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A MULTI-METHOD STUDY TO EXPLORE PERCEPTIONS AND ATTITUDES TOWARDS NEUROANATOMY IN AN UNDERGRADUATE MEDICAL CURRICULUM

PhD Anatomy

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2017 - 2020

DECLARATION OF ORIGINALITY

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Declaration

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- I declare that this PhD Anatomy dissertation is my own original work. Where other people's work has been used (either from a printed source, Internet or any other source), this has been properly acknowledged and referenced in accordance with departmental requirements.
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DEDICATION AND ACKNOWLEDGEMENTS

I would like to dedicate this PhD thesis to my mother, Trudie Coetsee (1957 – 2017). Although she did not see the completion of this thesis, she knew this was a dream that would come true and encouraged me to never give up on this dream.

I would like to express my gratitude to the following people; without whose support and guidance this thesis would not be completed:

- The participants and respondents of this study. Without your valuable input, this thesis could not have been materialized. I am grateful that you took time from your busy schedules to share your perceptions and teaching practices regarding neuroanatomy with me.

- My husband, Herkie. I am forever thankful for your love and support. Without your encouragement, I would not have been able to complete this study. You supported me through all the frustrating moments, disappointments, deadlines and small victories.

- My children, Hannes and Diané who had to sacrifice a lot of “mommy-time” so that I can pursue my dream.

- Prof Marius Bosman, my neuroanatomy lecturer, mentor, and co-supervisor. Words cannot express my appreciation for your guidance since my undergraduate years. You were the one that planted the “neuroanatomy-seed”, and stuck around to see it grow and blossom into a PhD.

- Dr Irene Lubbe, my education mentor and supervisor. You have opened a whole new world (in higher education and qualitative research) to me. Your guidance and patience with me, made me a better anatomy lecturer.

- My family, friends and former colleagues at SMU, who supported and encouraged me throughout this journey, especially Dr Lane Prigge, Dr Pieter Ackermann and Mrs Barbara Viljoen.

- My colleagues in the Department of Anatomy at UP, who had to listen to my ideas and volunteered to participate in this study. A very special thank you to Dr Jolandie Myburgh and Dr Natalie Keough, who were always available when I needed advice, from dealing with committees to very basic statistical analysis. Your guidance did not go unnoticed.

- Ms Yvette Daffue at the Health Professions Council of South Africa (HPCSA) who assisted me with information regarding the neuroscience specialists in South Africa.

- Dr Liebie Louw and Mrs Joyce Jordaan in the Department of Statistics at UP. Without your assistance with the statistical analysis of this study, especially Chapter 4, I would not never have known where to begin.

SUMMARY

A MULTI-METHOD STUDY TO EXPLORE PERCEPTIONS AND ATTITUDES TOWARDS NEUROANATOMY IN AN UNDERGRADUATE MEDICAL CURRICULUM

Human anatomy is a core module of the medical curriculum. Anatomy lecturers are expected to teach clinically-relevant content, while utilising interactive and student-centred teaching methods and approaches. This teaching and facilitation must happen in the context of decreased curriculum hours while credits remain mostly unchanged. Therefore, a dire need exists to explore the various teaching modalities currently used in medical education, to improve the teaching and facilitation of anatomy, and more specifically, neuroanatomy.

Neuroanatomy tends to be challenging for students. Their inability to integrate the basic concepts with the clinical environment could lead to the development of a negative attitude or fear towards neuroanatomy (neurophobia). Neuroanatomy provides exceptional opportunities for the integration of basic- and applied concepts, however, the teaching approaches and time allocated to this subject has a large influence on how staff and students perceive neuroanatomy and the teaching thereof.

A multi-method research study was conducted to explore the attitudes of anatomy lecturers, undergraduate- and postgraduate students towards the teaching and learning of neuroanatomy in the medical curriculum. This study further explored the perception of students on the importance of neuroanatomy as it relates to their future careers. The sample constituted four groups: Nineteen neuroanatomy lecturers from various medical schools in South Africa, five postgraduate neuroscience students and 299 undergraduate medical students from the University of Pretoria, as well as two international key-opinion leaders in the field of neuroanatomy education and neurophobia. Various methods were used for data collection which included online questionnaires, focus-group discussions, round-table discussions and semi-structured interviews.

All the neuroanatomy lecturers acknowledged that neuroanatomy is important in their students' medical training. However, only a few deem it necessary to modernize their teaching approaches to be more suitable for the 21st century student. Information of the medical neuroanatomy curriculum and teaching practices at the institutions were gathered, which was then benchmarked against various international medical schools' curricula. One-directional didactic lectures and guided dissection are mainly used for undergraduate neuroanatomy teaching. This indicated a need for more innovative, technology-supported teaching methods better suited for the 21st century medical student in South Africa.

Undergraduate medical students preferred lecture notes to other literature types while their most favourite topic was cranial nerves. The postgraduate students shared their undergraduate neuroanatomy experiences and provided constructive feedback and suggestions to undergraduate students and lecturing staff. These students perceive neuroanatomy as an interesting and important subject in their medical degree stating, however, that changes are needed to modernize neuroanatomy and make it more accessible and student-friendly.

The interviews with the experts yielded three themes namely the teaching practices in neuroanatomy, perceived relevance of neuroanatomy within the medical curriculum and the perception of neurophobia. The participants had opposing views on teaching approaches and the relevance of neuroanatomy in the undergraduate medical curriculum. However, they had similar opinions on neurophobia, its impact on the undergraduate medical students and possible preventative measures.

This study highlighted that there is neither a single best teaching method for neuroanatomy, nor does it need to be a modern teaching approach, but rather student-centred. Therefore, by reflecting on our own perceptions, attitudes and teaching approaches for neuroanatomy, and by making the necessary changes, we can help our students overcome this fear for the neurosciences.

Key words: medical education, neuroanatomy, neurophobia, postgraduate education, perceptions of staff, perceptions of students, student-centred, teaching competencies, teaching practices, undergraduate education.

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CHAPTER 1

Introduction and orientation

“Doctors without anatomy are like moles. They work in the dark and the work of their hands are mounds”, Tiedermann (1781-1861) in (Turney, 2007).

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1. INTRODUCTION

Human anatomy is a core subject in the medical curriculum. The time allocated to this subject within the curriculum has gradually been decreased over the past twenty years due to the shift in focus from basic medical sciences education to training which is more clinically relevant (Nham, 2012, Moxham et al., 2015). This, has led to the reduction of teaching time for anatomy (Moxham and Moxham, 2007, Nham, 2012), which, per implication, has a direct negative impact on the way neuroanatomy – a subject that many students fear – is taught. Medicine and medical education are constantly evolving and therefore, the way we teach neuroanatomy should also evolve and incorporate innovative and integrated approaches (Hazelton, 2011; Chang and Molnár, 2015; Arantes and Ferreira, 2016).

Debate whether major changes are needed in the approaches and methods of teaching neuroanatomy in a less intimidating, more understandable and "user friendly" way for the medical students, is long overdue. A good approach for teaching neurosciences is to make the subject dynamic, interactive, attractive and captivating (Maranhão-Filho, 2014).

Neuroanatomy is regarded as a productive area of research although the brain still remains the organ which is the least understood in the human body (Moxham et al., 2015). Students experience the anatomy of the nervous system to be perplexing based on its complexity (Zinchuk et al., 2010; Kennedy, 2013), as it not only entails the structure of the nervous system, but necessitates the connection between the structures and their functions (Pytte and Fienup, 2012). Case studies have been used with varying degrees of success to improve the understanding of the structure-function relationships in neuroanatomy (Hudson, 2006; Kennedy, 2013). Case studies and the discussion thereof, however, are better implemented in a small classroom set-up, since it provides the students with the opportunity to increase focus, engage with their peers, improve their communication skills and study some clinical relevant cases in greater detail (Kennedy, 2013; Whelan et al., 2016).

Students perceive the neurosciences and clinical neurology to be overly complex and in turn, this affects their attitude towards the subject matter (Zinchuk et al., 2010). Their inability to integrate the basic concepts with the clinical environment may lead to the development of a negative attitude or fear of neurosciences (Maranhão-Filho, 2014). Fitzgerald (1992)

mentioned that neuroanatomy has exceptional opportunities for the integration of basic- and applied concepts such as clinical applications and lectures presented by neurologists. It was further suggested by the participating anatomy instructors in the United Kingdom that the recommended average time spent on neuroanatomy for undergraduate medical students should be approximately 41 hours, which is nearly 50% of the time spent on the rest of gross anatomy (Fitzgerald, 1992).

Recent educational trends, as well as clinicians, support a hybrid teaching and assessment approach where there is a reduction in traditional teaching methods of one-directional didactic lectures, and an increase in student-engaged active and participatory-learning methods (Estevez et al., 2010; Mathiowetz et al., 2016; Ngan et al., 2017).

The purpose of this study is, in part, to identify teaching methods which will allow the student to understand and integrate the neuroanatomy content in a time-efficient way, while simultaneously enabling deep learning (Estevez et al., 2010). This will need to take place in the context of the current and future student population, which is becoming more technologically skilled, but are also burdened with non-academic responsibilities and time constraints. Therefore, a dire need exists to investigate various teaching modalities currently used in medical education to improve the teaching and facilitation of anatomy and, more specifically, neuroanatomy in the undergraduate medical curriculum.

2. RATIONALE AND BACKGROUND

"In every department of human knowledge men are asking guidance in the solution of a world-old problem – how to train the mind and the heart of the young" (Maranhão-Filho, 2014).

The reduction of time allocated to the teaching and facilitation of human anatomy, together with the increased demand for clinical relevance, resulted in revised content and outcome objectives, as well as the implementation of more innovative teaching and learning approaches in the medical curriculum (Arantes et al., 2018). The increasing shift from basic medical training towards clinical relevance has led to the decreased amount of neuroanatomy taught to medical students (Moxham et al., 2015). In general, the reduction

in the number of anatomy contact hours has not only been reported in the literature (Nham, 2012), but has been observed in South Africa as well, resulting in the reduction of exposure to neurosciences for the undergraduate medical students. This phenomenon is noted from personal experience, as well as discussions with lecturers at other South African universities. (See Chapters 2 and 3)

Neurosciences is a multifaceted, transdisciplinary scientific area and the teaching and learning thereof has always been regarded as complex (Arantes et al., 2017). One of the most persisting challenges in the teaching of neuroscience is neuroanatomy (Zinchuk et al., 2010; Allen et al., 2016). Neuroanatomy often comprises the association between the location of the brain, its characteristic structures and associated functions (Pytte and Fienup, 2012; Arantes and Ferreira, 2016). Neuroanatomy plays a vital role in medical education. Not only is it relevant for neurological assessment in the clinical environment, but also for basic neurosciences in which the structure and function of the neuron is important in health and disease (Geoghegan et al., 2018). Neuroanatomy offers exceptional opportunities for the integration between basic- and applied concepts such as clinical applications and lectures presented by neurologists (Fitzgerald, 1992). These statements remain unchallenged and are cited frequently in recent literature.

Fitzgerald, a previous century key-opinion leader in the field of neuroanatomy, reported on the perceptions of anatomy lecturers as it relates to the teaching of neuroanatomy. He concluded that the dissection of the brain, as well as the study of prosected specimens and brain sections, in combination with CT-scans, are all regarded as important methods of teaching neuroanatomy to undergraduate medical students (Fitzgerald, 1992). Case studies and a systemic approach are often used to improve understanding of brain-behaviour or relationships in neuroanatomy. This approach is perceived as easier methods of learning by 85% of undergraduate students (Hudson, 2006; Kennedy, 2013).

The approaches or methodologies used to teach human anatomy has evolved and adapted slowly to changes. Therefore, further research on the teaching and practice in neurology is needed to introduce new teaching-, facilitation- and assessment approaches in this field of training (Turney, 2007; Abushouk and Duc, 2016). This can be achieved by scrutinizing the

curriculum, teaching methods and approaches, and the context in which anatomy is presented (Turney, 2007; Papa and Vaccarezza, 2013; Maranhão-Filho, 2014).

The responsibility to engage in learning opportunities in neurosciences still remains with the student (Nham, 2012). However, the lecturer should make the subject interesting, contemporary and engaging by making use of various and novel teaching modalities and techniques (Geoghegan et al., 2018). Therefore, the primary goal of the anatomy lecturer is to enable the student to visualize and understand the structure of the human body by making use of various aids available to the practicing clinician, including medical imaging and physical examination (Johnson et al., 2012). The lecturer further needs to develop the clinical reasoning skills of the 21st century student in a clinical setting. In order to achieve these goals, the ideal anatomy course should include dissection, computer-assisted learning, surface and clinical anatomy and imaging, while promoting ethics, professionalism and humanism (Johnson et al., 2012).

Moxham and Moxham (2007) tested two hypotheses which stated firstly, that anatomy lecturers value their subject as part of the medical curriculum more than medical students do and secondly, that the anatomy lecturers and students differ in opinion regarding the best way to teach and study this subject (Moxham and Moxham, 2007). The results indicate that medical students believe that anatomy is an important subject in their medical training. Both students and instructors preferred anatomy to be taught in a practical way (dissection, prosected specimens, living- and radiological anatomy), rather than in a theoretical way (didactic teaching, models and computer-assisted learning), which contradicted one of the original hypotheses (Moxham and Moxham, 2007). Changes in the teaching methods of the neurosciences are therefore essential to make this subject more pleasant and “student friendly” by including more digital learning tools for the medical students.

Three different types of approaches to the teaching and facilitation of neuroanatomy at the undergraduate level are reported in the literature (Moxham et al., 2015). The more traditional method is that of neuroanatomy being presented as a separate module from the rest of the anatomy in comparison to another approach in which it is incorporated with the rest of human anatomy (Moxham et al., 2015). The University of Pretoria currently uses the incorporated approach for teaching neuroanatomy. A more recent approach is the integrated teaching

and facilitation of neurosciences, which include the related anatomy, physiology, histology, chemistry and even radiology (Moxham et al., 2015; Arantes et al., 2017).

Each of these teaching approaches has its advantages and disadvantages. The traditional approach exposes the student to a “well-defined body of knowledge”, which allows little room for integration with other aspects of anatomy and/or clinical relevance (Moxham et al., 2015). The integrated approach, in which neuroanatomy is incorporated into the same module as the rest of gross anatomy, allows for integration. However, the students might find it difficult to integrate neuroanatomy with the anatomy of the rest of the body (Moxham et al., 2015). In a more recent approach, a full integration of neurosciences might lead to a superficial overview of neuroanatomy, as more emphasis is placed on the clinical relevance (Moxham et al., 2015). They further state that more research is needed on the advantages and disadvantages of these teaching approaches pertaining to neuroanatomy. The authors emphasized that they prefer to use pedagogical measures to generate information to offer the most appropriate methodologies.

Arantes and co-workers (2018) conducted a systematic review using a total of 29 articles, on the tools and resources used in neuroanatomy education (Arantes et al., 2018). The teaching approaches investigated in this review were classified into one of two groups: digital tools and non-digital tools. About 50% of the teaching approaches investigated used digital tools which included three-dimensional computer models and applications that can be installed on hand-held devices, while non-digital tools included case-studies, emphasis on recall questions, a flipped-classroom approach and near-peer teaching (Arantes et al.,2018).

The systematic review indicated that the use of digital tools in neuroanatomy education is well designed for both lecturers and students, that the students’ performances increased with the use of such tools and that the students had a more positive attitude towards these teaching approaches. The investigators further mentioned that, although the students were satisfied with increased face-to-face teaching approaches, their marks did not increase significantly.

Although various teaching approaches for human anatomy education, and some for neuroanatomy education, are mentioned in the literature, the debate still continues as to which methods are the best to teach and facilitate neuroanatomy, specifically in the medical curriculum (Arantes et al., 2018).

3. PROBLEM STATEMENT

At the institution under study, many students are experiencing mixed feelings and a reluctance towards neuroanatomy in the undergraduate medical curriculum. This can be attributed to the limited exposure (currently only 37 hours) to this subject matter during their second year, as well as the way in which this subject is currently being presented and facilitated (Nham, 2012; Kam et al., 2013). The result is a deficiency in their basic anatomy knowledge, which might have an influence on the throughput rate and pass-marks. In the past five years only 70% - 82%, of the students pass this component in their anatomy module, and the pass mark varied between 50% - 70%, depending on the assessment. This anatomy knowledge deficit, in turn, prevents the students from applying basic neuroanatomy in the clinical environment (Hudson, 2006; Nham, 2012). A lack of integration of basic neuroanatomy and the clinical application thereof will result in a medical doctor with an insufficient knowledge of the human body and might put his/her patients' lives at risk (Zinchuk et al., 2010; Gorgich et al., 2017). Therefore, alternative educational approaches are needed to enhance the students' experience and facilitate deep-learning in neuroanatomy at an undergraduate level.

4. SIGNIFICANCE OF THE PROPOSED STUDY

This study aims to investigate the attitudes of the anatomy lecturers and undergraduate- and postgraduate students towards the teaching and learning of neuroanatomy in the medical curriculum. It further examines the current perceptions of these stakeholders on the importance of neuroanatomy as part of the medical curriculum and the various teaching approaches currently employed and reported on in the literature pertaining to the medical curriculum.

The results of this study will enable the researcher to make key recommendations for a proposed revised framework for the neuroanatomy module, applicable to the medical curriculum offered at various universities. The results and recommendations from this study will be shared internally, as well as disseminated via scientific journals and conferences. It will also be shared via Communities of Practice (CoPs) with the other South African universities offering medical degrees.

5. RESEARCH QUESTION

The research question focuses on how to best teach, facilitate and assess neuroanatomy based on the attitudes and preferences of anatomy lecturers and undergraduate- and postgraduate medical students. The question consists of four interrelated sub-questions that link closely to the aim of the study:

a) How important do students and staff view neuroanatomy as part of the undergraduate medical curriculum?
b) Which teaching approaches are currently used at South African universities to teach neuroanatomy to undergraduate medical students?
c) What are the attitudes and perception of the anatomy lecturers and undergraduate- and postgraduate medical students towards neuroanatomy and the teaching thereof?
d) Are there alternative or innovative teaching approaches for neuroanatomy which could be employed in the undergraduate medical curriculum?

6. AIM AND OBJECTIVES

The purpose of this study is to explore students' and lecturers' perceptions and attitudes towards the teaching, facilitation, learning and assessment of neuroanatomy, as well as their perceptions on the relevance of neuroanatomy in an undergraduate medical curriculum. This study further focuses on constructing key recommendations for the design of a revised micro-curriculum for an undergraduate neuroanatomy module, specific to the South African context.

The following objectives are intended to address the research questions:

1. To explore the perceptions and attitudes of anatomy lecturers towards the facilitation, and assessment of neuroanatomy and its relevance in the

medical curriculum.

2. To determine the preferred teaching, facilitation and assessment approaches and strategies used by anatomy lecturers in South African Universities, as it relates to neuroanatomy.
3. To explore the perceptions and attitudes of undergraduate- and postgraduate medical students towards the facilitation, learning and assessment of neuroanatomy and its relevance in the medical curriculum.
4. To conduct interviews with international key-opinion leaders in the field of neuroanatomy education.

7. DEMARCATION

This study has a dual demarcation. While the focus of this study is on human anatomy as a subject discipline, the theoretical grounding and application is in higher educational studies. Here, the application will be in three of Tight's (2003) eight sub-categories of educational research, namely teaching and learning, course design and quality (Bitzer and Wilkinson, 2008).

8. CONCEPT CLARIFICATION

Definitions are provided for the following concepts to prevent misconception and to operationalize these terms / phrases as it relates to this study.

8.1 ANDRAGOGICAL AND PEDAGOGICAL TEACHING

Andragogy refers to the way adults learn (Knowles, 1984, Chinnasamy, 2013, Fornaciari and Lund 2014) while pedagogy refers to the way children and adolescents learn new content (Fornaciari and Lund 2014). Andragogical teaching principles transfers the power, motivation and responsibility to the learner and is focused on the process of teaching rather than the content being taught. It is further based on five assumptions indicating that adult learners are self-directed in their learning, have their own prior experiences which influence their learning, are problem-solvers, have internal factors that motivate them and they are ready to learn (Chinnasamy, 2013, Fornaciari and Lund 2014). Andragogical teaching methods have a student-centered approach (Pew, 2007)

Pedagogical teaching principles have at large a teacher-centred approach (Pew, 2007) and are based on the assumptions that the learner is not aware of his/her own learning needs. Teaching and learning are mostly subject-based. External motivation is an important driving force for learning and the learner's prior experience is regarded as less important (Ozuah, 2005).

Although these are two distinctively different terms, recently Pedagogy is used as a blanket term to describe the teaching styles and practices used in higher education institutions (Jamieson, Dane and Lippman, 2005). In the context of this study the senior and post-graduate medical students are regarded as adult learners, while the junior students are viewed as adolescent learners who are gradually transitioning to a more mature way of interacting with content. They are still developing their own reflective thinking processes (metacognition) while their locus of motivation is still external. Therefore, pedagogical approaches are deemed appropriate where the students do not have any prior experience or is dependant (Ozuah, 2005).

8.2 CURRICULUM

A curriculum refers to the structure of training and expected learning and teaching methods that reinforce a specific qualification. A curriculum constitutes all the planned experiences the students will be exposed to which will enable them to reach the outcomes for the specific course studied. The curriculum for medical education is designed in such a way that it reflects the manner in which the students learn, the practice of medicine and social accountability and responsibility (Grant, 2010). In the context of this study, 'curriculum' will refer to the undergraduate MBChB medical curriculum, approved by Health Professions Council of South Africa (HPCSA).

For this study, the focus on the curriculum will be on the micro-curriculum and nano-curriculum. The micro-curriculum focuses on the content level presented in the classroom, while the nano-curriculum focus on the content, strategies and approaches to teaching and assessment. The micro-curriculum should be informative and communicated in the study guide to direct the lecturers and the students in their planning. The micro-curriculum will determine the nano-curriculum and the facilitation sessions, as well as assessment (Van Den Akker, 2004). The

curriculum should hold relevance to addressing some of the Sustainable Development Goals (SDG), in this particular context, SDG 3 "Good health and well-being" and SDG 4 "Quality Education" (UN, 2019).

8.4 LEARNING

Learning can be defined as more than just the accumulation of information. It includes the cognitive processes of organising, re-organising and linking of experiences with information and knowledge. This process can be referred to as elaboration and forms the core of the learning process (Jeffries and Huggett, 2010). In the context of this study, 'learning' refers to the students' process of acquiring neuroanatomy knowledge in order to apply it in the clinical environment.

8.5 LECTURER

A lecturer or staff member is regarded as an academic employee. According to the Higher Education Act 101 of 1997 (RSA, 1997) an academic employee is a person who is appointed to teach and/or do research at a public institution for higher education. For this study, the lecturer is viewed as the teacher of anatomy to any/all undergraduate- and postgraduate students at any of the South African universities.

8.6 NEUROPHOBIA

Neurophobia is described as the insights, beliefs, negative preconceptions, dislike and disinterest and even fear of neurosciences as experienced by medical students (Jozefowicz, 1994; Russell et al., 2015; Shelley et al., 2018; Tarolli and Jozefowicz, 2018). This fear can be caused by various factors including the teaching methodologies used in undergraduate neuroanatomy and can be exaggerated by the inability of students to apply basic neuroanatomical concepts to the clinical environment (Hudson, 2006; Nham, 2012).

In response to neurophobia, educational institutions have implemented various strategies to counteract this perception and improve neuroscience experiences for undergraduate students (Pakpoor et al., 2014). This study will explore the students' and staffs' perceptions of neurophobia within the medical curriculum.

8.7 NEUROSCIENCE, NEUROANATOMY AND NEUROLOGY

Neurosciences is defined as the scientific disciplines which are concerned with the study of the development, structure (anatomy), function (physiology), clinical assessments and pathology (neurology) of the nervous system (Stedman, 2000).

Neuroanatomy, a component of neurosciences, often comprises the association between the location of the brain, its characteristic structures and associated functions (Pytte and Fienup, 2012).Neurology is regarded as an aspect of medical sciences which is concerned with the different nervous systems, including central, peripheral and/or autonomic, as well as the neuromuscular junction, nerve supply to muscles and their associated disorders (Stedman, 2000). The terms neuroscience and neurology are often used interchangeably in the literature. However, there is a distinct difference between these terms and for this study, the above definitions apply.

8.8 STUDENTS

A student is a person who is registered for a degree at a higher education institution according to the Higher Education Act 101 of 1997 (RSA, 1997). For this study a distinction is made between the undergraduate- and postgraduate medical students at the University of Pretoria.

An undergraduate student is viewed as a person currently registered for a basic degree in medicine (MBChB). A postgraduate student is viewed as a person who is currently registered for an additional specialized degree, after completion of his/her MBChB degree, therefore, a master's degree, which may be an MMed (from the particular university and/or a Fellow (from the South African College of Medicine).

8.9 TEACHING AND FACILITATION IN HIGHER EDUCATION

"To provide higher education" means that the lecturer is responsible for providing and conveying curriculum content, as well as assessing learning (RSA, 1997). Educators – referred to as lecturers in this study - should create learning environments which enable the students to utilise higher order thinking skills (Bloom's taxonomy) such as application, analysis, evaluation and synthesis of information (Greenwald and Quitadamo, 2014).

8.10 UNIVERSITY

According to the Higher Education Act 101 of 1997 (RSA, 1997), a public higher education institution is an established institution where higher education can be obtained. For the purposes of this study such an institution will be referred to as a university. The South African universities included in this study are parastatal higher education institutions that offer medical degrees.

According to the White Paper for Post-school Education and Training as approved in 2013, a university has three main functions, namely the education and provision of high-level skills to people, the production of new knowledge and new applications of current knowledge, as well as the provision of social mobility, justice and democracy (DHET, 2014) .

9. THE ROLE OF THE RESEARCHER

The researcher is a lecturer in the Department of Anatomy at the University of Pretoria. She has nine years' experience in the teaching of neuroanatomy to undergraduate- and postgraduate medical students, as well as other medical science students. She has an insider perspective and takes on an emic approach in this study during the qualitative data collection phase of participants at the University of Pretoria. The reason for this is that she is a neuroanatomy lecturer to the undergraduate- and postgraduate student participants and a colleague of the staff participants. The researcher takes on an outsider and etic approach during the data collection from participants at the other eight medical schools in South Africa, as she is not involved in the teaching of neuroanatomy at the other institutions.

10. GAINING ACCESS TO THE SETTING

After ethical clearance was obtained from the Research Ethics Committee at the University of Pretoria (See Appendix A) and all the relevant parties, the researcher made contact with all the respondents/participants of this study.

10.1 UP PARTICIPANTS AND RESPONDENTS

In order to gain access to the anatomy lecturers at UP, the researcher made an

announcement regarding this study in an Anatomy Department meeting and requested that her fellow anatomy colleagues, who teaches neuroanatomy to other groups participate in a round-table discussion and complete the staff questionnaire. The participant information leaflet was then emailed to all of the anatomy lecturing staff who teach neuroanatomy.

To gain access to the medical students at UP, a class list with contact details of the students, from every year-group was obtained. An email, accompanied by a participant information leaflet and link to the online student-questionnaire (See Appendix C) was then sent to the whole class requesting that the students' participant in this study.

10.2 RESPONDENTS FROM OTHER MEDICAL SCHOOLS

The researcher had to search for the contact details of all the neuroanatomy lecturers from all nine of the medical schools on these schools' websites. Personal emails, accompanied by a participant information leaflet and a link to the online-questionnaire (See Appendix B) were sent to each of the identified lecturers to request their participation in this study. An announcement regarding this study was also made at the 2019 National conference of the Anatomical Society of South Africa (ASSA).

11. RESEARCH PARADIGM AND PHILOSOPHICAL ASSUMPTIONS

This study is based on a pragmatic philosophical stance/position where the researcher believes that the truth can constantly change or be re-evaluated. Therefore, the method being used to evaluate this truth, is the one that best solves the problem being investigated (Patel, 2015, Kaushik, 2019). This paradigm is commonly adopted in mixed-method- and multi-method research studies as the focus of this paradigm is on the significances of this research and the research questions instead of the methods used (Wahyuni, 2012, Kaushik, 2019). The researcher further believes that acquiring knowledge includes both subjectivity and objectivity instead of just choosing either one (Kaushik, 2019).

The pragmatic research paradigm is based on three ideas regarding a person's actions and include that it cannot be separated from his/her circumstances, its consequences can change and it is dependent on his/her beliefs and worldviews (Kaushik, 2019). Therefore, based on the researcher's involvement in the study and her own prior experience, this study was viewed and executed through a pragmatic lens. The three philosophical assumptions that underpin and guide this study are the ontological, epistemological- and the methodological assumptions. These assumptions shaped and determined the methods used to conduct this study.

11.1 ONTOLOGICAL ASSUMPTIONS

The ontological assumption of this study is what the researcher views to be reality and researchable (Patel, 2015, Smith, 2017). The ontology of research has two main approaches which are realism and relativism. A realism approach is based on the belief that only one truth exists and this can be discovered by making use of objectives, whereas the relativism approach (as in this study) is based on the belief of multiple versions of reality. Therefore, the truth can be shaped by context, changed and evolved as the study progresses (Nurse Killam, 2015; Patel, 2015, Kaushik, 2019).

The researcher, herself, struggled to fully grasp the anatomy of the brain during her undergraduate studies. It was only during her postgraduate years and the teaching the anatomy of the brain to other students that she fully understood the complexity of the brain and how to simplify certain concepts when teaching this subject matter to undergraduate medical students. The researcher, likewise, realized that the method of teaching of neuroanatomy plays an important role on how the students perceive the subject matter. Therefore, she believes that by changing and improving the teaching approaches of the neuroanatomy module to undergraduate medical students, she can achieve the three fundamental goals of a neuroanatomy lecturer as described by Chang and Molnar (2015).

These goals are to establish the basic level of understanding of the anatomy of the human nervous system needed to attend to patients with neurological complaints, the inspiration of a smaller group of students who will potentially consider a career in

the field of neuroscience and, lastly, to motivate students to consider neuroscience as a field of research (Chang and Molnár, 2015).

11.2 EPISTEMOLOGICAL ASSUMPTIONS

The epistemological assumptions refer to the relationship that the researcher has with his/her research as it dictates the way in which new knowledge is gathered and interpreted. The epistemology of pragmatism is that a person's knowledge is grounded on his/her experience (Kaushik, 2019). There are two different approaches to the epistemology of a research study, which are dictated by the ontological assumption that the researcher holds. This includes an etic approach and an emic approach. An etic approach is an objective approach where the researcher remains removed from the research. This epistemological approach is dictated by a realism ontology, whereas an emic epistemological approach (as in this study) is a subjective approach to reality and the research. The latter approach requires interaction between the researcher and the actual research and is therefore dictated by a relativist ontology (Nurse Killam, 2015).

