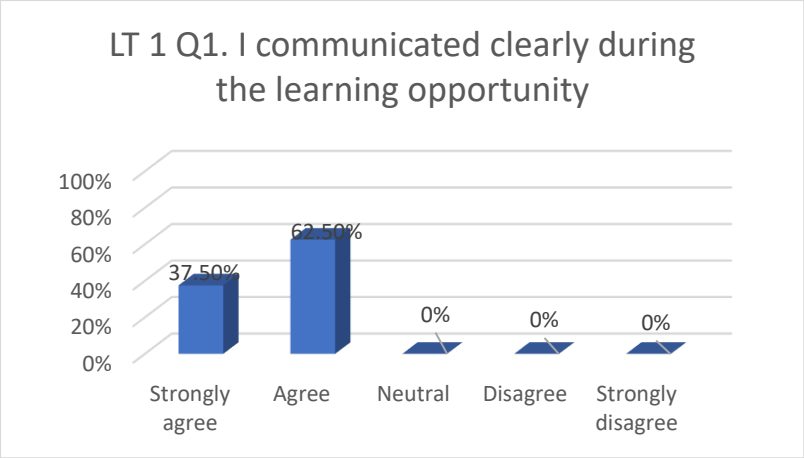


Figure 4.6: I communicated clearly during the learning opportunity

In the next graphical display, Figure 4.7, it is illustrated that 75% of the participants strongly agreed that I was well prepared for the learning opportunity session and 25% agreed on this. The process of initiating learning starts with learning task design (LTD) and must be creatively constructed from scratch. According to Slabbert *et al.* (2009:105) “LTD is therefore a very demanding and highly challenging professional responsibility, and must be done with thorough consideration and great care”. The learning task was designed in such a way that Whole Brain® thinking was promoted and that all the participants with their different thinking preferences were accommodated. As alluded to in Chapter 2, Section 2.4.1, while conducting the action research for each cycle I planned learning opportunities that would promote Whole Brain® self-regulated learning. These learning opportunities utilised the learning task design (LTD) model that is proposed by (Slabbert *et al.*, 2009:102).

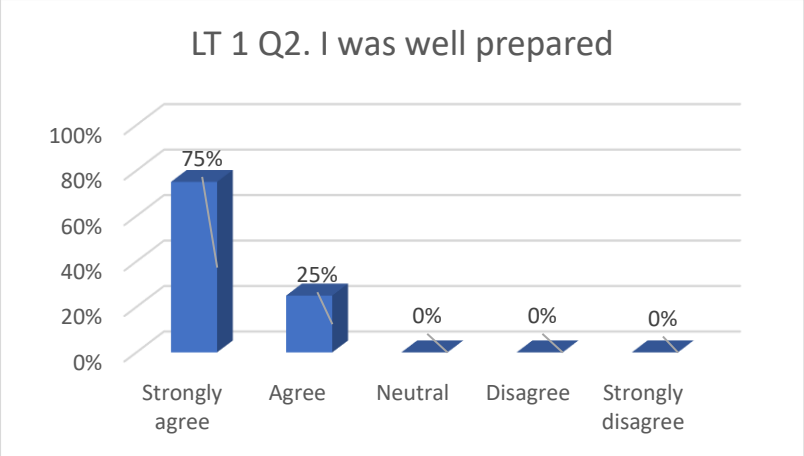


Figure 4.7: I was well prepared

Judging by the results in Figure 4.8, time management was successful as all the participants responded positively. Efficient time management is important to ensure that all planned activities can be completed in the available time.

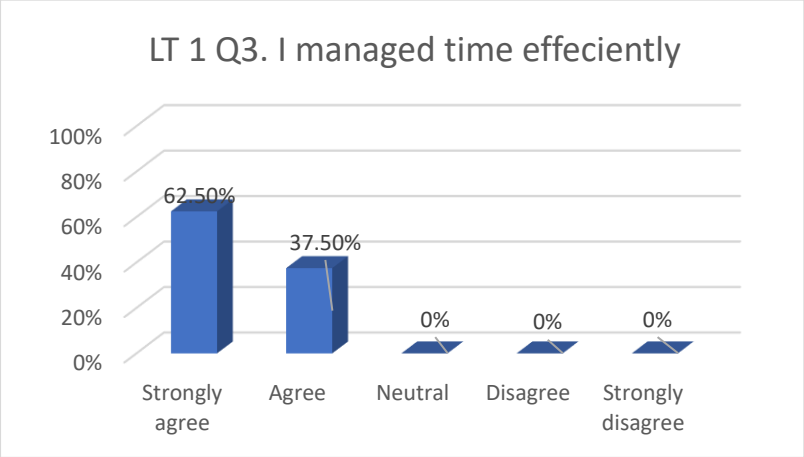


Figure 4.8: I managed time efficiently

When asked if I engaged the participants in what they had to learn by integrating tasks linked to their preferred modes of thinking (Figure 4.9), 87,5% strongly agreed and 12.5% agreed to some extent. The statistics emphasise that the learning task was holistic and accommodated each participant's thinking preference. At the same time, the participants were challenged to use their less preferred thinking preference in the holistic learning opportunity.

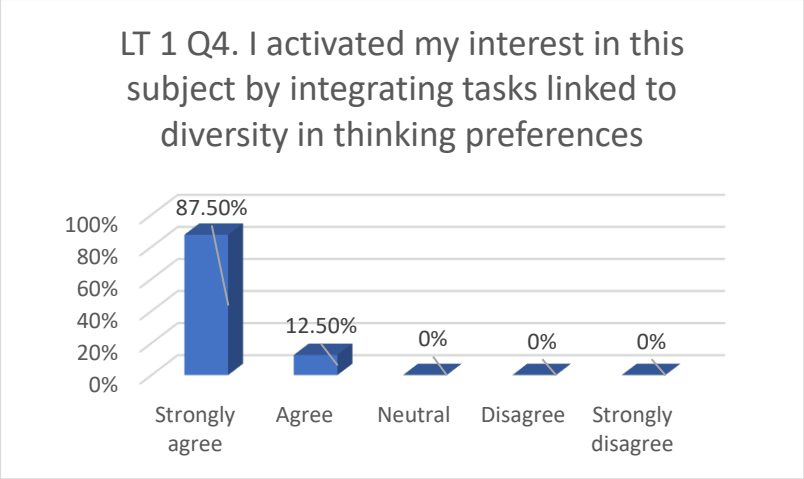


Figure 4.9: I activated my interest in this subject by integrating tasks linked to diversity in thinking preferences

Figure 4.10 indicates that I was responsive to learner queries and concerns about the learning opportunity. Seventy-five per cent of the participants strongly agreed and the remainder (25%) agreed to some extent. Timely and accurate responses to learner queries are essential to speed up the processes, eliminate possible misunderstandings and to exhibit the ability for problem solving. This improved trust and developed relationships between the participants and me.

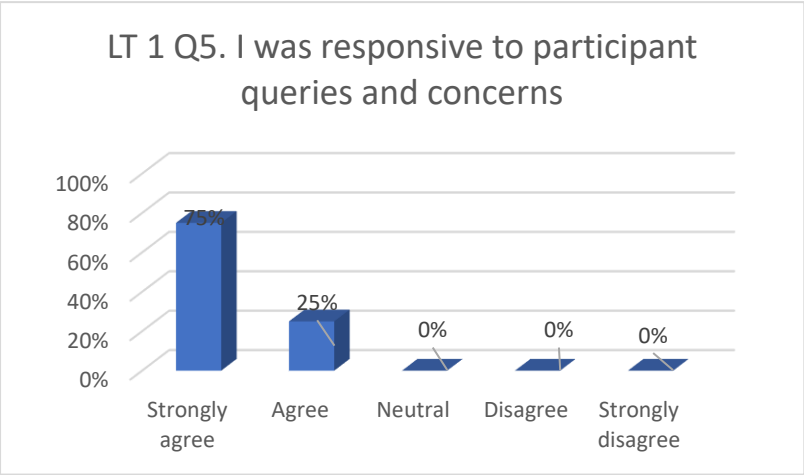


Figure 4.10: I was responsive to participant queries and concerns

According to Figure 4.11 I explained the aim to the participants adequately, as 75% of the participants strongly agreed and 25% agreed to some extent. According to the Kahoot! report the participants obtained an average of 73% for the assessment. The

results strongly suggest that the majority of the participants benefited from the learning opportunity.

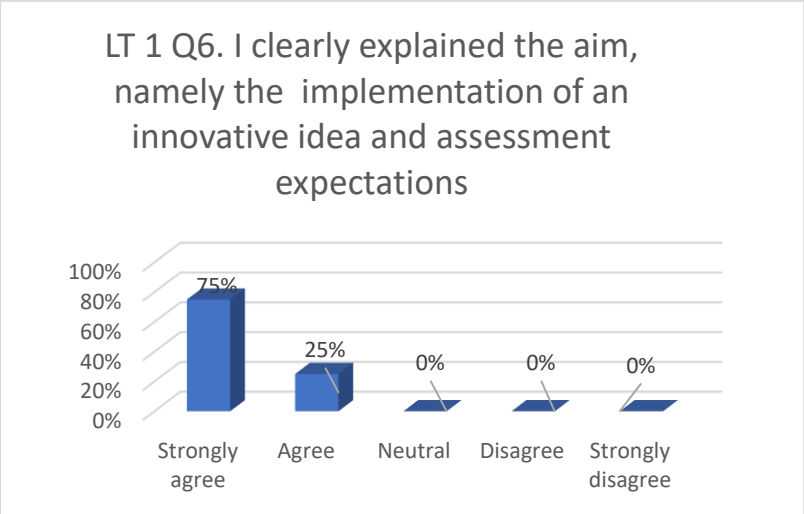


Figure 4.11: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations

The results in Figure 4.12 underscore the fact that that 75% of participants strongly agreed and 25% agreed to some extent that I used various types of media (handouts, videos, multimedia, internet and smartphone) effectively. Using smart cellular devices ensured participation by each participant. Game-based learning assists in developing self-regulated learners.

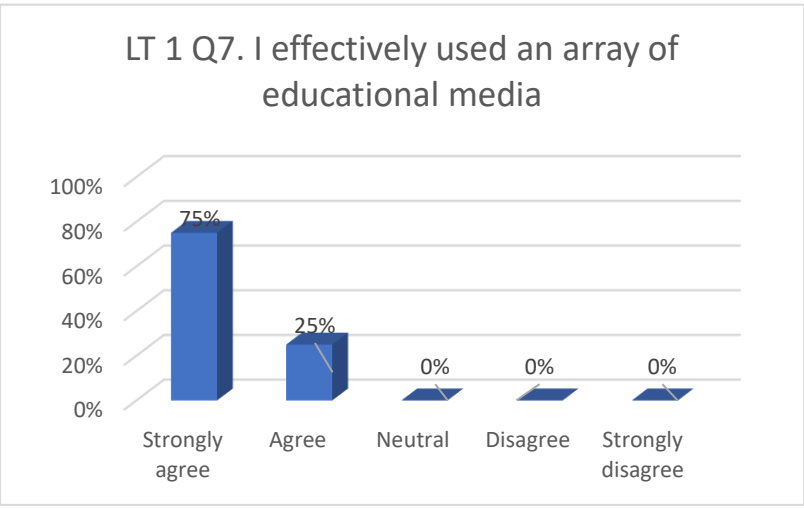


Figure 4.12: I effectively used an array of educational media

Figure 4.13 highlights that 100% of the participants acknowledged that I developed holistic and relevant assessment opportunities. The Whole Brain® assessment opportunities included tasks in each of the four quadrants. As discussed in Chapter 2, Section 2.5.1 and retrieved from (De Boer *et al.*, 2013) Quadrant A is associated with fact-based thinking processes where prior knowledge is tested. Quadrant B's thinking style is associated with organised and planned processes where participants had to use printed material to answer the questions. Quadrant C's thinking style is associated with interpersonal processes where group work or co-operative learning was allowed. Lastly Quadrant D's thinking style is associated with holistic and creative processes where a fun Kahoot! game with music and visuals was used to assess the participants.

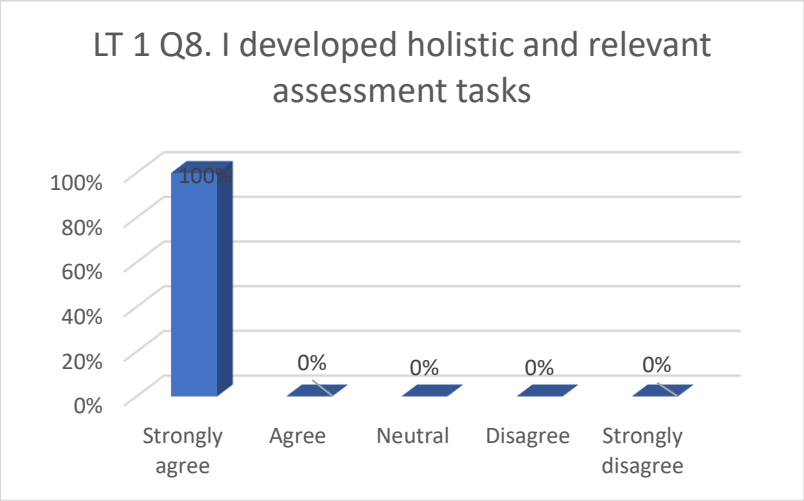


Figure 4.13: I developed holistic and relevant assessment tasks

The results displayed in Figure 4.14 indicate that half of the participants recognised that I provided useful feedback on the learning opportunity in a realistic time frame and the second half agreed on the statement. These results indicate that the participants responded positively. Although feedback is important, students need to take full control of their own learning, which makes them self-regulated practitioners. The students are in full control of their own learning and should construct meaning by themselves; this is known as constructivism.

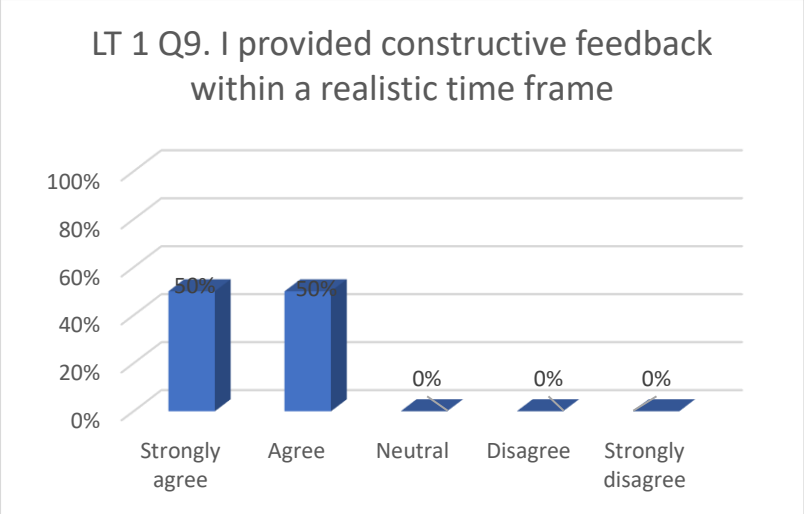


Figure 4.14: I provided constructive feedback in a realistic time frame

Figure 4.15 emphasises that all the participants strongly agreed that I made a genuine effort to enhance holistic (Whole Brain®) learning. This is satisfying as holistic Whole Brain® learning is the core of my study. It is rewarding for a researcher that the participants realised the effort and work put into the learning task design (LTD). The concept *design* is used because the learning task was creatively constructed from scratch.

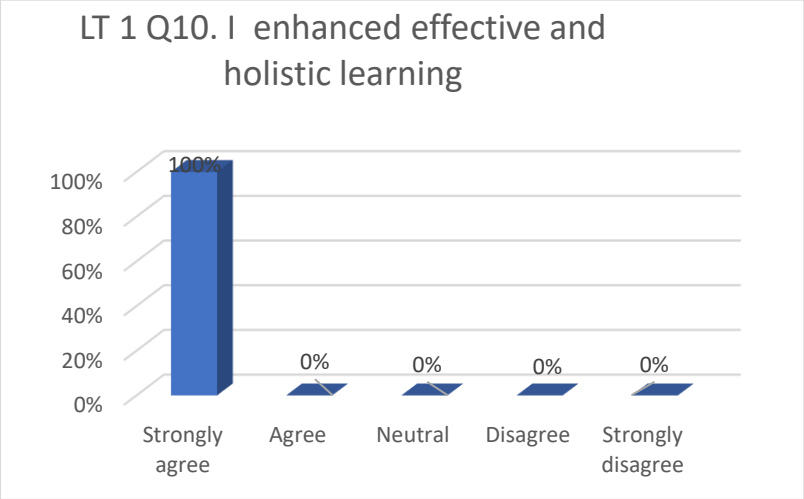


Figure 4.15: I enhanced effective and holistic learning

The assumption can be made that my role as facilitator was successful as 75% of the participants rated my facilitation as excellent and the remaining 25% considered it very good (Consult Figure 4.16). This evaluation provided me with great gratification and pride as it demonstrated the learners' positive experience in the learning opportunities created and offered.