This study adopts an emic approach and includes the process of gathering knowledge and information regarding the attitudes towards the teaching and learning of neuroanatomy, perceptions on its relevance in the medical curriculum, as well as current teaching approaches to the subject. This can only be achieved by interaction between the researcher, staff involved in the teaching of neuroanatomy in the undergraduate medical curriculum and students. The researcher assumes that, by changing the approaches in teaching of the subject matter, she might change the perceptions and attitudes of staff and students towards neuroanatomy and the teaching thereof.

11.3 METHODOLOGICAL ASSUMPTIONS

The methodological assumptions refer to the method in which new knowledge is discovered and analysed in a systematic way. Methodology is defined as the philosophy on how the data should be collected and is dictated by both the ontology and contextual epistemology of this study.

The multi-method methodological approach of this study aimed to gather knowledge from undergraduate- and postgraduate medical students by means of questionnaires and focus- group discussions on their opinions and experiences of neuroanatomy and the teaching thereof. Information was also obtained from teaching staff at various anatomy departments by means of questionnaires, round-table discussions and interviews with international key- opinion leaders, on their opinions and experiences of teaching neuroanatomy to undergraduate medical students.

12. RESEARCH DESIGN AND METHODOLOGY

This study has both qualitative and quantitative research design characteristics and, therefore, a multi-method (but not mixed method) approach was taken.

12.1 RESEARCH DESIGN

As the researcher utilised both qualitative and quantitative methods, an emerging design such as a multi-method study was chosen, but in a non-consequential and independent way. A multi-method (and not mixed-method) approach was deemed most appropriate, as it would allow the researcher to make use of qualitative and quantitative approaches for data collection (Goertz, 2016, Seawright, 2016). This type of research design enables the researcher to gather information regarding the attitudes of the students and staff towards the teaching approaches of neuroanatomy, the perceptions of these stakeholders on the importance of the subject and the current teaching approaches used during lectures – all pertaining to the medical curriculum.

The most distinguishing difference between the two approaches is that with a mixed-method design, the data collection process is dependent on a specific and consequential order/sequence where one phase is dependent on the previous phase and directly informs the next phase (Anguera et al., 2018). By combining these different types of data, the researcher creates a single data-set. However, in a multi-method design (as in this study) data is divided into different sections, each creating its own data-set and then analysed separately (Essays UK, 2013), allowing for data triangulation. In a multi-method research approach, the objectives can run

concurrently without objective influencing or depending on another objective.

The researcher expected that gathering information and knowledge, as mentioned above, would provide deep and rich data to make key recommendations for designing a framework for a revised program/curriculum for undergraduate neuroanatomy in the medical course. This methodical approach enables the researcher to do data triangulation to better understand the perceptions and attitudes of the lecturers and students towards neuroanatomy.

Through this triangulation and crystallization of data, the validity of the multi-method study and its various sources will be tested (Carter et al., 2014). Four different types of triangulation have been described and consist of method-, investigator-, theory- and data source triangulation (Carter et al., 2014). This study will conduct method triangulation and data source triangulation.

12.1.1 Qualitative research design

The advantages of making use of a qualitative research design are that detailed perspectives can be obtained from the participants and their experiences can easily be understood within the context of the study. However, this type of design is limited to handling mainly soft data. It is also highly interpretive and relies on the participant. Qualitative data normally emerge as the study progresses, contains mainly open questions and is collected by means of interviews, focus- or nominal groups, observations and/or documentation. The interpretation of this data is through text and image analysis (Creswell, 2011).

The qualitative data was collected by means of round table discussions with UP staff members (Objectives 1 and 2), focus-group discussions with postgraduate students (Objective 3) and semi-structured interviews with international key-opinion leaders (Objective 4).

12.1.2 Quantitative research design

The advantages of using a quantitative research design lie in the researcher being able to draw conclusions from large groups, conduct efficient data analysis and

control possible bias. The limitations of such a design are that it is impersonal, has a limited understanding of the context of the participant and is mainly driven by the researcher. Quantitative data is normally pre-determined and contains closed questions. The data was analysed by means of statistical methods by using the software program IBM SPSS, which also allows for statistical interpretation (Creswell, 2011).

This study contains quantitative data which was collected via questionnaires which were completed by anatomy lecturing staff at various South African universities (Objectives 1 and 2) and undergraduate medical students at the University of Pretoria (Objective 3).

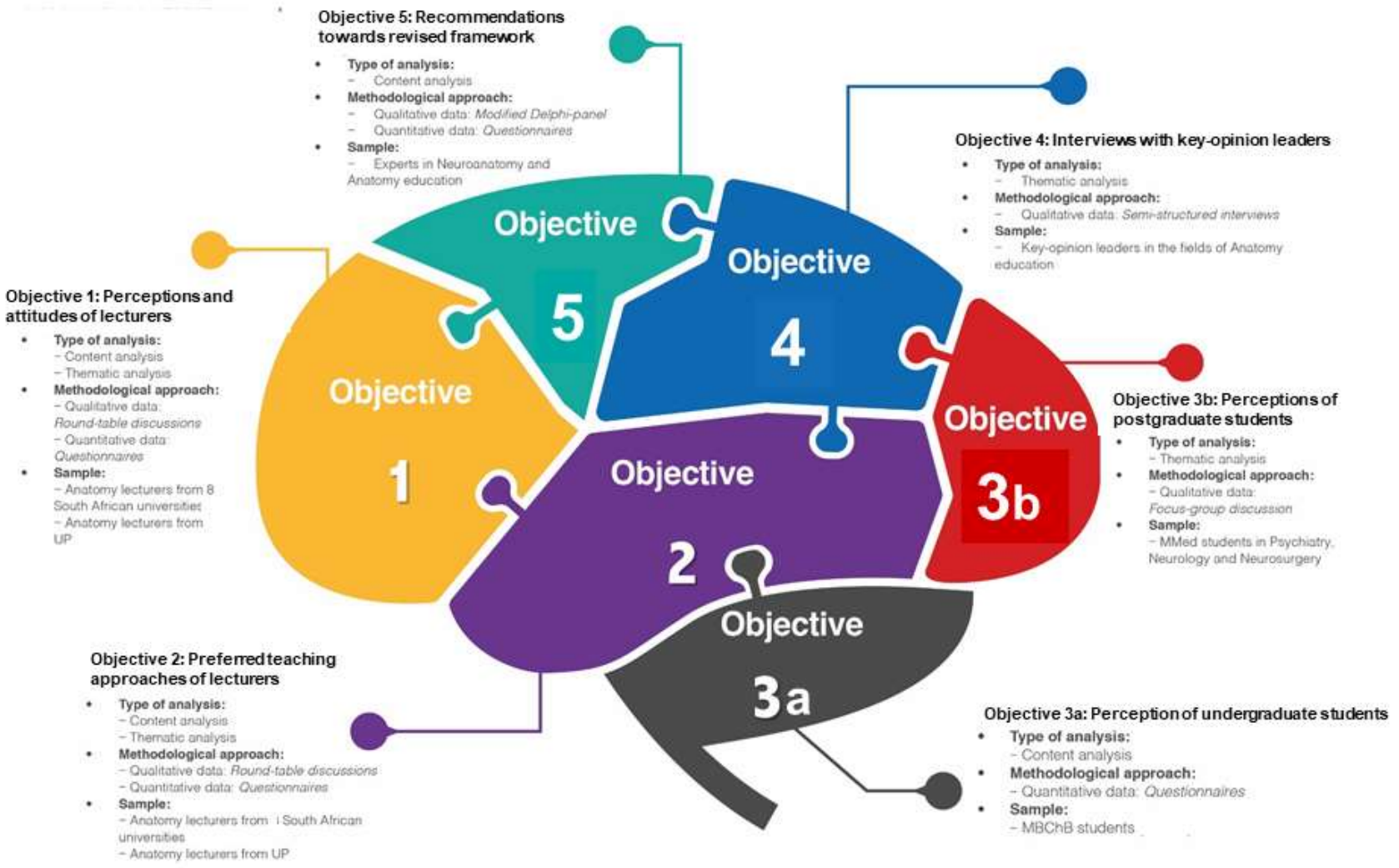
12.2 METHODOLOGY

Each data collection method is discussed separately in the corresponding chapter and the objectives pertaining to the specified method are highlighted. The objectives and their methodology are summarised in Table 1 and Figure 1.

Table 1. The research processes summarised for each objective

Objective	Short description	Type of analysis	Methodological approach	Sample and sample size	Sampling method
1 Chapter 2	Perceptions and attitudes of anatomy lecturers	Thematic analysis	Qualitative data Round table discussions	Anatomy lecturers (UP) n=5	Purposive sampling Convenient sampling
		Content analysis	Quantitative data Questionnaire (Annexure A)	Anatomy lecturers from 8 other universities n=14	Questionnaires – Qualtrics™ (web-based survey generator allows for anonymity) Purposive sampling
2 Chapter 3	Preferred teaching approaches of lecturers	Thematic analysis	Qualitative data Round table discussions	Anatomy lecturers (UP) n=5	Purposive sampling Convenient sampling
		Content analysis	Quantitative data Questionnaire (Annexure A)	Anatomy lecturers from 8 other universities n=14	Questionnaires – Qualtrics™ (web-based survey generator allows for anonymity) Purposive sampling
3 Chapter 4	Perceptions and attitudes of undergraduate students	Content analysis	Quantitative data Questionnaire (Annexure B)	Undergraduate students (MBChB) n=299	Questionnaires – Qualtrics™ (web-based survey generator allows for anonymity) Convenient sampling
	Perception of postgraduate students	Thematic analysis	Qualitative data Focus-group discussion	Postgraduate students (MMed) n=5	Purposive sampling
4 Chapter 5	Interviews with key-opinion leaders	Thematic analysis	Qualitative data Semi-structured interviews	Key-opinion leaders n=2	Purposive sampling

Figure 1: A visual representation of the multi-method research design for this study



12.2.1 Round table discussions

The first qualitative method of data collection was round table discussions and are elaborated on in Chapter 3. The focus of these discussions was to explore the perceptions and attitudes of anatomy lecturers towards the teaching, facilitation and assessment of neuroanatomy, as well their perceptions on its importance as part of the undergraduate medical curriculum (Objective 1), and also to share experiences in the teaching thereof (Objective 2).

12.2.1.1 Study population

The sample consists of all volunteering anatomy staff members involved in the teaching of undergraduate neuroanatomy modules or courses within the Department of Anatomy at the University of Pretoria (UP).

12.2.1.2 Sample size

The staff sample consisted of five individuals (n=5).

12.2.1.3 Data collection and organisation

The data collected during the round table discussions was not anonymous, however, during the presentation of the results, the data was depersonalised. All the data was backed up to an external hard drive, as well as a Dropbox account (which is shared with the supervisor and co-supervisor) and will be kept for a minimum of 15 years from the end of this study, as required. This Dropbox account is password protected.

12.2.1.4 Data analysis

A thematic analysis was conducted. This type of analysis is a flexible method which can be applied across a variety of epistemologies and research questions. Thematic analysis is a technique used to identify, analyse, organise, describe and report themes which were detected within the data investigated (Nowell et al., 2017). The software used for this analysis was ATLAS.ti, version 8.

12.2.1.5 Trustworthiness

All the opinions and data obtained were deemed valid and were included in the data analysis. See table 2.

12.2.1.6 Strengths and weaknesses

At a round table discussion, every participant's insight and opinion carries equal weight thus making it an excellent method of small group communication (Bridgeman, 2010). However, an inexperienced moderator/facilitator or one who dominates the discussion will lead to an ineffective discussion session (Newman, 2019). The researcher overcame this weakness by being the facilitator herself and guiding the discussions to neuroanatomy teaching and learning in the Department of Anatomy at the University of Pretoria.

12.2.2 Focus-group discussions

During this qualitative data collection round, focus-group discussions were held with postgraduate neuroscience students. These discussions form part of the third objective and fourth chapter, and involve the investigation into the perceptions and attitudes of the postgraduate medical students towards the teaching and learning of neuroanatomy and its importance as part of their specialized medical training, at the University of Pretoria.

12.2.2.1 Study population

The sample consists of all volunteering postgraduate medical students currently registered at the University of Pretoria. Henceforth, this group is referred to as the postgraduate student sample. The postgraduate medical students were required to be registered for courses including MMed Neurosurgery, MMed Neurology or MMed Psychiatry at the University of Pretoria. This group of students decided to further their careers in neurosciences and were therefore included in this sample.

12.2.2.2 Sample size

This group consisted of five postgraduate medical students (n=5).

12.2.2.3 Sampling method

All the volunteering postgraduate medical students were required to partake in a focus-group discussion. A focus-group discussion was chosen as it investigates how the participants express their perspectives and views on an issue, as members of a group.

This method of group interview/discussion, which there is a facilitator and several participants, the emphasis is on a defined topic and interaction within the group (Bryman and Bell, 2014).

12.2.2.4 Data collection

This discussion focused on the following five topics:

- Undergraduate neuroanatomy experience
- Role models in neuroanatomy during the participants' undergraduate training
- Reason for specialising in a neuroanatomy/neuroscience field
- Advice for teachers / facilitators of undergraduate neuroanatomy
- Advice for undergraduate students planning on specializing in neurosciences

The focus-group discussion was voice recorded with the consent of the participants and, as such, collected in an electronic format and then transcribed.

12.2.2.5 Data organization

A report was compiled on the transcribed data of the focus-group discussion and includes a summary of the meeting.

12.2.2.6 Data analysis

By conducting a focus-group discussion, a huge amount of words, as well as observational data, is generated, which need to be described and analysed. Possible relationships between themes discussed need to be identified and further analysed (Lacey and Luff, 2001). The best approach for such a data analysis would be a thematic analysis which is a flexible method that can be applied across a variety of epistemologies and research questions. The software used was ATLAS.ti, version 8.

Thematic data analysis is a six-stage method through which constant back-and-forth movement between the stages is possible, as it is a reflective process. Nowell and co- workers (2017) describe the following six main stages of a thematic analysis:

- Stage 1: Acquainting yourself with the data

- Stage 2: Generating preliminary codes
- Stage 3: Searching for themes
- Stage 4: Studying the themes
- Stage 5: Defining and naming themes
- Stage 6: Producing the report

Similar stages of the thematic analysis were described by Lacey and Luff (2001). The researchers made use of the six-stage system to conduct the data analysis and, in the process, establish the trustworthiness of this phase.

12.2.2.7 Trustworthiness and Authenticity

The trustworthiness of this phase lies in its credibility, transferability, dependability and confirmability (Nowell et al., 2017). The credibility of the study is determined when the readers are challenged with the experience and they can relate to it, whereas the transferability refers to the concept findings which can be transferred to another project. To ensure dependability, the research process should be logical and clearly documented. Confirmability can be achieved if the discoveries of the study is clearly resultant from the data and the conclusions are rational.

A focus-group discussion is a reliable source of gathering opinions, beliefs and attitudes of the participants (Simon, 1999; Colucci, 2007). All volunteering students in postgraduate degrees of MMed Psychiatry, Neurology and Neurosurgery were contacted and included in this phase. All the opinions and data obtained from this focus-group discussion were valid and analysed. The trustworthiness of this phase was ensured by making use of the six-steps system as previously described under data analysis.

12.2.2.8 Strengths and weaknesses

Focus-group discussions are regarded as a useful qualitative data collection method as it provided rich data and understanding of the experiences/beliefs of the participants (Gill et al., 2008, Hennink, 2013, Nyumba et al., 2018). However, this data collection method may be ineffective if the participants are not comfortable with each other, if the topic to be discussed is not of interest for the participants and if limited

discussion occurs due to the group being too small (Gill et al., 2008, Hennink, 2013, Nyumba et al., 2018).

The researcher overcame the weaknesses of focus-group discussions by including postgraduate medical students from the same institution in the session. The participants were comfortable with each other as they all specialize in the same neuroscience field and with the topics to be discussed as the researcher supplied them with these topics beforehand.

12.2.3 Semi-structured interviews

Semi-structured interviews with experts is a reliable qualitative data collection method (Wahyuni, 2012). These interviews form the basis of the fourth objective and fifth chapter. The purpose of these interviews was to explore the perceptions, attitudes and experiences of the experts on the topic of neuroanatomy education.

12.2.3.1 Sample population

The sample population for this data collection method consisted of key-opinion leaders who are experts in the field of neuroanatomy education. Therefore, purposive sampling was applied (Bullock, 2016).

12.2.3.2 Sample size

There are not many international key-opinion leaders with expertise in the field of neuroanatomy education and, specifically, neurophobia. Two experts were identified and interviewed (n=2).

12.2.3.3 Sampling method

Qualitative interviews can be conducted in one of three ways namely structured-, semi- structured- and unstructured interviews. Semi-structured interviews are commonly used in healthcare and were used for this specific method of data collection. This type of interview allows the researcher to have several predetermined questions, as well as the possibility to diverge from these questions based on responses received and/or the elaboration of information which is deemed important by the participant (Gill et al., 2008; Bullock, 2016).

12.2.3.4 Data collection and organisation

With the permission of the participants, the interviews were recorded, after which transcriptions and summaries were made, as outlined by Gill and co-workers (2008) and Bullock (2016).

12.2.3.5 Data analysis

A large amount of words and observational data were generated during these interviews that had to be transcribed and analysed. A thematic analysis approach was used to analyse the data and the possible relationships between the themes discussed were identified and further analysed (Lacey and Luff, 2001; Bullock, 2016). The software used for this analysis was ATLAS.ti, version 8.

12.2.3.6 Trustworthiness

The trustworthiness of this phase lies in its credibility, transferability, dependability and confirmability (Nowell et al., 2017). The purpose of this data collection method is to explore the attitudes, perceptions, beliefs and/or motivations of the participants on specific topics (Gill et al., 2008; Bullock, 2016). Interviews, as a form of qualitative data collection, are believed to provide better insight and a richer understanding of the data, in comparison to quantitative methods (Gill et al., 2008).

12.2.3.7 Strengths and weaknesses

Semi-structured interviews are an effective, flexible qualitative data collection approach that contain several key questions but also allow the interviewer to diverge from these questions, if necessary (Gill et al., 2008, DeJonckheere and Vaughn, 2019). However, the person being interviewed might not be a great participant or reluctant to share personal views or the interviewer is not probing adequately or even failing to listen actively to the participants comments (DeJonckheere and Vaughn, 2019). Regardless of the shortcomings of semi-structured interviews, it still remains a productive method to collect open-ended data (DeJonckheere and Vaughn, 2019.

The researcher overcame the weaknesses of this data collection method by preparing thoroughly for the interviews. Key-questions were identified before-hand together with

some probing questions should a particular response arise. The nature of the interview and the key-aspects to be discussed were disclosed to the interview participants upon the request of their participation. Key-opinion leaders, who are experts in their field and willing to participate, were selected for the interviews.

12.2.4 Questionnaires

Questionnaires, which include both quantitative and qualitative data collection methods, were distributed to anatomy lecturers and students to explore their attitudes towards the facilitation and learning of neuroanatomy, as well as their perceptions on its relevance as part of the medical curriculum. These questionnaires were part of the first and third objectives and the results are described in Chapters 2, 3 and 4. The questionnaires further investigated the current teaching approaches and strategies of anatomy lecturers at various South African universities (Objective 2 and Chapter 3).

12.2.4.1 Study population

The study population for the questionnaires were subdivided into a staff sample and a student sample. The staff sample consisted of all volunteering anatomy staff members involved in the teaching of undergraduate medical neuroanatomy modules or courses within the Departments of Anatomy at the following nine South African universities which offer medical degree programs:

- University of Pretoria (UP)
- Sefako Makgatho Health Sciences University (SMU)
- University of Cape Town (UCT)
- University of the Free State (UFS)
- University of KwaZulu-Natal (UKZN)
- University of Stellenbosch (SUN)
- Walter Sisulu University (WSU)
- University of the Witwatersrand (WITS)
- University of Limpopo (UL)

The student sample consisted of all volunteering undergraduate medical students currently registered at the University of Pretoria. The undergraduate medical students were required to be either engaged in a neuroanatomy block, or have attended a

neuroanatomy block within the past three years, irrespective of whether these students had previous medical- or medically related training. First year students and final year students were excluded from this study. Refer to Appendices B and C for the questionnaires sent to the lecturing staff and students, respectively.

12.2.4.2 Sample size

The staff sample consisted of 14 individuals (n=14). Equal representation from the various universities was not possible as the number of students registered and staff involved vary. The group of undergraduate medical students consisted of 299 individuals (n=299).

12.2.4.3 Sampling method

Each volunteering staff member was required to complete an anonymous electronic questionnaire. Moxham and co-workers (2015) conducted an extensive investigation of what exactly can be included as core curriculum for medical students regarding the nervous system. A detailed list of topics was provided, which was subdivided into eleven core categories. The staff members were required to evaluate these 11 categories as described by Moxham et al., 2015. Each volunteering undergraduate medical student was required to complete an anonymous electronic questionnaire.

12.2.4.4 Data collection

The electronic web-based questionnaires which included basic biographical information, as well as other relevant information, were used for this study.

12.2.4.5 Data organisation

The data was collected anonymously and in a digital format using Qualtrics™, which enabled the researcher to import all the data into MS Excel™ spreadsheets for further analysis. All the data was backed up to an external hard drive, as well as a Dropbox account which is shared with the supervisor and co-supervisor. The data is password protected and will be kept for a minimum of 15 years from the end of this study, as required.

12.2.4.6 Data analysis

Due to the small sample size of the staff members, data analysis consisted mainly of descriptive statistics, which included means, medians and/or modes. Descriptive statistics was also used for the student sample. Inferential statistical techniques such as the analysis of variance (ANOVA) was performed to find possible relationships between continuous dependent variables (preferred teaching approaches and the perceived importance of neuroanatomy in the medical curriculum) and independent factors. Independent factors included the gender, age and year-group of the students. The statistical analysis was conducted by a statistician in the Department of Statistics at the University of Pretoria by using the software program IBM SPSS™.

12.2.4.7 Trustworthiness

The trustworthiness of this phase and its criteria for evaluation lies in its reliability, validity and replicability as commonly used in quantitative research (Bryman and Bell, 2014; Du Plooy-Cilliers et al., 2014). Validity refers to the accuracy in which the results of the study reflect the data analysed, whereas reliability refers to the consistency of the systematic procedures (Noble and Smith, 2015). Therefore, the quality of the actions was used to capture the concepts investigated (Bryman and Bell, 2014). Replicability or generalisability is commonly present in cross-sectional studies and refers to the application of the findings to other contexts (Bryman and Bell, 2014; Noble and Smith, 2015).

These questionnaires are regarded as both reliable and valid by having ensured that all the universities in South Africa which offer a medical degree, were contacted and included in this study. All the opinions and data obtained are deemed valid and was included in the data analysis. All undergraduate students, who were at the time of data collection busy with their neuroanatomy block or have attended a neuroanatomy block, were included in this study. All the data and opinions obtained were regarded to be valid and were analysed.

12.2.4.8 Strengths and weaknesses

Online questionnaires have several advantages/strengths which include low cost, it gives the researcher access to a unique group of future respondents and it further

saves time by sending out a questionnaire to a large number of respondents in a short time (Wright, 2006, Beiske, 2007, McGuirk and O'Neill, 2016). It further is an excellent method to obtain data regarding people's attitudes, experiences and past behaviour, if managed properly (Beiske, 2007, McGuirk and O'Neill, 2016). Some of the weaknesses of this type of data collection include challenges with sampling, access to the online questionnaire (Wright, 2006, McGuirk and O'Neill, 2016) as well as a low response rate (Beiske, 2007, Rowley, 2014).

The researcher overcame the weaknesses of this data collection method by applying purposive sampling to include only neuroanatomy lecturers. A link to the online questionnaire was sent in an email, together with the request to participate in this study. Follow-up reminder emails were sent one month after the original request were sent out.

13. DELINEATION

The scope of this study is to investigate the lecturer's and the student's attitude towards the teaching and learning of neuroanatomy, to evaluate their perceptions on the importance of neuroanatomy in the medical curriculum, as well as to determine the current teaching approaches of neuroanatomy. This study was conducted in the South African context of higher education with the focus specifically on neuroanatomy within the undergraduate medical curriculum. However, international literature and trends were used during the literature control phase.

14. ETHICAL CONSIDERATIONS

Permission to include undergraduate and postgraduate medical students and staff members from the University of Pretoria in this study, was obtained through letters addressed to the Registrar and Deputy Dean of Teaching and Learning, in the Faculty of Health Sciences. Apart from this consent, the researcher consulted various other legal documents and papers to ensure that no deviation from the prescribed ethical principles would occur. The following documents were scrutinized:

- Nuremberg Code of 1949 (Weindling, 2001)
- Belmont Report of 1978 (USA, 1978; Sims, 2010)
- Declaration of Helsinki revised and published in 2013 (Association, 2013)

All of the above contain very important legislation, the essence of which can be summarised in the following three principles, as found in the Belmont Report of 1978 (USA, 1978; Sims, 2010):

- Beneficence
- Respect for persons
- Justice

Beneficence refers to the principle of minimising risk and concurrently enhancing the benefits for the participants. Human dignity is seen as treating the participant as an independent person which includes that the participant is provided with adequate information on the study, confirmation that participation in this study is voluntary and the overall respect for the participant, in general. Justice is regarded as the principles of treatment of the participants which include that they are treated fairly and that their privacy is respected (USA, 1978; Sims, 2010).

Each data collection activity was preceded by an information sharing session (verbally or written) which included a participant information leaflet that explained the details of the study, as well as the rights of the participant. The staff sample was not totally anonymous as the staff member was required to include the name of the university at which they are currently teaching undergraduate medical neuroanatomy, as well as provide some details regarding the specific neuroanatomy block/subject. However, the data obtained was treated with confidentiality. The student sample was completely anonymous. Each chapter contains specific detail regarding informed consent per data-collection round.

The participant information leaflet and consent documents were supplied to all the participants of the round-table discussions, focus-group discussions and semi-structured interviews. The anonymity of these participants was maintained at all times.

Ethical consent required for this research project was acquired after a meeting to propose the project to the Faculty of Health Sciences' Doctorate Committee and

thereafter, the Research Ethics Committee of the University of Pretoria (Reference number: 587/2018). Refer to Appendix A for the Ethical Clearance certificate. All sources used and included were appropriately cited and included in the list of references.

15. AUTHENTICITY: VALIDITY, RELIABILITY AND TRUSTWORTHINESS

The authenticity of a research project is embedded in its reliability, validity and trustworthiness. However, it is important to note that different terms are used to describe the trustworthiness for qualitative and quantitative research designs. Reliability and validity are terms commonly used in quantitative research, whereas terms such a credibility, transferability, dependability and confirmability are used in qualitative research (Du Plooy- Cilliers et al., 2014). As this project consisted of a multi-method research design, a clear distinction between these terms needs to be established. Table 2 provides a summary of the different terms used to clarify trustworthiness for both qualitative and quantitative research designs.

The practical applications of trustworthiness in this study are as follows: Truth value is enhanced by reflection of the researcher's own perspectives in the form of a reflective journal and peer anatomy lecturers' debriefing. Applicability is improved by applying the findings of this study to other contexts such as gross anatomy, in general. Neutrality and consistency can be heightened by achieving auditability in the form of transparency and clear descriptions of the research process, as well as discussions with the study supervisors (Noble and Smith, 2015).

Table 2. Trustworthiness terminology used for qualitative and quantitative research designs. (Adapted from Du Plooy et al., 2014 and Noble and Smith, 2015)

Quantitative terminology	Qualitative terminology	Alternative terminology
Internal validity The method used to conduct the study will answer the research question.	**Credibility** Accuracy in which the data from the participants is interpreted by the researcher.	**Truth value** Recognises that multiple versions of reality do exist. The participants' perceptions are clearly presented.
External validity The ability to apply the results of the study to a large sample population.	**Transferability** The ability to apply the results of the study to a similar situation and obtain similar results.	**Applicability** The findings of this study can be applied to other contexts, populations and/or settings.
Reliability Refers to the consistency of the analytical procedures.	**Dependability** The quality of integration which occurs between data collection and analysis.	**Consistency** An independent researcher should be able to obtain similar results.
Confirmability The data collection supports the results and the interpretation thereof by the researcher.	**Objectivity** Refers to how well the data obtained supports the results.	**Neutrality** Acknowledgement that the prolonged engagement with the participants affects the perspectives of the researcher.

16. UNIQUE CONTRIBUTIONS OF THIS STUDY

The unique contribution of this study is the key recommendations which are made and will contribute to the medical curriculum in South Africa, particularly to the current- and future medical neuroanatomy. These recommendations address good teaching practices for neuroanatomy lecturers, to enhance content integration and prevent neurophobia. Simultaneously this study is vital to the current state of neuroanatomy education in medical schools and the teaching strategies required to better prepare medical students for their clinical training and consequent safe medical practice.

The results of this study can be used to create awareness of the perceptions, preferences and needs of undergraduate medical students towards neuroanatomy and its teaching, facilitation and assessment within the South African curriculum and possibly for Africa and international application as well.

17. DIVISION OF CHAPTERS AND DISSEMINATION OF RESULTS

This dissertation follows a modern non-traditional approach: **Dissertation by publication**. Therefore, most chapters have the potential of stand-alone chapters in the format of a **publishable** article. The chapters are structured according to specific journals' requirements and therefore each chapter has a different lay-out, referencing method and approach.

There are seven chapters in this dissertation. The division of chapters for this study is as follows:

- **Chapter 1:** Introduction and orientation. This is the current chapter and contains all the general information and details regarding this study.
- **Chapter 2:** Neurophobia: A side-effect of neuroanatomy education? This chapter explores the perceptions and attitudes of anatomy lecturers towards neuroanatomy, the teaching thereof and its importance in the medical curriculum and is written for the Medical Teacher Journal (Article 1).
- **Chapter 3:** Teaching neuroanatomy: the good, the bad and the ugly truth. This chapter investigates the preferred approaches and teaching strategies of Anatomy lecturers for neuroanatomy at South African universities that currently offer medical degrees. This article/chapter is written for the Anatomical Sciences Education Journal (Article 2).
- **Chapter 4:** Neurophobia: the inconvenient truth**.** This chapter explores the perceptions and attitudes of undergraduate- and postgraduate medical students towards neuroanatomy at the University of Pretoria and is written for the Medical Education Journal (Article 3).
- **Chapter 5:** Neuroanatomy education: At the feet of giants. This chapter explores the attitudes, perceptions and beliefs of international key-opinion leaders in neuroanatomy education and neurophobia and is written for the Teaching and Learning in Medicine Journal (Article 4).
- **Chapter 6**: Personal reflection, discussion and recommendations. This non-traditional chapter contains the narrative reflections of the researcher, the overarching discussion and recommendations for neuroanatomy lecturers and the undergraduate neuroanatomy module.

- **Chapter 7**: Conclusion. This chapter contains the concluding summary of this dissertation.

Chapter two to chapter five are written in such a way that each chapter is constructed in a **publishable** article to be submitted to an appropriate journal. Research results obtained were submitted for publication in international DHET-accredited journals.

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CHAPTER 2

Neurophobia: A side effect of neuroanatomy education?

“Teaching is not something that should be done to the learner. The learner should be actively involved in learning and should be encouraged to be active”. (Collins 2004).

FOREWORD

This chapter is prepared to be published in the Medical Teacher Journal. Therefore, the format of this chapter is according the guidelines prescribed by this Journal. The author guidelines for the Medical Teacher Journal is included in Annexure E.

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Neurophobia: A side effect of neuroanatomy education?

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Key words: neuroanatomy education; undergraduate education; lecturers' perceptions; medical education, neurophobia

Type of manuscript: Article

Abstract word count: 287
Text word count: 3230
Number of references: 46
Number of tables and figures: 3
Number of videos: 0

1. ABSTRACT

Background: Neuroanatomy in the medical curriculum tends to be challenging for both lecturers and students. Students and lecturers perceive the relevance and importance of neuroanatomy differently. If not taught sufficiently, students develop a dislike or fear (termed neurophobia) for the subject. This fear prevents them from being receptive to the teaching and consequently applying the neuroanatomy knowledge in the clinical environment.

Aims: Information on the approach and perception of undergraduate neuroanatomy lecturers in South Africa regarding neuroanatomy in the medical curriculum is scarce and inconclusive. A study was undertaken to explore the attitudes and perceptions of neuroanatomy lecturers towards the relevance of neuroanatomy, as well as the teaching techniques and approach thereof, in the medical curriculum. In order to determine whether the lecturers' teaching approach and attitudes could be a contributing factor to neurophobia**.**

Methods: in a cross-sectional qualitative study, neuroanatomy lecturers from the nine South African medical schools were invited to complete an anonymous online questionnaire. Results were thematically analysed and grouped.

Results: Lecturing staff from seven of the medical schools participated in this study and included fourteen respondents. Most respondents are professional anatomists (92.9%) and one a clinician (7.1%). The respondents classified themselves mainly as either proficient (78.6%) or experts (15.8%) in their neuroanatomy teaching experience. All the respondents acknowledged that neuroanatomy is important in their students' medical training. Themes emerging from the data indicated that only a few respondents deem it necessary to modernize or adapt their teaching approaches to be more suitable for the 21st century student.

Conclusion: A lecturer's perceptions and attitude towards the subject or content, greatly affect the facilitation approaches and techniques used. This might have far-reaching consequences for students as it might impact on their attitude towards the content.

2. INTRODUCTION

Human anatomy is regarded as the cornerstone of any undergraduate medical degree (Sotgiu et al. 2019). As such, anatomy lecturers perceive human anatomy as extremely

important in the teaching of medicine, irrespective of whether these lecturers are professional anatomists or clinicians (Patel and Moxham 2006; Gogalniceanu et al. 2009; Chang and Molnár 2015). Students, however, do not always share this viewpoint. Students and lecturers perceive the relevance and importance of anatomy - and in this case, neuroanatomy - within the medical curriculum, differently (Moxham and Moxham 2007). Evidence suggests that medical students do not necessarily initially comprehend the relevance and importance of neuroanatomy in their studies and medical careers and further lack the ability to integrate their neuroanatomy knowledge in the clinical environment (Nham 2012; Geoghegan et al. 2019). Students perceive neuroanatomy as extremely difficult to understand (Arantes et al. 2017), to such an extent that some of them develop an intense dislike for the subject which eventually translates into a dreaded fear towards neurosciences - described as neurophobia (Russell et al. 2015; Arantes et al. 2017). This fear impacts on the subconscious mind of the student, altering the hidden curriculum. The hidden curriculum has a great influence in medical education (Lempp and Seale 2004; Alsubaie 2015) and includes the nonverbal messages that a student unconsciously accumulates from occurrences or experiences during his/her studies at an institution (Alsubaie 2015; Bandini et al. 2017; Rahimgir et al. 2018). The lecturer plays an irrefutable role in shaping these messages, perceptions and fears and will therefore be the focus of this phase of the study.

In any method of education, the role of the lecturer is indisputable (Rahimgir et al. 2018) and includes the didactical and pedagogical approach to the facilitation of learning, the ignition of curiosity, inspiration, as well as the engagement and support of the students to allow them to learn (Maranhão-Filho 2014; Kim and Hwang 2017) and to grow in their professional roles (Srinivasan et al. 2011). Therefore, all lecturers should have the following six basic core teaching competencies: content knowledge, student centeredness, professionalism, self-reflection and improvement, systems-based learning (in the form of dedication), as well as communication skills (Srinivasan et al. 2011; Stenfors-Hayes et al. 2011; AOME 2014). These competencies should enable the lecturer to facilitate student interaction with the content.

The contextualization and explanations of the material, combined with student engagement, create the greatest impact on learning (Maranhão-Filho 2014; Golshani

et al. 2018) and alter the perceptions of the students towards a module or course (Lam et al. 2002; Adamczyk et al. 2009). In essence, the teaching approach and method in which the lecturers facilitate a learning encounter, exchange information, the language used, intellectual honesty and the respect towards students and fellow staff members, all shape the hidden curriculum (Rahimgir et al. 2018) and the students' perception of the topic or content under discussion. Therefore, the subconscious messages transmitted by the lecturer and received by the students can be regarded as a "side-effect of education" (Rahimgir et al. 2018, p5) and can have either a positive or negative impact on the students' perception (Alsubaie 2015). This places a huge responsibility on the shoulders of the lecturer.

Besides the lecturer's core teaching competencies (AOME 2014), the lecturer's ontological assumptions, personal teaching philosophy, beliefs, values and viewpoints on teaching and learning must also be taken into account and consist of a combination of personal intentions and beliefs, prior experiences, as well situational circumstances (Collins and Pratt 2011; Jacobs et al. 2015). Five distinct perspectives of teaching and the reasons thereof have been identified in higher education and describe the way in which lecturers have different beliefs about their teaching, different didactical approaches, the justification thereof and various goals to accomplish it (Pratt 1998; Collins JB and Pratt 2011; Stenfors-Hayes et al. 2011; Jacobs et al. 2016). Personal factors that influence these perspectives include the lecturer's emotions, personal experiences as a student, professional identity and the perception of control over the content being taught and the teaching methods used. However, these perspectives can be influenced by the teaching environment, work engagement and -satisfaction of the lecturer (Jacobs et al. 2016), as well as the organizational culture of the institution's academic leadership and management (Jacobs et al. 2015). This is especially important in modules where students traditionally struggle to 'connect' with the content.

The consequences of an uninspiring and demotivated teaching approach to the facilitation of neuroanatomy conveys a message of the irrelevance or unimportance of the specialty within the medical curriculum. A negative connotation is created when inconsistencies occur between the formal structured curriculum and hidden curriculum, which in turn might contribute to the development of disinterest or fear (neurophobia) of the content (Nargis et al. 2013).

Neurophobia is not a new phenomenon. Jozefowicz coined the term in 1994 when he identified and described this fear in undergraduate medical students (Jozefowicz 1994; Russell et al. 2015; Arantes et al. 2017). Neurophobia is a global phenomenon reported in resource-rich countries such as the United States of America (USA) (McCarron et al. 2014), Saudi Arabia (Alhejaili et al. 2018), United Kingdom (UK) (Pakpoor et al. 2014), Portugal (Arantes et al. 2017), as well as in countries that tend to have limited resources such as India (Shelley et al. 2018). Factors contributing to, or fuelling this irrational fear towards neuroscience include poor and/or insufficient teaching methods (Kam et al. 2013; Alhejaili et al. 2018), limited time allocated within the medical curriculum for neuroscience (Pakpoor et al. 2014) leading to cognitive overload, the complexity of neuroanatomy as a subject (Nham 2012; Kam et al. 2013; Alhejaili et al. 2018) and the lack of the students' theory-practice integration, which causes an inability to apply their basic science knowledge to the clinical environment (Nham 2012; Shiels et al. 2017). Although the lecturer does not have control over all of these factors, his/her perceptions and willingness to address some of the modifiable factors might greatly contribute to alleviating this fear amongst students.

By exploring the factors contributing to neurophobia, some elements of the hidden curriculum become evident and the influence and impact of the perspectives of the neuroanatomy lecturer, more crucial. A cross-sectional, quantitative study was therefore undertaken to explore the attitudes and perceptions of neuroanatomy lecturers towards the relevance of neuroanatomy, and the teaching thereof, in the medical curriculum. The results reported in this study are part of a larger multi-phase, multi-method exploratory study into neuroanatomy within the South African medical curriculum where student and key-opinion leaders in the field of neurophobia are also surveyed.

3. METHODS

This study used a cross-sectional approach consisting of a quantitative data collection method with qualitative enhancement. A self-developed peer-validated questionnaire was sent to all the neuroanatomy teaching staff employed by the nine South African universities that offer medical degrees (refer to Appendix B). The study was purposefully restricted to the South African context as the researcher wanted to compare local universities prior to looking at international trends and perspectives.

Data was collected between May and November 2019.

3.1 RESPONDENTS

Only undergraduate neuroanatomy lecturing staff were invited to participate in this study. They were contacted via email and requested to complete an online/digital questionnaire anonymously. The anonymity of the respondents was upheld by means of the Qualtrics™ online survey platform used for the questionnaire. This software was set to not capture any identifying information of the respondents such as email addresses.

The respondents were from the Departments of Anatomy at the following nine participating South African medical universities: University of Cape Town (UCT), University of Pretoria (UP), University of Witwatersrand (WITS), Sefako Makgatho Health Sciences University (SMU), University of the Free State (UFS), University of KwaZulu-Natal (UKZN), University of Stellenbosch (SUN), Walter Sisulu University (WSU) and the University of Limpopo (UL). Figure 1 illustrates a geographical overview of the respective institutions' location.

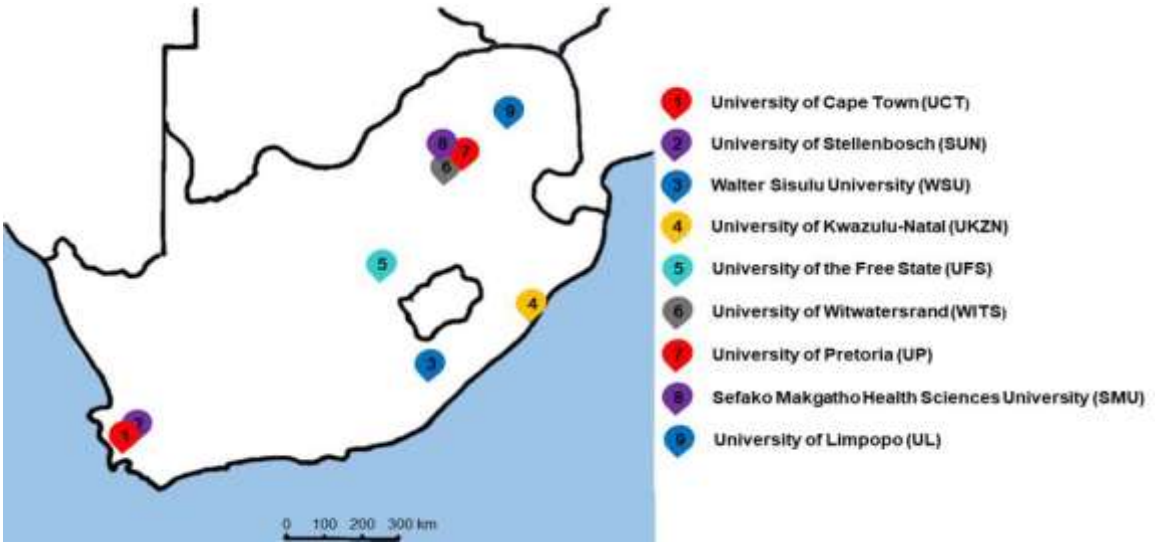

Figure 1: Map of South Africa indicating the location of the medical schools.

3.2 ETHICAL CONSIDERATIONS

Ethical approval for this study was obtained from the Research Ethics Committee of the University of Pretoria (Reference number: 587/2018). All other relevant approvals for the project were granted. Various legal documentation was further consulted. The

documents contain clear guidelines regarding research involving human participants and included the Nuremberg Code (Weindling 2001), the Belmont Report (Sims 2010) and the revised Declaration of Helsinki (Declaration of Helsinki: ethical principles for medical research involving human subjects. Adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964, and last amended by the 64th WMA General Assembly, Fortaleza, Brazil 2013). The researcher diligently adhered to the prescribed ethical principles of beneficence, respect for persons and justice (Sims 2010).

The initial email, containing the request for participation, an information leaflet, the details of the study and the rights of the respondent was sent to all the neuroanatomy lecturing staff at the various medical universities. Although this is a very small community and most of the lecturers are known to one another, the researcher focused on maintaining the anonymity of the respondents. All information received was automatically collated and depersonalized in the Qualtrics™ online survey software platform.

3.3 QUESTIONNAIRE DESCRIPTION

The design of the quantitative questionnaire included a four-point Likert scale-, matrix-, four-level item scale and a limited number of open-ended questions. A four-point Likert scale (forced Likert scale or ordinal scale) was intentionally chosen to prompt a response from the indifferent respondents by selecting their agreement/disagreement with the statements (Hopper, 2016). By removing the neutral options, this scale does not essentially distort the truth but it remains a possibility and allow the respondent to give thought to their response before moving on to the next question (Hopper, 2019). This four-point scale eased the reporting of the results which reflected that the respondents either agreed or disagreed with the particular statements as their opinions are essential (Garland, 1991, Hopper, 2019). The four-point Likert scale is widely used in market research and personal relations (Hopper, 2019). The questionnaire provided concise information regarding the current teaching, facilitation and assessment practices for neuroanatomy at the South African medical schools. The questionnaire collected biographical information on the qualifications and teaching experiences of the lecturing staff, as well as their perceptions on the relevance of neuroanatomy within the medical curriculum. The open-ended questions added

richness and depth to the quantitative questions.

3.4 STATISTICAL ANALYSIS

Statistical analysis was done with the support of a biostatistician (who validated the questionnaire prior to distribution), using IBM SPSS (Statistics for Windows, Version 22.0). Analysis mainly contained descriptive statistics, which included frequencies, means and standard deviations. Although a Cronbach alpha test might have provided insight to the reliability of the questionnaire (Taber, 2017), the biostatistician did not deemed it necessary at the time to assess the reliability of the Likert scale questions. Going forward, the reliability/internal consistency of questionnaires will be tested with the Cronbach alpha test.

4. RESULTS

The response rate of this study was 60.8%, with fourteen of the lecturing staff completing the online questionnaires. This is regarded as a high response rate since the 2019 average for online surveys is 29% and for email surveys, 30% (Lindemann, 2019). The respondents included all the lecturers involved in teaching neuroanatomy to medical students at seven of the nine medical schools in South Africa. Two universities opted to not participate. Their information is summarized in Table 1.

The respondents selected their level of teaching experience from a provided drop- down list provided. The list of teaching experiences was adapted from the Dreyfus model of adult skills acquisition (Dreyfus, 2004) and included beginner-r, trainee-, proficient- or expert levels. The definitions provided, described a beginner as a lecturer at the beginning of his/her career, with no teaching experience. A trainee lecturer works with the guidance of an expert, while a proficient neuroanatomy lecturer is one with teaching experience. The expert lecturer is a content expert and highly skilled in the teaching of neuroanatomy.

Most of the neuroanatomy lecturing staff at the South African medical schools are women (71.4%) and professional anatomists (92.9%). Only one of the respondents was a clinician (7.1%). The majority of the teaching staff had obtained additional training in medical education (57.1%) which included short courses, diplomas and masters' degrees. The respondents classified themselves mainly as proficient (78.6%) and

experts (15.8%).

Table 1: Information and characteristics of the respondents

	Respondents (n=14)
Age range **Mean age (SD)**	31 – 65 years 50.1 years (SD 13.6)
Self-identified gender	Females = 10 Males = 4
Highest qualification	Doctorate degree = 6 Master's degree = 6 Honours degree = 1 Medical degree = 1
Additional qualification in education	Master's degree = 2 Diploma = 4 Short courses = 2
Neuroanatomy teaching experience	Beginner = 1 Trainee = 0 Proficient = 11 Expert = 2

4.1 RELEVANCE OF NEUROANATOMY

The respondents were requested to select whether they agreed / disagreed with statements regarding the relevance of neuroanatomy in the medical curriculum. The statements were adapted from previous studies by Patel and co-workers (Patel and Moxham 2006) and Moxham and co-workers (Moxham and Moxham 2007). The results are summarized in Table 2.

All the respondents agreed that neuroanatomy is important in the medical students' training and is necessary for safe medical practice. The majority of the respondents (78.6%) disagreed with the statement that the importance of neuroanatomy is exaggerated in the medical curriculum. Two respondents (14.2%) agreed with the statement and one respondent did not answer this question. All the respondents further disagreed that neuroanatomy is time wasted or old-fashioned in the medical curriculum. Ten lecturers (71.4%) indicated that it is not necessary for neuroanatomy to be modernized in the medical curriculum, however, four respondents (28.6%) agreed that changes need to be made to the current neuroanatomy medical curriculum.

Table 2: The relevance of neuroanatomy in the medical curriculum as perceived by the lecturing staff.

Statement	Number of participants who agreed with the statement		Number of participants who disagreed with the statement	
	n	%	n	%
Neuroanatomy is an important component in my student's medical training.	**14**	**100**	0	0
Neuroanatomy is necessary for safe medical practice.	**14**	**100**	0	0
Neuroanatomy is of some use in the clinical setting, but its importance may be exaggerated. *	2	14.2	11	78.6
Neuroanatomy is only beneficial in certain medical specialities.	3	21.4	11	78.6
Neuroanatomy is so old-fashioned that is has no importance in contemporary medicine.	0	0	**14**	**100**
Neuroanatomy is time wasted in the medical curriculum.	0	0	**14**	**100**
Neuroanatomy needs to modernise if it is going to be really useful in medicine.	4	28.6	10	71.4
A very good doctor must have a good understanding of neuroanatomy.	13	92.9	1	7.1
It is impossible to conceive a good medical training without a major neuroanatomy component.	13	92.9	1	7.1
It is not possible to make a reasonable medical diagnosis without a sound knowledge of neuroanatomy.	9	64.3	5	35.7
Medicine would not exist without neuroanatomy.	12	85.7	2	14.2
Only a limited neuroanatomical knowledge is required for safe medical practice.	4	28.6	10	71.4
Rather than studying neuroanatomy, medical students should concentrate on clinical sciences.	0	0	14	100
Without knowledge of neuroanatomy, the doctor is of limited effectiveness.	12	85.7	2	14.2

* One respondent did not answer this question

5. DISCUSSION

When teaching, most lecturers are not always aware of the influence of the hidden curriculum on the content they teach (Alsubaie 2015) or what the students are actually learning in the process (Biggs 2012). Although the lecturers perceive the senior students as adult learners, more appropriate student-driven (andragogical) teaching

and learning approaches are not necessarily used in their undergraduate teaching and facilitation sessions (Collins 2004). The reason for this might be that some of the medical students, especially in the first and second year of study, are not yet self-directed learners and their locus of motivation is still externally located (Ozuah, 2005). These students further lack the neuroanatomy knowledge to scaffold onto their previously acquired knowledge of the nervous system.

Teaching methods or approaches should not be confused with teaching perspectives (Pratt 2002). The lecturer's perspectives include his/her intentions and beliefs that justify the teaching methods (Pratt 2002). Therefore, if the lecturer believes that neuroanatomy is not important and/or relevant in the medical curriculum, it might become apparent to the students through the hidden curriculum and the teaching methods used. The same implies if the lecturer is overwhelmingly didactic in his/her approach and expects the students to master the same amount of content as his / her own level of knowledge (Jones 1997), leading to cognitive overload. Other anatomy colleagues' scepticism and negative perceptions on the importance of neuroanatomy in the medical curriculum can also affect the neuroanatomy lecturer's attitude (Chang and Molnár 2015).

The results obtained from the characteristics of the respondents indicate that the majority of the lecturing staff is familiar and comfortable with neuroanatomy teaching in the undergraduate medical curriculum and comply with one of the core teaching competencies, namely content knowledge.

Enthusiasm, dedication and knowledge in neuroanatomy are regarded as successful attributes of neuroanatomy lecturers, regardless of whether they are professional anatomists or clinicians (Chang and Molnár 2015). Basic neuroscience, in particular, should be taught by enthusiastic lecturers who are knowledgeable in neuroanatomy (Neurologists 1995). Although the respondents were not asked to indicated their levels of enthusiasm in the questionnaire, their teaching experience in neuroanatomy can attribute to their knowledge levels. The dedication of these respondents is reflected in comments which were provided for some of the open-ended questions including: *"Students and staff members prefer the practical lectures instead of the didactive lectures*" as well as *"Love to teach it, just have very limited time".* Another comment

referred to the use of open-education resources such as brain dissection videos available online to supplement the limited resources available at a specific medical school.

All the respondents in this study acknowledged that the neuroanatomy which they teach and facilitate is important, and NOT time wasted in their students' medical training and is a necessity for safe medical practice. The teaching of neuroanatomy needs to remain current and exciting for both students and lecturing staff and should include formal training in education for the future generation of lecturers (Chang and Molnár 2015). However, the responses were divided on whether modern changes are needed for neuroanatomy within the medical curriculum, or not. Nearly 30% of the lecturers believe that changes are needed in the teaching of neuroanatomy in order to remain relevant in the medical curriculum, in comparison to 70% who feel that no changes are necessary.

Innovative change in a curriculum contains opposing forces of which personality- and logistical factors are part of (Rogan and Anderson 2011). Lecturers might perceive change as inconvenient and uncomfortable (Rogan and Anderson 2011), they might lack self-reflection (Srinivasan et al. 2011), or they are not familiar with new trends in education (de Castro et al. 2018) and therefore did not indicate that changes are necessary within the neuroanatomy curriculum. Logistical factors such as time, resources and resistance from colleagues at their institution, might also prevent lecturing staff from indicating that changes need to be made - there is no point in changing the curriculum if there is no additional time and funding available, or even support from the relevant stake-holders to implement innovative changes. Reflecting on available resource one respondent particularly stated "*Our brains are not well embalmed, which results in the students not successfully dissecting it* "This, in turn, will affect the teaching of neuroanatomy as it is most effective when the lecturing staff is encouraged and supported by faculty (Chang and Molnár 2015).

Most (90%) of the neuroanatomy lecturing staff have positive attitudes towards the teaching and facilitation of neuroanatomy in the South African medical curriculum. These respondents have indicated that they receive positive feedback from students and love teaching neuroanatomy to the medical students. Others have mentioned that

they have a well-integrated teaching approach which includes basic sciences and clinical departments. However, neuroanatomy lecturers should be careful not to teach irrelevant, but interesting content within the medical curriculum, as it increases the cognitive load and leads to curriculum-overloaded students who might become despondent, neurophobic and mainly rely on rote learning (Neurologists 1995; Svirko and Mellanby 2008). Neuroanatomy as a subject is known to be heavily loaded with facts and information (Svirko and Mellanby 2008).

6. CONCLUSION

A lecturer's attitude towards teaching and the content taught (in this case neuroanatomy) affects the teaching approaches used. This study focused on the perceptions and attitudes of the South African neuroanatomy lecturing staff towards their teaching of neuroanatomy in the medical curriculum. These lecturers recognized the relevance and need of neuroanatomy in their medical students' training and further acknowledged the need for modern changes to the curriculum for neuroanatomy to remain relevant for the 21st century medical student. As neuroanatomy lecturers, our attitudes, perspectives and perceptions influence our actions, teaching competencies and teaching approaches which might influence our students' perceptions, attitudes and fears towards neuroanatomy in the medical curriculum. Further creating a lack of integration of basic neuroanatomy and the clinical application thereof, which will result in a medical doctor with insufficient knowledge of the human body that might put his/her patients' lives at risk If the lecturer has a negative attitude it could be instilled in the medical student which may contribute to the development of neurophobia. Therefore, our perceptions affect our teaching competencies, our teaching competencies affect our teaching styles and our teaching styles indirectly affect our students' attitudes towards the module. It is therefore safe to conclude that neurophobia is a side-effect of improper neuroanatomy education.

7. NOTES ON CONTRIBUTORS

GERDA VENTER, MSc, is a lecturer and PhD student in the Department of Anatomy at the University of Pretoria. She teaches neuroanatomy to second year medical students and postgraduate medical students, as well as anatomy to first year clinical associate students. Her research interests include neuroanatomy and medical education.

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8. ACKNOWLEDGEMENTS

Dr Jolandie Myburgh, a lecturer in the Department of Anatomy, University of Pretoria for her assistance and guidance with the statistical data analysis.

9. DECLARATION OF INTEREST

The authors declare no conflict of interest. This work has not been presented at a conference or meeting.

10. PRACTICE POINTS

- The perceptions and perspectives of the neuroanatomy lecturer influence the teaching approaches which will be used.
- The teaching approaches used in neuroanatomy teaching influence the perceptions of the undergraduate medical students
- Neuroanatomy lecturers acknowledge the importance of neuroanatomy in the undergraduate medical curriculum
- More attention should be given to, and studies conducted on the perceptions of lecturers within the medical curriculum
- These lecturers recognize that the neuroanatomy teaching approaches in the medical curriculum need to be modernized to remain relevant.

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CHAPTER 3

Teaching neuroanatomy: The good, the bad and the ugly truth.

“In every department of human knowledge men are asking guidance in the solution of a world-old problem – how to train the mind and the heart of the young”, William Osler, (1913). Maranhão-Filho (2014).

FOREWORD

This chapter is prepared to be published in the Anatomical Sciences Education Journal. Therefore, the format of this chapter is according the guidelines prescribed by this Journal. The author guidelines for Anatomical Sciences Education is included in Annexure F.

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Teaching neuroanatomy: the good, the bad and the ugly truth.

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Type of article: Research Report

Abstract word count: 244
Text word count: 5489
Number of references: 50
Number of tables and figures: 7
Number of videos: 0

1. ABSTRACT

The teaching and studying of neuroanatomy in the medical curriculum are challenging for both lecturing staff and students. If not taught effectively, students might dislike or even develop a fear, termed neurophobia, for the subject, which in turn might prevent them from applying their neuroanatomy knowledge in the clinical environment. Lecturers are constantly under pressure to make use of more innovative teaching methods due to changes in the higher educational sphere and in the medical curriculum, especially given time constraints for the basic medical science subjects such as human anatomy. The lack of national standardized practices and content for undergraduate neuroanatomy in the South African medical curriculum causes uncertainty and contributes to this pressure. Therefore, the current teaching and facilitation methods used, specifically for undergraduate neuroanatomy in the South African medical setting, was explored. Neuroanatomy lecturers from all nine South African medical schools were approached to complete an anonymous questionnaire on the current neuroanatomy-relevant teaching, facilitation and assessment practices used at their institutions, to look for common threads and constructive alignment within the curriculum. Seven of the medical schools participated in this study. The medical neuroanatomy curriculum and teaching practices were then benchmarked against various international medical schools' curricula. The results showed that traditional teaching pedagogy such as one-directional didactic lectures and guided dissection are mainly used in the teaching of undergraduate neuroanatomy. This indicated a need for more innovative, technology-supported teaching methods more suitable for the 21st century medical students in South Africa.

Key words: medical education, neuroanatomy, neurophobia, postgraduate education, undergraduate education

2. INTRODUCTION

Anatomy forms a crucial component of any undergraduate medical degree. However, without a solid foundational knowledge in the basic anatomical positions, structures and functionalities, scaffolding and integration of content is not only challenging and problematic, but also nearly impossible. It would appear, however, as if students do not always grasp the extent, relevance and importance of anatomy, specifically neuroanatomy, for their medical studies and envisioned professional lives. Many

undergraduate students are voicing a dislike or even a fear towards the neurosciences. This fear, described in literature as neurophobia, might be attributed to the limited exposure to neuroanatomy as a topic, as well as the way in which the content is currently being taught (Nham, 2012; Kam et al., 2013; Russell et al., 2015; Shiels et al., 2017). This, in turn, prevents the students from applying basic neuroanatomical principles and concepts in the clinical environment (Nham, 2012; Geoghegan et al., 2019). This lack of theory-practice integration might result in a medical practitioner who will have insufficient in-depth knowledge of the human body, impacting on the correct diagnoses and treatment of patients, with potential harmful results (Gorgich et al., 2017).

One of the major challenges of integrating neurosciences in the medical curriculum is the content-span and teaching-approach in neuroanatomy. This subject is traditionally taught using a systemic approach, as opposed to a regional approach (Arantes et al., 2017; Harrison et al., 2019). Students, in general, find it challenging to master the anatomy of the nervous system due to its complexity (Kennedy, 2013; Shiels et al., 2017; Neuwirth et al., 2018). However, in neuroanatomy, there are numerous opportunities for the integration of basic- and applied concepts, such as clinical applications and seminars or lectures presented by neurologists (Javaid et al., 2019).

Changes in the academic landscape within the medical curriculum promoted the need to find new, innovative and alternative methods to teach anatomy, in order to prevent surface and strategic learning to ensure optimal knowledge retention and application (Johnson et al., 2012; Sotgiu et al., 2019). Internationally, anatomy is taught using a variety of teaching strategies and techniques, such as small group facilitation (Whelan et al., 2016), team-based learning (Anwar et al., 2015), problem-based learning (Sotgiu et al., 2019), computer-assisted learning (Russell et al., 2015), augmented reality (Henssen et al., 2019), laboratory teaching and practicals (Sugand et al., 2010), near-peer teaching (Dickman et al., 2017; Harrison et al., 2019; Karamaroudis et al., 2020), teaching neuroanatomy through historical content (Neuwirth et al., 2018) and flipped classroom approach (Watson, 2015). Selecting the most appropriate teaching modality needs serious consideration, taking into account human, physical and fiscal resources. Unfortunately, at the institution under study, the approach is mainly one-directional lecturing supplemented by a few group dissections in the wet-lab.

Embedded in the training is the development of the 21st century transferable skills, such as problem solving, critical thinking, communication, collaboration flexibility and adaptability, initiative and self-direction (Greenwald and Quitadamo, 2014; Lamb et al., 2017; Dingle et al., 2019). Students benefit and learn more efficiently when a variety of teaching and learning methods are used to enhance their active participation and engagement with the content (Johnson et al., 2012). Therefore, a blended or hybrid-teaching model, consisting of various teaching and facilitation techniques, as well as the implementation of innovative student activities, is recommended in the teaching of anatomy in the medical curriculum (Johnson et al., 2012; Dingle et al., 2019; Sotgiu et al., 2019).