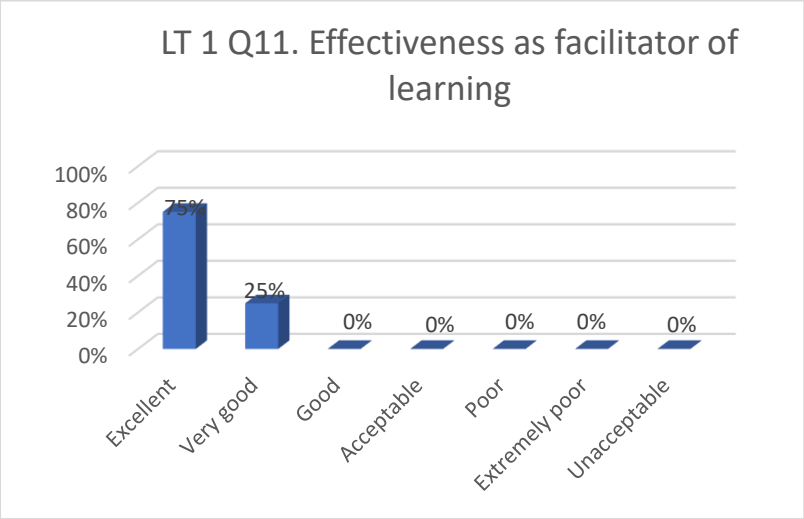


Figure 4.16: How would you rate my effectiveness of facilitator of learning

After the eleven closed-ended quantitative feedback discussed above, the following qualitative feedback from the participants was obtained by means of the open-ended section of the questionnaire, namely *Comments*:

Table 4.1: Qualitative feedback from respondents regarding their experience of the first learning opportunity[2]

Respondent	Response (verbatim)
R1	*This is a bit (sic) challenging and nice.*
	Good learning experience (R2; R3).
	This made me realise what I did not know about (sic) heart anatomy. I know my loopholes where I need to improve. I learnt a lot about how to do coronary scans and now I have an idea of certain precautions and parameters that need to be taken before and during the scan and also how the patient needs to be prepared for the coronary scan (R6; R8).
R2	*Not what I expected but more exciting.*

[2] Responses are provided verbatim and have not been edited.

	Overall the experience was wonderful.
	With regard to the challenge the time given to read and answer quizzes was extremely short therefore causing panic.
R3	*Innovative*
	I wish this was (sic) how school lectures were done.
	This was a good way to challenge the brain into a different form of learning. It was also good to be able to challenge my mind into thinking quick as opposed to guessing answers. (R4) (This response is important as it relates to the theory that forms the epicentre of the study).
	I thought this would be a typical class setting like how most universities lectures are conducted, but I was pleasantly surprised at how fun and structured it was (R4; R5; R7).
	Thank you to the teacher for giving us something fruitful (R6; R7).
R4	*Brain-stimulating way to study.*
	A great way to remember answers, learn new things and more importantly a new way of studying and enjoying while doing it.
	The way everything was explained with each question made it easy to answer the ones that followed.
R5	*It made me want to participate and learn* (R7).
	It was not boring which is very important (R7).
	Instead of a clinical slideshow presentation like in the past (R6; R7; R8).
	She was patient with us.
	Usually when lectures present work it tends to be tedious and we lose focus and end leaving the lecture hall without grasping much.
	Today I learned things I had no idea about (sic) and I would not mind doing this again.
	I loved the interactive learning.
R6	-
R7	*She was bringing a very multi-dimensional way of learning.*
	Even though I was not able to see some of the images displayed.
	The facilitator made the session very easy for us. I was able to understand anatomy more because of the way she was presenting.
	Have more interest on (sic) the session.
R8	*The anatomy of these arteries was also a good revision.*
	I am now more confident in regards (sic) to the anatomy.

Evident in the responses outlined in Table 4.1 above is that most of the participants had a positive learning experience. Another major theme that emerged from the respondents' feedback is how they enjoyed the hands-on (Quadrant C), fun, and playful approach to learning (Quadrant D), with it being structured (Quadrant B) at the same time (R3; R4; R5; R7). The respondents (R3; R4) preferred this "different form of learning" to the traditional lecture-centred teaching where only Quadrant A and Quadrant B are accounted for.

According to Slabbert *et al.* (2009:94) it is important that the learning process be initiated by means of a challenge, to such an extent that hesitation is provoked and anxiety not necessarily excluded. Thus, the panic created (R2) is not necessarily negative feedback. For me, the most significant factor was the short time allowed to answer the questions. I increased the time allowed to answer questions. This allowed the participants to collaborate with one another, stimulating peer-learning that aids in the construction of knowledge known as constructivism that is discussed in Section 4.4.2).

Learning task 2 (LT2) and Learning task 3 (LT3)

Figure 4.17 (LT2) and Figure 4.18 (LT3) indicate that the learning task presentation was successful. When comparing this to the same question in the first learning opportunity (Figure 4.6) it is clear that the participants knew what was expected of them in the three learning opportunities.

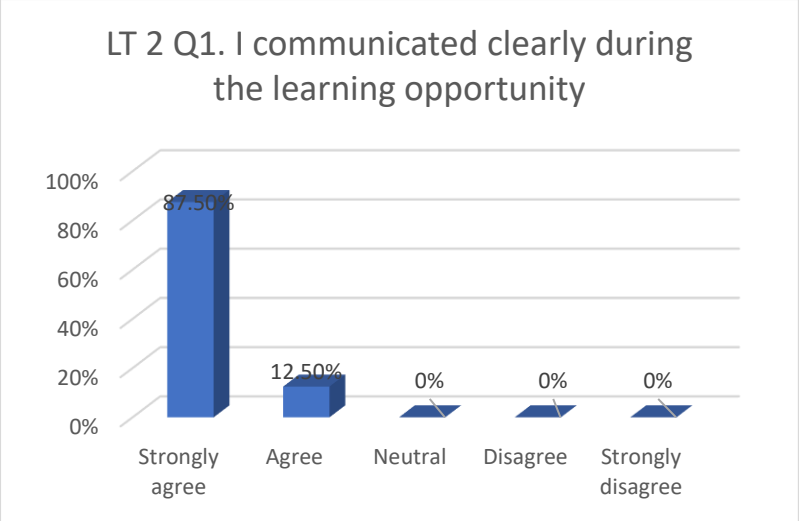


Figure 4.17 LT 2: I communicated clearly in the learning opportunity

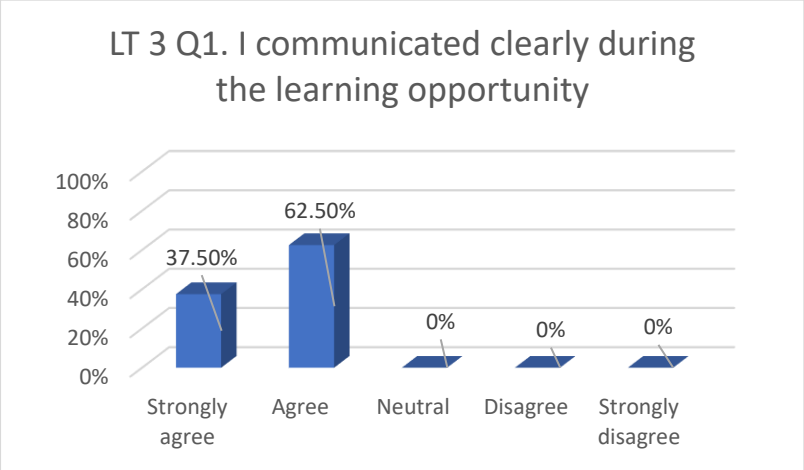


Figure 4.18 LT 3: I communicated clearly in the learning opportunity

In the next graphical displays, Figure 4.19, and Figure 4.20, it is illustrated that 75% of the participants strongly agreed that I was well prepared for the learning opportunity and 25% agreed about this. In comparison to Figure 4.7, the results are identical, which demonstrates I was indeed well prepared for all the learning opportunities.

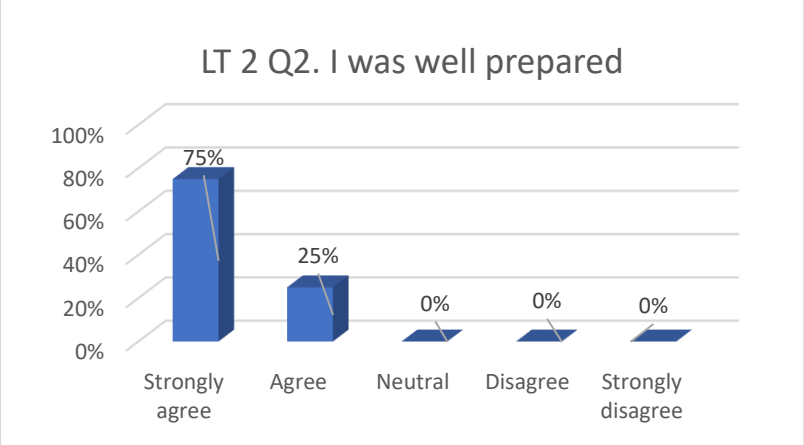


Figure 4.19 LT 1: I was well prepared

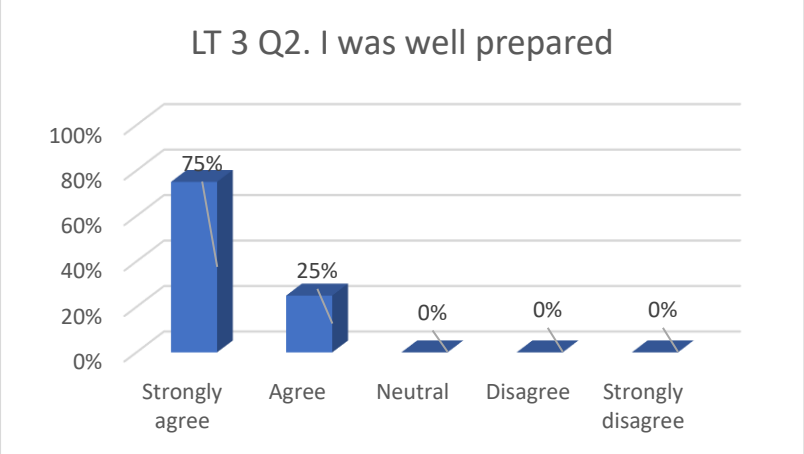


Figure 4.20 LT 2: was well prepared

According to the results in Figure 4.21 and Figure 4.22 below, time was managed in the learning opportunities. In learning task 2 (LT2) I did not allocate a specific time for the learning opportunity as the participants were expected to construct their own meaning in a self-regulated fashion.

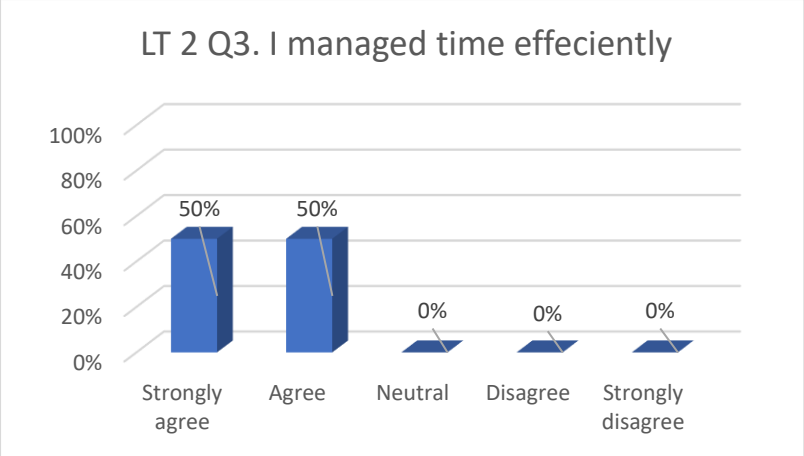


Figure 4.21 LT 2: I managed time efficiently

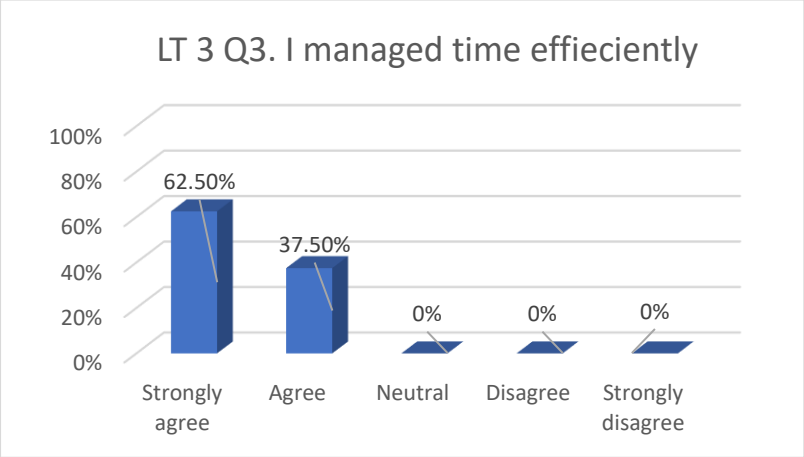


Figure 4.22 LT3: I managed time efficiently

When asked if I stimulated the participants' interest in the learning opportunities by integrating tasks linked to their thinking preferences (Figure 4.23 and Figure 4.24), 87,5% strongly agreed and 12,5% agreed to some extent of both learning opportunities. In comparison with Figure 4.9, the results are identical, which is satisfactory as they indicate the learning task was holistic and accommodated each participant's thinking preference.

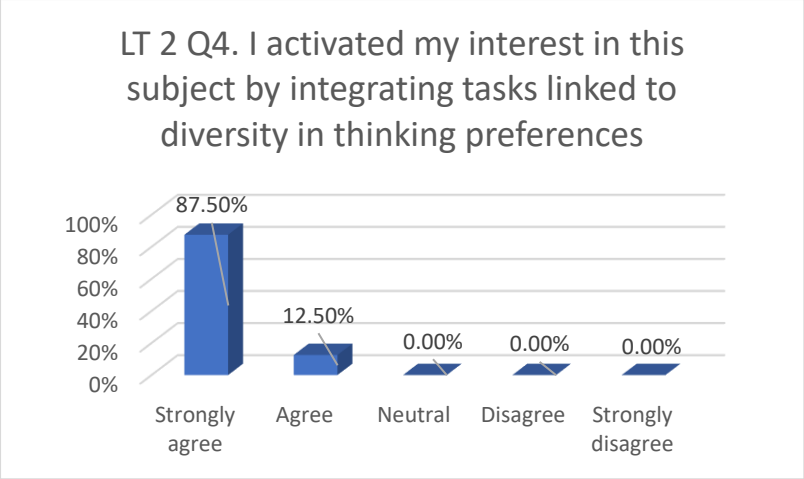


Figure 4.23 LT 2: I displayed my interest in this subject by integrating tasks linked to diversity in thinking preferences

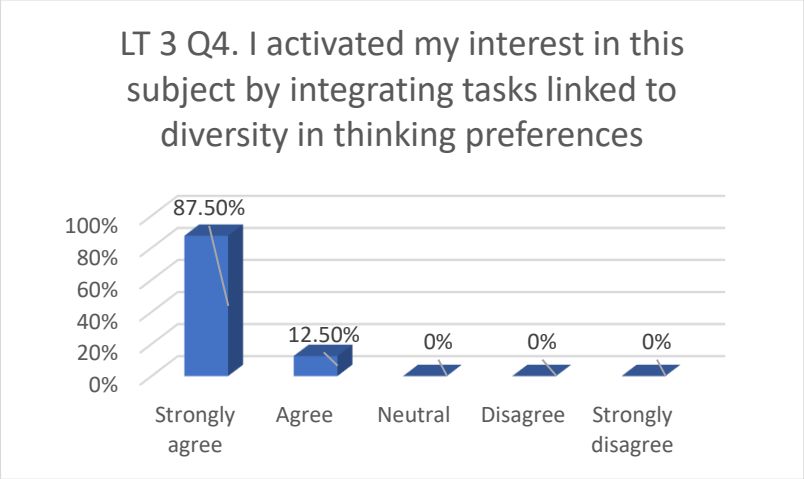


Figure 4.24 LT3: I displayed my interest in this subject by integrating tasks linked to diversity in thinking preferences

Figure 4.25 and Figure 4.26 indicate that I was responsive to learner queries and concerns in the learning opportunities. In learning task 2 (LT2) 100% of the participants strongly agreed, which was a pleasant surprise. The session was student-centred, as I did not provide any answers during the session. During the interactive learning opportunity, the participants had to solve the problem before the end of the session. This resulted in the queries being resolved, which made the participants feel positive.

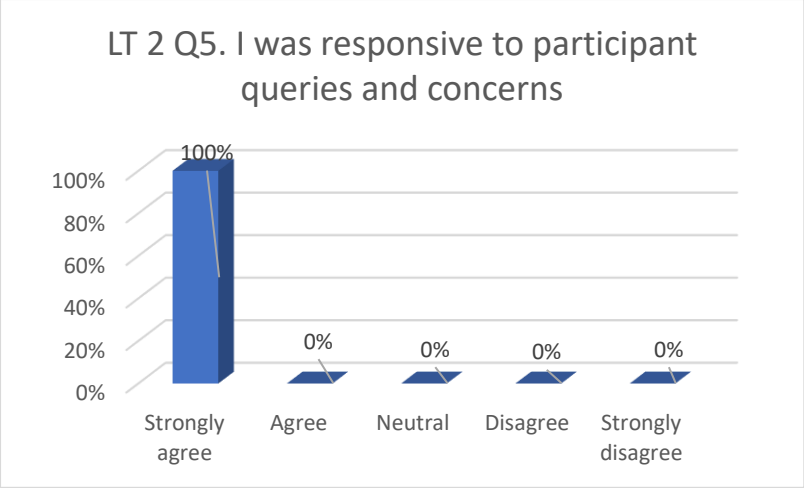


Figure 4.25 LT2: I was responsive to participant queries and concerns

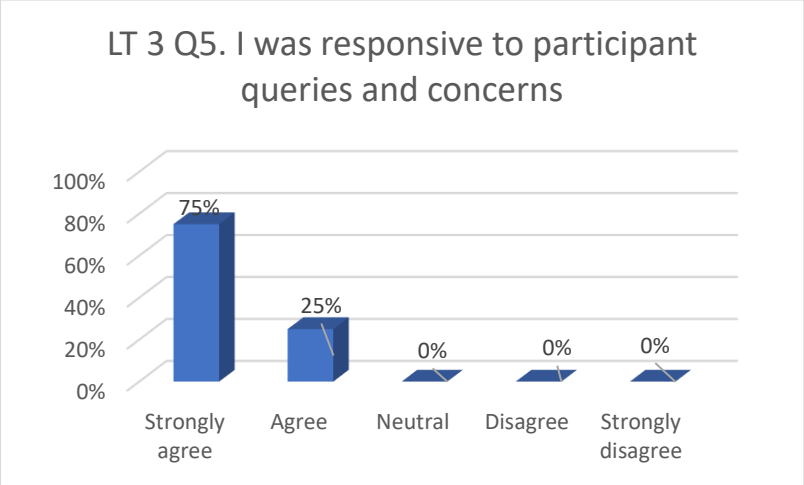


Figure 4.26 LT3: I was responsive to participant queries and concerns

In Figure 4.27 and Figure 4.28 it is evident that I explained the aim to the participants adequately. In learning task 2 (LT2) 63% of the participants strongly agreed; 38% of the participants agreed to some extent. In learning task 3 (LT3) 75% of the participants strongly agreed and 25% of the participants agreed to some extent. This indicates that in all three learning tasks the aim was clear to the participants.

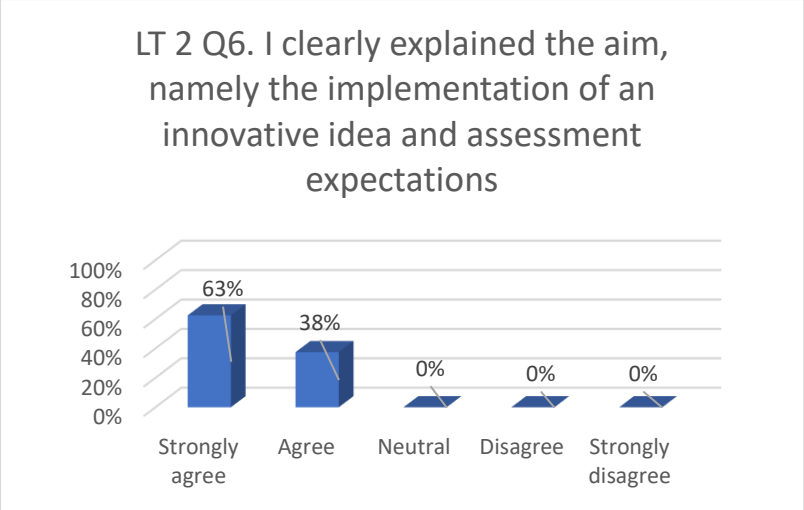


Figure 4.27 LT 2: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations

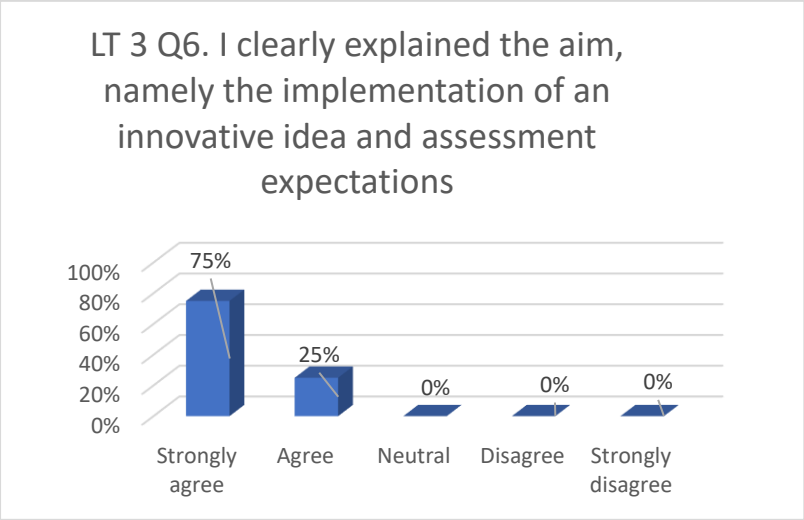


Figure 4.28 LT 3: I clearly explained the aim, namely the implementation of an innovative idea and assessment expectations

The results in Figure 4.29 underscore the fact that 50% of the participants strongly agreed, 38% of the participants agreed to some extent and 13% were neutral that I used various types of educational media (handouts, videos, multimedia, internet and smartphone) effectively. There is a definite decrease in the outcome in comparison to the previous learning opportunity (Figure 4.12). The learning opportunity entailed practical participation, where the students had to work on the advanced working station, reconstructing the coronary tree (Consult step 2 learning task 2 above).

In Figure 4.30 the participants responded to the question with positive feedback. The participants had to mould the heart organ out of clay and could use a textbook; anatomically correct plastic heart figures were provided to complete the learning task. (Consult Figure 4.5).

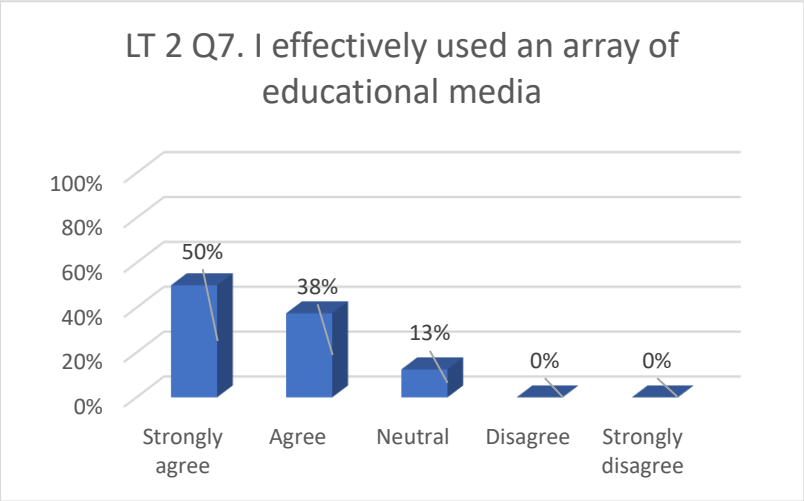


Figure 4.29 LT2: I effectively used an array of educational media

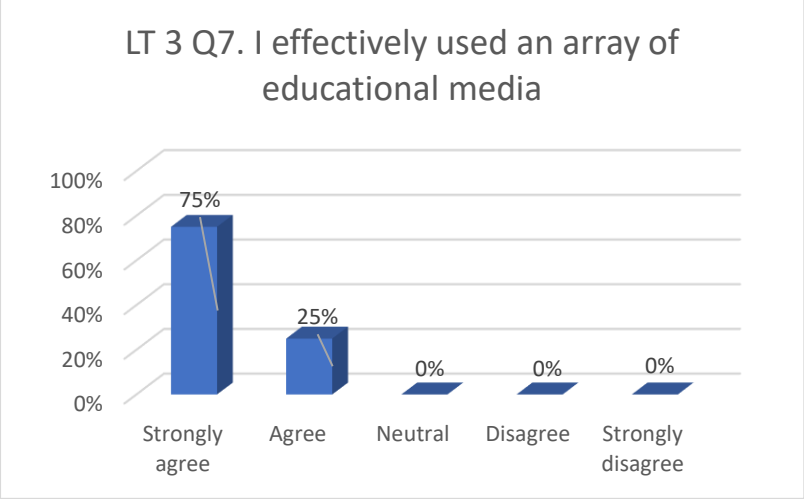


Figure 4.30 LT 3: I effectively used an array of educational media

Figure 4.31 demonstrates that in the second learning task 87,0% of the participants strongly agreed and 12,5% agreed about the statement that I developed holistic and relevant assessment tasks. In this learning opportunity the participants were assessed on their coronary tree reconstruction. The steps they had to put in place as they were reconstructing meant that they either could not produce anything or that they

accomplished the task. In the third learning task (Figure 4.32) all the participants strongly agreed that I developed holistic and relevant assessment tasks.

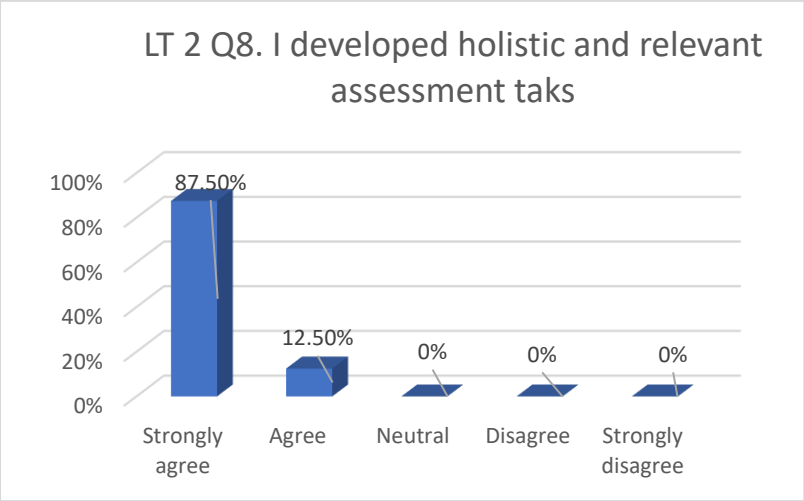


Figure 4.31 LT 2: I developed holistic and relevant assessment tasks

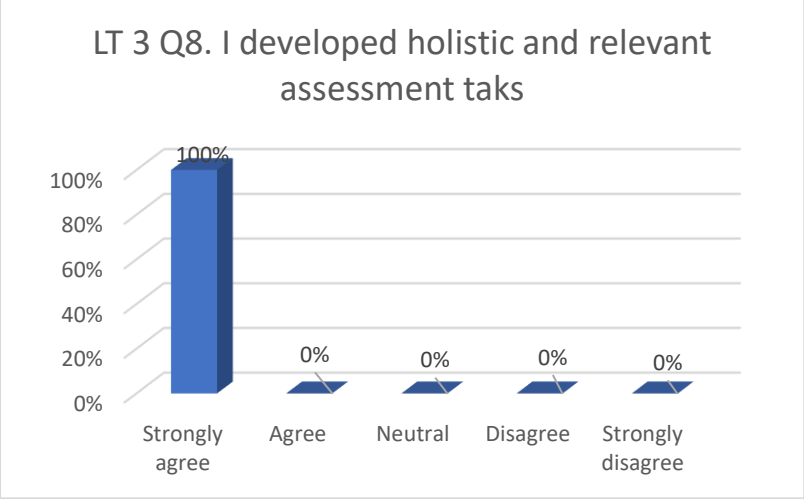


Figure 4.32 LT 3: I developed holistic and relevant assessment tasks

Figure 4.33 and Figure 4.43 highlight the fact that all the participants appreciated the learning task feedback (LTF) they received on the execution of the second and third learning task. According to Slabbert *et al.* (2009: 114) learning is maintained through learning task feedback; it is important that the feedback is provided while the participant is executing the task. Although I did not provide feedback as I was traditionally used to, I asked questions to get the participants re-engaged with the learning task.

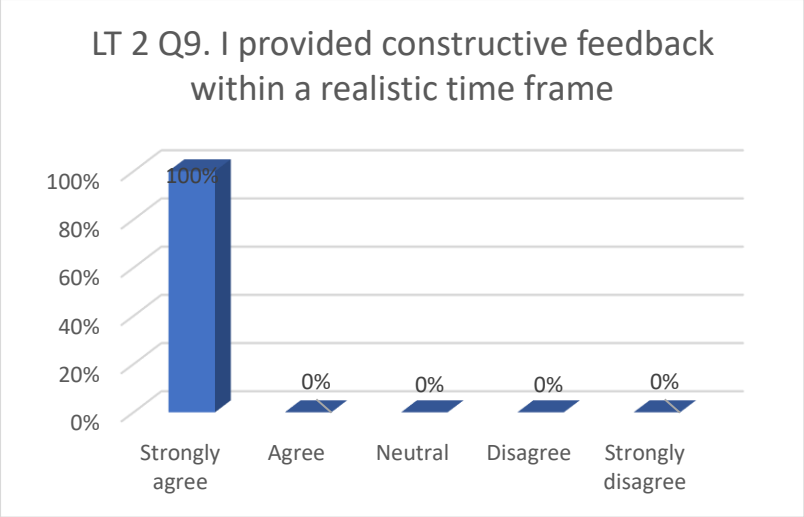


Figure 4.33 LT 2: I provided constructive feedback in a realistic time frame

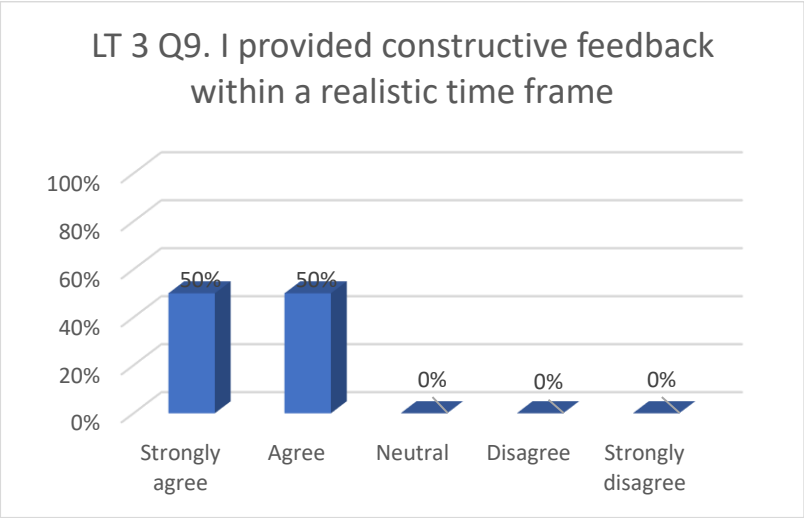


Figure 4.34 LT 3: I provided constructive feedback in a realistic time frame

The results displayed in Figure 4.35 and Figure 4.36 suggest that all the participants strongly agreed that I made an effort to promote effective and holistic learning. The results were similar for all three learning opportunities (Figure 4.15) which was gratifying as holistic learning is the core of my study.