The nine medical schools in South Africa collectively produce approximately 1800 graduates each year (Kahn, 2018). However, inter-institutional communication, the establishment of a core neuroanatomy curriculum (baseline knowledge necessary for safe medical practice) (Moxham et al., 2015a) and sharing of good practices as it relates to teaching approaches ,is not common practice, resulting in limited information regarding the teaching practices used for undergraduate neuroanatomy in South Africa. This gap in sharing good practices and collaboration prompted a multi-tier exploratory study into the teaching of neuroanatomy in the South African medical curriculum.

3. AIMS

The focus of this project was to identify good teaching, facilitation and assessment practices for neuroanatomy in the medical curriculum at South African universities. This was achieved by exploring the current teaching approaches for neuroanatomy at South African medical schools and identifying its relevance within the medical curriculum at these institutions.

4. MATERIALS AND METHODS

In this multi-phase two-year project, a cross-sectional study with a mainly quantitative approach was followed. The quantitate data was supplemented with qualitative data for richness and depth. This combined approach was selected as it accommodates the use of various data collection techniques, allowing a natural flow of activities without restricting the researchers to a specific sequence of steps or methods.

This paper reports on the independent quantitative data collected during one of the phases of the project. For data collection, a self-developed, peer-validated questionnaire was distributed to teaching staff employed by the nine South African universities which offer a medical degree. Data was collected from May to November 2019.

4.1 RESPONDENTS

Only lecturing staff members involved in the teaching of undergraduate neuroanatomy blocks or courses were invited to participate in this study. They were contacted via email and requested to complete an online electronic questionnaire anonymously. These respondents were from the Departments of Anatomy at the following nine participating South African medical universities: University of Pretoria (UP), Sefako Makgatho Health Sciences University (SMU), University of Cape Town (UCT), University of the Free State (UFS), University of KwaZulu-Natal (UKZN), University of Stellenbosch (SUN), Walter Sisulu University (WSU), University of Limpopo (UL) and the University of Witwatersrand (WITS). See Table 1 for the geographical summary of each institution's location.

Table 1: Summary of the nine South African universities with medical schools and their geographical locations.

Institution	Province located	City / Town located
Sefako Makgatho Health Sciences University (SMU)	Gauteng	Ga-Rankuwa
University of Cape Town (UCT)	Western Cape	Cape Town
University of KwaZulu-Natal (UKZN)	Kwa-Zulu Natal	Durban
University of Limpopo (UL)	Limpopo	Polokwane
University of Pretoria (UP)	Gauteng	Pretoria
University of Stellenbosch (SUN)	Western Cape	Stellenbosch
University of the Free State (UFS)	Free State	Bloemfontein
University of Witwatersrand (WITS)	Gauteng	Johannesburg
Walter Sisulu University (WSU)	Eastern Cape	Mthatha

4.2 ETHICAL CONSIDERATIONS

To conduct this study, ethical approval was obtained from the University of Pretoria's Research Ethics Committee (Reference number: 587/2018). Apart from all the applicable consents granted, various other legal documents and papers were consulted to ensure that no deviation from the prescribed ethical principles would occur. Such documents included the Nuremberg Code (Weindling, 2001), the Belmont Report (Sims,

2010) and the Declaration of Helsinki revised and published in 2013 (World Medical Association, 2013).

An information leaflet containing the details of the study as well as the rights of the participant was included in the initial email with the request for participation. The anonymity of the respondents was maintained throughout the study as all information received was collated and depersonalized.

4.3 QUESTIONNAIRE DESCRIPTION

The questionnaire was designed to provide concise information on the current neuroanatomy-relevant teaching, facilitation and assessment practices used at the various medical schools in South Africa. Refer to Annexure B for the full questionnaire. The questionnaire consisted of one Likert scale question, three matrix questions, seven close-ended questions and seven open-ended questions.

The questionnaire collected information regarding the neuroanatomy module taught and included the year-group of students taught, whether the module is a stand-alone module or part of a larger module, prescribed and recommended literature and the types and format of assessments in this module. Questions regarding the teaching practices of the respondents included the provision of lecture notes, teaching of clinical relevance, the recommended usage of internet resources, as well as electronic devices permitted during contact sessions.

Moxham's eleven core categories (Moxham et al., 2015a) formed the framework for the questionnaire and comprises of the development of the nervous system, histology of the nervous system, spinal cord, brainstem, cranial nerves, diencephalon and the pituitary gland, cerebral hemispheres, limbic system and reticular formation, autonomic system, ventricular system, meninges and blood vessels (See Figure 2). The teaching practices and time allocation for each of these 11 core categories were also explored.

4.4 STATISTICAL ANALYSIS

Data analysis was done in conjunction with a statistical analyst, using the IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY). The statistical analysis consisted mainly of descriptive statistics which included frequencies, means and standard deviations.

5. RESULTS

The response rate for this online questionnaire in which nineteen anatomy lecturers participated, was 82.8%. Online questionnaires, in general, have an acceptable response rate of 29% and email surveys, 30% (Lindemann, 2019) which makes this an excellent response rate. The respondents were categorized in two groups. The first group, purposively sampled, consisting of 14 respondents, included all the lecturers that teach neuroanatomy to medical students at seven of the nine medical schools in South Africa. The second group, conveniently sampled, consisting of five respondents, included the lecturers who teach neuroanatomy to other groups of students in the Department of Anatomy at the university under study in South Africa. Information regarding the respondents is summarized in Table 2.

A list containing levels of teaching experience, adapted from the Dreyfus model of skills acquisition (Dreyfus, 2004), was provided to the respondents. Each respondent had to select his/her level of neuroanatomy teaching experience from this list which included beginner, trainee, proficient and expert. The definitions provided, described a beginner to be a lecturer at the beginning of his/her career, with no teaching experience. A trainee is regarded as a lecturer who is still guided by an expert in comparison to a proficient lecturer, who is accomplished with more than two years' experience in teaching neuroanatomy. The expert lecturer is a skilled 'teacher' and is regarded as a content expert.

Table 2: Characteristics of the respondents.

	Group 1 (n=14)	**Group 2 (n=5)**	**Total sample (n=19)**
Age range **Mean age (SD)**	31 – 65 years 50.1 years (SD 13.6)	29 – 38 years 33.6 years (SD 3.7)	29 – 65 years 45.1 years (SD 13.6)
Gender	Females = 10 Males = 4	Females = 3 Males = 2	Females = 13 Males = 6
Highest qualification	Doctorate degree = 6 Master's degree = 6 Honours degree = 1 Medical degree = 1	Doctorate degree = 3 Master's degree = 2	Doctorate degree = 9 Master's degree = 8 Honours degree = 1 Medical degree = 1
Additional qualification in education	Master's degree = 2 Diploma = 4 Short courses = 2	Short courses = 3	Master's degree = 2 Diploma = 4 Short courses = 5
Neuroanatomy teaching experience	Beginner = 1 Proficient = 11 Expert = 2	Trainee = 1 Proficient = 3 Expert = 1	Beginner = 1 Trainee = 1 Proficient = 14 Expert = 3

5.1 TEACHING PRACTICES

The respondents were requested to indicate the amount of clinical relevance taught during their contact sessions and nine (47.4%) indicated that they teach clinical relevance in neuroanatomy in almost every contact-session. Four of the respondents (21.1%) indicated that clinical relevance is taught in most sessions and five respondents (26.3%) teach clinical relevance only in a few contact sessions. One lecturer (5.3%) indicated that no clinical relevance is taught during his/her contact sessions. All, but two respondents provide their medical students with lecture notes.

The recommendation of internet resources, as additional neuroanatomy literature for the medical students, was explored and only one respondent did not recommend such sources. Anatomy-related websites were recommended by 14 respondents (73.7%), YouTube videos by 13 respondents (68.4%), scientific journals by seven respondents (36.8%) and e-books and applications on electronic devices by six respondents (31.6%).

The use of electronic devices by students during neuroanatomy contact sessions is, in general, not significantly encouraged by the South African anatomy lecturing staff, as evident in Table 3. Audience response systems are the least utilized as indicated by two respondents (10.5%). Laptops, in comparison, are the most supported device during contact sessions as indicated by 14 respondents (73.7%), although the frequency in usage varies.

Table 3: The allowed use of electronic devices by students, during neuroanatomy contact-sessions. The number and percentage (in brackets) have been indicated.

Electronic device	All contact sessions	Most contact sessions	Few contact sessions	Do not encourage
Smart phone	1 (5.3%)	4 (21.1%)	4 (21.1%)	9 (47.4%)
Hand-held device (including tablets)	2 (10.5%)	4 (21.1%)	6 (31.6%)	7 (36.8%)
Laptop	6 (31.6%)	3 (15.8%)	5 (26.3%)	5 (26.3%)
Desktop computer	0	2 (10.5%)	3 (15.8%)	12 (63.2%)
Audience response system	0	1 (5.3%)	1 (5.3%)	14 (73.7%)

5.2 NEUROANATOMY IN THE MEDICAL CURRICULUM

This specific component focused exclusively on the first group of respondents to determine the current stance of neuroanatomy within the South African medical curriculum. Respondents from the various institutions were required to indicate whether the neuroanatomy taught is a stand-alone module or part of a greater anatomy course and also the year-group of students they teach. One respondent indicated that the second-year neuroanatomy is a stand-alone module, while the rest of the respondents indicated that, at their institutions, neuroanatomy is taught in combination with the other components of anatomy in a single course. The results regarding the contribution of neuroanatomy towards the inclusive anatomy courses for the various institutions are illustrated in Figure 1. Also indicated is the year in which neuroanatomy is taught to the medical students. The institutions are renamed to ensure anonymity.

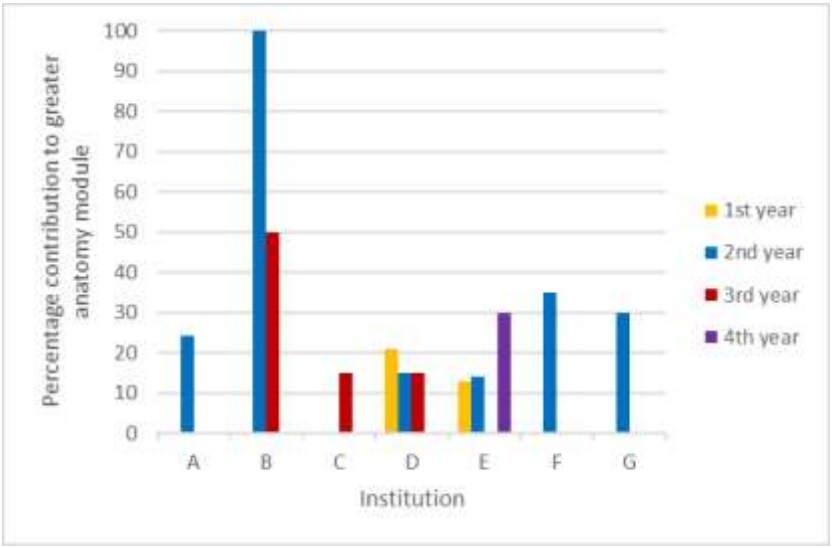

Figure 1: Summary of the contribution of neuroanatomy (in percentage values) towards the greater anatomy courses for the various institutions.

All the institutions indicated that they supply the medical students with study-guides, however, the type of study-guide differs between the institutions. Three of the institutions (A, E and F) indicated that they use school published study-guides in comparison to the rest of the institutions that use departmental study-guides. School study-guides are published by the medical school, usually for integrated modules/courses which involves both basic science and clinical departments while departmental study-guides that are published by the host department of the specific module/course.

The respondents were required to indicate their prescribed and recommended literature for their neuroanatomy module. The most commonly prescribed literature, used by multiple medical schools, included Neuroanatomy by Bosman (28.6%), Neuroanatomy: an illustrated color text by Crossman and Neary (21.4%) and Atlas of human anatomy by Netter (14.3%). The most recommended literature for neuroanatomy included Neuroanatomy: an illustrated color text by Crossman and Neary (14.3%) and Gray's anatomy for students by Drake et al. (14.3%). Several other literature sources were mentioned but only used by a single institution.

The respondents had to indicate whether the neuroanatomy module follows a hybrid teaching approach consisting of interactive face-to-face teaching, digital resources and an online component (Dingle et al., 2019; Sotgiu et al., 2019). Seven (50%) respondents originally indicated this hybrid approach. However, the respondents had to elaborate on their approach, and it appears from their responses that only two lecturers (14.3%) were actually following a true hybrid approach for their undergraduate neuroanatomy module.

The type and format of assessments for undergraduate neuroanatomy was explored. Six out of the seven institutions (85.7%) use summative assessment, Institution F being the exception. Formative assessment is used by five institutions (71.4%), however, two institutions do not use this type of assessment for their undergraduate neuroanatomy programs. Only one medical school indicated that continuous assessment is not part of their neuroanatomy assessment. Peer-assessment is only used by two institutions (28.6%) and only one medical school uses programmatic assessment (14.3%). Programmatic assessment consists of multiple assessments with meaningful feedback, which focus on the student's learning and competence, throughout the course without any summative assessment (Van Der Vleuten et al., 2015; Schuwirth et al., 2017). According to the responses, all the institutions assess their students by means of theoretical- and practical tests. Assessment of the theoretical component is conducted in multiple-choice format by five medical schools (71.4%), short-question format by six schools (85.7%) and computer-based format by three schools (42.9%). The practical assessment is conducted in a spot-test format in all seven of the medical schools and in a computer-based format by two of the schools (28.6%). Three of the institutions (42.9%) indicated that a computer-based test, with the theory- and practical components combined, is used to assess undergraduate

neuroanatomy. None of the institutions use oral assessment for neuroanatomy.

5.3 NEUROANATOMY CONTENT

The respondents were required to indicate which of the 11 core neuroanatomy categories are included in their modules. Figure 2 summarizes the results obtained, irrespective of the year in which the topics were taught. This figure indicates that Institution E does not include the development of the nervous system and Institution B the histology of the nervous system in their medical curriculum. The rest of the institutions include all 11 core categories of neuroanatomy for their medical students.

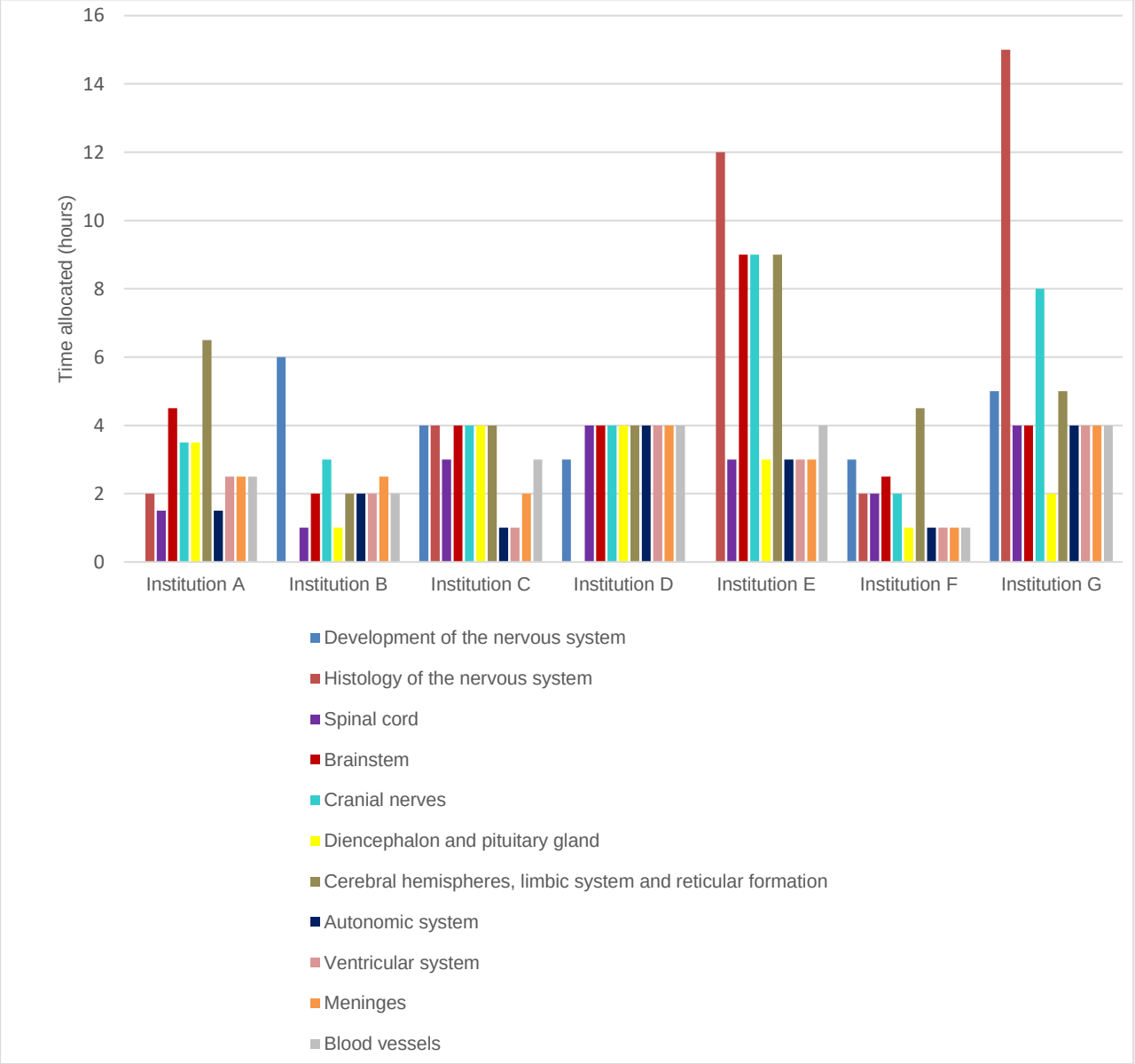

Figure 2: Summary of the core neuroanatomy categories included in neuroanatomy, and the hours devoted, at the various South African medical schools.

A further examination of the amount of time spent and the teaching method for each of the core categories were conducted, and is summarized in Table 3. The most preferred teaching method for neuroanatomy is lectures presented with Microsoft PowerPoint, on average, by nine respondents (SD 1.0). Other preferred teaching methods include dissection on human cadaveric brains, indicated, on average by six respondents (SD 2.1) and practical based lectures (combined into a single session) as indicated, on average, by six respondents (SD 2.1). The least preferred teaching method is the use of wet specimen and/or model demonstrations by staff members, as indicated by an average of one respondent (SD 0.4), followed by problem-solving scenarios, indicated by an average of two respondents (SD 0.8) and Wet specimen and/or model practicals, as indicated by two respondents (SD 0.5), on average.

As illustrated in Table 4, the majority of contact time was allocated to histology of the nervous system with an average of 5.7 hours (31.5% of the total time), followed by cranial nerves with 4.4 hours (24.3% of the total time) on average, and then development of the nervous system and cerebral hemispheres, limbic system and reticular formation, each with 3.3 hours on average (18.2% of the total time). The diencephalon and pituitary gland (1.6 hours), as well as the meninges (1.7 hours) are the categories with the lowest time allocation. The total amount of time dedicated to neuroanatomy ranged from 23 - 59 hours, depending on the topic taught, year group of students and the institution. Figure 3 illustrates the time allocated to neuroanatomy at the different institutions.

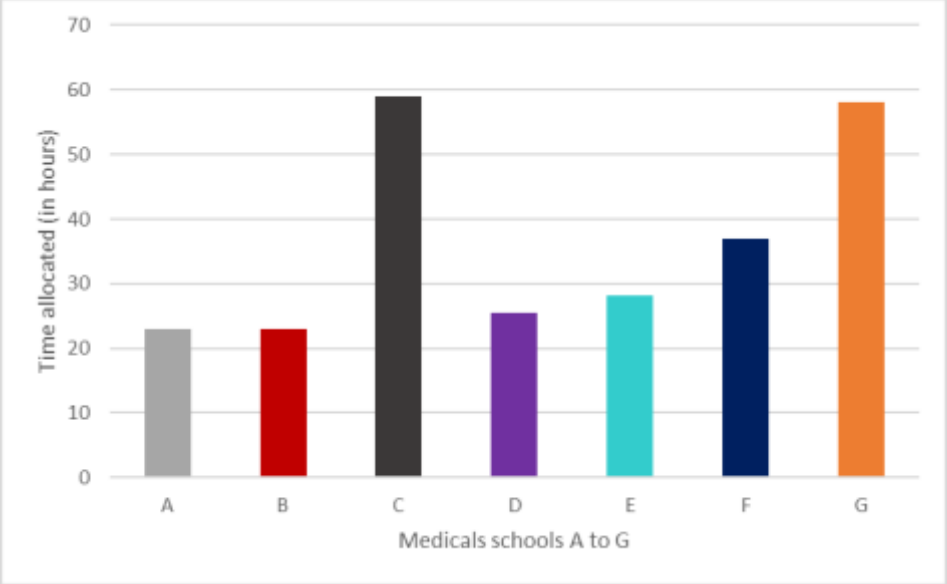

Figure 3: Time allocated to neuroanatomy contact sessions (indicated in hours) for the South African medical schools labelled A to G.

Table 4: Preferred teaching approaches for the neuroanatomy core categories.

Core category	Most preferred teaching method	Least preferred teaching method	Other preferred methods	Average time spent (in hours)
Development of nervous system	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Problem-solving scenarios • Computer-based practical / tutorial	3.3 (SD 1.6)
Histology of nervous system	PowerPoint lectures	Wet specimen / model practical	• Practical based lectures • Problem-solving scenarios • Computer-based practical / tutorial	5.7 (SD 5.4)
Spinal cord	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Dissection	2.0 (SD 1.3)
Brainstem	PowerPoint lectures	Problem-solving scenarios	• Practical based lectures • Dissection • Dissection video demonstrations	2.8 (SD 2.7)
Cranial nerves	PowerPoint lectures	Problem-solving scenarios	• Practical based lectures • Computer-based practical / tutorial • Dissection	4.1 (SD 3.1)
Diencephalon and pituitary gland	PowerPoint lectures	Wet specimen / model practical	• Practical based lectures • Dissection • Dissection video demonstrations	1.6 (SD 1.2)
Cerebral hemispheres, limbic system and reticular formation	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Dissection • Dissection video demonstrations	3.3 (SD 2.7)
Autonomic system	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Dissection video demonstrations	1.8 (SD 1.3)
Ventricular system	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Computer-based practical / tutorial • Dissection video demonstrations	1.9 (SD 1.4)
Meninges	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Dissection • Computer-based practical / tutorial	1.7 (SD 1.2)
Blood vessels	PowerPoint lectures	Wet specimen / model demonstration	• Practical based lectures • Dissection • Computer-based practical / tutorial	2.2 (SD 1.4)

6. DISCUSSION

There has been an increased burden placed on the teaching staff to justify the proportion of time allocated to the teaching of neuroanatomy within the medical curriculum (Hazelton, 2011; Neuwirth et al., 2018). The representative contribution and teaching standards of anatomy (and neuroanatomy) within the medical curriculum has been a topic of debate amongst academics and clinicians for a number of years (Sugand et al., 2010; Smith et al., 2016; Sotgiu et al., 2019). It is evident from the data that the nine Higher Education Institutions of South African do not follow a standardized neuroanatomy curriculum. South African medical schools teach different neuroanatomy topics and have different time allocations, as well as teaching methods. Therefore the need for curricular mapping and constructive alignment is necessary for quality assurance in the neuroanatomy taught in medical schools (Harden, 2001, Biggs and Tang, 2015, El-Eyd et al., 2018) and further to ensure that the current and future neurological health needs of the South African population (and international community) are met (Arantes et al., 2020). Evidence of such variations in other countries is discussed in the literature and should be compared to the South African setting.

The medical field is continuously evolving and the teaching of neuroanatomy should not be any different (Chang and Molnár, 2015). A multimodal or hybrid teaching method for neurosciences to make the subject more appropriate, relevant, dynamic, attractive and captivating (Maranhão-Filho, 2014), while enhancing active student engagement (Drake et al., 2014; Javaid et al., 2019), is needed be more appealing to the 21st century student (Henssen et al., 2019). The question remains: are we as lecturers taking our modern, digitally oriented student into account when planning and structuring our teaching intervention for neuroanatomy? Hence, all neuroanatomy lecturers should have mastered the six basic core teaching competencies which will allow them to facilitate the students' interaction with the content. These competencies are professionalism, communication skills, content knowledge, student centeredness, self-reflection and improvement, and systems-based learning (Srinivasan et al., 2011; Stenfors-Hayes et al., 2011; AOME 2014).

More than two-thirds of the teaching staff at the participating medical schools are female (68.4%) and also not clinicians, but rather full-time academics (94.7%). Only

one of the respondents is a clinician. The majority of the teaching staff had either a doctorate degree (47.4%) or at least a master's degree (42.1%) and most obtained additional training in teaching at a higher education institution (57.9%). The respondents classified themselves as either proficient (73.9%) or an expert (15.8%) in neuroanatomy teaching. It appears that all these respondents are at the very least familiar with neuroanatomy and the complexity thereof. This is a positive aspect, since one of the most successful attributes of a neuroanatomy lecturer is their dedication and enthusiasm towards the subject matter, irrespective of whether they are clinicians or neuroanatomists (Chang and Molnár, 2015).

6.1 TEACHING PRACTICES

Although the teaching of clinical relevance during contact sessions may be taken for granted, this study explored this teaching practice in the South African context. Clinical relevance is commonly taught during neuroanatomy contact sessions by approximately 68.4% of the lecturing staff, while the rest (31.6%) only teach clinical relevance on occasion. It is important that medical students are introduced to clinically relevant neuroanatomy content at an early stage during their training to allow them to see the application and integration of content (Moxham et al., 2015b).

South African lecturing staff are recommending additional internet resources to students to enhance their neuroanatomy learning experience. Such sources include anatomy-related websites, scientific journals, e-books and applications on electronic devices. Applications on electronic devices, to enhance the neuroanatomy experience for students, has been successfully implemented in medical training (Morris et al., 2016). Interactive three-dimensional software, available on the internet, has been investigated and reported to improve the student's understanding of the spatial complexity of the nervous system (Drapkin et al., 2015; Allen et al., 2016). Lecturing staff in South Africa do recommend internet resources to supplement neuroanatomy learning, but the use of electronic devices during contact sessions are not encouraged by these staff members. Although pure speculation, this could be attributed to the fact that the lecturers might not be aware of the current benefits, especially in student engagement, that these devices have in higher education. Electronic devices are mainly used by students for information retrieval (Morris et al., 2016), these devices can also be incorporated into the learning environment to make it more attractive to the

medical students. There are three commonly used teaching approaches for neuroanatomy: dissection of cadaveric brains, computer-assisted learning and problem-based learning – each with its own advantages and disadvantages (Chang and Molnár, 2015). The data obtained in this study indicates that 62.3% of South African lecturers mainly teach neuroanatomy to medical students by means of lectures in MS PowerPoint, irrespective of the neuroanatomy topic. Dissection of the human brain is still the most common method for laboratory practicals in comparison to wet specimens, models, video demonstrations and computerized practicals/ tutorials. Only 12.3% of the respondents indicated that they use of problem-based or case-based scenarios in their teaching, although this method of teaching is reported to improve the understanding of brain behavior or structure-function relationships in neuroanatomy (Kennedy,2013). Near-peer teaching in the form of supplementary instruction and assistance during dissection sessions, have been mentioned by a few respondents. This method of instruction is commonly used in Anatomy teaching, in which the senior students act as demonstrators in the dissection halls (Sugand et al., 2010; Dickman et al., 2017; Geoghegan et al., 2019) and has benefits for both the students and staff (Harrison et al., 2019). A form of flipped classrooms was mentioned by some of the respondents, in which the students had to work through neuroanatomy content and videos prior to the contact sessions. Flipped classrooms is a teaching modality in which the student is required to prepare and familiarize themselves with threshold concepts and obtain foundational didactic information prior to the contact session (Sotgiu et al., 2019). The success of this teaching approach in neuroanatomy has been recently reported on (Watson, 2015; Veeramani et al., 2017; Sotgiu et al., 2019). Short flipped classrooms can be considered as a useful approach for the introduction to neuroanatomy to undergraduate medical students (Watson, 2015).

The teaching methods currently used by some of the respondents, might not necessarily be out of choice, but rather convenience as it could be the only viable method in the current conditions of the institution. Some respondents indicated that the cadaveric brains are badly preserved at their institutions and consequently they have to rely on a specimen-bank of brain specimens for demonstrations, instead of the students dissecting the cadaveric brains. Others indicated that they do not have practical sessions in neuroanatomy and have to rely on two-dimensional images, due to this lack of resources. This in turn may cause an inability of the students to visualize

and interpret the three-dimensional aspect of the brain. Similar teaching approaches, including lectures and laboratory practicals, have been reported at the medical schools in Portugal (Arantes and Ferreira, 2016).

There can be no single method prescribed for neuroanatomy teaching at the various medical schools, due to the difference in strategic approaches of the institutions, resources, curricular approaches and different populations of students (Drake et al., 2014). This remains true for South African medical schools as well, though, the majority of these medical schools have a similar teaching pedagogy for neuroanatomy in the medical curriculum.

6.2 NEUROANATOMY IN THE MEDICAL CURRICULUM

Neuroanatomy is mainly taught in the second year of most of the medical courses, with the exception of one medical school, where neuroanatomy in only taught in the third year – ascribed to the fact that this is the most difficult section of anatomy to be mastered by students. Three institutions include neuroanatomy into multiple years in their medical courses, as a form of spiral curriculum. The reason for this spiral curriculum is that the students learn neuroanatomy progressively during their studies, thus making the content less challenging and more meaningful, with more complex scaffolded content (Hazelton, 2011; Hall et al., 2018). The only way in which a spiral curriculum can be properly implemented, is when the clinical staff and basic science staff work together. Three medical schools only teach neuroanatomy only during the second year of the medical course. This compares well with most medical schools in Portugal (Arantes and Ferreira, 2016), the National and Kapodistrian University of Athens in Greece (Karamaroudis et al., 2020), the University of Padova in Italy (Macchi et al., 2007), the University College Cork in Ireland (Javaid et al., 2018) and the University of Western Ontario in Canada (Allen et al., 2016), where neuroanatomy is taught in the second year. The St. George's University in Grenada, one of the Caribbean islands, has a neuroscience course during the first year of medical training (Shiels et al., 2017).

South African medical schools mainly teach neuroanatomy as part of a greater anatomy course and not as a stand-alone course. Similar neuroanatomy courses are taught in Italy (Macchi et al., 2007), Portugal (Arantes and Ferreira, 2016), the United

States of America (Mcbride and Drake, 2018) and the United Kingdom (Harrison et al., 2019). However, stand-alone neuroanatomy courses are presented in the majority of medical schools, including the United States of America (Drake et al., 2014), Ireland (Javaid et al., 2018) and Canada (Allen et al., 2016). It appears that the institutions commonly follow the more traditional approach in the teaching of neuroanatomy, as a stand-alone course (Moxham et al., 2015b) in comparison to South African institutions.