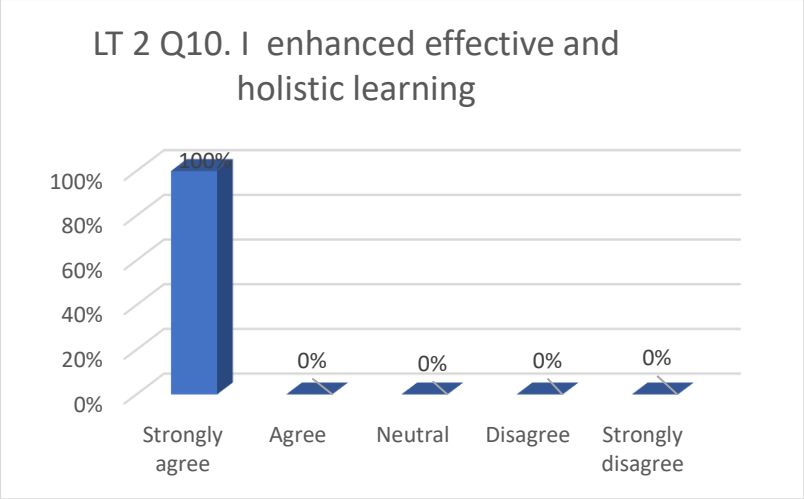


Figure 4.35 LT 2: I enhanced effective and holistic learning

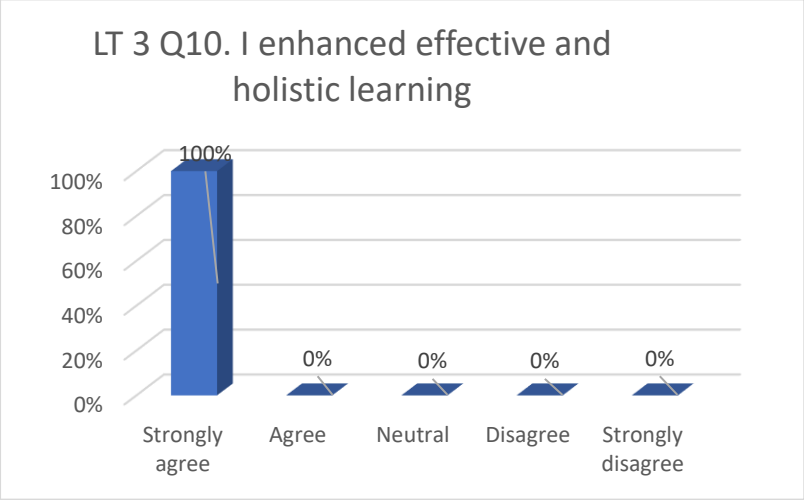


Figure 4.36 LT 3: I enhanced effective and holistic learning

My role as facilitator was successful as 100% of the participants rated my facilitating of learning as excellent as can be seen in Figure 4.37 and Figure 4.38 below. Referring to Figure 4.16 in the first learning opportunity, there is a positive improvement in my effectiveness as a facilitator of learning.

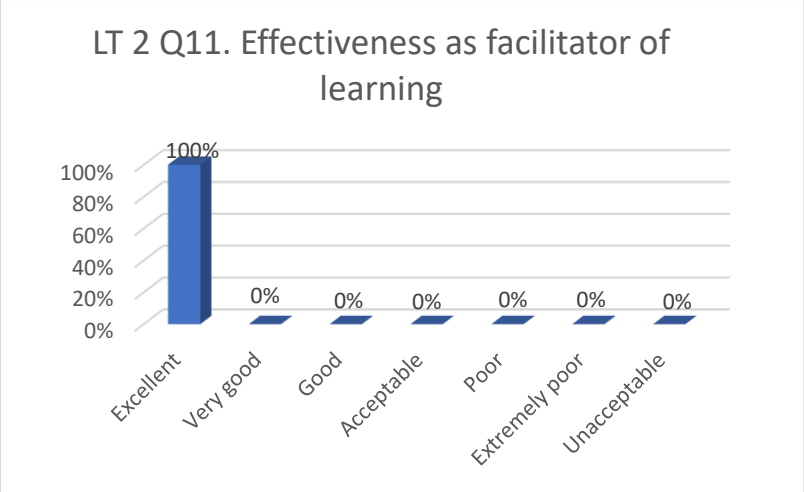


Figure 4.37 LT 2: Effectiveness as facilitator of learning

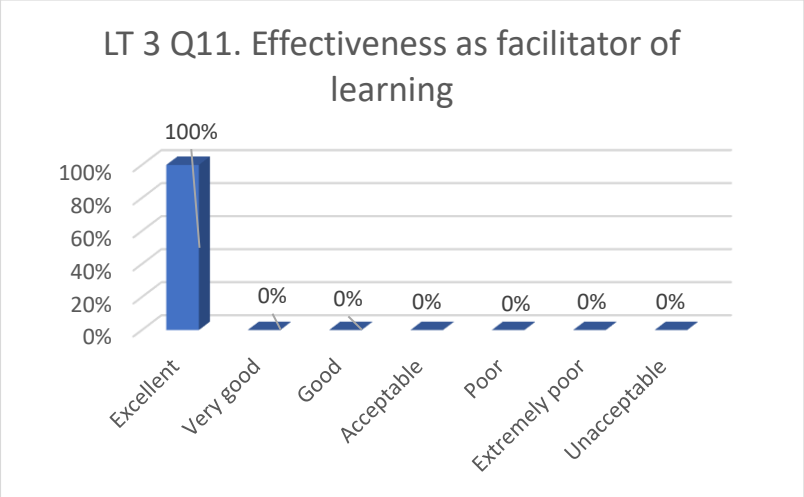


Figure 4.38 LT 3: Effectiveness as facilitator of learning

The positive feedback from the participants revealed that the learning opportunities were successful. Having analysed the results, I now realised how important the learning task design was for the success of the learning opportunities. I had significantly improved my confidence in developing Whole Brain® learning activities. After the eleven closed-ended quantitative questions had been discussed (learning task 2 and 3), I obtained qualitative feedback from the participants by means of the open-ended section of the questionnaire, named “Comments”.

Learning task 2

Table 4.2: Qualitative feedback from respondents regarding their experience of the second learning opportunity[3]

Respondent	Response (verbatim)
R1	*Excellent learning opportunity* (R2; R3; R7).
	I now have an idea on (sic) the coronary scan and will now be able to do it on my own (R4; R8).
	There are some aspects which were very difficult, but now are easier, especially to reconstruct the coronary tree as well as the blue heart (R7).
	She did a great job of incorporating theory and practice all in a session (R5; R6).
R2	*Impressed with the session.*
	The facilitator gave the opportunity to do the session myself which helped with how much I really got from what she was teaching. Can now do the coronary tree and blue heart myself (R8).
	Learning experience was really eye opening to how fast I can get what is being taught because the facilitator gave, he (sic) opportunity to do the work practically (R3; R4; R7).
R3	*This was a fun way to learn how to do the main coronary examination with very minimal technicalities (R5).*
	Very informative (R5).
	Well done to the researcher for facilitating this study.
	I have learned how to do the tree and the blue heart in a new way and it helped a lot more than someone just rambling off how it should be done (R8).
R4	*Once the correct steps are figured out, we could produce the coronary tree (R6).*
	It makes it easy to learn especially (sic) to know (sic) and understand the reasons we do everything.
R5	*A great and innovative way of learning that includes using visuals to stimulate our brains (sic) to learn.*
R6	-
R7	-
R8	-

[3] Responses are provided verbatim and have not been edited.

Learning task 3

Table 4.3: Qualitative feedback from respondents regarding their experience of the third learning opportunity[4]

Respondent	Response (verbatim)
R1	*I never knew I had a creative part in me.*
	What a fun session (R4; R8).
R2	*I won't (sic) confuse the arteries again after today (R5).*
R3	*Lecturer did so much effort with the session (R4; R8).*
R4	-
R5	-
R6	*Facilitator did not want to answer my question and asked me questions back.*
R7	-
R8	*Theoretical session made practically (sic).*

The qualitative feedback provided by the participants was the most useful to me. It is noteworthy and satisfying as depicted in Table 4.2 that half of the participants indicated that the learning opportunity was excellent. I did not expect such positive feedback. This is probably due to the fact that I facilitated the session differently; it was student-centred where the participants had to construct their own meaning, using the principles of constructivism and of socio-constructivism when working as co-operative teams. I did not assist them with steps to produce a coronary tree; instead I gave them the opportunity to do it themselves. At some stages it was difficult for me as the facilitator not to intervene and guide them with answers, but in hindsight I am so impressed that I forced myself not to take control as half of the participants appreciated the fact that they could complete the task independently.

The previous two learning tasks provided an increase in qualitative feedback in comparison to feedback received as depicted in Table 4.3. This could be due to my facilitating the session on a Friday afternoon, and the participants wanted to finish the questionnaire hastily. As a matter of importance, I learnt that the participants enjoyed the fun and playful approach of the learning opportunity. The participants discovered

[4] Responses are provided verbatim and have not been edited.

and explored the placement of the coronary arteries. What could traditionally be a very theoretical session, was facilitated in a practical Whole Brain® fashion.

4.3.3.2 Feedback from peers

To search for advocacy on how to advance my facilitating of learning from a professional viewpoint, I obtained feedback from two peers. The collaboration with these peers or critical friends, fellow PGCHE graduates (Consult Chapter 1, Section 1.1), is essential for any research claims made (McNiff, 2014:81) on my professional development. According to Singh (2015:106), (Du Toit, 2009:45) posit the following: "Your critical friend (also called a 'critical colleague' or 'learning partner') is someone whose opinion you value and who is able to critique your work and help you see it in a new light. Critique is essential for helping us to evaluate the quality of the research. You would ask one or two people to be critical friends from the start of the project."

Learning task 1

Both critical friends were available to observe my practice during the Kahoot! learning opportunity. The following closed-ended responses (Consult Appendix IV) from my peers on my facilitating of learning indicated the following:

i) Have knowledge of the content (topic) to a great extent.
ii) The learning opportunity (outcomes, course, sequence, and flow) was well structured and clearly stated.
iii) Good time management was evident.
iv) Self-presentation (language, quality of voice, eye contact, body language, etc.) reflects professionalism.
v) Learners interacted with one another to a large extent.
vi) Authentic learning was activated.
vii) Whole Brain® learning was visible, all thinking preferences were accommodated for.
viii) Learning media was used in a professional manner where appropriate.
ix) Overall, I was well prepared for the learning opportunity.

Additionally, the peers were instructed to give comments on my facilitating of learning to enrich the data. The following comments were made:

i) Both peers agreed that The Kahoot! game served as an ideal diagnostic testing of knowledge. The game-based learning or gamification used here was motivating and created a perceived engaging and fun environment, with extrinsic motivation evident.

ii) A peer said the following: *Students were challenged as they did not remember their anatomy. The interactions after the questions encouraged co-operative learning*.

iii) The interactions among students encouraged co-operative learning and students were challenged during the learning opportunity. The social interaction was used for socio-constructivist approaches and possibly the formation of a community of practice.

iv) Feedback provided to clarify concepts could be augmented as some was very brief. The feedback could be by students to stimulate peer-learning (where the students must explain to the rest). By redoing some of the questions their knowledge and competency could be increased. In addition, Use reflective guidance or questioning when students got an incorrect answer to promote thought and higher level of learning.

v) A peer said the following: “Although it is heavy on cognitive learning, it is presented in a way that allows for a fun and engaging environment using the game. The techniques used encapsulate many of the Whole Brain® principles. Overall, clearly a fun activity where students learnt and could assess their knowledge. Well done.”

vi) One of the peers commented in a Whole Brain® manner that included detailed descriptions (quadrant A) in an organised, bullet format (quadrant B); he discussed some of the feedback with me personally (quadrant C) and provided a visual sketch (quadrant D) as depicted in Figure 4.39 below.

Figure 4.39: Whole Brain® diagram provided by a peer (Dr W Cordier)

The visual indicates the metaphoric Whole Brain® model, representing how each of the four quadrants (Consult Chapter 2, Section 5.1) was incorporated into the learning tasks during the learning opportunity. It is evident that the learning opportunity was facilitated in a holistic Whole Brain® manner that accommodated every student's thinking preference.

The feedback from my peers indicated that I succeeded in facilitating learning opportunities that accommodated all the different thinking preferences. Throughout the learning opportunities I encouraged the participants to construct their own meaning in a self-directed fashion. I will continue facilitating learning opportunities in a holistic Whole Brain®, preparing learners for the 21st century.

Learning task 2

Only one critical friend was available to observe my practice in this learning opportunity. The next section summarises the overall response. The following closed-ended responses (Consult Appendix IV) indicated the following:

i) Has knowledge of the content (topic) to a great extent.

ii) The learning opportunity (outcomes, course, sequence, and flow) was well structured and clearly stated.
iii) Good time management was evident.
iv) Self-presentation (language, quality of voice, eye contact, body language, etc.) reflects professionalism.
v) That learners interacted with one another to a large extent.
vi) Authentic learning was activated.
vii) Whole Brain® learning was visible, all thinking preferences were accommodated.
viii) Learning media was used in a professional manner when appropriate.
ix) Overall, I was well prepared for the learning opportunity.

Additionally, the peer was instructed to give comments on my facilitating of learning to enrich the data. The following comments were contributed:

The learning opportunity was well prepared for. The learning task presented challenges to the students. Co-operative learning took place when students had to solve the challenge co-operatively.

Time allocation for solving the challenge should be clearly stated at the beginning of the learning task presentation. Learning was maintained through questioning. This could have been done more frequently (active facilitation).

The learning task accommodated students with the learning or thinking preferences Quadrant A (when students had to open a prescribed textbook to look for facts). Quadrant B (organising the labels); Quadrant C (working together in small groups); Quadrant D (Visuals); self-regulated learning was encouraged so that students could be more efficient and competent in performing the task. The venue was not ideal as students had to move from one venue to another.

4.3.3.3 Observing the participants

In the data collection phase I used video recordings and photographs as observational tools while observing the series of the first learning opportunities presented. The advantage of using video recordings is that they provide a permanent record that I can use to review and reflect on. After data collection, I used a behaviour log to focus on what mode of thinking was accommodated during the learning opportunity presented (Consultable below). The observation strategy followed was a closed-structure observation, based on mainly categories, namely Quadrant A, Quadrant B, Quadrant C and Quadrant D. The outcome is numerical data (Efron, 2013:86).

Table 4.4: Observation of accommodating modes of thinking in the first learning task

*P(s) refers to participant(s)

Learning task 1				
Time	**Quadrant A**	**Quadrant B**	**Quadrant C**	**Quadrant D**
1:00	Ps sat quietly listening	P asks to repeat: How many seconds to complete answer?	P asks if they could help one another	
2:28				
3.22	Ps concentrate on question asked			
3:45		P asked to clarify rules		
4.17	Ps concentrate on question asked			
4:28			Ps collaborate	
4:43		P: others to act faster; stay on track; be able to obtain marks		
5:25			Ps collaborate	
6:00	Ps listen to precise information			
6:29			Ps collaborate	
6:38		Ps very competitive	P: “You are keeping your phone to yourself and don’t want to share”	

6:39	P expresses no emotion on statement			
6:45				P enjoys pictures in questions. “Wow! I just realised I can use the picture to work out the answer.”
7:37	P says they have not done anatomy in a very long time; asked to use textbook			
8:04				Ps laughs; enjoys playful approach
8:22				Ps asks to continue – enjoy quick pace
9:39			Ps collaborate	
10:26			Ps collaborate	
10:28	P does not want to collaborate due to competition			
10:43				Ps laugh; enjoy fun game
11:07	Ps concentrate on question asked			
12:11			Ps collaborate	
12:50		P says time allocated too little		Another P disagrees – prefers quick pace
13:00	P: “You see we like cramming”	P prefers practical application questions		
15:43			Ps collaborate	
16:40			Ps collaborate	
17:54	Ps concentrate on question asked			
18:20				Ps laughs; enjoys fun game
19:39			Ps collaborate	
20:00				P to another: “Welcome back to the game” in laughing tone

20:43			P shows excitement for hands-on learning. Genuine interest towards learning opportunity e.g. 'fist pump' P raised fist in the air – a celebratory gesture
21:30		Ps collaborate	
23:23			P said: "This was such a fun activity"
26:00 -30:00	Ps use textbook to find answers	Ps collaborate	

Evident in the behaviour log (Table 4.4) above is that the learning opportunity was facilitated in a holistic Whole Brain® manner. Eleven entries were recorded in Quadrant A, five in Quadrant B, fifteen in Quadrant C and seven in Quadrant D. This result is useful to me as facilitator because it indicates that the learning opportunity was facilitated in a Whole Brain® manner.

Table 4.5: Observation of accommodating modes of thinking in the second learning task

P(s): Participants(s)

*LT: Learning task

*LO: Learning opportunity

Learning task 2				
Time	**Quadrant A**	**Quadrant B**	**Quadrant C**	**Quadrant D**
	Ps listen to LT presentation			
	Ps read written instructions provided			
		P repeats instruction asks if she understood clearly		
3:30				Ps opportunity throughout LO to experiment with advanced working station
3:35			Ps collaborate	
4:28		P explains steps she is following to me		
5:08		P explains to peer why she is doing a specific step		
5:30	P refers to what she read in a textbook		Ps collaborate	
7:05			Ps collaborate	
7:25		P asks if they could put steps above working station for future reference		
8:25				P comments: “Glad we can learn by doing it ourselves”
Hands-on learning throughout entire session				

Evident in the behaviour log (Table 4.5) above, the learning opportunity was facilitated in a holistic Whole Brain® manner. Three entries were recorded in Quadrant A, four in Quadrant B, four in Quadrant C, and two in Quadrant D. With this equal distribution in each quadrant, it is evident that I did reach the desired outcome of facilitating a holistic Whole Brain® learning opportunity.

Table 4.6: Observation of accommodating modes of thinking during the third learning task

*P(s): Participant(s)

* LT Learning task

*LO: Learning opportunity

Learning task 3				
Time	**Quadrant A**	**Quadrant B**	**Quadrant C**	**Quadrant D**
00:40	Ps listen to LT presentation			
00:50				Throughout LO Ps had opportunity to experiment
1:12	P: “So basically, you want us to first mould the heart and then indicate the different arteries?”			
1:25			Ps collaborate	
2:20		P: “We are skipping the most important step”		
2:27		P:“Okay, so let’s start at the beginning and go back to the anatomy”		
2:33			Ps share ideas	
2:45				Experiment with different ideas how to make rope stick on clay
3:02	P uses textbook to answer question			
3:03			Ps collaborate	

3:15		P: “When we did the CT reconstructions, we knew the left coronary artery supplied part of the right ventricle”		
3:22	P uses logical rationale to answer question: “If you think about it, the artery branches to the back and downwards, then it could only be the posterior descending artery”			
4:00		P: “We are going off the topic”		
4:15			Ps collaborate; group discussion	
4:22				P laughs; says: “I never realised I was so creative.”
4:28				P: “Yes, I’m also really enjoying the activity”
4:55		P asks d if she could compare her arteries on the heart with her peers		
5:28			Collaboration; P: “Are you sure it’s not the anterior artery?”	
6:10	P uses logic: “How can it be anterior if it is going to the back?”			
6:30				P asks to pass heart phantom to double check something

Evident in the behaviour log (Table 4.6) above is that the learning opportunity was facilitated in a holistic Whole Brain® manner. Five entries were recorded in Quadrant A, five in Quadrant B, five in Quadrant C and five in Quadrant D. For me, the most significant outcome in the three behaviour logs was that there was a definite improvement from the first to third learning task in terms of the distribution of the characteristic in each quadrant. These holistic Whole Brain® learning opportunities would accommodate each participant’s thinking preference.

4.3.3.4 Self-observation

I completed questionnaires on my contribution as a facilitator (Du Toit, 2019b:30) after each learning opportunity presented. The questionnaire consisted of three categories, namely a focus on me as facilitator who inspires my participants; on me as a facilitator who initiates learning, and as a facilitator maintaining learning. Consult Appendix V for an example of the questionnaire.

Figure 4.40 indicates my contribution to the participants' learning in category 1 in the three learning opportunities. In all three learning opportunities I almost always showed enthusiasm for the subject matter and learning tasks. As I am competent in expressing myself well, I frequently used this competence during my first learning opportunity and almost always during the second and third learning opportunity. When assessing whether I promoted the importance and significance of the subject matter, I occasionally did in the first learning opportunity. In learning opportunity 2, I frequently did so and in the third learning opportunity I almost always promoted the importance of the subject matter. In my view I always provided lively and encouraging learning tasks in all three learning opportunities.

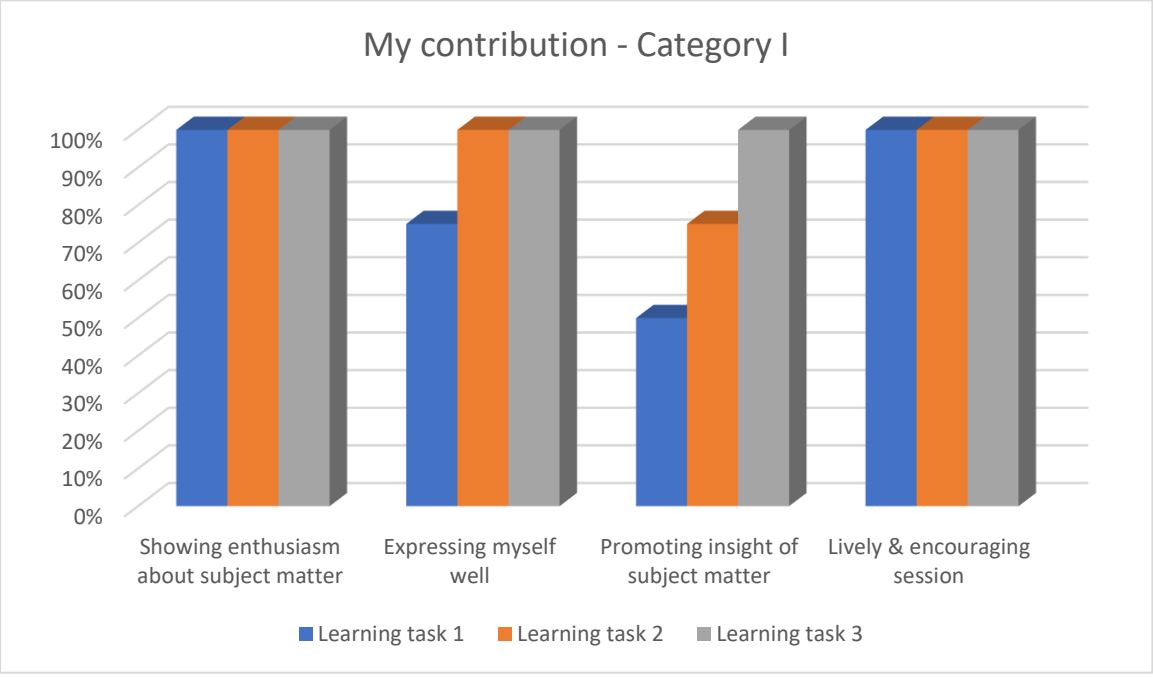


Figure 4.40: My contribution to participants' learning in the first category

Figure 4.41 indicates my contribution to the participants' learning in category 2 in all three learning opportunities. I believed I almost always created a climate that promoted deep learning in all three learning opportunities. In learning opportunity 1 I frequently stated the purpose and learning outcomes of the session, and almost always did so in the second and third learning opportunities. Linking learning to real-life situations varied in the three learning opportunities. In the first learning opportunity I occasionally did link the applicable learning task to real-life contexts; in the second I almost always did so and in the third learning task I frequently linked the learning to real-life situations.

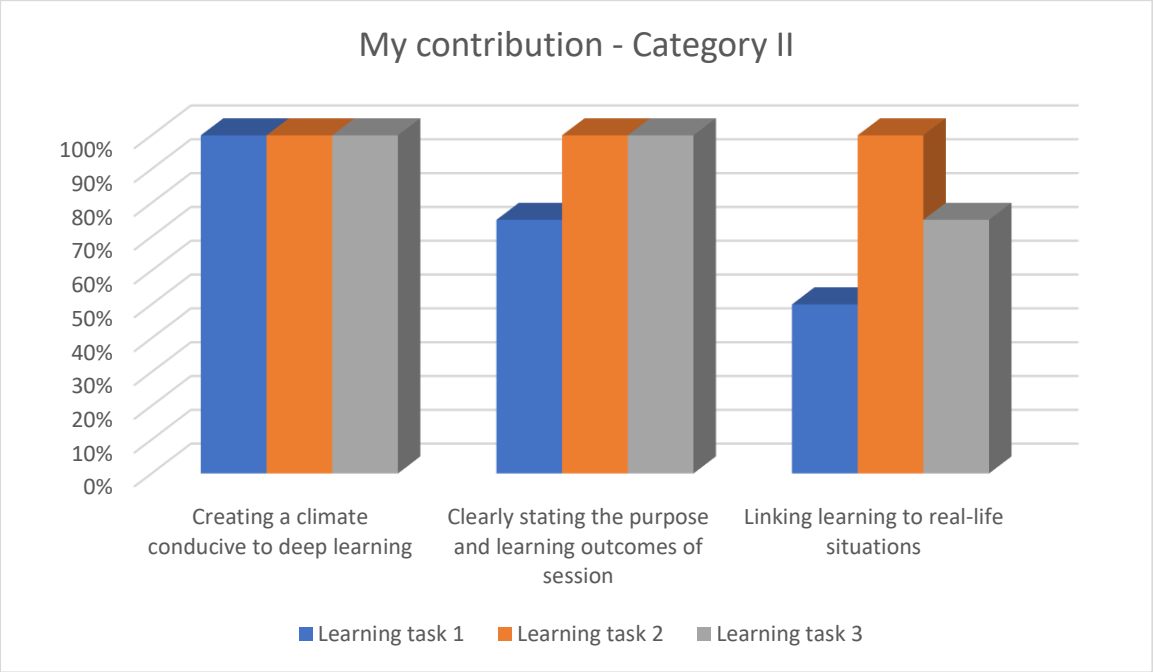


Figure 4.41: My contribution to participants' learning in the second category

Figure 4.42 indicates my contribution to the participants' learning in category 3 in the three learning tasks. In the first learning task, I hardly ever promoted lecturer-student discussions with the learning opportunity being lecturer-driven. This changed in the second and third learning task where I almost always promoted lecturer-student discussions. In the first learning task I frequently encouraged my participants to construct their own understanding (constructivism) of the material by allowing them to choose their own answer to each question. As for the second and third learning task, I almost always encouraged constructivism. In my opinion all three the learning tasks were conducted in a Whole-Brain® manner and not only according to the participants'

own thinking preferences. According to my observation, I occasionally encouraged my participants to express themselves freely and openly in the first learning task. In the second and third learning task I almost always encouraged them to express themselves. In the first learning task I occasionally encouraged critical thinking and self-reflection and almost always in the second and third learning tasks. In the first learning task I occasionally created opportunities for co-operative learning. I paid attention to this in the second and third learning task and almost always encouraged co-operative learning.

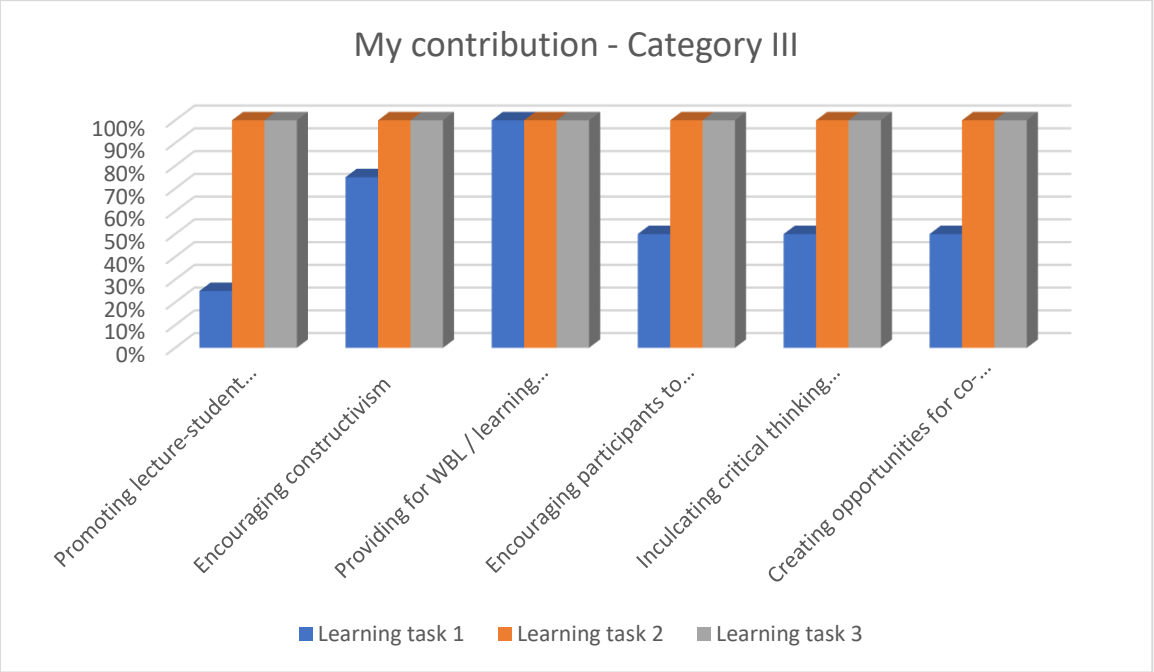


Figure 4.42: My contribution to participants' learning in the third category

For me, the most meaningful conclusion from the data presented above is the improvement evident from the first learning opportunity to the third. Although I did reflect on the design of the first learning task design in the first learning opportunity, I noticed what I could work on in the next learning opportunity after observing myself and completing the self-observation questionnaire. I significantly developed my ability to promote discussion between myself and the participants, redirecting questions to the participants and encouraging constructivism.

4.3.4 Step 5: Evaluating the process

The successes, strengths, errors and weaknesses were revealed, followed by an explanation of how I planned on improving the next learning opportunity.

My professional development and the learning of my participants in essence revolved on professional identity formation (Du Toit, 2018). When planning the study, I did not realise how I would be challenged with my own advocacy of being able to solve real-life challenges. Having experienced a life changing pandemic, I now realise how important the array of attributes of the 21st century is. As I was challenged by a number of real-life problems, I had to think of creative ways to solve them. However, I could have been more successful in terms of statistical backbone – the number of participants and learning opportunities offered. However, I did facilitate learning opportunities where I promoted Whole Brain® self-regulated learning. The biggest issue was working with participants in a busy work environment and not being able to work with students in a university setting. Working with participants at the hospital as an informal context is quite different to working with students in a formal setting, such as a public higher education institution.

Chapter 5: Stage 4 in the study's life cycle (Discussion, conclusion, recommendations)

As discussed in Chapter 1, Section 1.5, my perception of action research can be compared to the butterfly effect and the stages in the butterfly's life cycle. Finally, after all previous habits have been addressed, critically reflected upon, and changed, the butterfly will emerge from its chrysalis. This symbolises the transformation that took place and which is the core of this chapter.

5.1 Introduction

As discussed in Chapter 1, the rationale for conducting this study was to take responsibility for my professional development as scholar and practitioner in the field of Radiographic Clinical Practice. I wanted to have a positive effect on it and on how demonstrations of different radiographic techniques are enacted. This final chapter presents the reflection on the entire action research process and demonstrates the claims made for my professional development journey. The empirical research findings are linked to the innovative research questions presented in Chapter 1. The contributions and challenges of the study are discussed, followed by recommendations for future research.

5.2 Addressing the research questions

To explore and clarify the main research question, I formulated the following secondary research questions that assisted me in remaining focused during the action research process and are discussed as they lead to answering the main research question.

With the first secondary research question I wanted to determine how my thinking preference could inform my practice.

5.2.1 First secondary research question

What is my thinking preference according to the Herrmann Brain Dominance Instrument® (HBDI®)?

As discussed in detail in Chapter 4 Section 4.2, my thinking preference was determined by the HBDI®. The results provided by Herrmann International (2016:1-5) are important for my professional development. By knowing what my thinking preference under normal circumstances as well as under pressure is, I could focus on accommodating all the participants with different thinking preferences. The focus was not only on accommodating them, but also on challenging each participant to use his less preferred thinking preference to complete the task. This ensured that holistic or Whole Brain® learning occurred.

My profile was identified as a triple dominant profile, 1112, with strong thinking preference in three quadrants. The preference code 1 in my profile indicates a brain dominance in quadrant B, followed by quadrants C and A, respectively. The preference code 2 indicates a lesser preference, but I am still comfortable to use the thinking preference when the situations requires it. This thinking preference is neither preferred nor avoided.

These results had a positive effect on my facilitating of learning. During learning task design, I acknowledged that each student has a unique thinking preference. I designed holistic Whole Brain® activities that promoted authentic learning and developed different thinking preferences.

5.2.2 Second secondary-research question

How does my thinking preference inform my teaching practice?

According to the literature I consulted as discussed in Chapter 2, it can be said that both my students and I have our own comfort zones as a point of departure when engaging in tasks. In my opinion my triple dominant profile gives me an advantage in my teaching practice. This thinking flexibility allows me to think from multiple angles in learning task design. I should, however, be attentive to include my less preferred Quadrant D thinking preference in every learning task design and constantly think "out of my box" (Du Toit (2012:1219).

With Quadrant B being my preferred mode of thinking, I typically struggle with unclear instructions, concepts and risk taking as explained in (De Boer *et al.*, 2015:58). This means my instructions are clear and I do not expect my students to take risks unless I force myself to include them in a learning opportunity. My most comfortable communication approaches include step-by-step unfolding of the topic and well-articulated ideas presented in a logical format (Herrmann International, 2016:31). When reflecting on the way I communicated in the learning opportunities, this is the exact approach I used. This knowledge is important to me as facilitator because it indicates whether the learning opportunity execution was fun and playful (which is characteristic of Quadrant D) or whether I could have designed the learning task in such a way that students would engage more spontaneously in executing the task.

5.2.3 Third secondary research question

How can the mastering of radiographic clinical demonstration be facilitated with a view to promoting Whole Brain® self-regulated learning?