The use of blended- and electronic learning has increased in higher education in the last decade. Well-planned and effective blended learning approaches can enhance student engagement with the content and improve results (Allen et al., 2016; Morris et al., 2016). The majority of medical schools in Ireland follow a hybrid approach in their curricula (Javaid et al., 2018). It appears that neuroanatomy in South African medical schools is not facilitated in a blended learning environment, rather in the more traditional one-directional way of lectures and practicals. There is room for improvement in the South African neuroanatomy curriculum by introducing and incorporating blended learning.

In general, the South African medical students are assessed in neuroanatomy by means of theoretical and practical components, as seen in the United States of America (Drake et al., 2014; Mcbride and Drake, 2018) and Portugal (Arantes and Ferreira, 2016). However, these assessments do not necessarily contain only neuroanatomy content, as neuroanatomy, within the South African medical curriculum, forms part of a more comprehensive anatomy course.

6.3 NEUROANATOMY CONTENT

The aim of establishing core content in neuroanatomy is to provide a baseline of knowledge required for the medical student, for safe medical practice (Moxham et al., 2015a). This curriculum therefore ensures that the medical students are not overloaded with additional “nice-to-know facts”. The cognitive load theory states that the cognitive load or working memory of a student is overwhelmed when the student is exposed to/taught unnecessary details. These redundant demands on their working memory then complicates their learning process (Van Merriënboer and Sweller, 2010; Leppink and Van Den Heuvel, 2015). It is almost an automatic response of lecturers to say that all the components of the nervous system are important (Chang and Molnár, 2015).

The lecturer should, however, draw the line somewhere, especially where guidelines have been published in the literature. Moxham et al. (2015) published an article with a proposed core neuroanatomy curriculum in which the authors clearly state that there is not always consensus on what is regarded as core neuroanatomy knowledge (Moxham et al., 2015a). This study made use of those reported guidelines to explore the neuroanatomy content taught at the South African medical schools.

The majority of the South African medical schools teach all of the core categories as described by Moxham et al. (2015), with the exception of Institution E, which does not teach development of the nervous system, and institution B, which does not teach histology of the nervous system. One participant indicated that, according to the study outcomes, the neuroanatomy taught is introductory, although they have selected all the core categories in the questionnaire. This might affect the students' understanding of the "bigger picture" of neuroanatomy, should they not be exposed to all its components, including the development and cellular structure.

On average, 36.2 hours (SD 15.9) are dedicated to neuroanatomy within the South African medical curriculum. One participant indicated that the neuroanatomy contact time is very limited and that he/she would gladly accept more time, if possible. Similar contact time for neuroanatomy was reported in Greece (Karamaroudis et al., 2020). Medical schools in the United States of America dedicate an average of 79 - 83 hours to neuroanatomy, of which 51 - 66 hours are dedicated to lectures and 13 - 21 hours to laboratory practical sessions (Drake et al., 2014; Mcbride and Drake, 2018). Medical schools in Portugal have an average of 61 hours contact time, if neuroanatomy is presented as a stand-alone course and an average of 21.3 hours, if neuroanatomy is part of an integrated neuroscience course (Arantes and Ferreira, 2016). In this study, no distinction was made between the time allocations for theory and practicals. This might be the reason for the low reported time allocated in comparison with American medical schools. Neuroanatomy teaching in South Africa compares better to that in Portugal, when taking into account that in both these countries, neuroanatomy is taught in combination with the other components of anatomy, in a single course. It is evident that it would be challenging to standardize neuroanatomy within the medical curriculum in South Africa and the rest of the world, as each and every lecturer involved has his/her own teaching approach and philosophy.

7. LIMITATIONS OF THE STUDY

The main limitation of this study is that not all the respondents that were approached completed the questionnaires. Even though seven of the nine medical schools participated in this study and nineteen out of the 23 respondents approached, completed the questionnaires (60.8%), the results of this study are regarded as representative of neuroanatomy teaching in South African higher education institutions. A further limitation is that this study was only conducted in the South African context which make the results only locally applicable. However, the aim of the study was to compare South African institutions to gather information on current practices. In phase four of the study, international key-opinion leaders and experts in the field of neuroanatomy education were consulted and their feedback and recommendations included.

8. CONCLUSION

The South African medical neuroanatomy curriculum is similar to that reported by various international medical schools. Although South African lecturers recommended that the medical students use digital tools for studying neuroanatomy, they did not encourage the use of these tools during their contact sessions. This leaves little room for the use of innovative, technologically advanced teaching methods, more suitable for our 21st century medical students. Very little time is dedicated to neuroanatomy within the medical curriculum in South Africa, when compared to other countries. Similar teaching pedagogies are followed by the various medical schools. With some fine-tuning and key recommendations towards the medical neuroanatomy curriculum, however, South Africa could be in the forefront of neuroanatomy education in medical schools.

Through this study, the first step was taken to explore the current stance of neuroanatomy within the medical curriculum in the South African context. Not only was the teaching practices and pedagogy investigated, but also the time allocated to neuroanatomy content itself, as well as assessment practices. This valuable information is needed to gain a better understanding of the exposure students receive to neuroanatomy and whether inadequate time, content and teaching approach could it be contributing factors for neurophobia among undergraduate medical students in

South Africa, as two of the common denominators are teaching methods and limited time for neuroanatomy. The researcher's recommendation from this phase of the study is, therefore, to explore virtual-reality neuroanatomy platforms which could support the students in their neuroanatomy learning process.

9. ACKNOWLEDGEMENTS

The authors wish to thank Dr Jolandie Myburgh, a lecturer in the Department of Anatomy, University of Pretoria for her assistance and guidance with the statistical data analysis. The authors declare no conflict of interest. This work has not yet been presented at a conference or meeting.

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CHAPTER 4

Neurophobia: the inconvenient truth

“Studies have shown that 90% of error in thinking is due to error in perception. If you can change your perception, you can change your emotion and this can lead to new ideas.”

Edward de Bono

FOREWORD

This chapter is prepared to be published in the Medical Education Journal. Therefore, the format of this chapter is according to the guidelines prescribed by this Journal. The author made use of an autobiography style of reporting, using first person reporting and personal insights where appropriate. The author guidelines for Medical Education Journal is included in Annexure G.

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Neurophobia: The inconvenient truth

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Key words: neuroanatomy education; undergraduate education; postgraduate education; medical education; neurophobia

Type of article: Original research

Abstract word count: 241
Text word count: 4096
Number of references: 41
Number of tables and figures: 5
Number of videos: 0

1. ABSTRACT

OBJECTIVES Medical schools have implemented strategies in response to neurophobia to counteract the negative perception and improve neuroscience experiences for undergraduate medical students. In this study we explored the attitudes, perceptions and preferred learning approaches of undergraduate- and postgraduate medical students toward the teaching, facilitation, learning and assessment of neuroanatomy, as well as their perceptions on its relevance in the South African medical curriculum.

METHODS A total of 299 undergraduate and five postgraduate students from the University of Pretoria participated in this study. We used a multi-method approach in which the undergraduate students completed an anonymous quantitative questionnaire, while the postgraduate students participated in a qualitative focus-group discussion.

RESULTS Undergraduate medical students preferred lecture notes to study from above any other type of literature and mainly used laptop computers as preferred electronic devices in preparation for their assessments. The most favourite topic was cranial nerves and the least favourite was histology of the nervous system. Postgraduate students shared their undergraduate neuroanatomy experiences and provided constructive feedback and suggestions to undergraduate students and lecturing staff.

CONCLUSIONS Ineffective teaching methods and limited contact time still remain factors that contribute to neurophobia in South Africa. Students perceive neuroanatomy as an interesting and important subject in their medical degree, however, changes are needed to modernize neuroanatomy and make it more accessible and student-friendly. The challenge then remains, how do we, as lecturers, modernize neuroanatomy in the medical curriculum to make it contemporary and clinically applicable?

2. INTRODUCTION

Human anatomy, which includes neuroanatomy, is regarded as a foundational subject of the medical curriculum.[1] If obstacles such as students' irrational fear towards the subject, threaten the stability of this foundation, there will be dire consequences later in a medical students' career.

Students experience a fear toward neuroanatomy in their undergraduate medical training which can be attributed to their perception of neurosciences, limited exposure to neuroanatomy during their training, as well as the way in which this subject is currently being presented and facilitated.[2-5] This leads to a deficit in their basic anatomy knowledge and, in turn, inhibits the application of basic neuroanatomy in the clinical environment.[2] This deficiency of theory-practice integration could result in general medical practitioners who lack a sufficient level of applied theoretical knowledge of the human body. This may then have a direct influence on the way they assess, diagnose, treat or refer patients with neurological disorders and diagnoses.[6,7] Therefore, the perceptions and attitudes of medical students towards neuroanatomy in the medical curriculum need to be explored, and measures put in place to address any negative perceptions.

Often, the perception of medical students is that neurosciences, including neuroanatomy and clinical neurology, are overwhelming in both content and context, and overly complex.[8] This, in turn, may lead to the development of an irrational fear towards the neurosciences,[4, 5] known as neurophobia.[9] The term ‘neurophobia‘ was coined by Ralph Jozefowicz in 1994.[10 8, 9] The irrational fear of the neurosciences has further been referred to as a “real and prevalent educational disease”[3] reported to manifest within the first two years of medical study,[5] affecting 50% of undergraduate medical students[10-13] and has no gender preference.[10] Neurophobia, as a symptom, has been recognized in a variety of countries such as Nigeria, United States of America (USA), United Kingdom (UK)[14], Saudi Arabia[15, 16], Singapore[3], China[17], Sri Lanka [18], Brazil[19], Trinidad and Tobago[20], Portugal[8], West India[21], India[12] and Sudan[22].

Neurophobia is an all-inclusive term that describes the insights, beliefs, negative preconceptions, apprehensive feelings, dislikes and disinterest that medical students have toward neuroscience education.[12] Unfortunately, despite the fact that neurophobia, its causes and possible prevention plans have been extensively described in the literature, some lecturing staff still view this as a trivial issue[23] and remain unwilling to acknowledge its existence.

Several factors influence the presence and severity of neurophobia. Causative and contributing factors to neurophobia can be divided into three risk categories. The first category is non-modifiable and includes all the preconceptions and past experiences that students have towards neurosciences before they start medical school.[24] The second group consists of all the factors affecting the students during their pre-clinical years and include the students' inability to apply their basic science knowledge to the clinical environment,[2] a lack of self-confidence in the approach and understanding of the elementary neurological concepts,[2,19] inadequate or inappropriate teaching techniques[2, 3, 15, 16, 20], the complexity of neuroanatomy as a subject[2, 3, 16, 21, 25] and the habit of superficial learning instead of deep learning, as well as rote learning by students.[1, 26] The last group of contributing factors affects the medical students during their clinical training years and include the difficulty, complexity and length of the clinical examination,[2] the lack of proper exposure to neurologically impaired patients and insufficient bedside teaching,[2, 3] the large number of rare and intricate diagnoses and, at times, the inability to have a conclusive curative treatment plan for many of the cases.[18] The second and third group of risk factors during the students' pre-clinical and clinical training years are modifiable[24] and, therefore, the development of neurophobia can be classified according to intrinsic and extrinsic factors.

Intrinsic factors refer to the students and include the perception of neurology within the medical community,[2, 23] the students' perception of the complexity of neuroanatomy as a subject[2, 3, 23], their inability to apply basic scientific knowledge to the clinical environment[2] and a lack of self-confidence in the approach and understanding of the elementary neurological concepts.[2, 5] Extrinsic factors include poor or insufficient teaching of neuroanatomy[2, 3] and the limited exposure to the clinical environment and its relevance.[23] In response to neurophobia, educational institutions have implemented various strategies to counteract this perception and improve neuroscience experiences for undergraduate students.[27] It is important to maintain high standards in neuroscience teaching and this can only be upheld if the current cohort of undergraduate medical students are given the opportunity to develop the relevant knowledge, skills and enthusiasm to cultivate an interest or career in the neurosciences.[5]

A study was therefore undertaken to explore undergraduate- and postgraduate medical students' attitudes towards the teaching, facilitation, learning and assessment of neuroanatomy, as well as their perceptions on the relevance of neuroanatomy in the medical curriculum. The results reported in this study are part of a larger exploratory study into neuroanatomy within the South African medical curriculum.

3. METHODS

We used a multi-method approach which included both qualitative and quantitative research design characteristics. In a multi-method research approach, the objectives can run concurrently without one objective influencing, or depending on, another[28].

3.1 PARTICIPANTS

We collected information from undergraduate and postgraduate medical students at the University of Pretoria. Email requests were sent to the undergraduate medical students to invite them to anonymously participate in a survey. These students had exposure to neuroanatomy during their previous years. Each volunteering student completed an anonymous electronic questionnaire. We further approached postgraduate medical students from the same institution, who were specializing in either Neurosurgery, Neurology or Psychiatry. They were invited to participate in a qualitative focus-group discussion.

3.2 DATA COLLECTION

The questionnaires were developed by the researchers and validated by independent academic consultants and statisticians (See Appendix C) These questionnaires were completed by the undergraduate students, contained mostly quantitative questions and were designed to gather information on the perceptions of the students towards the current neuroanatomy teaching and facilitation approaches, as well as their perceived importance of neuroanatomy within the medical curriculum. Likert-scale-, matrix- and open-ended questions were included in the questionnaires.

The questionnaire requested information such as the year of study, other neuroanatomy exposure, preferred teaching approaches and study materials including their use of electronic devices for studying neuroanatomy. Information regarding the students' view on the importance of neuroanatomy as part of their training was also

requested. Eleven core categories previously identified by Moxham and co-workers[29] were assessed in this questionnaire and included questions on the development of the nervous system, histology of the nervous system, spinal cord, brainstem, cranial nerves, diencephalon and the pituitary gland, cerebral hemispheres, limbic system and reticular formation, autonomic system, ventricular system, meninges and blood vessels. The perceptions on the importance and relevance of the 11 core categories were explored.

For the postgraduate students, we conducted a focus-group discussion which related to their undergraduate neuroanatomy experience, possible role-models, the reason for specializing in a neuroscience field, as well as their advice and suggestions to the current undergraduate students and lecturing staff. The focus-group approach worked well, since it allowed equal expression of the perspectives and views on the specific issues of neurophobia[30, 31].

3.3 DATA ANALYSIS

The data obtained from the undergraduate students' questionnaires was analysed with IBM SPSS, Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY) for the descriptive statistics and the statistical software SAS^{R}, Version 9.4 (SAS Institute) for the inferential statistics. The statistical significance was determined by a p-value of less than 0.05. The statistical analysis consisted mainly of descriptive statistics which included frequencies and means with standard deviations. Inferential statistical techniques such as the analysis of variance (ANOVA) were performed to find possible simultaneous relationships between continuous dependent variables and independent factors. Through the process of statistical model building, significant independent factors such as the year-group of students and time allocated to neuroanatomy could be identified to have a simultaneous influence on dependent variables such as preferred teaching approaches, literature used and neuroanatomy topics, as well as perceived importance of neuroanatomy within the medical curriculum.

All open-ended questions underwent thematic analysis by means of Atlas.ti^{TM} Version 8.0 software (Scientific Software, Berlin, Germany). The postgraduate focus-group discussions were transcribed and thematically analysed with the Atlas.ti^{TM} software. Relationships between the themes were identified, further analysed and discussed. [32,33]

4. RESULTS

4.1 PARTICIPANTS' CHARACTERISTICS

A total number of 299 undergraduate medical students and five (out of a possible 25) postgraduate students participated in this study. The undergraduate student sample self-identified as 101 males (34%) and 196 females (66%). Two students did not indicate the gender they associate with. The mean age of this group of students was 22.04 years, which ranged from 18 – 36 years.

The students had to indicate in which year they were registered. Hundred-and-twenty-four (124) students (41.4%) were in their second year of studies, 60 students (20.1%) in their third year, 66 students (22.1%) in their fourth year and 49 students (16.4%) in their sixth and final year. The first-year group was excluded from this study since they have not had any neuroanatomy experience within the medical curriculum at the time of data collection. The fifth-year group was also excluded from this study as they were used as part of a pilot study to test the relevance of the questionnaires.

Ten students (3.3%) indicated that they were repeating the current neuroanatomy module, while 14 students (4.7%) indicated that they had previously studied another degree that included neuroanatomy content. The postgraduate students consisted of four females and one male.

4.2 STUDY MATERIALS AND ELECTRONIC DEVICES USED

We explored different types of study materials used by the undergraduate students. The participants had to indicate whether they did/did not use the prescribed- and recommended literature, as well as other information sources. The results are summarized in Figure 1.

Lecture notes provided to the students was the most preferred resource used (93.7%) in preparation for neuroanatomy assessments. Self-identified gender had a statically significant impact on the usage of lecture notes, as 63.6% females preferred lecture notes, compared to 30.1% males (p-value=0.0025). The prescribed literature (80.3%) and internet resources (77.9%) were other preferred resources used for studying neuroanatomy. One-way ANOVA models were built for the preferred use of prescribed literature and internet resources. Scheffe's- and Bonferroni tests revealed that the

year-group of the students had a statistically significant impact on the study materials used in their preparation for assessments. A statistically significant difference was found between the second-year group and the third-year group regarding the use of prescribed literature (p-value = 0.022). Approximately 53.2% of the second-year group of medical students used prescribed literature, in comparison to 16% of the third-year group.

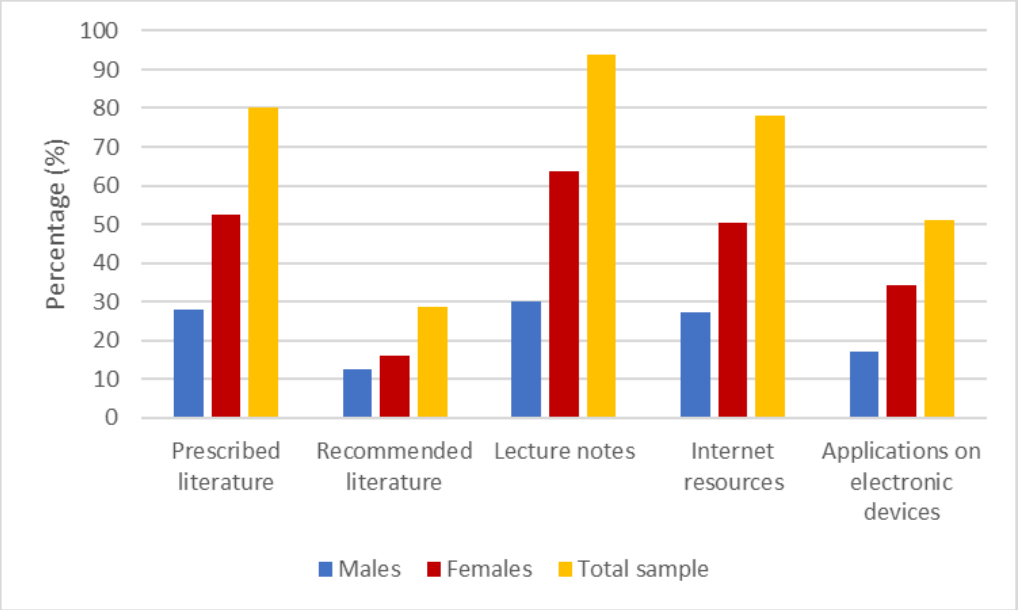

Figure 1: The use of literature by self-identified male and female students in their preparation for neuroanatomy assessments. Percentage values (%) are indicated.

The participants had to further indicate whether they used of the specified electronic devices in their preparation for assessment. The most preferred electronic device was laptop computers, as indicated by 90% of the undergraduate participants. A statistically significant difference was noted in the usage of the second-year students and the final year students (p-value < 0.0001). Approximately 50% of the second-year students prefer to use their laptop computers, compared to the 9.8% of final-year students. Smartphones and hand-held devices were preferred by about 50% of the participants. The data obtained is summarized in Figure 2.

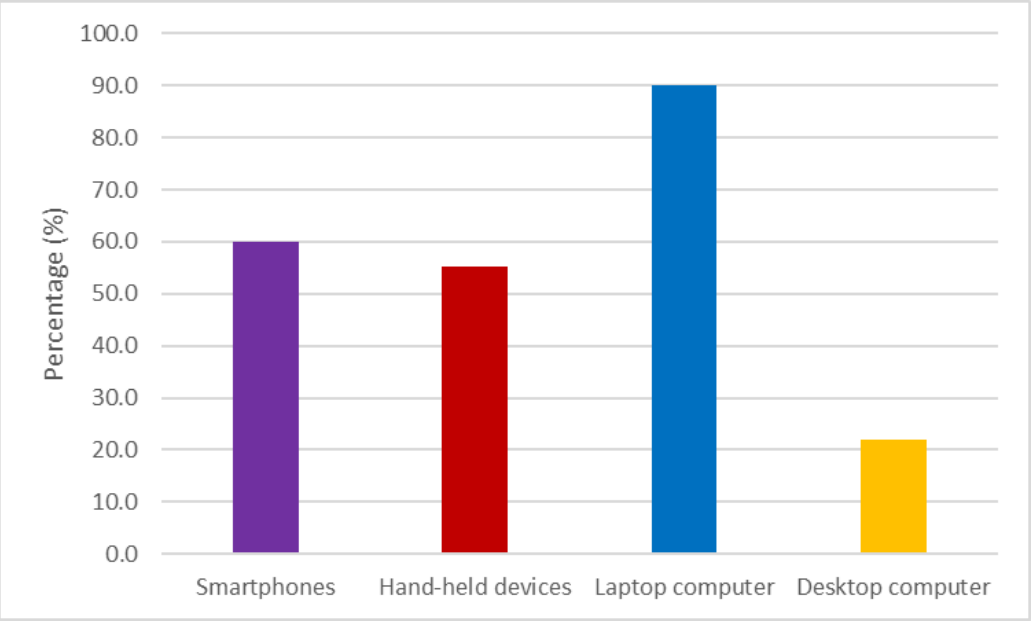

Figure 2: The use of electronic devices by students in their preparation for neuroanatomy assessments. Percentage values (%) are indicated.

4.3 PREFERRED TEACHING APPROACHES

The undergraduate respondents had to indicate their most- and least favourite teaching approaches for neuroanatomy from a list provided. An 'other' option was supplied where the respondents could include approaches not mentioned. The highest ranking for favourite teaching approaches were practicals containing wet brain specimens, as preferred by 77 students (25.8%) and dissection of cadaveric brain specimens, indicated by 64 students (21.4%). Video demonstrations of dissected brain specimens were preferred by 46 students (15.4%). Seven students (2.3%) indicated the 'other' option, which they described as a combination of the teaching approaches from the list provided. Teaching approaches that students disliked included didactic sessions (lectures) without the use of MS PowerPoint presentations, as indicated by 97 students (32.4%). Another unpopular approach was self-study or self-directed learning, which 60 students (20.1%) selected. Students were not asked to provide a rational for their choice. A possible follow-up study could be done to determine why this is not a favourable choice for students and whether the students' perceptions has changes after the COVID-19 lock-down when they were forced into a higher level of self-directed learning. Table 1 summarizes the results for preferred teaching approaches.

Table 1: Teaching approaches in neuroanatomy as selected by undergraduate medical students.

Neuroanatomy teaching approaches	Indicated as most favourite (n=299)		Indicated as least favourite (n=299)	
	n	%	n	%
Lectures with MS PowerPoint presentations	56	18.7	22	7.4
Lectures without MS PowerPoint presentations	3	1	**97**	**32.4**
Video demonstrations	46	15.4	8	2.7
Computer-based practicals	-	-	24	8
Dissection of cadavers	64	21.4	13	4.3
Wet specimen / models practicals	**77**	**25.8**	13	4.3
Practical and lecture combined into a single session	21	7	14	4.7
Problem-solving scenarios	14	4.7	8	2.7
Self-study	9	3	60	21.1
Tutor-classes	-	-	29	9.7
Other	7	2.3	5	1.7

4.4 PREFERRED NEUROANATOMY TOPICS

The undergraduate respondents were requested to indicate their most- and least favourite neuroanatomy topics from a list provided and then supplement their choice with a motivation. The most preferred neuroanatomy topic was cranial nerves, as indicated by 91 students (30.4%). Other preferred topics included blood vessels (21.4%), the cerebral hemispheres (19.4%) and the brainstem (12%). The rest of the topics had values lower than ten percent. The least favoured neuroanatomy topic was the histology of the nervous system, as indicated by nearly half of the students - 137 students (45.8%). Another unpopular topic was the development of the nervous system (19.7%). See Chapter 6 for the researcher's personal reflections on possible causes, contributing factors and measures to be taken to address this. The results for all the topics are summarized in Table 2.

Students were further asked to indicate whether appropriate time was allocated to each of the topics during their contact sessions. The students agreed that enough time was allocated to the brainstem (70.8%), cranial nerves (77.5%), meninges (76.8%) and blood vessels (83.8%). They indicated that more time should be allocated to histology of the nervous system (63.8%). We can assume that the dislike of histology of the nervous system can be linked to amount of time spent on this topic, since the students would prefer more time. The rest of the neuroanatomy topics had an almost

50:50 distribution between enough time and not enough time allocated to the various topics.

Table 2: The most- and least favourite neuroanatomy topics of undergraduate medical students.

Neuroanatomy topic	Indicated as most favourite (n=299)		Indicated as least favourite (n=299)	
	n	**%**	**n**	**%**
Development of nervous system	2	0.7	59	19.7
Histology of nervous system	2	0.7	**137**	**45.8**
Spinal cord	6	2	10	3.3
Brainstem	36	12	5	1.7
Cranial nerves	**91**	**30.4**	15	5
Diencephalon and pituitary gland	2	0.7	9	3
Cerebral hemispheres, limbic system and reticular formation	58	19.4	20	6.7
Autonomic system	14	4.7	17	5.7
Ventricular system	15	5	21	7
Meninges	8	2.7	6	2
Blood vessels	64	21.4	-	-

4.5 RELEVANCE OF NEUROANATOMY

The undergraduate respondents had to indicate whether they agreed / disagreed with statements regarding the importance of neuroanatomy within the medical curriculum. The statements were adapted from a previous study by Moxham and co-workers[34]. The results of these statements are summarized in Table 3. The majority of the participants (97.7%) agreed that knowledge of neuroanatomy is essential for safe medical practice. Without this knowledge, the medical practitioner's effectiveness will be limited, as indicated by 83.9% of the participants. A two-way ANOVA model indicated that the year-group of the students and their self-identified gender had a simultaneous impact on the student's disagreement with the statement: "Neuroanatomy needs to modernize if it is going to be really useful in medicine". A statistically significant difference was noted in the students who disagreed with the statement in which 29.6% were males and 70.4% were females (p-value=0.011).

Table 3: The importance of neuroanatomy within the medical curriculum as perceived by undergraduate medical students.

Statement	Agreed with the statement (n=299)		Disagreed with the statement (n=299)	
	n	**%**	**n**	**%**
Neuroanatomy is an important component in my medical training.	293	97.9	5	1.7
Although neuroanatomy is interesting, the subject needs selective understanding in the clinical setting.	224	75.4	73	24.4
Neuroanatomy is necessary for safe medical practice.	**291**	**97.7**	7	2.3
Neuroanatomy is of some use in the clinical setting, but its importance may be exaggerated.	59	19.9	238	79.6
Neuroanatomy is only beneficial in certain medical specialities.	70	23.6	227	75.9
Neuroanatomy is so old-fashioned that is has no importance in contemporary medicine.	5	1.7	294	98.3
Neuroanatomy is time wasted in the medical curriculum.	6	2	292	97.7
Neuroanatomy needs to modernise if it is going to be really useful in medicine.	**110**	**37.2**	**186**	**62.2**
A very good doctor must have a good understanding of neuroanatomy.	279	93.3	20	6.7
It is impossible to conceive a good medical training without a major neuroanatomy component.	229	76.8	69	23.1
It is not possible to make a reasonable medical diagnosis without a sound knowledge of neuroanatomy.	204	68.7	93	31.1
Medicine would not exist without neuroanatomy.	235	78.6	64	21.4
Only a limited neuroanatomical knowledge is required for safe medical practice.	99	33.2	199	66.6
Rather than studying neuroanatomy, medical students should concentrate on clinical sciences.	44	14.8	254	84.9
Without knowledge of neuroanatomy, the doctor is of limited effectiveness.	**250**	**83.9**	48	16.1

Further significant differences were noted between the second-year group and third-year group of students (p-value = 0.025), as well as the second-year group and final-year group of students (p-value = 0.037). In the second-year group, 48.4% of the students disagreed with the statement, in comparison to the third-year group with 16.1% and the final-year group with 13.4%. We can then assume that female second-year students do not want modern changes to occur in the medical neuroanatomy curriculum, and that they are content with the current stance of neuroanatomy.

4.6 ADVICE FROM POSTGRADUATE STUDENTS

The postgraduate student sample is small (five out of a possible 25 students) due to the small number of students who want to specialize in neurosciences for an MMed degree. These students had to elaborate on their undergraduate neuroanatomy experiences. Only one student (20%) had positive comments regarding his/her experience with the statement "*I find the neurosciences interesting, it's not difficult, just need to have enough time to study it, it can be fun*." The rest of the group (80%) described their negative experiences which included "*very difficult and not easy to understand", "cannot remember anything about undergraduate neuroanatomy training besides that it was difficult and confusing" and "we had to rely on ourselves".*

This group was further asked to provide constructive feedback and suggestions on how to approach neuroanatomy. The majority of the group suggested that the lecturing staff should make neuroanatomy more fun, accessible and simplified to the students. Their advice to the students was mainly to understand the basic fundamentals of neuroanatomy and allocate enough time for study purposes. Only one of the participants indicated that she had a neuroanatomy role-model during her undergraduate training.

5. DISCUSSION

Neurological disorders constitute more than 6.4% of the health burden and 12% of mortality globally.[15, 35] The prevalence and impact of neurological conditions place a higher demand on the healthcare system to improve on neurological care. Therefore, doctors/physicians need to be better prepared in their approach and diagnosis to this specialty.[24] Given these statistics, the effect that neurophobia has on medical students will greatly affect the treatment provided to patients who complain of neurological symptoms.[2] Neurology is considered by medical students to be the most difficult, but also most interesting of all the internal medicine specialties, especially after completion of that specific rotation.[2, 14, 25] Neuroanatomy has even been mentioned as the main reason for this perception of difficulty.[8]

In this study we explored the perceptions of medical students towards neuroanatomy, and its position and assumed importance within the undergraduate medical curriculum. This study forms part of a larger study which investigates neuroanatomy within the

South African medical curriculum. The results of this study can be used to create awareness of the perceptions, preferences and needs of undergraduate medical students towards neuroanatomy and its teaching, facilitation and assessment within the South African curriculum.