This sub-research question is composed of two secondary questions, namely (a) How can the mastering of radiographic clinical demonstration be facilitated with a view to promoting Whole Brain® learning? (b) How can the mastering of radiographic clinical demonstration be facilitated with a view to promoting self-regulated learning?

To answer part (a) of the secondary research question I first had to determine whether the learning opportunities were facilitated in a Whole Brain® manner. Findings from the data analysis revealed that all the participants (Chapter 4, Figure 4.35) and both peers (Chapter 4, Section 4.3.3.2) strongly agreed that I did facilitate the radiographic clinical demonstrations in a Whole Brain® manner. I video-recorded the different learning opportunities and by means of closed-ended behaviour logs I focused on what quadrant I accommodated (Chapter 4, Section 4.3.3). This result indicated that the learning opportunity was facilitated in a Whole Brain® manner. With the different sets of data being successful, I can draw the conclusion that my way of facilitating learning was effective in terms of the steps taken to ensure that Whole Brain® learning occurred. The main method used was recognising that the group of participants had different thinking preferences and that I had to design holistic Whole Brain® learning opportunities.

As in part (a) above, I first had to determine whether participants completed the tasks in a self-regulated fashion. A peer (Chapter 4, Section 4.3.2.2) indicated that the feedback provided was lecturer-centred and that I should encourage feedback by the participants themselves. When studying Figure 4.42 (Chapter 4, Section 4.3.3.4), which indicates my contribution to the participants' learning, it is clear that in the first learning task I hardly ever promoted lecturer-student discussions with the learning opportunity being lecturer-driven. After reflecting on this feedback I ensured that I almost always promoted lecturer-student discussions in the second and third learning opportunities.

Looking back and reflecting on the process I now realise that although the learning opportunities were completed by the participants themselves, I should have improved the self-regulated learning part. This is outlined next in the discussion of the main research question.

5.2.4 Main research question

How can my professional development and the learning of my students be developed?

Initially my research vision was to introduce Whole Brain® learning at Tshwane University of Technology and to conduct action research in a half year model. Every learning opportunity had already been planned in the greatest detail with only learning task execution left. Part of the vision was for my students to conduct their own action research project. This project was supposed to create spin-off spirals from the main action research spiral (Chapter 3, Figure 3.1). The main spiral in Figure 3.1 represents the process of my professional development monitored by me in a self-regulated fashion, using action research as a justified process. However, I had to adapt my vision on very short notice due to the Covid-19 pandemic. Working with healthcare professionals in practice during the pandemic, I had very limited time to facilitate sessions on advanced coronary scans. It was not possible for my participants to conduct action research on their practice during this time.

5.3 Contributions

The study mainly contributed to my own professional development in a self-regulated fashion − the ability to understand and control my own professional learning in practice. This action research project proves that theoretical content can be facilitated in a Whole Brain® manner, not only accommodating the left mode or thinking processes (A and B quadrants). I received the following appreciative feedback from the Department:

“Thank you so much for volunteering to assist our practice and facilitating the sessions by teaching our radiographers how to perform the advanced coronary artery scans with all the post-processing. Our practice has booked and performed multiple coronary artery scans that were successful due to your time and effort.”

5.4 Challenges

The unexpected appearance of Covid-19 created a number of challenges. It affected my planning as I am a first-time mother and needed to balance my personal and professional responsibilities. I had to facilitate sessions in the healthcare system that was already under pressure. The pandemic forced me to facilitate sessions with only two or three participants at a time without having a classroom or open area for facilitating learning. I had to use the space available that was a reporting room where radiologists reported diagnostic X-Ray images. Due to Covid-19 regulations the facilitating was done with a mask on that hampered my communication.

The recommended areas of research that emerged from this study are highlighted in the next session.

5.5 Recommendations for future research

i) This small-scale action research project is just the beginning of my professional development. I will continue using action research to transform my practice.
ii) A study is proposed to investigate the thinking preferences of a group of radiography students in their first year by introducing them to action research and Whole Brain® learning; their feedback in their final year can then be utilised. Such a can study will demonstrate how an individual can develop when working towards completing tasks in a holistic Whole Brain® manner.

5.6 Meta-reflection

This concluding section is known as meta-reflection (Hagström & Scheja, 2014:242) where I reflect on my reflections during the action research. I demonstrate the claims made on my professional development journey in a Whole Brain® effort. The four chambers of the heart were chosen as a metaphor for this section. The heart as a metaphor had a two-fold meaning. Firstly, the learning opportunity that I could facilitate in practice was on the advanced coronary (heart) scan. The second reason was

because the four heart chambers were used as a framework for the Whole Brain® model® that is discussed in Chapter 2 (Section 2.5.1) and Chapter 3 (Section 3.5.1.1).

Right atrium: my rational self

This professional development journey started with the theoretical framework where the indication of research references and the reporting of different fact-based reading were essential (Consult Figure 5.1). It continued during the precise quantitative half of the mixed method action research study.

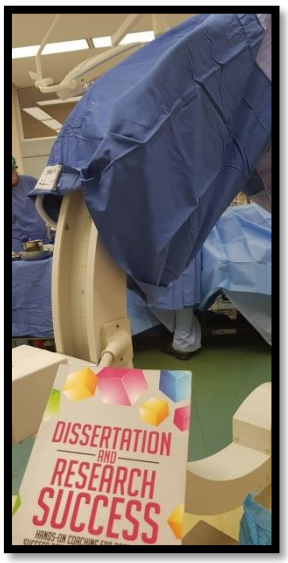


Figure 5.1: Fact-based reading whenever the opportunity arose − during theatre nightshift

Right ventricle: my safekeeping self

My safekeeping organised, and detailed processes are of essence here. This thinking preference is usually my point of departure when I need to execute any task. All the detailed plans did not realise during the data collection phase due to the Covid-19 pandemic. Due to having a new-born baby at this time, I had a very tight schedule that was impossible to follow. This professional and self-development journey was an adrenaline-pumping roller coaster ride with many highs and lows in a short time frame.

There were several procedures available to assist me to remain focused during this process.

The Faculty of Education at the University of Pretoria offered support sessions throughout the process. Although these sessions were not compulsory for magister students, I did attend the sessions, which was helpful during my first year of registration. On the University of Pretoria online student platform there were proposed milestones that had to be reached by specific dates for the successful and timely completion of my studies.

The department of Humanities Education offered several innovative cohort sessions in our first year. This is discussed in the next section – my feeling self.

Left ventricle: my feeling self

My feeling self or emotive self represents my preference for interpersonal and intra-personal, feeling-based and emotional processes that are typical of Quadrant C thinking.

Cohort sessions offered participation that included a group of peers with the shared characteristic of professional development that did fulfil my interpersonal need. We were a group of magister and doctoral postgraduate students that benefited from the sessions. Different themes were facilitated in innovative ways for us to construct our own meaning in a self-regulated manner. In the photograph presented below is an example of a session facilitated. The theme facilitated was *Theoretical and Conceptual Framework*. We received different types of hat (for example, a construction hat, a clown hat, a military hat and baseball cap) and we had to explain what the hat represents and suggest a paradigm that will fit the type of hat.

Figure 5.2: Cohort session 4: Theoretical and conceptual framework learning opportunity [Used with permission]

In my second year of study, due to Covid-19, we could not have a support group as originally planned. In stressful situations (like completing a master's degree) an individual's profile could change, known as the adjective pair (discussed in Chapter 2, Section 2.5.1). In my case (Consult Chapter 4, Figure 4.2) my profile changed considerably indicating that I respond noticeable differently when under pressure. My need for inter-personal relationships was amplified. I satisfied this need by means of WhatsApp academic conversations and video calls with critical friends, colleagues, and my supervisor to expose and share my ideas and construct meaning (My support group in Figure 5.3).

Figure 5.3: WhatsApp Video calls with critical friends [Used with permission]

The critical friends below were part of the cohort sessions discussed above.

Left atrium: My experimental self

Quadrant D captures the holistic, intuitive, integrating and creative processes.

The qualitative part of the mixed methods action research study is part of myself discovering and exploring new ways of conducting research. I have recognised multiple intelligences (Gardner, 1993) and throughout the project, from the proposal, learning opportunities and writing this dissertation. The fun and playful learning opportunities (Consult Chapter 4, Section 4.3.2) together with the pictures and multiple metaphors are my attempt not only to meet the requirements, but to improve the ‘self’.

Coming from a health science background and working with hard facts and logic, I am extremely proud of what I have accomplished through this action research project. This was the first time I explored the experimental and emotional ways in which research can be done. I can honestly say that I have developed in my personal and professional life due to this action research project. Ending this chapter leaves me with butterflies in my stomach and excites me to what the future might hold.

Figure 5.4: Butterflies in my stomach

This Whole Brain® action research study has not only contributed to my professional development but changed me as a wife, daughter, sister, employer, and mother. I challenge you as reader to implement Whole Brain® thinking in your day-to-day life and I hope the effect will be profound.

List of references

Beitz, J. (1996). Using metacognition to promote certification success: the testing health promotion plan. *Journal of Continuing Education in Nursing, 27*(4), 159.

Biggs, J. (1996). Enhancing Teaching through Constructive Alignment. *Higher Education, 32*(3), 347-364.

Bransford, J., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind, Experience and School (Expanded Edition)* Retrieved from https://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=3375510

Brink, H., Van der Walt, C., & Van Rensburg, G. (2007). *Fundamentals of research methodology for health care professionals* (2nd ed.). Kenwyn: Juta.

Bushong, S. C. (2008). *Radiologic science for technologists: physics, biology, and protection* (9th ed.). St. Louis, Mo: Elsevier.

Carrasco, G. A., Behling, K. C., & Lopez, O. J. (2019). A Novel Grading Strategy for Team-Based Learning Exercises in a Hands-on Course in Molecular Biology for Senior Undergraduate Underrepresented Students in Medicine Resulted in Stronger Student Performance. *Biochemistry and Molecular Biology Education, 47*(2), 115-123. doi:10.1002/bmb.21200

Chuang, H.-H., Weng, C.-Y., & Chen, C.-H. (2018). Which students benefit most from a flipped classroom approach to language learning? Flipped classroom does not fit all students. *British Journal of Educational Technology, 49*(1), 56-68. doi:10.1111/bjet.12530

Clements, D. H., & Battista, M. T. (1990). Constructivist learning and teaching. *Arithmetic Teacher, 38*(1), 34-35.

Cockbain, M., Blyth, C., Bovill, C., & Morss, K. (2009). Adopting a blended approach to learning: Experiences from Radiography at Queen Margaret University, Edinburgh. *Radiography, 15*(3), 242-246.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning styles and pedagogy in post-16 learning: A systematic and critical review*. Retrieved from https://scholar.google.com/scholar?q=Learning+styles+and+pedagogy+in+post-16+learning%3A+A+systematic+and+critical+review&inst=3850658151283745516&submit3.x=0&submit3.y=0

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London: Routledge Falmer.

Cosson, P., & Willis, R. (2012). Comparison of student radiographers' performance in a real x-ray room after training with a screen based computer simulator. *Shaderware Limited*.

Costello, P. J. M. (2003). *Action research*. London: Continuum.

Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, Calif: SAGE.

Creswell, J. W. (2012). *Educational research: planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston: Pearson.

Creswell, J. W., & Guetterman, T. C. (2019). *Educational research : planning, conducting, and evaluating quantitative and qualitative research* (6th ed.). New York: Pearson.

Cronin, K., Fitzgerald, J., Gillard, M., Ghotra, S., Kieft, I., & Reynolds, O. (2018). *Mapping University Skills labs in Radiography: Students' Perspectives.* Paper presented at the OPTIMAX Conference 2018.

Curry, T. S., Dowdey, J. E., Murry, R. C., & Christensen, E. E. (1990). *Christensen's physics of diagnostic radiology* (4th ed.). Philadelphia: Lea & Febiger.

Dahl, D. W., & Smimou, K. (2011). Does motivation matter?: On the relationship between perceived quality of teaching and students' motivational orientations. *Managerial Finance, 37*(7), 582-609.

Davis, J. M. (2004). Writing an action research thesis: One researcher's resolution of the problematic of form and process *Performing educational research: Theories, methods and practices* (pp. 15-30): Post Pressed.

De Boer, A., Du Toit, P., Scheepers, M. D., & Bothma, T. (2013). *Whole Brain® learning in higher education: evidence-based practice*. Oxford: Chandos Publishing.

De Boer, A., Du Toit, P. H., & Bothma, T. (2015). Activating whole brain® innovation: a means of nourishing multiple intelligence in higher education. *TD: The Journal for Transdisciplinary Research in Southern Africa, 11*(2), 55-72.

De Boer, A., & Van den Berg, D. (2001). The value of the Herrmann Brain Dominance Instrument (HBDI) in facilitating effective teaching and learning of Criminology. *Acta Criminologica: Southern African Journal of Criminology, 14*(1), 119-129.

Dellos, R. (2015). Kahoot! A digital game resource for learning. *International Journal of Instructional technology and distance learning, 12*(4), 49-52.

Dos Reis, C. S., Pires-Jorge, J., York, H., Flaction, L., Johansen, S., & Maehle, S. (2018). Curricula, attributes and clinical experiences of radiography programs in four European educational institutions. *Radiography, 24*(3), e61-e68.

Du Toit, P. (2009). An action research approach to monitoring one's professional development as manager. *Foundation for Professional Development: Pretoria*.

Du Toit, P. (2012). Using action research as process for sustaining knowledge production: a case study of a higher education qualification for academics. *South African Journal of Higher Education, 26*(6), 1216-1233.

Du Toit, P. (2013). Social transformation starts with the self: an autobiographical perspective on the thinking style preferences of an educator. *South African Journal of Education, 33*(4), 1-12.

Du Toit, P. (2014). *Good practice in culture-rich classrooms: research-informed perspectives*. Cape Town: Oxford University Press.

Du Toit, P. (2018). *PGCHE Reader: PFO 400, LMD 400 & ASK 410*. Faculty of Education. University of Pretoria.

Du Toit, P. (2019a). Linking multiple intelligence and thinking preferences as a means of facilitatinng multiliteracies: evidencebased practice. In A. Engelbrecht & G. Genis (Eds.), *Multiliteracies in education : South African perspectives*. Pretoria, South Africa: Van Schaik.

Du Toit, P. (2019b). *PGCHE Reader: PFO 400, LMD 400 & ASK 410*. Faculty of Education. University of Pretoria.

Du Toit, P., de Boer, A., Bothma, T., & Scheepers, D. (2012). Multidissiplinêre samewerking: 'n Noodsaaklikheid vir onderwysinnovering. *Tydskrif vir Geesteswetenskappe, 52*(2), 236-251.

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

Efron, S. E. (2013). *Action research in education: a practical guide*. New York: Guilford Press.

England, A., Geers-van Gemeren, S., Henner, A., Kukkes, T., Pronk-Larive, D., Rainford, L., & McNulty, J. (2017). Clinical radiography education across Europe. *Radiography, 23*, S7-S15.

Foulger, T. S. (2010). External conversations: An unexpected discovery about the critical friend in action research inquiries. *Action Research, 8*(2), 135-152.

Fringe, J. J. d. S. (2013). *Promoting critical reflection for academic professional development in higher education.* University of Pretoria.

Gainor, M., Bline, D., & Zheng, X. (2014). Teaching internal control through active learning. *Journal of Accounting Education, 32*(2), 200-221. doi:10.1016/j.jaccedu.2014.03.003

Gardner, H. (1993). *Multiple intelligences: the theory in practice*. New York: Basic Books.

Gee, J. P. (2008). Learning and games. *The ecology of games: Connecting youth, games, and learning, 3*, 21-40.

Goode, H. (2014). *Using the Herrmann Whole Brain® model for mentoring academic staff.* University of Pretoria.

Hagström, L., & Scheja, M. (2014). Using Meta-Reflection to Improve Learning and Throughput: Redesigning Assessment Procedures in a Political Science Course on Power. *Assessment & Evaluation in Higher Education, 39*(2), 242-252.

Har, L. (2013). Authentic learning. *The Hong Kong Institute of Education*.

Herrmann-Nehdi, A. (2009). The Best of Both Worlds-Making Blended Learning Really Work By Engaging the Whole Brain®. *Lake Laurie, NC: Herrmann International*.

Herrmann International. (2009). Understanding the Herrmann Whole Brain® model. *HBDI®*.

Herrmann International. (2016). An explanation of your HBDI profile. *HBDI® Profile Package*.

Herrmann, N. (1995a). *The creative brain*. Lake Lure: Ned Herrmann Group.

Herrmann, N. (1995b). *Creativity, learning, and the specialized brain in the context of education for gifted and talented children.* Paper presented at the Adapted from an address to the 7th world conference on gifted and talented children, Salt Lake City, Utah.

Herrmann, N. (1996). *The whole brain business book*. New York: McGraw-Hill Education.

Herrmann, N. (1998). The Theory behind the HBDI® and Whole Brain Technology®. *Lake Laurie, NC: Herrmann International*.

Herrmann, N. (1999). The theory behind the HBDI® and Whole Brain® technology. *Better results through better thinking*.

Herrmann, N. (2013). Hermann Brain Dominance Instrument. Retrieved from https://engage.herrmannsolutions.com/hubfs/AXON_Files/J_Doe_Example_HBDI.pdf

Herrmann, N., & Herrmann-Nehdi, A. (2015). *The whole brain business book: unlocking the power of whole brain thinking in organizations, teams, and individuals* (2nd ed.). New York: McGraw-Hill Education.

Holmström, A., & Ahonen, S. M. (2016). Radiography Students' Learning: A Literature Review. *Radiologic technology, 87*(4), 371-379.

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field methods, 18*(1), 3-20.

Killam, L. (2015). Ontology, Epistemology, Methodology and Methods in Research Simplified. Retrieved from https://www.youtube.com/watch?v=hCOsY5rkRs8

Lorimer, J., & Hilliard, A. (2009). Incorporating learning technologies into undergraduate radiography education. *Radiography, 15*(3), 214-219.

Lothian, M. J. (2011). *How can I improve my practice to enhance the teaching of literacy?* , Library and Archives Canada, Ottawa. Retrieved from https://central.bac-lac.gc.ca/.item?id=NR68488&op=pdf&app=Library http://www.collectionscanada.gc.ca/obj/thesescanada/vol2/002/NR68488.PDF WorldCat.org database.

Lumsdaine, M., & Lumsdaine, E. (1995). Thinking preferences of engineering students: Implications for curriculum restructuring. *Journal of engineering education, 84*(2), 193-204.

Maree, K. (2016). *First steps in research* (2nd ed.). Pretoria: Van Schaik.

Mc Inerney, J., & Baird, M. (2016). Developing critical practitioners: A review of teaching methods in the Bachelor of Radiography and Medical Imaging. *Radiography, 22*(1), e40-e53.

Mc Inerney, J., & Druva, R. (2019). Clinical educators' attitudes towards the use of technology in the clinical teaching environment. A mixed methods study. *Journal of medical radiation sciences*.

McClanahan, E. B., & McClanahan, L. L. (2002). Active learning in a non-majors biology class: lessons learned. *College Teaching, 50*(3), 92-96.

McNiff, J. (2002). *Action research for professional development: Concise advice for new action researchers*: September books Dorset.

McNiff, J. (2008). The significance of 'I'in educational research and the responsibility of intellectuals. *South African Journal of Education, 28*(3), 351-364.

McNiff, J. (2014). *Writing and doing action research*. London: SAGE.

McNiff, J., & Whitehead, J. (2002). *Action research: principles and practice* (2nd ed.). London: Routledge Falmer.

McNiff, J., & Whitehead, J. (2006). *All you need to know about action research*. London: SAGE.

McNiff, J., & Whitehead, J. (2011). *All you need to know about action research* (2nd ed.). Los Angeles: SAGE.

Melrose, M. J. (2001). Maximizing the rigor of action research: why would you want to? How could you? *Field methods, 13*(2), 160-180.

Miller, R. L., & Brewer, J. D. (2003). *The A-Z of social research: a dictionary of key social science research concepts* Retrieved from http://www.123library.org/book_details/?id=491

Nelson, D. (2013). Action research: An appropriate research paradigm for practitioners. *Language in India, 13*(10), 183.

Norms and standards for educators. (2002). Goverment Gazette Retrieved from https://www.gov.za/sites/default/files/gcis_document/201409/20844.pdf.

Oliveira, M., Geambastiani, P., Lopez, G., Cambui, M., Ubeda, C., & Mdletshe, S. (2019). The Development of a Free Radiological Anatomy Software Teaching Tool. *Int. J. Morphol, 37*(1), 205-211.

Oosthuizen, M. P. (2001). *An investigation into facilitating learning via the whole brain model in the study unit of toothmorphology.* University of Pretoria.

Pascual, T. N., Chhem, R., Wang, S.-C., & Vujnovic, S. (2011). Undergraduate radiology education in the era of dynamism in medical curriculum: An educational perspective. *European journal of radiology, 78*(3), 319-325.

Piaget, J. (1976). Piaget's theory *Piaget and his school* (pp. 11-23): Springer.

Pieterse, T., Lawrence, H., & Friedrich-Nel, H. (2014). Problem-solving abilities of radiography students at a South African university. *African Journal of Health Professions Education, 6*(1), 33-36.

Pieterse, T., Lawrence, H., & Friedrich-Nel, H. (2016). Critical thinking ability of 3rd year radiography students. *Health SA Gesondheid, 21*(1), 381-390. doi:doi:http://dx.doi.org/10.1016/j.hsag.2016.07.002

Polit, D. F., & Beck, C. T. (2007). *Resource manual to accompany Nursing research: generating and assessing evidence for nursing practice* (8th ed.). Philadelphia: Williams & Wilkins.

Raby, C. (2017). Perceptions of Effective Teaching Strategies and Assessments of Critical Thinking in Radiographic Clinical Practice.

Randewijk, E. (2019). *Informing the facilitation of Mathematics in the senior phase using Herrmann's Whole Brain® theory.* University of Pretoria.

Richardson, V. (2005). Constructivist teaching and teacher education: Theory and practice *Constructivist teacher education* (pp. 13-24). London: Routledge Falmer.

Rossouw, T. (2015). *Professional development of teachers at a private high school: a peer mentoring initiative.* University of Pretoria.

SAQA. (2012). *South African Qualifications Authority*. Retrieved from http://regqs.saqa.org.za/viewQualification.php?id=66949.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational technology, 35*(5), 31-38.

Scheepers, H. (2014). *Mentoring academic staff at a higher education institution: a whole brain approach.* University of Pretoria. Retrieved from http://hdl.handle.net/2263/40392

Scherman, V. (2014). Mentor and mentoring: Negotiating relationships. Retrieved from http://www.academia.edu/835615/Mentor_and_mentoring_Negotiating_relationships

Schön, D. A. (1987). *Educating the reflective practitioner: toward a new design for teaching and learning in the professions* (1st ed.). San Francisco: Jossey-Bass.

Sedden, M. L., & Clark, K. R. (2016). Motivating Students in the 21st Century. *Radiologic technology, 87*(6), 609-616.

Shanahan, M. (2016). Student perspective on using a virtual radiography simulation: Shaderware Limited.

Singh, Y. (2015). *Implementing a holistic model that promotes learning style diversity.* University of Pretoria. Retrieved from http://hdl.handle.net/2263/50784 WorldCat database.

Slabbert, J. A., De Kock, D. M., & Hattingh, A. (2009). *The brave 'new' world of education: creating a unique professionalism*. Cape Town: Juta.

Spencer, C. (2008). Critical thinking in nursing: Teaching to diverse groups. *Teaching and learning in Nursing, 3*(3), 87-89.

Tekin, A. K., & Kotaman, H. (2013). The epistemological perspectives on action research. *Journal of Educational and Social Research, 3*(1), 81-91.

Tomal, D. R. (2010). *Action research for educators* (2nd ed.). Lanham: Rowman & Littlefield Education.

Urek, H. (2020). Sudoku puzzles for practicing SI prefixes: A case study with Turkish undergraduates. *Cypriot Journal of Educational Sciences, 15*(5), 1065-1077.

Van der Watt, M. A. (2008). *The integration of critical reflection as a learning strategy in the training of health science practitioners.* University of Pretoria.

Von Glasersfeld, E. (1996). Footnotes to ‘the many faces of constructivism’. *Educational researcher, 25*(6), 19.

Von Glasersfeld, E. (2001). Radical constructivism and teaching. *Prospects, 31*(2), 161-173. doi:10.1007/bf03220058

Wang, C., & Burris, M. A. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health education & behavior, 24*(3), 369-387.

Wertz, C., Mickelsen, W., & Hobbs, D. L. (2014). Integrating technology into radiologic science education. *Journal of the American Society of Radiologic Technologists Volume, 86*(1).

Whitehead, J., & McNiff, J. (2006). *Action research: living theory* Retrieved from http://www.dawsonera.com/depp/reader/protected/external/AbstractView/S9781847874641

Wolvaardt, G., & Du Toit, P. (2012). Action research-driven professional development: developing transformational health care managers and creating learning organisations. *South African Journal of Higher Education, 26*(6), 1249-1264.

Yazicioğlu, S., & Cavuş-Güngören, S. (2019). Investigate the Effect of Game-Based Activities on Middle School Students' Science Learning According to Achievement, Motivation, Attitude and Gender Variables. *Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education, 13*(1).

Zohrabi, M. (2013). Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. *Theory & practice in language studies, 3*(2).

Zuber-Skerritt, O. (1992). *Professional development in higher education: a theoretical framework for action research*. London: Kogan Page.

Zuber-Skerritt, O. (2001). Action learning and action research: paradigm, praxis and programs. *Effective change management through action research and action learning: Concepts, perspectives, processes and applications*, 1-20.

Appendix I

Marriage between the scholarship of Teaching and Learning and Research scholarship

The programme coordinator of the PGCHE takes pleasure in inviting you to the marriage between

Teaching

&

Research

Venue:	**Professional Development Commons (Aldoel Building 2-87 GPS Co-ordinates: S25)**
Date:	**9 February – November 2016**
Time:	**17:00**
Dress code:	**Informal**
RSVP:	**Adel Taljaard at adel.taljaard@up.ac.za or**
	012 420 5582

Gift list:

The couple requested that no money be offered as gifts. Instead, they would like to receive more personalised gifts such as:

- **An artefact (object), piece of music or poem that best represents or describes you as an individual, which you can use to introduce yourself to the guests around the table at the commencement of the buffer dinner (you will be offered 1 minute to do so)**

And

- **A photo or self-portrait on A-4 paper with a short bio of 300 words, personally signed, that the couple can include in their wedding scrap book**

In addition, you are welcome to showcase your talents, such as dancing, singing, poem writing, dramatising as soon as the dance floor is opened by the couple

As the wedding celebrations will continue till the end of the buffet dinner consisting of a selection of Cordon Bleu modules in November, you are expected to fully contribute to all the activities on offer

HBDI

Herrmann Brain Dominance Instrument
Thinking Styles Assessment

This 120-question survey form results in a profile of your preferred thinking styles. By understanding your thinking style preferences you can achieve greater appreciation how you learn, make decisions, solve problems, and communicate, and why you do these things — and others — the way you do. The survey measures preferences rather than skills. It is not a test; there are no wrong answers. You will gain the greatest understanding by answering the questions frankly and sincerely

Herrmann International
Your HBDI Practitioner: Dr Pieter H du Toit
Fax completed form to: (012) 4203003
International telephone number: +27 12 4202817
E-mail: pieter.dutoit@up.ac.za

INSTRUCTIONS

A profile of your mental preferences will be determined by your responses to the following 120 questions. Answer each question by writing in the appropriate words or numbers, or marking the boxes provided. This is not a test, and there are no right or wrong answers. You are only indicating your preferences. Please respond to questions as authentically as possible, keeping in mind your total self, at work and at home. When you have completed the survey form, confirm that you have answered every question. Then complete the name and address information on the back of the form, and send or fax pages 2 to 5 to Herrmann International Africa at the address on the cover.

Refer to the glossary of terms for clarification of the terms used. Save the glossary page for reference when you receive your profile results.

GLOSSARY OF TERMS

Analytic: Breaking up things or ideas into parts and examining them to see how they fit together.
Artistic: Taking enjoyment from or skilful in painting, drawing, music, or sculpture. Able to coordinate colour, design, and texture for pleasing effects.
Conceptual: Able to conceive thoughts and ideas, to generalize abstract ideas from specific instances.
Controlled: Restrained, holding back, in charge of one's emotions.
Conservative: Tending towards maintaining traditional and proven views, conditions, and institutions.
Creative: Having unusual ideas and innovative thoughts. Able to put things together in new and imaginative ways.
Critical: Exercising or involving careful judgement or evaluation, e.g., judging the feasibility of an idea or product.
Detailed: Paying attention to the small items or parts of an idea or project.
Dominant: Ruling or controlling; having strong impact on others.
Emotional: having feelings that are easily stirred, displaying those feelings.
Empathetic: Able to understand how another person feels, and able to communicate that feeling.
Extrovert: More interested in people and things outside of self than internal thoughts and feelings. Quickly and easily exposes thoughts, reactions, feelings, etc. to others.
Financial: Competent in monitoring and handling of quantitative issues related to costs, budgets, and investments.
Holistic: Able to perceive and understand the "big picture" without dwelling on individual elements of an idea, concepts, or situation. Can see the forest as contrasted with the trees.
Imaginative: Able to form mental images of things not immediately available to the senses or never wholly perceived in reality, able to confront and deal with a problem in a new way.
Implementation: Able to carry out an activity and ensure fulfilment by concrete measures and results.
Innovating: Able to introduce new or novel ideas, methods, or devices.
Integration: The ability to combine pieces, parts and elements of ideas, concepts and situations into a unified whole.
Intellectual: Having superior reasoning powers, able to acquire and retain knowledge.
Interpersonal: Easily able to develop and maintain meaningful and pleasant relationships with many different kinds of people.
Introvert: Directed more towards inward reflection and understanding than towards people and things outside of self. Slow to expose reactions, feelings, and thoughts to others.
Intuitive: Knowing something without thinking it out – having instant understanding without need for facts or proof.
Logical: Able to reason deductively from what has gone before.
Mathematical: Perceiving and understanding numbers and being able to manipulate them to a desired end.
Metaphorical: Able to understand and make use of visual and verbal figures of speech to suggest a likeness or an analogy in place of literal descriptions, e.g., "heart of gold."
Musical: Having an interest in or talent for music and/or dance.
Organized: Able to arrange people, concepts, objects, elements, etc. into coherent relationships with each other.
Planning: Formulating methods or means to achieve a desired end in advance of taking actions to implement.
Problem solving: Able to find solutions to difficult problems by reasoning.
Quantitative: Oriented toward numerical relationships; inclined to know or seek exact measures.
Rational: Making choices on the basis of reason as opposed to emotion.
Reader: One who reads often and enjoys it.
Rigorous thinking: Having a thorough, detailed approach to problem- solving.
Sequential: Dealing with things and ideas one after another or in order.
Simultaneous: Able to process more than one type of mental input at a time, e.g. visual, verbal, and musical; able to attend to more than one activity at a time.
Spatial: Able to perceive, understand and manipulate the relative positions of objects in space.
Spiritual: Having to do with spirit or soul as apart from the body or material things.
Symbolic: Able to use and understand objects, marks, and signs as representative of facts and ideas.
Synthesizer: One who unites separate ideas, elements, or concepts into something new.
Technical: Able to understand and apply engineering and scientific knowledge.
Teaching/ training: Able to explain ideas and procedures in a way that people can understand and apply them.
Verbal: Having good speaking skills, clear and effective with words.
Writer: One who communicates clearly with the written word and enjoys it.

BIOGRAPHICAL INFORMATION

Please complete **every** question according to the directions given. Each response, including your answers to questions 1, 2, 3 and 4 provides important data. When directions are not followed or data is incomplete we are unable to process your survey, and must return it to you.

1. Name _____ **2. Gender** **M** ☐ **F** ☐

3. Educational focus or specialist subject(s) _____

4. Occupation or job title _____

Describe your work (please be as specific as possible) _____

HANDEDNESS

5. Which picture most closely resembles the way you hold a pencil? Mark box A, B, C or D.

A ☐  **B** ☐  **C** ☐  **D** ☐ 

6. What is the strength and direction of your handedness? Mark box A, B, C, D or E.

A ☐ Primary left **B** ☐ Primary left Some right **C** ☐ Both hands equal **D** ☐ Primary right, some left **E** ☐ Primary right

SCHOOL SUBJECTS

Think back to your performance in the elementary and/or secondary school subjects identified below. Rank order all three subjects on the basis of how well you did: **1 = best; 2 = second best; 3 = third best.**

7 ☐ **Mathematics** **8** ☐ **Foreign language** **9** ☐ **Native language or mother tongue**

Please check that no number is duplicated**: The numbers** 1**, 2, and** 3 must be used once **and** only once**. Correct if necessary**

WORK ELEMENTS

Rate each of the work elements below according to your strength in that activity, using the following scale**: 5 = work I do best; 4 = work I do well; 3 = neutral; 2 = work I do less well; 1 = work I do least well**.
Enter the appropriate number next to each element. Do not use any number more than four times.