5.1 STUDY MATERIAL AND ELECTRONIC DEVICES

The respondents indicated that they prefer lecture notes, supplied by the lecturers, above any of the other forms of literature. Ninety percent (90%) of the students used laptop computers in their preparation for neuroanatomy assessments in comparison to smartphones and hand-held devices which are only used by 55-59%. This contradicts assumptions that students prefer to use their smartphones and hand-held devices for studying, as these devices are always readily available.

Students mainly use electronic devices, including smart phones and hand-held devices, for information retrieval.[36] In the UK, the successfully integrated use of hand-held devices in neuroanatomy practicals and learning support has been reported with an increased success-rate in the students' results.[36] The students' perception of their learning and class enjoyment can be enhanced by integrating mobile learning opportunities within the curriculum.[36] Medical students in Ireland deem internet sources for neuroanatomy as very useful, as indicated by 81.8%, especially in understanding the clinical relevance of neuroanatomy.[37]

5.2 PREFERRED TEACHING APPROACHES

The undergraduate students prefer their contact sessions in neuroanatomy to be in the format of practicals with cadaveric brain specimens and plastic models, as well as dissections of human cadaveric brains. These students want to interact with the content instead of attending didactic lectures, especially those that do not include MS PowerPoint presentations. They want to be actively involved in their learning processes which is in line with the transferrable skills of the 21st century student. However, self-directed learning is a very unpopular approach to neuroanatomy according to these students. One can speculate that it can be ascribed to factors such as poor self-management, readiness, openness, work-drive and even access to resources which might be challenging.[38,39] A follow-up study with the same cohort of students is advisable to confirm these assumptions. Exposure to more complicated brain

dissections is considered to be a valuable learning experience for students.[40, 41] In Ireland, senior medical students (already in their clinical years) valued the use of case-based learning more than prosected brain specimens, in comparison to the junior medical students (still in their basic sciences years).[37] This supports the findings of this study.

Our findings concur with those reported in Saudi Arabia, in which 70.4% of students ascribed their lack of interest in neurology to bad teaching experiences.[15] In the United Kingdom (UK), 35% of the participating medical students indicated that the time allocated for neurology and related content is insufficient.[27] Medical students from Brazil, especially senior students, also indicated that more teaching was needed for neurosciences.[19] Students from West India indicated that they prefer educational interventions such as team-based learning, problem-based learning and case-based teaching for neuroscience.[21]

Although the responsibility to engage in learning opportunities in neurosciences still remains the responsibility of the student,[2] the lecturer can contribute by making the subject interesting, contemporary and engaging by using various student-centred teaching modalities and techniques. Furthermore, the lecturers need to guide the students into taking responsibility for their own learning through student-centred teaching and facilitation methods. Educational interventions in the early stages of a medical career may enhance long-term motivation and interest in the neurosciences.[42] Such interventions to expand the student's competency in neurology include more clinical- or bedside teaching, more case discussions, additional teaching aids, as well as extra neurology and neuroanatomy lectures.[18]

5.3 PREFERRED NEUROANATOMY TOPICS

The participants in this study indicated that cranial nerves, on average, was their most favourite neuroanatomy topic. We explored the reasons for this choice and five themes emerged from their answers. The participants indicated cranial nerves as an interesting and easy to understand topic. They see the clinical relevance for their future careers, they understand how cranial nerves are integrated with the rest of the body and they had a good teaching experience on this topic. Medical students in Ireland made similar statements in which they rated the cranial nerves as a relatively easy

neuroanatomy topic, with the exception of the cranial nerve nuclei.[37] The students indicated that their least favourite topic is the histology of the nervous system and ascribed this to unconducive didactic teaching experiences, complex and uninteresting content, not enough time allocated and, in their opinion, no clinical relevance.

5.4 IMPORTANCE OF NEUROANATOMY

Overall, the undergraduate medical students perceive neuroanatomy as an interesting and important, but not stand-alone component in their medical curriculum. They understand that a good foundational knowledge of neuroanatomy is necessary for safe medical practice, irrespective of the discipline. When asked whether neuroanatomy needs to modernize, more than 50% of the students, mostly females, were in support of the statement, indicating the need to revamp the teaching approaches in the current medical neuroanatomy curriculum. Which might be ascribed to the fact that female students are more likely to be neurophobic[3], perceive neuroanatomy as complicated and not consider a future career in the neurosciences in comparison to male students.[15] However, the perception of difficulty, with reference to the three-dimensional complexity of the brain might also affect the students attitude towards neuroanatomy and it is reported to affect females more than males.[44, 45] Furthermore, male students tend to be more reliant on images and prefer “hands-on” during contact sessions in comparison to females. [44]

As part of our own personal introspection, reflections and contemplations, the question that needs to be answered is: How can we, as lecturers, modernize neuroanatomy in the medical curriculum and subsequently prevent the development of neurophobia? Possible recommendations include more clinical relevance in the neuroanatomy content for the students[27] as well as the inclusion of medical images, anatomical models and virtual anatomy. We need to acknowledge that, by separating basic neuroscience from clinical sciences, and removing clinical relevance, the students become neurophobic as they struggle to implement the basic neuroanatomy concepts in the clinical environment, therefore enhancing the lack of theory-practice integration. Neurophobia is a result of our teaching and attitudes towards the content as well as the use of a non-transformed, outdated curricula. We as lecturers, therefore, need to take ownership of the fact that we might be the cause of neurophobia among our undergraduate medical students and, consequently, have to adapt our attitude and teaching methods towards the student’s

training in medical school[8, 21, 43]. We need to allocate more time to basic neuroscience concepts, as medical students worldwide indicated that more time is needed for basic neuroanatomy. [19, 27]

Our teaching approaches should be person-focused and student-friendly, as suggested by the postgraduate students. Lecturers should engage in student-centred teaching methods in an effort to assist students in overcoming/minimizing neurophobia. We, the lecturers, are not the centre-point of the teaching environment anymore, as we are mere facilitators in the learning process of our students. We can instil in them the enthusiasm for neuroanatomy and not drown them with cognitive and content overload or attempt to make content-experts of them in the early years of their medical degree. [45, 46] We should rather provide them with the necessary tools and guidance, but they, themselves, have to master the neuroanatomy content and apply it, when necessary, in the clinical environment.

6. CONCLUSION

A less than optimal teaching experience and limited contact-time for students still remain important factors contributing to neurophobia, even in the South African medical schools. This affects how our students perceive neuroanatomy and its importance in the medical curriculum, irrespective of whether the students are undergraduate or postgraduate. If we, as lecturers, can address these issues at our institutions, we can start to make a difference in our students' lives regarding neurophobia. Dedicating more time to neuroanatomy is a difficult task to accomplish, as it implies that time must be negotiated and reduced from another discipline or subject to accommodate this change. Collaboration between the basic sciences departments and clinical departments is vital for such changes. Nonetheless, we can reflect on our teaching approaches and make the necessary changes to help our students overcome this fear for the neurosciences. After all, we want our students to be competent healthcare professionals with a sound foundation in neuroanatomy.

7. CONTRIBUTORS

GV was the main investigator of this study. JCL and MCB acted as the supervisors of this research project. EML provided statistical support to this project. All the authors

were involved in the original concept of this project, study design, data analysis and revision of this article. All the authors approved the final manuscript for publication.

8. ACKNOWLEDGEMENTS

We would like to thank the students who participated in this study. The authors wish to thank Ms Joyce C. Jordaan, a research consultant in the Department of Statistics, University of Pretoria, for her assistance with the statistical analysis of the data obtained in this study.

9. FUNDING

None

10. CONFLICT OF INTEREST

To our knowledge no conflict of interest exists for any of the authors.

11. ETHICAL APPROVAL

Permission to include students from the University of Pretoria was obtained from the Registrar and Deputy Dean of Teaching and Learning, in the Faculty of Health Sciences at the University of Pretoria. The questionnaires completed by the volunteering students were accompanied by a participant information leaflet which explained the details of the study, as well as the rights of the participant. The anonymity of these participants was always maintained. The ethical consent required for this research project was acquired from the Research Ethics Committee of the University of Pretoria (Reference number: 587/2018).

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CHAPTER 5

Neuroanatomy Education: At the feet of giants

"I am a poor student sitting at the feet of giants, yearning for their wisdom and begging for lessons that might one day make me a complete artist, so that if all goes well, I may one day sit beside them." (Rod Taylor)

FOREWORD

This chapter is prepared as an educational case report to be published in the Teaching and Learning in Medicine Journal. Therefore, the format of this chapter is according to the guidelines prescribed by this Journal. The author guidelines for this journal is included in Annexure H.

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Neuroanatomy education: At the feet of giants

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Running title: Expert opinions on neuroanatomy education

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Key words: neuroanatomy; expert opinions, key-opinion leaders, neurophobia, medical education

Type of article: Educational Case Report

Abstract word count: 373
Text word count: 2287
Number of references: 23
Number of figures and tables: 2
Number of videos:

1. ABSTRACT

Problem: Key-opinion leaders are important information resources and are often used in the medical- and pharmaceutical fields. These content experts have characteristics which include, but are not limited to, expertise, knowledge, good interpersonal skills and exposure to mass media. However, despite their valuable contribution to the academia, little has been published in the scientific literature on engaging key-opinion leaders or experts and their added value to the pedagogy of undergraduate medical education.

Intervention: Interviews with experts are not common practice in anatomy education or at the very least reported on. Therefore, the aim of this report was to conduct interviews with international key-opinion leaders in the field of neuroanatomy education. The focus of this study was to explore the attitudes, perceptions, motivations and/or beliefs of these experts on neuroanatomy education and neurophobia.

Context: An interpretive research approach with a qualitative case study design was followed, where semi-structured interviews were conducted with international experts. The latter are experts in the field of neuroanatomy education and neurophobia in the medical curriculum. Eight such thought leaders were purposively selected and contacted based on their multiple recent scientific publications on neuroanatomy education, development of core curriculum and/or neurophobia. Those who responded to the email requests were interviewed via Skype. All data was captured electronically, thematically analyzed and the themes and categories were extracted.

Impact: Themes included the teaching practices in neuroanatomy, perceived relevance of neuroanatomy within the medical curriculum and the perception of neurophobia. The participants had opposing views on teaching approaches and the relevance of neuroanatomy within the undergraduate medical curriculum. They did, however, have similar opinions on neurophobia, its impact on the undergraduate medical students and possible preventative measures.

Lessons learned: The findings of this study highlighted the important fact that there is neither a single best teaching method for neuroanatomy, nor does it have to be a modern teaching approach, but rather one that is student-centered. The

opinions/viewpoints of these experts are based on their ontological beliefs, personal experiences and perceptions which forms their reality. These thought leaders have contributed greatly to the scientific community through their widely published and highly cited research on neurophobia, teaching strategies and development of core curriculum in neuroanatomy. Therefore, they are regarded as giants in medical neuroanatomy education.

2. PROBLEM

Key-opinion leaders are regarded as thought leaders, advisors, 'influentials' and/or experts, who have earned their reputation in their field of study.[1-3] These experts are important information resources in fields such as social- and cultural trends, politics, medicine and science,[1] and can be helpful in the translation of knowledge into practice.[4] Opinion leaders are considered to be knowledgeable, content specialists, have expertise in the field of study, exposure to mass media and good interpersonal skills.[3, 4]

Such thought leaders are currently used in the medical devices- and pharmaceutical industry and are sometimes remunerated for their opinions and advice and, in the process, endorse/advertise a safer/better product.[2] However, very little is reported on the use of key-opinion leaders/experts regarding teaching, role-modelling and added value to undergraduate neuroanatomy medical education.

3. INTERVENTION

Interviewing experts is not common practice in anatomy education or, at the very least, reported on. Therefore, the aim of this report was to conduct interviews with international key-opinion leaders in the field of neuroanatomy education. The focus of this study was to explore the attitudes, perceptions, motivations and/or beliefs of these experts on neuroanatomy education and neurophobia.

4. CONTEXT

The researchers used an interpretive research approach with a qualitative case study design, in which semi-structured interviews were conducted with experts in

the fields of neuroanatomy education and neurophobia within the medical curriculum. This approach was selected, as the researchers believe that reality is based on the participants' perceptions, and further constructed by each participant's own experiences, background and philosophical assumptions.[5]

Semi-structured interviews are commonly used in healthcare as this type of interview allows the researcher to have several predetermined questions as well as the capability to diverge from these questions based on responses received and/or the elaboration and probing of information which is deemed important by the participant. [5-7] Interviews, as a form of qualitative data collection, are believed to provide better insight and a richer and deeper understanding of the data, in comparison with quantitative methods.[6]

Recent scientific literature was perused to identify the key-opinion leaders (unit of analysis) in the field. They were selected based on multiple recent scientific publications on neuroanatomy education, development of core curriculum and/or neurophobia. Purposeful sampling was used to identify these experts through an observational method.[3] The key-opinion leaders were contacted via email and requested to participate in a Skype interview to be conducted at their leisure. The initial email contained the request for participation, an information leaflet, the details of the study and the rights of the respondent. The participants were made aware that they will not be completely anonymous, as some of their expert characteristics had to be elaborated on.

Eight experts were originally identified and contacted, of which three responded to the email requests and only two agreed to be interviewed. The third respondent initially agreed to the interview, however, no further contact could be established. With the permission of the participants, the Skype™ interviews were recorded, after which transcription and summaries were made. Table 1 contains a summary of the characteristics of the two participants. The interviews were approximately an hour in duration and focused on the following topics (See Appendix D for the interview guide):

- Lecture notes
- Recommended internet resources for students

- Use of electronic devices during contact sessions
- Teaching approaches used for neuroanatomy
- Favourite neuroanatomy topic to teach
- Importance of neuroanatomy in the medical curriculum
- Neurophobia
- Advice for the researcher

Table 1: Characteristics of the key-opinion leaders interviewed.

	Participant A	**Participant B**
Country located	United Kingdom	United States of America
Training	Clinical training	Clinical training
Teaching experience	46 years	35 years
Current position at medical institution	Emeritus Professor in Anatomy	Professor in Neurology
Additional formal training in education	No	No
Additional formal training in Neuroscience	No	Yes
Reason for selection as a key-opinion leader	• Development of core syllabi for anatomy and neuroanatomy in the medical curriculum • Chairperson of various such curriculum committees • Multiple publications on neuroanatomy in the medical curriculum	• Received numerous education- and teaching awards for his teaching in neurology • Developed successful neurology courses • Contributions to neuroscience atlases • **Multiple publications on neurophobia**

The interviews included baseline questions such as additional formal training in education and neuroanatomy, provision of lecture notes to students, recommended additional internet resources, the use of electronic devices during contact sessions, favorite neuroanatomy topic to teach, position of neuroanatomy at their current institution and globally, and, very specifically, their opinions on neurophobia. On

reflection, the basic baseline information could have been collected with a tick-list questionnaire to save time.

A large amount of words and observational data were generated during these interviews, which needed to be transcribed and analyzed. A thematic analysis approach, with its six-stage system, was used to analyze the data and the possible relationships between themes discussed.[5-7] The computer-assisted qualitative data analysis software used for this analysis was ATLAS.ti™, version 8. This software package is designed for qualitative- and thematic data analysis and enables activities such as text analysis and interpretation.[8]

The ethical consent required for this research project was acquired from the Research Ethics Committee of the University of Pretoria (Reference number: 587/2018). Various legal documentation was further examined and the following prescribed ethical principles were adhered to: beneficence, respect for persons and justice.[9] The documentation provides clear guidelines regarding research on living human participants and include the Nuremberg Code,[10] the Belmont Report[9] and the revised Declaration of Helsinki.[11]

5. IMPACT

Data was transcribed and thematically analyzed by the main researcher. The following three themes were identified from the data obtained: the teaching practices in neuroanatomy, perceived relevance of neuroanatomy within the medical curriculum and the perception of neurophobia. Figure 1 illustrates the three themes.

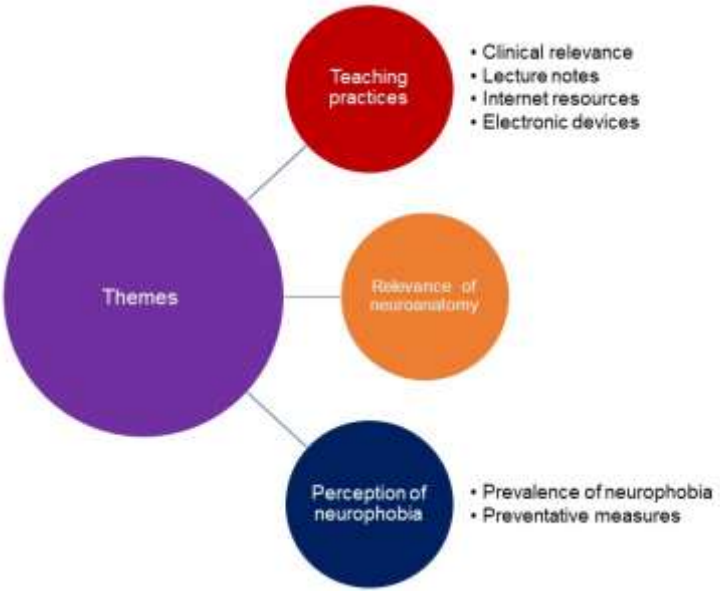

Figure 1: Illustration of the themes and associated categories identified during the data analysis of the expert-interviews

5.1 TEACHING NEUROANATOMY

As per the first theme, teaching neuroanatomy, the selection of the most appropriate and feasible teaching approach needs serious consideration and must take human-, physical- and fiscal resources into account. The development of 21st century transferable skills, such as problem solving, critical thinking, communication, collaboration flexibility and adaptability, initiative and self-direction[12-14] should be embedded in the training of our medical students. Student-centred teaching is another important factor to consider as teaching modalities. Students will benefit and learn more efficiently when a variety of teaching and learning methods are used to enhance their active participation and engagement with the content.[15]

Both participants either teach, or have taught neuroanatomy to medical students at undergraduate level and include/d clinical relevance in their teaching. Participant A stated that *"Normal anatomy and normal neuroanatomy describe the function and health state that all clinicians should aspire to getting their patients to and therefore anatomy and neuroanatomy are clinical by definition".* Participant B further indicated that he teaches an integrated neuroscience course to second-year medical students that include neuroanatomy, neurophysiology, neuropathology, psychopathology, neuropharmacology and psychopharmacology.

Both participants provide/d their students with lecture notes. Participant A stated that the notes are not complete, as the students have access to recorded versions of the lectures on their learning management system and attendance of these sessions is not compulsory. Participant B, however, mentioned that the notes provided are extensive, mainly Adobe Acrobat PDF documents and MS PowerPoint slides. Participant B stated that he still uses the *"chalkboard with the lights on"* approach to teach neuroanatomy, as it enables him to interact with the students and draw the neural pathways on the board. He further mentioned that he has a 90% class attendance and that the students enjoy these sessions and most of his colleagues present their sessions/lectures with a similar approach. No mention was made on whether the lectures were compulsory or not. This appears to be a valued and effective teaching method as he has won multiple awards and prizes for his neurology teaching.

The recommendation of internet resources gained interesting responses. Participant B provided a list of additional internet resources which are shared with his students. His department further created their own image sets for student use. Participant A stated that he does not recommend any additional internet resources to his students. However, at his institution, a group of students within the module has the responsibility of investigating possible additional resources and then informing the lecturing staff and fellow students of these resources. This practice is referred to as a '*shadow module'*. He further mentioned that these students sometimes produce their own quality resources to share with the class by stating *"It is the role of the shadow module to alert staff and students to appropriate learning resources and often produce their own excellent learning resources".*

Shadow modules and its effectiveness in neuroanatomy have been described in the literature and is regarded as a form of near-peer or peer-teaching.[16] This form of teaching occurs outside the formal curriculum and assists the students to obtain insights through collaborations with fellow students and in the process, supplement the lecture material. These sessions are student-led and may include topic reviews, brainstorm sessions, group discussions and even the development of artefacts/content resources.[16, 17] The lecturing staff and students become

partners in shared learning experiences through the shadow modules teaching/learning method.[16]

Participant A stated that audience response systems (clickers) are used during the contact sessions and the students are allowed to bring their electronic devices to class. However, he is not comfortable with the use of electronic devices during contact sessions as he stated *"although personally I have issues with this since I've seen students often on the internet, emails amazon etc",* as the students tend to get distracted and lose focus instead of concentrating and participating in class. Although mobile learning is increasing in medical education[18], it is unfortunately also accompanied by digital device distractions.[19-21] Participant B, on the other hand, mentioned that he encouraged the use of electronic devices to such an extent that his neurology course is a *"iPad curriculum*", as all the notes are made available electronically to the students prior to their contact sessions.

Participant A stated the development of the nervous system is his favourite neuroanatomy topic. He elaborated that "*although a difficult topic, it lays the foundation for better understanding of the rest of neuroanatomy".* Participant B stated that the organization of the nervous system is his favourite, as it provides an overview of the nervous system, its structure and function. He further mentioned that this topic is taught to the undergraduate medical students over a time span of 12 hours.

5.2 RELEVANCE OF NEUROANATOMY IN THE MEDICAL CURRICULUM

In the second theme, the relevance of neuroanatomy within the medical curriculum was explored. The participants had opposing views regarding the current stance of neuroanatomy in the medical curriculum. Participant A stated that he has an unorthodox view on the teaching of neuroanatomy to medical students and exclaimed that *"there is too much of it*". He further elaborated *"We are not training neurologists at the undergraduate stage and too often neuro is taught at the expense of other basic subjects (gross anatomy for example)"*. It seems that clinicians, for example neurologists, are employed in teaching positions based on their research, rather than their didactical, pedagogical or clinical skills/experience. Such lecturing staff then overload the students with factual information instead of providing a

proper foundation and integration of the nervous system (peripheral and central). This phenomenon is described by the cognitive load theory which states that the working memory (cognitive load) of a student is overwhelmed when the student is taught unnecessary details.[22, 23] Participant B, on the contrary, developed and incorporated an integrated neuroscience module which covers a 10-week period. He stated that enough time and emphasis is allocated to this module.

5.3 PERCEPTION OF NEUROPHOBIA

The final theme covered was related to the concept of neurophobia and the experts' perception thereof. The participants were asked about their perception of neurophobia, whether it exists and if it does, how it can be addressed and prevented. Both participants confirmed that there is no doubt that neurophobia exists and that it is prevalent amongst medical students. Participant A stated that neurophobia can be prevented by aligning teaching to the core neuroanatomy with emphasis on common clinical conditions such as dementia, stroke and Parkinson's disease, to name a few. He further mentioned that neurophobia becomes more prevalent when the students are taught by the researchers instead of academically oriented lecturing staff. Participant B is a strong believer of neurophobia and its effects on the medical students, as is evident by a number of articles he has published in the past 30 years on this phenomenon, its causes and preventative measures. He is a firm believer that if the basic sciences are taught separate from the clinical sciences, neurophobia will continue, as this affects the students' theory-practice integration.

6. LESSONS LEARNED

Participant B concluded the interview by stating that the key to good teaching of neuroscience is to be an enthusiastic teacher with the support of dedicated fellow lecturing staff, who are willing to attend one's lectures and maybe learn a few new concepts themselves. Not only are the lecturing colleagues attending and participating in the contact-sessions with the students, they simultaneously act as peer evaluators for these sessions. He added that assessment is important for a successful course and further emphasized that clinicians need basic neuroanatomy knowledge to which Participant A concurred with this statement in

his concluding remarks by mentioning that, as a neuroanatomy lecturer, one should stick to the basics and ensure that the students have a good foundation in basic neuroanatomy.

Even though these key-opinion leaders might have different opinions on what entails effective teaching approaches and methods for undergraduate neuroanatomy, these findings illustrate their particular viewpoints and experiences. They do, however, have similar views on the relevance of neuroanatomy within the medical curriculum and neurophobia. The findings of this study highlight the importance of there being neither a single best teaching method for neuroanatomy, nor does it need to be a modern, digitally-based teaching approach. Teaching methods need to be appropriate, contextual and student-centred. This approach will support deep learning, enhance the development of the transferable skills of the 21st century student and prevent the development of fear towards a given subject.

Although we deem the views of experts as valuable, it is important to realize that this study reflects their personal opinions based on their assumptions, background and many years of imbedded and personal experiences in the teaching of neuroanatomy to medical students. These thought-leaders have contributed greatly to the scientific community through their research on neurophobia, teaching strategies and the development of core curriculum in neuroanatomy. Therefore, they are regarded as giants in medical neuroanatomy education and we, the 21st century neuroanatomy lecturers, are the scholars at their feet. We are learning from their wisdom and experiences, hoping that in future, we will be regarded as part of them.

7. ACKNOWLEDGEMENTS

We would like to thank the key-opinion leaders who participated in this study, not only for their valuable insights, but also for their contribution to neuroanatomy education within the medical curriculum. Without their multiple publications and breakthrough research, this report would not have been possible.

8. FUNDING

None

9. DECLARATION OF INTEREST

To our knowledge no conflict of interest exists for any of the authors.

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CHAPTER 6

Personal reflection, discussion and recommendations

“An academic who only presents facts is not a teacher; a teacher is one who nurtures the learning process and thereby modifies the behaviour and patterns of thinking for a lifetime.” (Woosley, 1997) (Shelley et al., 2018).

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1. OVERVIEW AND LAY-OUT

Although the previous chapters contained the discussions of the results, feedback and literature review per focus area, this additional chapter contains the integrated discussion of these results. It differs from other chapters as it also includes the narrative reflections of the researcher as someone embedded in the current situation. Therefore, this non-traditional approach to the discussion alternates between personal reflections or narratives and the most significant results from the previous chapters. Some components of this discussion will, at a later stage, be restructured as letters to an editor and short communications to scientific journals. It follows an autobiography style to allow the incorporation of the researcher's experiences. The referencing and citation style of this chapter is the same as for Chapter 1.

In this multi-phase multi-method study the focus was on determining the perceptions and attitudes of students, faculty members (lecturers) and key-opinion leader in the field of neuroanatomy regarding the teaching, learning and assessment of neuroanatomy, and how that might influence the development of an irrational fear (neurophobia) amongst students towards this subject. The study aimed at answering the following research questions:

a) How important do students and staff view neuroanatomy as part of the undergraduate medical curriculum?
b) Which teaching approaches are currently used at South African universities to teach neuroanatomy to undergraduate medical students?
c) What are the attitudes and perceptions of the anatomy lecturers and undergraduate- and postgraduate medical students towards neuroanatomy and the teaching thereof?
d) Are there alternative or innovative teaching approaches for neuroanatomy which could be employed in the undergraduate medical curriculum?

These questions were all addressed and the research results discussed in the respective chapters. Therefore, this additional chapter will follow a non-traditional approach, as used by Kartveit (2016), Long (2016) and Humble (2018) in their narrative PhD theses, where the researcher combines the results of the previous chapters with his/her own reflections and personal interpretations of the results (Kartveit, 2016; Long, 2016; Humble, 2018). I believe that this narrative approach will

bring a richness and depth to the study that would otherwise not be possible

2. INTRODUCTION

A healthy brain is the most valuable resource of humankind irrespective of age and levels of activity, which means that appropriate resources and attention need to be allocated to brain health (Carroll, 2019). However, the current global burden of neurological disorders indicate that these disorders are the second-highest cause of death (16.5%) and the leading cause of disability (11.6%) worldwide (Carroll, 2019; Feigin and Vos, 2019). The burden of neurological disorders has increased in the last three decades and is likely to increase in the future, placing high demands on already overstrained services and resources (Feigin and Vos, 2019). The neurological services available in most countries are insufficient to meet the needs of the patients (Kaji, 2019).

Neurological disorders have become more prevalent in Sub-Saharan Africa. However, it still remains under-reported due to cultural and religious beliefs, as well as the stigma associated with brain disorders. The availability of resources, including diagnostic resources and trained health care providers, has an enormous impact on the morbidity and mortality of neurological disorders in Sub-Saharan Africa (Silberberg and Katabira, 2006). There are not enough qualified clinical neuroscience staff such as neurologists, psychiatrists and neurosurgeons, and most of them are based in metropolitan cities and often lecture at medical schools, limiting their availability to render services in the rural areas (Silberberg and Katabira, 2006).

South Africa has nine medical schools who collectively produce approximately 1800 graduates each year (Kahn, 2018). A tenth medical school is planned to open in 2021, thus potentially increasing the number of annual graduates. At the end of 2019, 46096 medical practitioners were registered with the Health Professions Council of South Africa (HPCSA, 2019). Of these medical practitioners, 193 are neurologists (0.42%), 34 are paediatric neurologists (0.07%), 238 are neurosurgeons (0.52%) and 924 are psychiatrists (2.01%) (Y Daffue 2020, personal communication, 15 January).

Statistics South Africa estimated the population to be 58,78 million in 2019, with an annual growth rate of 1.3%. In South Africa the average life expectancy at birth is 61.5

years for males and 67.7 years for females (Statistics South Africa, 2019). This indicates a ratio of one neurologist to 422 878 South Africans, one neurosurgeon to 246 975 South Africans and one psychiatrist to 63 615 South Africans. There are, however, huge variances in these ratios when compared to other countries, as seen in Figure 1. There is currently no recommended ratio by the World Health Organization. However, their website mentions that there is currently less than one medical doctor for every 1000 people in most countries. Africa has approximately 24% of the world disease burden but only access to 3% of the current health care workers (WHO, 2020). Therefore, we need to significantly increase our numbers of neuroscience specialists in an effort to address Sustainable Development Goal (Nr 3) “Good health and well-being” (UN, 2019).

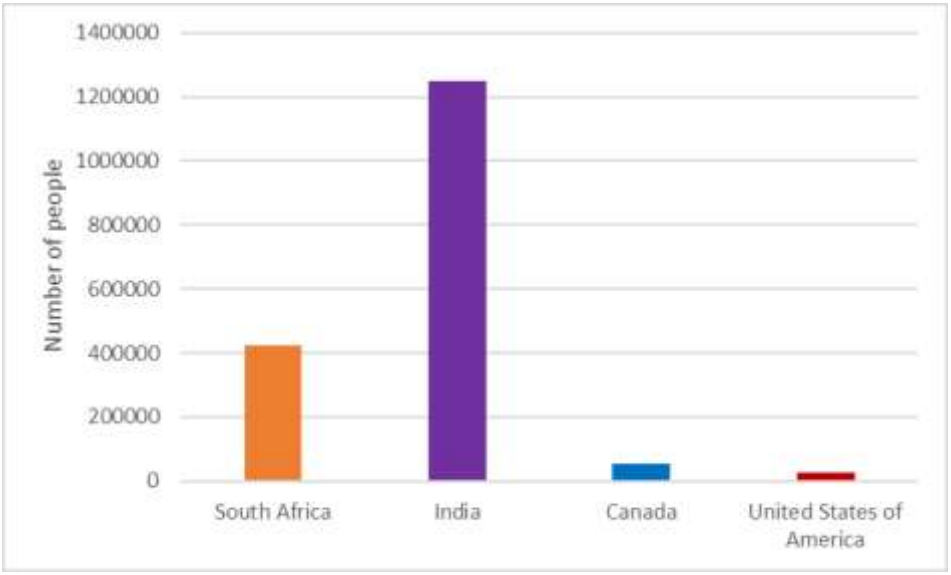

Figure 1: The ratio of one neurologist per number of people for several countries including South Africa (Shelley et al., 2018).

Thus, there is a need to explore neuroanatomy and its relevance within the undergraduate medical curriculum on a global scale, as it still remains one the foundational building blocks of the medical curriculum or stumbling block for those students who dislike or even fear it. This fear, in turn, might prevent these students from specializing in the clinical neurosciences. 131 neurologists were registered in South Africa in 2006, (Rosman, 2006). Therefore, in a 14-year period, the South African neurologist community grew by 63 clinicians, with an average of four to five new neurologists registering each year. The psychiatry community grew by 354 clinicians (average of 25 additional clinicians per year) and the neurosurgery community grew by

91 clinicians, with an average of six to seven new neurosurgeons per year. Table 1 summarizes the number of clinical neuroscience specialists registered with the HPCSA for the past 14 years. Of statistical importance here is that these numbers are merely an estimation, since it includes specialists who might have immigrated to other countries, but who decided to keep their HPCSA registration active in South Africa.

Table 1: Number of clinical neuroscience specialists registered with the HPCSA in South Africa from 2006 to 2019 (Y Daffue 2020, personal communication, 23 January) (South Africa, 2019).

Speciality	**2006**	**2011**	**2016**	**2019**
Neurologists	131	150	179	193
Paediatric neurologists	15	23	29	34
Psychiatrists	570	726	807	924
Neurosurgeons	147	173	213	238
Total clinical neuroscience specialists	863	1072	1228	1389
South African population in millions	49.36	52.26	56.02	58.78

This implies that, on average, some of the South African medical schools did not even produce a single neurologist or neurosurgeon in a year and possibly only two to three psychiatrists in a year. The very slow growth rate of our clinical neuroscience specialist population in the last fourteen years deems it necessary to examine neurophobia, its causes and possible effect on our undergraduate medical students. I feel that this is required before most or all of our medical students become neurophobic and we, as a growing South African population with a growing neurological disease burden, place even more pressure on the existing community of neurologists, neurosurgeons and psychiatrists.

Of further concern is that, in the South African context, many general practitioners specializing in Neurology, Neurosurgery or Psychiatry do it through the MMed programs at universities and write the Colleges of Medicine of South Africa (CMSA) examinations where, very often, the basic neuroanatomy knowledge is assumed as prior knowledge and very seldom revisited or revised and assessed on, as is evident through guidelines and past assessments published on the CMSA website (CMSA, 2020). This implies that the undergraduate foundation built during the basic years of

medical training is the only neuroanatomy taught to these neuroscience specialists and is, therefore, crucial to be of a high standard and quality. Consequently, we need to discuss the perception of neuroanatomy within the medical curriculum from the viewpoints of the lecturing staff, medical students and experts.

3. THE PERCEPTION OF NEUROANATOMY

I explored how students (Chapter 4), lecturing staff (Chapter 2) and key-opinion leaders (Chapter 5) perceive the importance/relevance of neuroanatomy. Authors such as Moxham and Moxham (2007) mentioned that the relevance of anatomy is perceived differently by staff and students. This is where the dissonance develops; junior medical students might not grasp the importance of neuroanatomy, while neuroanatomy lecturers, as found in Chapter 2, (clinically trained or professional anatomists) perceive neuroanatomy to be extremely important in medical education (Patel and Moxham, 2006; Gogalniceanu et al., 2009; Chang and Molnár, 2015a).

From personal experience as a student and as a lecturer, and validated in Chapter 4, it is evident that students in their early years of medical training have a tendency of not grasping the importance and relevance of neuroanatomy within their curriculum and thus struggle to integrate their basic neuroanatomical knowledge in the clinical setting (Nham, 2012; Geoghegan et al., 2019). This, in turn, can potentially lead to their fear towards neuroanatomy, referred to as neurophobia (Russell et al., 2015; Arantes et al., 2017).

There is ample evidence in the literature (Nham, 2012; Kam et al., 2013; Maranhão-Filho, 2014; Geoghegan et al., 2019) that undergraduate medical students experience a fear toward neuroanatomy. This fear may be ascribed to their limited exposure to neurosciences, teaching approaches used and perception of neurosciences (Nham, 2012; Kam et al., 2013; Maranhão-Filho, 2014; Geoghegan et al., 2019). My concern is that this will lead to medical practitioners with limited knowledge of the neuroanatomy of the human body, due to the lack of theory-practice integration. This, in turn, might influence the way these practitioners diagnose and treat their patients, a view which is shared with Zinchuk and co-workers (2010) and Gorgich and co- workers (2017).

In Chapter 2, I reported on the hidden curriculum and how is it known to affect medical education and student perceptions (Lempp and Seale, 2004; Alsubaie, 2015), as well as the perceptions and viewpoints of the lecturers. Teaching the formal curriculum is known to indirectly support the hidden curriculum (Rahimgir et al., 2018). In essence, the method in which the lecturers/facilitators share information, the language used, intellectual honesty and the respect towards students and fellow staff members all contribute to the underlying influences or hidden curriculum (Rahimgir et al., 2018). The hidden curriculum is therefore a "side-effect of education" (Rahimgir et al., 2018, p5), and I now fully agree with this statement (Chapter 2). The content that we intend to teach our medical students is not necessarily what they all learn. In fact, students learn from and pick up on our attitudes, as lecturers, towards the content being taught. Therefore, we can create a negative impression amongst our students if we, the lecturers, lack an understanding and, even more importantly, convey a disinterest towards the module that we teach (Lam et al., 2002; Nargis et al., 2013).

I further came to the conclusion, in Chapter 2, that a neuroanatomy lecturer, in a bad mood, can possibly indirectly contribute to neurophobia among medical students. A neuroanatomy lecturer who is not teaching inclined, but rather research oriented, can perhaps cause an undergraduate medical student to dislike or even fear neurosciences, because he/she is overloading the students with facts. Even worse, in my opinion, is a neuroanatomy lecturer who believes that it is irrelevant and over-emphasized in the medical curriculum, and by means of his/her negative attitude towards the content, subconsciously conveys the same perceptions and beliefs to the medical students. The expression, "Do *as I say, not as I do*", then becomes completely irrelevant as the students will mirror that lecturer's negative attitude and behaviour.

I shared the feedback from the neuroanatomy lecturers in South African universities (Chapter 2) and determined that not all the components of the hidden curriculum should be regarded as negative - the opposite is also true and valid (Alsubaie, 2015). All the lecturers who responded believe that neuroanatomy is important, not a waste of time and essential for the medical students' training and preparation to became safe medical practitioners.

Enthusiasm, dedication and teaching experience in neuroanatomy are regarded as some of the most successful attributes of a neuroanatomy lecturer, regardless of whether they are professional anatomists or clinicians (Chang and Molnár, 2015a). Basic neuroscience, in particular, should be taught by enthusiastic lecturers who are knowledgeable in neuroanatomy (Neurologists, 1995). The lecturer's enthusiasm should be contagious and spark interest in the student towards the field of science. Although we did not explore the enthusiasm of the South African neuroanatomy lecturers per se, their teaching experience is consistent with lecturers that are knowledgeable in the field of neuroscience. Of these respondents, 90% expressed a positive attitude towards the teaching and learning of neuroanatomy in South Africa.

The above-mentioned characteristics are confirmed by the students (Chapter 4), lecturers (Chapters 2 and 3) and key-opinion leaders (Chapter 5), as one of the participants stated that "The key to good teaching is an enthusiastic teacher" (See Chapter 5). These participants shared their honest viewpoints and beliefs with me. They had strong opinions, although sometimes opposing viewpoints. Both experts in their field, with years of experience in the teaching of neuroanatomy, would disagree with each other on the amount of neuroanatomy necessary for safe clinical practise and the best teaching approach. Even though both participants are clinically qualified Participant A voiced his opinion that too much neuroanatomy is taught to the medical students at an undergraduate level in comparison to Participant B who stated that he feels that the amount of neuroanatomy that he teaches is enough. It would have been interesting if one could have arranged for a panel discussion between these two experts.

The commitment and dedication of the respondents (in Chapter 4) and participants (in Chapter 5) to their profession and the subject of neuroanatomy education was evident and inspiring in their comments regarding the challenges they experience. The latter included not only limited brain specimen resources at their institutions, but they also share how they creatively overcome this gap by supplementation of scans, brain images, demonstrations of brain specimens to their students, as well as the use of open-education resources. In Chapter 5, Participant B mentioned how lack of dedication amongst teaching staff can affect neurophobia amongst the students. He discussed how lecturing staff with a focus on research, rather than on teaching, might

overload the students with facts, leading to cognitive overload which indirectly causes neurophobia. Therefore, the need exists to do proper curriculum mapping to identify gaps in and overlapping of content in the medical curriculum. The broader curricular map must consist of horizontal and vertical content alignment and scaffolding as well as levels of increased difficulty and mastery of content. The content of the curriculum map then needs to be broken down into learning outcomes, learning opportunity and, assessment to ensure constructive alignment (Harden, 2001, Biggs and Tang, 2015). This should be a team effort where everyone involved in the teaching of neuroanatomy participate to create a modern and transformed medical and neuroanatomy curriculum.

I was also curious to know whether the lecturers, appointed in a teaching position, received any additional training to become a lecturer (Chapter 2). Additional formal education training is not a prerequisite for South African anatomy lecturers. The lack of formal teaching training might have a direct influence on the way lecturers facilitate a contact-session and further indirectly contribute to the development of neurophobia amongst medical undergraduate students. Although there is a drive from the Department of Higher Education in South Africa that all lecturing staff should have an additional qualification in teaching (DHET, 2018), only 57% of the lecturing staff respondents indicated that they had additional formal training in education, apart from their anatomy-relevant qualifications. Such training included Master's degrees, Diplomas and short courses. This implies that a large percentage of the South African neuroanatomy lecturing staff, although content specialists, are not academically trained to teach, and might not have been exposed to the theories, underlying principles and finer nuances of teaching and assessment. Attendance of educational short courses, diplomas and/or educationally-focused degrees should be encouraged for our neuroanatomy lecturers, as it will not only be self-enrichening, but might also introduce them to new and alternative ideas and possible teaching strategies to become a more didactically-sound facilitator of learning.

The Department of Higher Education and Training (DHET) in South Africa published a framework to support academics as teachers in higher education in November 2018. This framework includes important principles of what good teaching entails. The following principles regarding "good teaching" was emphasised in this document: Good teaching is important for the students' learning and their success is grounded in the

understanding of the discipline being taught. Ideology is then the greatest barrier for good teaching, which can only move forward if the lecturers identify and address their own teaching development needs, as well as the fact that it cannot be imposed but should rather be accepted by the lecturer him/herself (DHET 2018). The Medical Council of India recommends that medical educators train in education however it is not compulsory (Bansal and Supe, 2007, Zodpey et al., 2016). This is in sharp contrast to expectations of the Accreditation Council for Graduate Medical Education Common Program Requirements, in the USA, in which medical educators are obliged to do faculty development training (ACGME, 2018). By publishing the chapters/articles generated as part of this PhD dissertation as well as presenting the findings of my study at various anatomical and medical education conferences. I hope to create more awareness for the need for additional education qualifications for all lecturing staff teaching at medical schools, especially neuroanatomy lecturers. Furthermore, there are currently ten institutional priority courses, run by the Department for Education Innovation to guide and support lecturers in their teaching, facilitation and assessment practices. Participation in these in-house programmes are currently based on a voluntary participation principle, but should be made compulsory for all faculty involved in the teaching and assessing of students.

Taking the viewpoints of all the participants and respondents into consideration, I came to the conclusion that neurophobia is indeed a side-effect of neuroanatomy education. As lecturers, our attitudes towards the content and perceptions have an impact on our teaching approaches, which, together with our attitudes, have an effect on our student's attitudes and perceptions towards the content. Consequently, I want to briefly summarize neurophobia, the factors causing it and its effect on our medical students.

4. NEUROPHOBIA

Neurophobia has been recognised as a global educational risk since 1994 and it negatively affects medical students and young health care practitioners (Shelley et al., 2018). This irrational fear is perceived as real by those experiencing it and as a previous student and current lecturer, I belief that it is becoming increasingly more prevalent among our undergraduate medical students. This fear of the neurosciences includes the students' negative perceptions, beliefs and their inability to apply basic neuroscientific concepts in the clinical environment (Nham, 2012; Shelley et al., 2018).

Neurophobia was first described in 1994 by Dr Ralph Jozefowicz, a neurologist at the University of Rochester in the United States of America (USA). This phobia (irrational fear) of the neurosciences affects half of the students within their first two years at medical school, with no differentiation between the genders (Jozefowicz, 1994). Since Jozefowicz coined this term in 1994, many authors reported on the prevalence, possible causes and even preventative measures towards neurophobia. Reference to it can be found in literature from the USA, Nigeria and the United Kingdom (Mccarron et al., 2014), Saudi Arabia (Abulaban et al., 2015; Alhejaili et al., 2018), Singapore (Kam et al., 2013), China (Lukas et al., 2014), Sri Lanka (Matthias et al., 2013), Brazil (Santos-Lobato et al., 2018), Trinidad and Tobago (Youssef, 2009), Portugal (Arantes et al., 2017), West India (Shiels et al., 2017), India (Shelley et al., 2018) and Sudan (Elnaeim et al., 2019). Of concern is that despite evidence, there are lecturing staff, even at my institution of employment, who reject the existence of such a fear and the impact it might have on the number of neurologists, psychiatrists and neurosurgeons that will graduate in the future. This view was corroborated by Tarolli and Jozefowicz (2018).

As a researcher, embedded in this study and also lecturing neuroanatomy, I bracketed myself during the study and aimed to remain as objective as possible, but now I deem it essential to reflect on, and share my personal experience as a student and as a lecturer with you as the reader: I was a neurophobic undergraduate student. I did not grasp the three-dimensional internal structures of the brain. The external surface and mid-sagittal sections were manageable, but the moment the horizontal and/or coronal sections of the brain were presented, I could not comprehend it. I felt total resentment towards neuroanatomy and, for the remainder of my studies, would rather focus on any other region/system in the human body, which I understood and was good at. Even in my early academic career as a novice lecturer, I'd prefer that someone else teach the abstract and difficult part (neuroanatomy) to my students. This resentment was not due to insufficient exposure to neuroanatomy as a student or that I had bad teaching experiences – rather it was the illusiveness - the inability to grasp the three-dimensional aspects of the human brain. Was it not for my mentor and senior colleague's support, guidance and inspiration, I might never have grasped these concepts in such a way that I could conquer this irrational fear for the human brain, fell

in love with the brain, teach on it and even do a PhD study on neuroanatomy education.

Having lost my fear for neuroanatomy, I became curious and wanted to know more about this irrational, but academically crippling fear that one develops. Through extensive research of the literature, I came to the conclusion that several factors contribute to the development, prevalence and severity of neurophobia - factors that I could personally identify with. These factors can be classified into two major groups: modifiable- versus non-modifiable factors, and intrinsic- versus extrinsic factors.

Non-modifiable factors are regarded as the preconceptions that the student might have of neurosciences before he/she starts medical school, such as past experiences with neuroscience (Fantaneanu et al., 2014). The **modifiable factors** are those aspects which can be altered, and are regarded as the students' experiences during their medical training (Nham, 2012; Kam et al., 2013). **Intrinsic factors** refer to the perceptions, beliefs and lack of self-confidence of the student (Nham, 2012; Tarolli and Jozefowicz, 2018), in comparison to the **extrinsic factors** which include the effect that the content, clinical environment, hidden curriculum and even the lecturer might have on the student during his/her training (Nham, 2012; Kam et al., 2013; Shiels et al., 2017; Tarolli and Jozefowicz, 2018).

Worldwide, medical schools have implemented a multitude of teaching strategies in response to neurophobia in order to counterbalance the negative stigma associated with the neurosciences (Maranhão-Filho, 2014; Arantes et al., 2017; Javaid et al., 2019). However, these questions remain: Are changes in a single extrinsic factor, such as teaching approaches, sufficient, and is this an effective method to combat this fear of the neurosciences; How do the attitudes and perceptions of the lecturing staff, as it relates to neuroanatomy, affect the hidden curriculum of neuroanatomy and the neurosciences?

5. THE TEACHING APPROACHES USED FOR NEUROANATOMY

Neuroanatomy remains one of the major challenges for neuroscience teaching in the medical curriculum, as it is taught mainly using a systemic approach as opposed to a regional approach as for the rest of the human body (Arantes et al., 2017; Harrison et al., 2019). In Chapter 3, I discussed that, although challenging, teaching

neuroanatomy creates frequent opportunities to integrate the basic- and applied clinical concepts as mentioned by Javaid and co-workers (2019). However, if presented using a different approach, the teaching of neuroanatomy requires a total paradigm-shift for the lecturers to convert to an integrated systematic approach. From personal experience, I can confess that it took me some time getting used to it and figuring out how to do it.

Student-centred or teacher-centred approaches have a direct influence on the teaching techniques used by lecturers (De Castro et al., 2018). Students will benefit and learn more efficiently when they are actively involved in the learning process and when a variety of teaching- and learning methods are used (Johnson et al., 2012; Green et al., 2016; Wilson et al., 2019). Lecturers will more easily adopt student- centred teaching approaches if they understand the underlying value and principles of a student-centred approach to teaching (Bayram-Jacobs and Hayırsever, 2016; Kim and Hwang, 2017). Some of these principles include that the student is actively involved in, and responsible for his/her learning process, while the lecturer's role is to facilitate and not to teach, thereby allowing the students to learn independently and construct their own knowledge, to name but a few (Sawant and Rizvi, 2015; Bayram- Jacobs and Hayırsever, 2016). The data obtained from focus group discussions with postgraduate medical students specialising in neuroscience, indicated that the teaching approaches used for undergraduate neuroanatomy should be more student- friendly and student-centered.

Therefore, I concur that a hybrid-teaching model, consisting of various teaching and facilitation techniques, as well as the implementation of innovative student activities in the teaching of anatomy in the medical curriculum (Johnson et al., 2012; Dingle et al., 2019; Sotgiu et al., 2019), is essential. By exposing the students to a blend of platforms, techniques and approaches we can easily adapt the neuroanatomy curriculum to make it more student-friendly and manageable for our 21st century students.

Based on the literature search for Chapter 3, it became evident that human anatomy (and neuroanatomy) is taught in a variety of ways, using different teaching strategies and techniques. These techniques include small group facilitation (Whelan et al., 2016), team-based learning (Anwar et al., 2015), problem-based learning (Sotgiu et al.,

2019), computer-assisted learning (Russell et al., 2015), augmented reality (Henssen et al., 2019), laboratory teaching and practicals (Sugand et al., 2010), near- peer teaching (Dickman et al., 2017; Harrison et al., 2019; Karamaroudis et al., 2020), flipped classrooms (Watson, 2015) and through historical context in a narrative form (Neuwirth et al., 2018). With so many options at our disposal, we need to consider the most appropriate and feasible teaching modality and simultaneously take all utility factors (human-, physical- and fiscal resources) into account. The development of 21st century transferable skills, such as problem solving, critical thinking, communication, collaboration flexibility and adaptability, initiative and self-direction (Greenwald and Quitadamo, 2014; Lamb et al., 2017; Dingle et al., 2019) should be embedded in the training of our medical students.

Discussions with the two key-opinion leaders showed that, although from different parts of the world, they share certain common teaching practices. Both experts mentioned that they teach clinical relevance and supply the students with lecture notes, which tally with standard teaching practices for neuroanatomy in South Africa. However, the completeness of the notes might vary at different institutions. The students from one institution in the United Kingdom are supplied with recorded lectures and do not necessarily need to attend the contact-sessions, while students at other institutions (United States of America) need to attend the contact-sessions as the lecturers still use the chalk board for neuroanatomy teaching. Both approaches have value and depend greatly on the context and teaching approach.

In Chapter 3, a variety of teaching modalities, such as didactic MS PowerPoint lectures and dissection (still the most preferred methods), practical-lectures, problem-based learning, dissection video demonstrations and computer-based practicals/tutorials, are reported on for neuroanatomy teaching in South African medical schools. Refer to Table 3 in Chapter 3 for a detailed overview of these teaching modalities.

Some of these teaching methods are used, not out of choice or convenience, but rather as the only feasible method in the current resource-restricted conditions at some of the South African medical schools. These respondents also shared some innovative ways in which they supplement their neuroanatomy modules with alternative online resources. I explored these open-education resources and since then have started

sharing these sources with my medical students. One such source is the neuroanatomy dissection videos which were made by Dr Suzanne Stensaas at the University of Utah in the United States of America (Stensaas, 2015). I concur with Wilson and co-workers (2019) that computer-assisted learning is an innovative method in supplementing, not replacing, (brain) dissections when the actual dissection of the human body is not feasible (Wilson et al., 2019).

Changes in the curriculum does not appear to be a major concern or focus. Only 30% of the lecturers involved in this study indicated that they feel that changes are necessary in neuroanatomy in order to keep up with modern trends in education and the medical curriculum (Chapter 2). The readiness to change, especially in a student-centred direction might be to blame and common challenges to this adjustment include limited time to prepare, clashing timetables and the lack of confidence (Mccabe and O'connor, 2014). This is a concern, as the field of teaching and learning is constantly evolving (Hazelton, 2011; Chang and Molnár, 2015a; Arantes and Ferreira, 2016).

Although speculative, it might be that the neuroanatomy lecturers' teaching practices are already modernized and updated and does not need further revamping at the moment. One such respondent is Participant B, who, from the interviews (Chapter 5), indicated that he is happy with the current stance of his courses, his teaching approaches and the positive and appreciative feedback from his students. Opposing to the latter, was Participant A who believes that in general, change is necessary for teaching neuroanatomy within the medical curriculum. He voiced concern regarding the cognitive overload and the over-emphasis of advanced neuroanatomy content within the undergraduate medical curriculum.

Reflecting on my own teaching career, I have encountered situations that confirm the above where a colleague, despite HPCSA recommendations, refused to adapt and decrease his contact hours. His response was that he was using the same amount of time for the past 30 years to teach the specific anatomy component in that particular way and he refused to make any changes. Unfortunately, as discussed in Chapter 2, his viewpoints are not unique. A personal assumption, based on experience and informal conversations with peers and colleagues, is that some lecturers are set in their ways and comfortable with the status quo. They are oblivious, or even ignorant, to new

innovative teaching methods and are reluctant to make changes to their current teaching approaches and techniques (De Castro et al., 2018). These lecturers might be teacher-centred and not student-centred and subconsciously try to maintain the locus of control and knowledge, instead of promoting and guiding the students' learning process towards self-directed learning and growth as medical professionals. They do not realize the detrimental effect that their unawareness has on our medical students and, indirectly, on the health of the population. The undergraduate medical students might become antagonistic towards the content or module and not even consider a career in a related speciality. It is my fervent hope that the respondents of the questionnaires in this study are not so inclined.

Upon further exploration of the students' perception of neuroanatomy (Chapter 4), I realized that the medical students consider neuroanatomy as both interesting and important in their medical training. These students further indicated that they understood that neuroanatomy is necessary for safe medical practise. However, almost 50% indicated that changes are necessary for neuroanatomy tuition within the medical curriculum. Further analysis on the 'modernise' statement revealed that the second-year female students, on average, did not agree with the statement. This might be ascribed to the fact that female students are more likely to be neurophobic (Kam et al., 2013), perceive neuroanatomy as complicated and not consider a future career in the neurosciences, in comparison to male students (Abulaban et al., 2015).

When I asked the students about their preferred teaching-sessions (Chapter 4), I expected that they would select virtual-reality online brain models and computer-assisted practicals/tutorials, however, they indicated that they prefer contact sessions which include practicals with cadaveric brain specimens and dissections combined with plastic models, above any other method of neuroanatomy teaching. I assume that the reason for this is that the students want to interact with the content which actively involves them in their learning process. In my opinion, physical interaction with the brain specimens is still the best way to study and understand neuroanatomy.

By reflecting on my own teaching approaches for undergraduate medical neuroanatomy, and implementing the necessary changes to modernize this subject, I can contribute to protecting my students from developing this fear for the

neurosciences – I want the medical students to be competent health care professionals with a sound foundation in neuroanatomy. After all, they might become our future neurologists, neurosurgeons or psychiatrists, of whom we expect great things and competent care.

6. NEUROANATOMY WITHIN THE MEDICAL CURRICULUM

During my unpacking of the current position of neuroanatomy within the South African medical curriculum, I specifically looked at the academic years in which neuroanatomy is taught, the amount of contact-time dedicated and whether the core curriculum is implemented at the nine medical schools. I further explored the students' perspective on their preferred types of literature, they use to prepare for assessments and whether they preferred making use of certain electronic devices during these preparations. Lastly, I asked to students to indicate their most- and least favourite neuroanatomy topics and to elaborate on their choices.

6.1 WHEN DO WE TEACH NEUROANATOMY IN THE MEDICAL CURRICULUM?

Basic neurosciences are separated from the relevant clinical disciplines in the medical curriculum of most medical schools across the world, including my institution of employment. This has an enormous impact on our medical students' perception of the neurosciences and neurophobia (Ridsdale et al., 2007; Arantes et al., 2017; Shiels et al., 2017). Our undergraduate medical students find it challenging to incorporate the basic neuroanatomy concepts, taught within the first three to four years of their degree, with their clinical rotations during their senior years. By incorporating consolidation sessions at the beginning of clinical sessions/rotations we as anatomists can aid our students with the implementation of neuroanatomy into their neurology and psychiatry rotations.

6.2 DO WE HAVE ENOUGH CONTACT TIME FOR NEUROANATOMY?

The battle for more neuroanatomy contact time is one that I'm actively fighting for behalf of my medical students. At the institution of my employment, I am the primary neuroanatomy lecturer for medical neuroanatomy and managed to negotiate eight more hours for the second-year medical students. However, 22 hours is still not enough. The 22 hours of contact time (second-year medical students) are distributed as follows: ten hours are allocated to lectures, eight hours to dissection of human

cadaveric brain specimens and four hours for assessment (at various stages during their eight weeks human anatomy block). During the Neurology rotation of the fourth-year group of medical students,15 hours are allocated for neuroanatomy contact time: eight hours for lectures, four hours for practicals which consist of plastic models, brain scans and prosected cadaveric brain specimens and three hours to assessments (at various stages during their Neurology block). The total amount of contact time for neuroanatomy adds up to a mere 37 hours during a medical student's training. If one puts this into perspective – less than two weeks is spent on neuroanatomy during six years of undergraduate medical training.

6.3 DO WE TEACH THE CORE NEUROANATOMY CONTENT?

The core content in neuroanatomy for the medical curriculum has been determined to secure the baseline of knowledge which is required for the medical student to ensure safe medical practice (Moxham et al., 2015). The reason for this is to set a basic level of understanding of the anatomy of the human nervous system that is needed to attend to patients with neurological complaints, create the inspiration for a smaller group of students who will potentially consider a career in the field of neuroscience and, lastly, to motivate students to consider neuroscience as a research field (Chang and Molnár, 2015b). This curriculum, therefore, attempts to guarantee that the medical students do not suffer from factual overload. The cognitive load theory mentions that redundant demands on their working memory complicates their learning process (Van Merriënboer and Sweller, 2010; Leppink and Van Den Heuvel, 2015).

I used the reported guidelines to explore the neuroanatomy content taught at the South African medical schools. The results yielded that most of these medical schools adhere to the core curriculum as established by Moxham and co-workers (2015).

6.4 WHAT ARE THE STUDENTS' PERSPECTIVE ON THE USE OF LITERATURE AND ELECTRONIC DEVICES?

In Chapter 4, I explored the use of literature and electronic devices by our medical students, in preparation for their assessments. These students indicated that they mainly prefer lecture notes to prepare and study for neuroanatomy assessment and it seemed that their self-identified gender has a significant impact on the use of notes. Females mainly prefer to use lecture notes, while the male students prefer to study

with a combination of lecture notes, prescribed literature and internet resources. The students generally prefer to use their laptop computers for studying purposes, rather than using smartphones and/or any other hand-held device. This fact surprised me, as my students are normally quick to reach for a smartphone and either search or query relevant neuroanatomy content during contact sessions, including dissections and wet specimen practical sessions. Strangely, the more senior students rely less on laptop computers for studying purposes. A possible explanation for this could be that they get accustomed to using the now readily available mobile neuroscience- and clinical applications available on smartphones

6.5 WHAT ARE THE STUDENTS MOST- AND LEAST FAVOURITE TOPICS?

In the questionnaires (Chapter 4), I asked the students to disclose their most- and least favourite neuroanatomy topics and elaborate on their reasons. Their responses yielded the cranial nerves as the most favourite topic. A thematic analysis of their reasons revealed five recurring themes which include clinical relevance, interesting topic, easy to understand, pleasant teaching experiences and relevant integration with the rest of the body. During informal discussions with some of these students during practical sessions, they told me that they find it very rewarding to test the cranial nerves of patients and, by doing so, practically and sensibly verify the anatomy of the cranial nerves.

The students identified the histology of the nervous system as their least favourite topic. The themes emerging from their reasons included that this topic was difficult to understand, they had unpleasant teaching experiences and the limited time allocated to it. The students could not see any clinical relevance for this topic. Neurohistology tends to be problematic. As these students only have limited neurohistology exposure during the second semester of their first year, their knowledge retention is low due to their lack of interest in the topic. It is then difficult for me, their neuroanatomy lecturer, to scaffold new knowledge on their current understanding of nervous system histology during their second- and fourth-years of study. It would appear as if these students 'block' this content (histology) because of their negative perceptions towards it.

I believe, also evident from Chapter 4, that the limited contact time and less than optimal teaching experience still contribute to neurophobia amongst our South African

undergraduate medical students. This affects our students' preconception of neuroanatomy and its importance in the medical curriculum. More time dedicated to neuroanatomy is a challenging task to accomplish in the current medical curriculum, as it will affect other subjects or disciplines and their credits (weighting in the program).