10 ☐	Analytical	**16** ☐	Technical Aspects	**21** ☐	Innovating
11 ☐	Administrative	**17** ☐	Implementation	**22** ☐	Teaching/Training
12 ☐	Conceptualising	**18** ☐	Planning	**23** ☐	Organisation
13 ☐	Expressing Ideas	**19** ☐	Interpersonal Aspects	**24** ☐	Creative Aspects
14 ☐	Integration	**20** ☐	Problem Solving	**25** ☐	Financial Aspects
15 ☐	Writing				

Please tally: Number of: 5's ☐ 4's ☐ 3's ☐ 2's ☐ 1's ☐

If there are more than four **for any category, please redistribute.**

KEY DESCRIPTORS

Select eight adjectives, which best describe the way you see yourself. Enter a **2** next to each of your eight selections. Then change one **2** to a **3** for the adjective which best describes you.

26		Logical	**35**		Emotional	**43**		Symbolic
27		Creative	**36**		Spatial	**44**		Dominant
28		Musical	**37**		Critical	**45**		Holistic
29		Sequential	**38**		Artistic	**46**		Intuitive
30		Synthesizer	**39**		Spiritual	**47**		Quantitative
31		Verbal	**40**		Rational	**48**		Reader
32		Conservative	**41**		Controlled	**49**		Simultaneous
33		Analytical	**42**		Mathematical	**50**		Factual
34		Detailed						

Please count: seven 2's and one 3? **Correct if necessary.**

HOBBIES

Indicate a maximum of six hobbies you are actively engaged in. **Enter a 3** next to your major hobby, a **2 next** to each primary hobby, and a **1 next** to each secondary hobby. **Enter only one 3**.

51		Arts/Crafts	**59**		Gardening/Plants	**67**		Sewing
52		Boating	**60**		Golf	**68**		Spectator Sports
53		Camping/Hiking	**61**		Home Improvements	**69**		Swimming/Diving
54		Cards	**62**		Music Listening	**70**		Tennis
55		Collecting	**63**		Music Playing	**71**		Travel
56		Cooking	**64**		Photography	**72**		Woodworking
57		Creative Writing	**65**		Reading	**Other**		
58		Fishing	**66**		Sailing	**Other**		

Please review**: Only one** 3 **and** no more than six hobbies**. Correct if necessary.**

ENERGY LEVEL

73. Thinking about your energy level or "drive," select the one that best represents you. Mark box A, B, **or** C**.**

A ☐ **Day person** **B** ☐ **Day/night person equally** **C** ☐ **Night person**

MOTION SICKNESS

74. Have you ever experienced motion sickness (nausea, vomiting) in response to vehicular motion (while in a car, boat, plane, bus, train, amusement ride)? Check boxes A, B, C, or D to indicate the number of times.

A ☐ **None** **B** ☐ **1-2** **C** ☐ **3-10** **D** ☐ **More than 10**

75. Can you read while traveling in a car without stomach awareness, nausea, or vomiting?

A ☐ **Yes** **B** ☐ **No**

ADJECTIVE PAIRS

For each paired item **below, check the word or phrase, which is more descriptive of you. Mark box** A **or** B **for** each **pair, even if the choice is a difficult one.** Do not omit any pairs**.**

76	Conservative			Empathetic	**88**	Imaginative			Sequential
77	Analyst			Synthesizer	**89**	Original			Reliable
78	Quantitative			Musical	**90**	Creative			Logical
79	Problem-solver			Planner	**91**	Controlled			Emotional
80	Controlled			Creative	**92**	Musical			Detailed
81	Original			Emotional	**93**	Simultaneous			Empathetic
82	Feeling			Thinking	**94**	Communicator			Conceptualise
83	Interpersonal			Organiser	**95**	Technical things			People-oriented
84	Spiritual			Creative	**96**	Well-organised			Logical
85	Detailed			Holistic	**97**	Rigorous Thinking			Metaphorical Thinking
86	Originate Ideas			Test and Prove Ideas	**98**	Like Things Planned			Like Things Mathematical
87	Warm, Friendly			Analytical	**99**	Technical			Dominant

Please review**: Did you mark one and only one of each pair? Correct if necessary.**

INTROVERSION / EXTROVERTION

100. Mark one box to place yourself on this scale from introvert to extrovert:

Introvert								**Extrovert**

TWENTY QUESTIONS

Respond to each statement by marking the box in the appropriate column		**Strongly agree** ▼	**Agree** ▼	**In between** ▼	**Disagree** ▼	**Strongly** ▼ **disagree**
101	I feel that a step-by-step method is best for solving problems.					
102	Daydreaming has provided the impetus for the solution of many of my more important problems.					
103	I like people who are most sure of their conclusions.					
104	I would rather be known as a reliable than an imaginative person.					
105	I often get my best ideas when doing nothing in particular.					
106	I rely on hunches and the feeling of “rightness” or “wrongness” when moving toward the solution to a problem					
107	I sometimes get a kick out of breaking the rules and doing things I’m not supposed to do.					

108	Much of what is most important in life cannot be expressed in words.					
109	I'm basically more competitive with others than self-competitive					
110	I would enjoy spending an entire day "alone with my thoughts."					
111	I dislike things being uncertain and unpredictable.					
112	I prefer to work with others in a team effort rather than solo.					
113	It is important for me to have a place for everything and everything in its place.					
114	Unusual ideas and daring concepts interest and intrigue me.					
115	I prefer specific instructions to those which leave many details optional					
116	Know-why is more important than know-how.					
117	Thorough planning and organisation of time are mandatory for solving difficult problems.					
118	I can frequently anticipate the solutions to my problems.					
119	I tend to rely more on my first impressions and feelings when making judgments than on a careful analysis of the situation.					
120	I feel that laws should be strictly enforced.					

Please review to make sure you have answered all 120 questions.

FORM

You must provide an address and indicate the method of payment in order to receive your HBDI results. Please print.

Name _____ **Date** _____

Company _____

Division _____

Company address _____

Daytime phone _____ **Evening phone** _____ **Fax** _____

Home address _____

_____

E-mail address _____

Note: There is a fee for processing this survey form. Please consult your HBDI practitioner.

CONFIDENTIAL RESEARCH

The following questions are not used in scoring the HBDI. However, the answers to these questions are valuable in our continuing brain dominance research. Skip any questions you wish, but please answer as many as you feel you can.

Indicate the birth order of your brothers, sisters, and self by marking the appropriate symbols. Then circle the symbol representing you.

MALE ♂ Brothers												♂ MALE
	Oldest	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**
SELF												
FEMALE ♀ Sisters												♀ FEMALE

Ethnicity: Black ☐ White ☐ Asian ☐ Other _____

If you are a parent, please indicate: number of children ☐ Age of oldest ☐ Age of youngest ☐

Couple status Married ☐ Separated ☐ Divorced ☐ Living together ☐ Widow/widower ☐ Single ☐

To what extent were you formally educated for the field you are now working in?

☐ Not at all ☐ Somewhat ☐ To a great degree ☐ Fully

Have you filled out the HBDI survey previously? If so, and your name or address has changed since then, please specify the previous name or address

How do you see yourself? Please distribute 100 points between these four descriptions:

Rational ☐ Organised ☐ Interpersonal ☐ Imaginative ☐

Please check the best descriptor indicating your mood or the way you felt at the time you were completing this survey:

☐ Happy ☐ Enthusiastic ☐ Interested ☐ OK ☐ Relaxed ☐ Indifferent

☐ Distracted ☐ Tired ☐ Unhappy ☐

Appendix III

Participant feedback questionnaire

- Please complete every question with the best fitting answer.
- Remember that the questionnaire is anonymous.
- Respond to each statement, by marking the appropriate column with an X.

SA = strongly agree (5) **A = agree (4)**
N = neutral / in between (3) **D = disagree (2)**
SD = strongly disagree (1)

Learning opportunity: _____

		SA	A	N	D	SD
1	Facilitator of Learning has communicated the learning opportunities (lessons) clearly	5	4	3	2	1
2	Facilitator of Learning has been well prepared for classes	5	4	3	2	1
3	Facilitator of Learning has organised class time effectively	5	4	3	2	1
4	Facilitator of Learning has stimulated my interest in this subject by integrating activities linked to learning style diversity	5	4	3	2	1
5	Facilitator of Learning has been responsive to learner queries and concerns	5	4	3	2	1
6	Facilitator of Learning has explained the aim, that is, implementation of an innovative idea and assessment expectations adequately	5	4	3	2	1
7	Facilitator of Learning has used media (whiteboard, videos, multimedia, internet) effectively	5	4	3	2	1
8	Facilitator of Learning has developed holistic and relevant assessment activities	5	4	3	2	1
9	Facilitator of Learning has provided useful feedback on all learning opportunities (lessons) within a realistic time frame	5	4	3	2	1

10	Facilitator of Learning has made genuine effort to enhance effective and holistic learning	5	4	3	2	1

		Excellent	Very good	Good	Acceptable	Poor	Extremely poor	Unacceptable
11	How would you rate the effectiveness of this Facilitator of Learning?							

Comments:

Appendix IV

Observation feedback sheets for peers (Adapted from (Du Toit, 2018:30)

Please indicate to what extent the lecturer has met each of the following criteria.

- Respond to each statement by marking the appropriate column with a X

1 = not at all **2 = to some extent**

3 = to a large extent **4 = to a great extent**

		1	2	3	4
1	Knowledge of the content (topic) is evident and adequate				
2	Learning opportunity (outcomes, course, sequence, flow) is well structured				
3	Good time management is evident				
4	Self-presentation (language, quality of voice, eye contact, body language, etc.) reflects professionalism				
5	Learner interaction is visible				
6	Authentic learning is activated				
7	Facilitating whole brain learning (accommodating learning styles) is visible				
8	Learning media is used in a professional manner and where appropriate				
9	Overall the lecturer is well prepared				
10	General comments				

Appendix V

Self-assessment of Teaching Practice (Du Toit, 2018:28)

Describing my contribution to learning in terms of each of the aspects addressed in the items below, using the following scale: 1 hardly ever 2 occasionally 3 frequently 4 almost always					
Category I As lecturer I inspire my students by:	NA	1	2	3	4
• showing enthusiasm about the subject matter and learning tasks					
• expressing myself well (variety in tone of voice)					
• promoting insight in the importance and significance of the subject matter/constructs and related problems/innovations					
• providing learning opportunities (sessions) that are lively and encouraging					
Category II As lecturer I initiate learning by:					
• creating a climate conducive to deep learning					
• clearly stating the purpose and learning outcomes of the session					
• linking learning to real-life situations					
Category III As lecturer I maintain learning by:					
• promoting lecturer-student discussions/academic discourse to allow my students to develop an enquiring mind					
• encouraging my students to construct own understanding and material (constructivism)					
• providing for whole brain learning/learning style flexibility (other ways of learning, not only according to students' own preference – challenge beyond comfort zone)					
• encouraging my students to express themselves freely and openly					
• inculcating critical thinking and self-reflection as integral part of self-regulated learning					
• creating opportunities for cooperative learning – establishing communities of practice					

General Comments:

Appendix VI

Written consent from participants

Dear colleague

I am currently enrolled at the University of Pretoria for my master's in education (MEd). My research topic is: "Integrating principles of Whole Brain thinking to transform Radiographic Clinical Practice: an action research approach".

The aim of the study is to undertake an action enquiry, into how I can improve radiographic clinical practice, and I am asking you if you would volunteer to be a participant in my research. You will benefit from the study, by receiving information on your learning style preferences, accompanied by activities how to engage in less preferred modes of learning.

This letter serves to inform you of my wish to gather data in this regard as part of a longitudinal study. The data will only be of value for my own professional development as a lecturer.

I promise the following:

- I will always give priority to your interests.
- There are no risks involved in the study.
- Your identity will always be protected and kept confidential.
- Should you wish to withdraw from the project you may do so at any time, without being penalised in whatever way. I will blur you out of the video if it is the case.
- The data collected will be save on my password protected computer.
- The data collected will be given to my supervisor, Prof P.H. du Toit, and be kept 15 years.

- I will make a copy of my research report available to you prior to its publication.

Data gathering includes:

- Learning style survey
- Feedback questionnaires
- Observations through photo and video evidence (e.g. execution of tasks)
- Focus group interviews (will receive separate consent form)

Should you agree to me making using of the above, please sign the consent letter in the space provided below.

Your cooperation in this regard is appreciated.

Consent:
I agree to participate in this study as outlined above.

Name: ..... Date: .....

Signature: .....

Researcher: Zanelle Kruger Date: .....

Signature: .....

Appendix VII

Information leaflet

1. Introduction

I want to introduce myself and my action research proposal.

As a scholar of facilitating learning in higher education on a part-time basis for only three years, I continuously strive to develop my full potential. I enrolled for a Magister Education (MEd) to contribute to my professional development as a higher education practitioner, allowing me to apply for a lecturing post, should the opportunity arise

I would like to invite you to participate in an action research project on my professional development. Before you agree to take part, you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to ask the facilitator (see number nine for contact details). This activity is part of a MEd research project at the Faculty of Education, University of Pretoria.

Title of the study

Integrating principles of Whole Brain thinking to transform Radiographic Clinical Practice: an action research approach

2. The nature and purpose of this study

The aim of the study is to undertake an action enquiry, into how I can improve radiographic clinical practice, and I am asking you if you would volunteer to be a participant in my research.

3. Purpose of the facilitating sessions on radiographic clinical practice

This sessions forms part of a research project investigating the principles of whole brain® thinking to transform radiographic clinical practice.

4. Explanation of procedures to be followed

The participants will complete an adapted learning style survey that will indicate their learning preferences. I will inform them of their quadrant preferences, and the importance of Whole brain thinking. I will design and implement a whole brain holistic learning opportunity. I will create variation of learning opportunities to accommodate and challenge all students in the session. The participants will be instructed to complete two different questionnaires. One on my facilitating of learning and a second questionnaire on their own learning. I will ask peers to evaluate these sessions through observations. Self-observation of my practice will be done by means of video-recordings and photographs. At the end of the study by means of focus groups and semi-structured interviews the

interviewer will ask you questions on your experiences. The interview will be recorded and then transcribed. More information on interview will be made available to all the participants in these sessions.

5. Risk and discomfort involved

There are no risks or discomfort involved and it is important to know that these sessions are not an evaluation of your work.

6. Protection of confidentiality and your rights as participant

You are assured your identity as well as your responses will be treated confidentially at all times and will not be made available to any unauthorised user. Your participation in this study is completely voluntary. Should you not wish to continue being part of the research project, you are free to withdraw at any time. Precautions will be taken that you will not be harmed in any way by this research. The data collected will be save on my password protected computer. The data will be given to my supervisor, Prof P.H du Toit, and be kept 15 years. I will make a copy of my research report available to you prior to its publication.

7. Possible benefits of this study

You will benefit from this study, by receiving information on your learning style preferences, accompanied by activities how to engage in less preferred modes of learning. Throughout the sessions you will become a whole brain self-regulated learner making a positive difference in the ever-changing world-of-work. I want to have a positive effect on radiographic clinical practice and how demonstrations of different radiographic techniques are enacted.

8. Compensation

Your participation is voluntary with no compensation offered; however, there is no cost involved to be part of the study.

9. Information and contact person

The contact person for the study is Zanelle Kruger (084 553 6121 or zanelle3213@gmail.com) or Prof. PH du Toit (014 420 2817 or pieter.dutoit@up.ac.za).

Consent for being part of an action research study

I herewith give consent to be part of the action research study. I understand that the data will only be used for this study. Once the study has been concluded all the material will be archived with the other data collected for the study according to the regulations of the University of Pretoria. Should the researcher wish to use any audio-visual material for any other purpose, additional written permission will be sought.

Participant's name: ....(please print)
Participant's signature: ..... Date: …….
Person seeking consent: Ms Z Kruger
Signature: ..... Date: …….
Supervisor Name: Prof. PH du Toit
Supervisor's signature: Date: …….

Consent for the photographs video-taping of the facilitating session

I herewith give consent that the interview may be videotaped. I understand that the recording will only be used for this study. Once the study has been concluded the audio-visual material will be archived with the other data collected for the study according to the regulations of the University of Pretoria. Should the researcher wish to use any audio-visual material for any other purpose, additional written permission will be sought.

Participant's name: ....(please print)
Participants signature: ..... Date: …….
Person seeking consent: Mrs Z Kruger
Signature: ..... Date: …….
Supervisor Name: Prof. PH du Toit
Supervisor's signature:..... Date: …….

Consent for the video-taping of the focus group

I herewith give consent that the interview may be videotaped. I understand that the recording will only be used for this study. Once the study has been concluded the audio-visual material will be archived with the other data collected for the study according to the regulations of the University of Pretoria. Should the researcher wish to use any audio-visual material for any other purpose, additional written permission will be sought.

Participant's name: ....(please print)
Participants signature: ..... Date: …….
Person seeking consent: Mrs Z Kruger
Signature: ..... Date: …….
Supervisor Name: Prof PH du Toit
Supervisor's signature:..... Date: …….