7. RECOMMENDATIONS

Based on the results discussed in the previous chapters and collated in this additional chapter, I propose the following (as illustrated in Figure 2) as it relates to:

- The characteristics of a good neuroanatomy lecturer
- The features of a medical neuroanatomy course
- Recommended teaching approaches for neuroanatomy

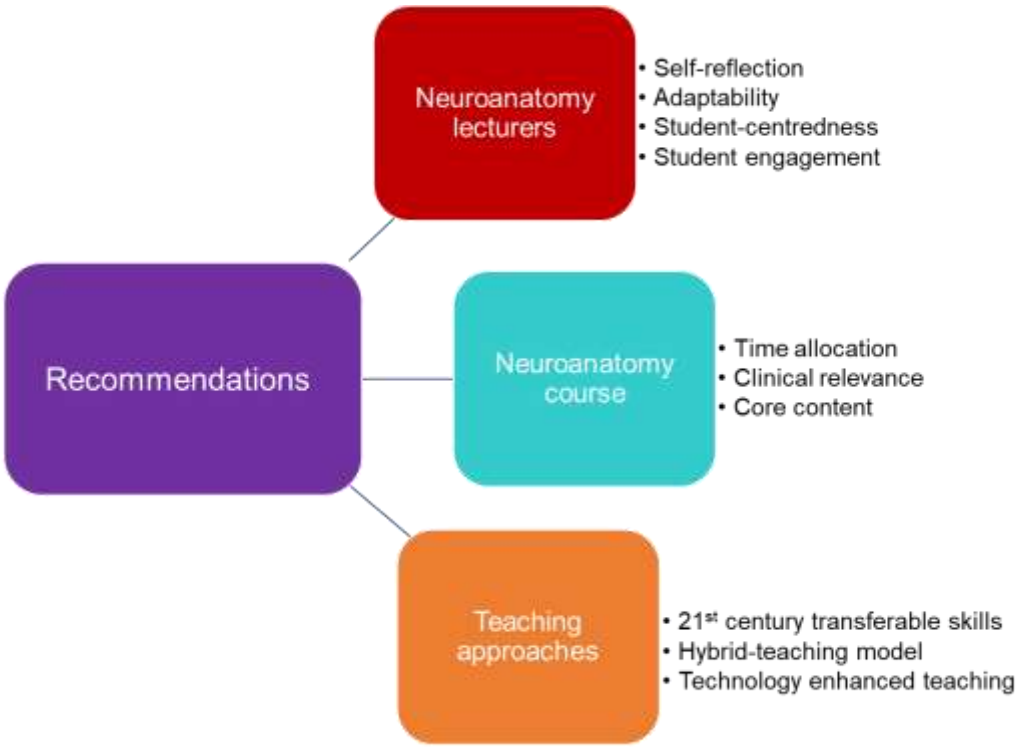

Figure 2: Visual illustration of my recommendations.

7.1 CHARACTERISTICS OF A GOOD NEUROANATOMY LECTURER

Most lecturers enter their positions as medical educators based on their content knowledge, combined with their research capability and/or current disciplinary research. It is also assumed that, due to their content knowledge, they will be effective educators or lecturers (Srinivasan et al., 2011; DHET, 2018). However, this assumption appears to be inaccurate at times. Many lecturers are not skilled in, or

familiar with the teaching competencies needed for teaching in higher education context. Therefore, I recommend that neuroanatomy lecturers should value and practice the following four main principles in medical education: self-reflection, adaptability, student-centredness and student engagement (Srinivasan et al., 2011).

7.1.1 Self-reflection

Self-reflection should be the starting point for any dedicated neuroanatomy lecturer who is enthusiastic about the content and the students that they teach. The staff respondents did show dedication towards their students and the content that they teach and therefore, I propose that we need to critically reflect on our own perceptions and teaching practices and ask ourselves whether we are student-centered, engaging with our 21st century students and adaptable in order to facilitate their learning experience.

Self-reflection might not be a comfortable process, but it is necessary. We have to ask ourselves whether we are doing the things we do because it is in the best interest of our medical students, or ourselves.

7.1.2 Adaptability

The adaptability of the (neuroanatomy) lecturer is another principle that should be embedded in our teaching practices. I am of the opinion that a neuroanatomy lecturer should be able to make the necessary appropriate changes to the content taught, his/her teaching approaches and even the teaching environment, as a form of self-development. Furthermore, it is essential to keep up with the latest trends and techniques for contact sessions and assessments by attending and participating in additional training such as short courses and/or diplomas by educational professionals on a regular basis. Only then can we make the necessary adaptations to our teaching practices and assessments based on their recommendations.

7.1.3 Student-centredness

Student-centeredness refers to the fact that we, the lecturers, have to put our students' needs first, which includes the teaching approaches that we employ. The majority of the respondents and participants of this study used this term and emphasized that the neuroanatomy content, teaching approaches and even assessment should be student-

centred. This approach is, as we know, not always applied in our medical schools. Neurophobia occurs more frequently amongst our undergraduate medical students because we, the neuroanatomy lecturers, are not employing this teaching principle. Consequently, we need to teach neuroanatomy systematically and appropriately, simultaneously act as a role model, evaluate our students and provide them with timeous feedback as described by Srinivasan and co-workers (2011). I concur with Sawant and Rizvi (2015) that traditional teacher-centred approaches should not be rejected altogether, but we should rather find a balance between these approaches that best supports the students in their learning process (Sawant and Rizvi, 2015).

South African neuroanatomy lecturers, including myself, have implemented some of these student-centred approaches into the curriculum which include small-group discussions (Sawant and Rizvi, 2015), near-peer teaching (Sawant and Rizvi, 2015), the use of audio-response systems (Sawant and Rizvi, 2015), case-based- and problem-based learning (Sawant and Rizvi, 2015; Wilson et al., 2019). Lecturers who have not done so yet, should consider such student-friendly approaches. Another such approach is team-based learning (Anwar et al., 2015; Wilson et al., 2019) which presents excellent opportunities that can be practiced in our dissection halls. By making a few changes to our dissection practices, including the implementation of group- and individual assessments on the related content, this approach can be implemented with ease.

7.1.4 Student engagement

Engaging with the students during the contact-session might be challenging for some lecturers, especially those who still practice the one-directional didactic form of teaching, with the white-coated lecturer standing in the front of the lecture venue, often behind a podium, teaching the students the content, figuratively forcing it down their throats. Active student participation during the contact sessions can change this method and will encourage student engagement, even outside the classroom. Students benefit and learn more efficiently when a variety of teaching and learning methods are used to enhance their active participation and engagement with the content (Johnson et al., 2012; Sawant and Rizvi, 2015). The students even mentioned that they prefer to interact with the content during practicals and dissection.

How can we let them interact with the neuroanatomy content? The students want to hold the brain specimens and feel the weight in their hands once we start with neuroanatomy. They want to pick up the specimens and models and examine them from all angles. Although these specimens are precious and limited, this should be encouraged and conducted under supervision – it provides them with a sense of wonder - that 'wow-moment'. I further supply the students with a few plastic brain-models which can be taken apart. I normally disassemble them before the contact sessions and then let the students "build a brain puzzle" during the session. This has proven to work well, especially during revision sessions. The students discuss and sometimes even argue about the position and orientation of the various parts. I will then intervene and facilitate, when necessary.

There is an integration between the teaching principles and competencies of good teaching in medical education. Only once we acknowledge and implement all of these teaching principles and competencies, will we be regarded as good neuroanatomy lecturers.

7.2 FEATURES OF A MEDICAL NEUROANATOMY COURSE

The teaching approaches, content span and time allocated to neuroanatomy remain three of the major challenges for integrating neurosciences in the medical curriculum for both students and lecturing staff. There are three main issues which need to be addressed in the current stance of neuroanatomy within the medical curriculum: the time allocated to neuroanatomy, implementation of the clinical relevance and core content.

7.2.1 Time allocation for neuroanatomy

Although neuroanatomy is regarded as an important component of the medical curriculum, limited time is allocated to it and teaching staff need to justify the proportion of time allocated to it within the medical curriculum (Hazelton, 2011; Neuwirth et al., 2018). In comparison to medical schools around the world, South African medical schools dedicate very little time to the neuroanatomy component in the medical curriculum, even though limited exposure to neuroanatomy has been reported as a contributing factor for neurophobia (Nham, 2012; Kam et al., 2013; Maranhão-Filho, 2014; Geoghegan et al., 2019). Dedicating more time to neuroanatomy is a difficult

task to accomplish as it implies that time must be taken away from another discipline or subject to accommodate this change.

Collaboration between the basic sciences departments and clinical departments is vital for such changes to occur. Thus, I recommend that we evaluate the time allocated to neuroanatomy, in comparison to other regions of the human body, especially when (what is?) part of the same module. We have to ask ourselves whether this number of hours is justified. I understand that it might not be possible to make significant changes in time allocation. However, every hour gained for neuroanatomy where it is deemed necessary, is a step in the right direction.

We need appropriate curriculum mapping, including vertical and horizontal alignment, as well as integration, to ensure that some basic science modules (such as neuroanatomy) is adequately represented in the curriculum. After all, these medical students need the foundational grounding of the basic science modules in order to understand, examine and properly diagnose a patient who presents with a potential neurological disorder.

7.2.2 Clinical relevance in neuroanatomy

Another major concern for me is the separation of basic neurosciences from the clinical neurosciences, as it affects the students' ability to integrate their basic neuroanatomy knowledge in the clinical environment. Even though neuroanatomy is commonly taught within the first four years of the medical curriculum, it holds excellent opportunities for clinical integration. I recommend that we include clinically relevant content in our neuroanatomy lectures and, by doing so, introduce the clinical aspects (real-life) into the basic sciences. The students can then see the relevance of the basic neuroanatomy that we teach.

Furthermore, we should ask academic neurologists, psychiatrists and/or neurosurgeons to present introductory clinical lectures and attend practical sessions, of which the former is already a common practise at the institution of my employment. There are, however, some challenges to these practices, as the neuroscience specialists have busy schedules, often not allowing them to present these sessions. I found that by asking my MMed neuroscience students to attend the undergraduate

medical neuroanatomy sessions and interact with them, benefit the undergraduate medical students tremendously. Simultaneously, the postgraduate students revise the content in preparation for their primary examinations.

7.2.3 Core content of neuroanatomy

Our students find it difficult to master the nervous system anatomy due to its complexity (Kennedy, 2013; Shiels et al., 2017; Neuwirth et al., 2018). The core curriculum establishes the baseline of neuroanatomy knowledge and understanding which the students need to examine patients who might present with neurological symptoms. By adhering to the core neuroanatomy curriculum, we ensure that our medical students do not suffer from factual overload, as mentioned by the cognitive load theory.

Although the majority of neuroanatomy lecturers in South Africa teach the core curriculum, I recommend that we continually revise our content and re-align with the established international core curriculum for neuroanatomy. I am a firm believer of "less is more" pertaining to neuroanatomy – I would rather make sure that my medical students understand the basic neuroanatomy concepts and are able to implement these in their clinical rounds instead of teaching them additional "nice to know" information on the human nervous system.

7.3 TEACHING APPROACHES FOR NEUROANATOMY

Traditionally, neuroanatomy is taught in a systemic approach as opposed to a regional approach with the rest of the human body (Arantes et al., 2017; Harrison et al., 2019).

7.3.1 21st century transferable skills

The teaching approaches used in the training of our medical students should include the development of the 21st century transferable skills and competencies such as problem solving, critical thinking, communication, collaboration flexibility and adaptability, initiative and self-direction (Greenwald and Quitadamo, 2014; Lamb et al., 2017; Dingle et al., 2019). Do our current teaching approaches include these skills and competencies? Since MS PowerPoint lectures and dissection are still the most preferred methods used for neuroanatomy teaching in South Africa, very little of these competencies are addressed. Although problem-based learning, dissection video demonstrations, near-peer teaching and computer-based practicals/tutorial are used

to a lesser extent, more emphasis should be placed on these approaches in order to address the remaining competencies necessary for our 21st century students.

7.3.2 Hybrid teaching model

A hybrid-teaching model, consisting of various teaching and facilitation techniques, as well as the implementation of innovative student activities, is recommended in the teaching of anatomy in the medical curriculum (Johnson et al., 2012; Dingle et al., 2019; Sotgiu et al., 2019). I reaffirm the fact that no single teaching modality is effective and sufficient in the neuroanatomy medical curriculum.

The use of modern, virtual-relevant teaching practices is not the only relevant form of teaching neuroanatomy. Through interviews with experts, I came to the conclusion that the “chalk-board”, longstanding as it is in teaching, can still be used for certain illustrations. These experts, in first-world countries, still have enormous success in their teaching practices by using this age-old method.

7.3.3 Technology enhanced teaching

Most of the lecture venues which I currently use, do not have a white-board or black-board. These venues are now equipped with an Aver visualizer (document camera), a digital presentation tool that projects illustrations/diagrams and/or documents to the students in class. I no longer have to turn my back on the students in order to illustrate certain neuroanatomy concepts on the board. I can face them while illustrating and describing these concepts. Through this process, I can then actively involve them by requesting the students to draw / illustrate the images themselves, as I go along. This system is user-friendly, as it is easy to navigate between a MS PowerPoint presentation and images drawn on this system. I found this method to be effective when teaching the functional areas of the cerebral cortex, as we can draw these areas and simultaneously summarize the function and blood supply of these areas, as well as creating summaries of the cranial nerves. This didactic teaching method, which is still used, but with a modern twist, can be regarded as a form of equivalence-based teaching.

To ensure a sound foundation in neuroanatomy for our medical students and the possible prevention of neurophobia amongst them, we need to re-evaluate our

neuroanatomy modules/courses, especially the content taught, teaching approaches used and time allocated to this very important component of the human body. These components all carry equal weight in our neuroanatomy modules and one cannot be sacrificed for the sake of another. These factors still remain the major influences on our students' perceptions of neuroanatomy and its relevance within the medical curriculum in South Africa and around the world.

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CHAPTER 7

Conclusion and limitations

“Education is not the learning of facts, but the training of the mind to think.”

(Albert Einstein)

TABLE OF CONTENTS

1. INTRODUCTION

In this concluding chapter of my dissertation, I present a final reflection on the research design and data collected to support the theoretical argument described in Chapter 1 and the consecutive chapters as per focus area. I further discuss the general limitations encountered during my study and propose some recommendations for the teaching of anatomy in the undergraduate medical curriculum in an attempt to prevent students from developing an irrational fear towards neuroanatomy (neurophobia).

I want to emphasize that neurophobia is real and prevalent among our medical students who are experiencing mixed feelings and even a fear towards neuroanatomy in the undergraduate medical curriculum. This phobia can be ascribed to the teaching approaches currently used and the limited exposure to neuroanatomy during their undergraduate years. The result is a lack in their theory-practise integration, with further consequences such as medical doctors with insufficient neuroanatomy knowledge, potentially putting their patients' lives at risk.

2. EVALUATION OF THE STUDY OBJECTIVES

My overall aim of this study was to explore the perceptions and attitudes of medical students, lecturers and international experts towards the teaching, facilitation, learning and assessment of neuroanatomy within the South African medical curriculum. The reason for this is that the literature clearly indicates an association between these aspects of the neuroanatomy curriculum and neurophobia experienced by undergraduate medical students. In addition, I explored how to best teach and facilitate neuroanatomy based on the respondents' and participants' attitudes, preferences and current teaching and learning practices, as a possible way to prevent the development of neurophobia amongst our South African medical students.

My main focus in objectives 1, 2 and 4 was on the anatomy lecturer. In the first objective, I explored the perceptions and attitudes of anatomy lecturers towards the facilitation, learning and assessment of neuroanatomy and its relevance in the medical curriculum. The findings of this phase reaffirmed that the lecturer's attitude towards the content that he/she teaches does affect the teaching approaches which he/she will use, especially in neuroanatomy. As neuroanatomy lecturers, our perceptions affect our teaching competencies, our teaching competencies affect our teaching styles and

our teaching styles indirectly affect our students' attitudes towards the module.

I determined the preferred teaching, facilitation and assessment approaches and strategies used by anatomy lecturers in South African Universities, as it relates to neuroanatomy in the second objective. Of relevance here was that, apart from the limited dedicated time to neuroanatomy, the South African medical curriculum is similar to those of international medical schools. Furthermore, there is little room for the use of innovative, technological-advanced teaching methods more suitable for our 21st century medical students, as neuroanatomy lecturers do not encourage the use of electronic devices during contact-sessions.

The fourth objective is linked to the first- and second objectives during which I conducted interviews with two international key-opinion leaders in the field of neuroanatomy education. It was evident from these interviews that, even though we might have different viewpoints on the best teaching strategies, no single best teaching approach should be considered. Neuroanatomy should rather be taught/facilitated in a student-centred way which is appropriate and contextual for our modern students.

The third objective focused exclusively on the medical student. During this phase, I explored the perceptions and attitudes of undergraduate- and postgraduate medical students towards the facilitation, learning and assessment of neuroanatomy, as well as its relevance in the medical curriculum. The results clearly indicate that in South African medical schools, limited contact time and a less than optimal teaching experience for students, still remain important factors contributing to neurophobia. This then further affects how these students perceive neuroanatomy and its importance in the medical curriculum.

3. STUDY APPROACH

By using multiple methods, I examined the South African medical neuroanatomy curriculum in order to gain a better understanding of the exposure medical students have, in terms of time spent and methods of instruction, during their undergraduate training. I additionally wanted to explore the reasons why these students perceive

neuroanatomy as overly complex. In South Africa, the current stance of neuroanatomy and teaching approaches used yielded similar results to those reported by various international medical schools, with the exception that, in our local curriculum, very little time is dedicated to this part of the human body.

Based on the qualitative- and quantitative analyses of the online questionnaires, focus groups discussions, round-table discussions and interviews, I can conclude that both limited contact time and less than optimal teaching experiences remain important factors contributing to neurophobia, even in South African medical schools. This indirectly affects the perceptions of our students regarding the complexity and the importance of this subject matter in the medical curriculum, irrespective of whether they are undergraduate or postgraduate. Our South African medical students are giving us the message loud and clear – change is needed in neuroanatomy education in order for it to be more accessible and manageable for them. Simultaneously, it also raised the questions of which teaching/facilitation practices are best suited for neuroanatomy within the medical curriculum, as well as the characteristics that a good neuroanatomy lecturer should have.

The unique contribution of this study is the key recommendations to the current- and future South African neuroanatomy lecturers. These recommendations address good teaching practices within this subject matter, to enhance content integration and prevent neurophobia. Based on these results, neuroanatomy lecturers at medical schools should do self-reflection on their attitudes and perceptions of neuroanatomy as it stands in the current medical curriculum. Our attitudes, perspectives and perceptions of neuroanatomy and its relevance within the medical curriculum, have an impact on our actions, teaching competencies and teaching approaches. This, in turn, might indirectly affect our students' perceptions and attitudes towards neuroanatomy in the medical curriculum. By reflecting on our own perceptions, attitudes and teaching approaches for neuroanatomy, and creating and implementing the necessary changes – within our means – we can help our students overcome this fear for the neurosciences. After all, we want our students to be competent health care professionals with a sound foundation in neuroanatomy. The results of this study further allowed me to make recommendations towards the medical neuroanatomy curriculum which includes adhering to core content and increasing the neuroanatomy contact time

at undergraduate level. Lastly, this study aided me in exploring more suitable student-centred teaching approaches for our undergraduate medical students, as the current use of innovative, technologically-advanced, student- centred teaching methods for neuroanatomy, more suitable for our 21st century medical students, are not yet fully implemented in our medical schools. Although some innovative teaching pedagogies are used by these medical schools, there is still much room for improvement.

I conclude that there is not a single best teaching method for neuroanatomy, or that a modern, digitally-based teaching approach be adopted. These methods should rather be appropriate, dynamic, contextual and student-centred. This will support deep learning, enhance the development of the transferable skills of our 21st century student and, subsequently, prevent neurophobia.

4. EMIC PERSPECTIVE

Reflecting on my past teaching experiences as a neuroanatomy lecturer and experience as a researcher in this study I conclude that we should treat our medical students as developing individuals who are not always ready for pure andragogical teaching approaches but rather pedagogical approaches. However, once these students grow into responsible mature individuals, they will take ownership of their learning, and we can practise student-centred teaching approaches. The student respondents and participants in this study confirmed this in their responses. I'm part of the teaching community who needs to make these necessary adaptations to my attitudes and teaching methods to ensure that our medical students do not develop neurophobia due to our actions, omissions, preconceived perceptions or biases.

5. LIMITATIONS OF THE STUDY

There were certain limitations pertaining to my study. The study was limited to the South African context and the student population used was limited to one institution. As for the lecturer participation, all the medical schools in South Africa did not participate, although all were invited. Only seven of the current nine medical schools' lecturers participated. Furthermore, only two international experts agreed to be interviewed. Even though the sizes of the population groups limit the generalizability of the results, this study provides new and rich insights into the current stance of, and

perceptions towards teaching practices used for neuroanatomy within the South African medical curriculum.

6. RECOMMENDATIONS FROM THE CURRENT STUDY

Based on the results from the different phases, and discussed in the separate chapters, the following specific recommendation pertaining to teaching neuroanatomy to undergraduate medical students are:

- Neuroanatomy lecturers need to recognize and practice the four competencies of good teaching (Chapter 2).
- These lecturers need to evaluate whether enough time is allocated to, and clinical relevance included in neuroanatomy within the medical curriculum. If not, they should implement the necessary changes, where conceivable (Chapter 3).
- Neuroanatomy lecturers should refrain from teaching more than the established core curriculum for neuroanatomy (Chapter 3 and Chapter 5).
- Neuroanatomy lectures should investigate and then practise, where possible, relevant teaching approaches that address the competencies and skills of the 21st century medical students (Chapter 4).
- All lecturers should be required to obtain an additional qualification in teaching (e.g. Postgraduate Certificate in Higher Education) (Chapter 2 and Chapter 3).

7. RECOMMENDATIONS FOR FURTHER RESEARCH

Based on these conclusions, further research is needed for other regions of human anatomy and components of the basic sciences, as it forms the core of the medical curriculum. Future studies will be conducted on the students' performance in neuroanatomy in comparison to other regions of the human body, in order to examine whether the students' perception of neuroanatomy affect their performance during assessments. A follow-up study could be done to determine why students to no like self-directed learning as an approach to neuroanatomy and whether these students' perceptions has changed after the COVID-19 lock-down when they were forced into a higher level of self-directed learning.

By using this study as a framework, similar studies in South Africa and worldwide can scaffold on this type of research, as uniformity within our national and international

medical curricula is vital for our medical students.

8. FINAL REMARKS

My fellow neuroanatomy lecturer, I now challenge you to become an, even better lecturer – one who passionately portrays neuroanatomy as an interesting and intriguing content area and by doing that, instil the passion, the understanding and the love for neuroanatomy amongst our undergraduate students. Deliberately focus on making the content come ‘alive’ for the students, help them to make the connections and, in doing so, prevent the development of this irrational fear toward neuroanatomy (neurophobia). Embrace, apply and integrate the recommendations of good teaching, teach core curriculum by making use of student-centred approaches and inspire your students to consider a career in the neurosciences. Alone we can make a significant difference in our own institutions, but together we can change the world for our students and profession!

APPENDICES

TABLE OF APPENDICES

APPENDIX A: Ethical Clearance certificate (and renewal)

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00002567, Approved dd 22 May 2002 and Expires 03/20/2022.
- IRB 0000 2235 IORG0001762 Approved dd 22/04/2014 and Exoires 03/14/2020.

6 November 2018

Approval Certificate
New Application

Ethics Reference No.: 587/2018
Title: A multi-method study to explore perceptions and attitudes towards neuroanatomy in an undergraduate medical curriculum

Dear Mrs G Venter

The **New Application** as supported by documents received between 2018-10-19 and 2018-11-06 for your research, was approved by the Faculty of Health Sciences Research Ethics Committee on its quorate meeting of 2018-10-24.

Please note the following about your ethics approval:

- Ethics Approval is valid for 1 year and needs to be renewed annually by 2019-11-06.
- Please remember to use your protocol number (587/2018) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.

Ethics approval is subject to the following:

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

Dr R Sommers
MBChB MMed (Int) MPharmMed PhD
Deputy Chairperson of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes, Second Edition 2015 (Department of Health)

Research Ethics Committee
Room 4-60, Level 4, Tswelopele Building
University of Pretoria, Private Bag X323
Arcadia 0007, South Africa
Tel +27 (0)12 356 3084
Email deepeka.behari@up.ac.za
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Fakulteit Gesondheidswetenskappe
Lefapha la Disaense tša Maphelo

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00002567, Approved dd 22 May 2002 and Expires 03/20/2022.
- IRB 0000 2235 IORG0001762 Approved dd 22/04/2014 and Exoires 03/14/2020.

13 November 2019

Approval Certificate
Annual Renewal

Ethics Reference No.: 587/2018
Title: A multi-method study to explore perceptions and attitudes towards neuroanatomy in an undergraduate medical curriculum

Dear Mrs G Venter

The **Annual Renewal** as supported by documents received between 2019-10-23 and 2019-11-06 for your research, was approved by the Faculty of Health Sciences Research Ethics Committee on its quorate meeting of 2019-11-06.

Please note the following about your ethics approval:

- Renewal of ethics approval is valid for 1 year, subsequent annual renewal will become due on 2020-11-13.
- Please remember to use your protocol number (587/2018) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.

Ethics approval is subject to the following:

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

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Lefapha la Disaense tša Maphelo

APPENDIX B: Staff questionnaire

Participant's information & informed consent document

STUDY TITLE: A multi-method study to explore perceptions and attitudes towards neuroanatomy in an undergraduate medical curriculum

PRINCIPAL INVESTIGATOR: Mrs Gerda Venter, Student number: 23082471
SUPERVISORS: Dr JC Lubbe and Prof MC Bosman
INSTITUTION: Department of Anatomy, University of Pretoria

Dear Anatomy lecturer

I am a PhD student in the Department of Anatomy, University of Pretoria. You are invited to volunteer to participate in my research project, by completing the following questionnaire regarding the exploration of perceptions and attitudes of both staff and students towards neuroanatomy in the South African undergraduate medical curriculum. This letter provides you with information to help you decide whether you want to take part in this study. Before you agree you should fully understand what is involved. You should not agree to take part unless you are completely happy about what we are requesting from of you.

The aim of this study is to investigate the attitudes of anatomy lecturers, undergraduate and postgraduate students towards the teaching and learning of neuroanatomy in the medical curriculum. This study will further examine the perception of students on the importance of neuroanatomy as it relates to their future careers as well as the current teaching and assessment practices used by anatomy lecturers at South African Universities.

This study involves answering some questions regarding your personal opinion towards the facilitation and learning of neuroanatomy, the relevance of neuroanatomy as part of the medical curriculum and the current teaching approaches and strategies that you are making use of.

We would like you to complete an anonymous online questionnaire. This may take about

10 - 20 minutes. Please do not enter your name on the questionnaire. This will ensure confidentiality and anonymity. The Research Ethics Committee of the University of Pretoria, Faculty of Health Sciences granted written approval for this study (nr 587/2018). This study has been structured in accordance with the Declaration of Helsinki, of which a copy may be obtained from the primary investigator, should you wish to review it.

This questionnaire consists of the following three parts:

- Section A: General information which involves answering some questions about your age, teaching experience etc.
- Section B: Current teaching approaches, assessment and coursework which involves answering some questions about your teaching methods.
- Section C: Perceptions and attitudes towards neuroanatomy which involves answering some questions about your personal view towards neuroanatomy and its place in the medical curriculum

Your participation in this study is voluntary. You can refuse to participate, omit questions or stop at any time without providing any reason. As you do not type your name on the questionnaire, you give us the information anonymously. Once you have submitted the questionnaire, you cannot recall your consent as we will be unable to trace (identify) your information-sheet. Therefore, you will also not be identified as a participant in any publication that results from this study. There is no foreseeable physical discomfort or risk involved. If there are questions that are too sensitive for you to answer, you do not need to answer them. This study may help to make key recommendations towards the formation of a framework for a revised neuroanatomy module for undergraduate medical students, specific to the South African context.

Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus, all information derived from you and all records from this study will be regarded as confidential (which will be depersonalised and anonymous) may be used for e.g. publication, by the researchers. If you have any questions concerning this study, you should contact the primary investigator, Mrs Gerda Venter at (+27)12 319 2536 or gerda.venter@up.ac.za.

If you are lecturing multiple Neuroanatomy modules, in the undergraduate medical curriculum, kindly complete this questionnaire separately for each of your courses.

We sincerely appreciate your help.
Yours truly,
Gerda Venter

Consent to participate in this study:

- I confirm that the person requesting my consent to take part in this study has informed me about the nature and process, any risks or discomforts, and the benefits of the study.
- I have received, read and understood the attached written information leaflet about the study.
- I am aware that the information obtained in the study, including personal details, will be anonymously processed and presented in the reporting of results.
- I am participating willingly.

o I agree (1)
o I do not agree (2)

Q2 The gender I identify with:
o Male (1)
o Female (2)
o Prefer not to answer (3)
o Other (4) _____

Q3 My current age in years:
_____

Q4 The institution where I currently teach neuroanatomy:

- o Sefako Makgatho Health Sciences University (1)
- o University of Cape Town (2)
- o University of KwaZulu-Natal (3)
- o University of Pretoria (4)
- o University of Stellenbosch (5)
- o University of the Free State (6)
- o University of the Witwatersrand (7)
- o Walter Sisulu University (8)
- o University of Limpopo (9)

Q5 My highest qualification: (Select from the list provided)

- o BSc, B, or MBChB degree (1)
- o Honours degree (2)
- o Master's degree (3)
- o Doctorate degree (4)
- o Other (Please specify below) (5)

_____

Q6 I have received / attended formal additional training in a Neuroanatomy course.

- o No (1)
- o Yes (Please elaborate) (2)

_____

Q7 I have received / attended formal additional training in an Educational course.

- o No (1)
- o Yes (Please elaborate) (2)

_____

Q8 I classify myself, based on my teaching experience of Neuroanatomy, as a (Select only the appropriate option)

o Beginner / Novice (1)

o Trainee (2)

o Proficient (3)

o Expert (4)

Q9 Give a short description of the Neuroanatomy course and the year-group of students which you teach. (e.g. Neuroanatomy for MBChB II students) PLEASE REMEMBER TO COMPLETE SEPARATE QUESTIONNAIRES FOR EACH YEAR GROUP / MODULE.

_____

Q10 Is this a stand-alone neuroanatomy module?

o Yes (4)

o No (Please indicate the percentage that neuroanatomy contributes to the overall anatomy module) (5) _____

Q11 Regarding clinical relevance of my Neuroanatomy module,

o I teach clinical relevance in almost every session (1)

o I teach clinical relevance in most of the contact sessions (2)

o I teach clinical relevance in only a few of the contact sessions (3)

o I do not teach clinical relevance in my module (4)

Q12 I do provide the students with a study-guide for this Neuroanatomy module.

o Yes (1)

o No (2)

Q13 If yes, please specify the type of study-guide

o Departmental study-guide (1)

o School published study-guide (2)

o Commercially available study-guide (3)

o Open educational resource guide (OER) (4)

Q14 What is the PRESCRIBED literature for your Neuroanatomy module?

_____

Q15 What is the RECOMMENDED literature for your Neuroanatomy module?

_____

Q16 I provide the students with lecture notes in this Neuroanatomy module.

o Yes (1)

o No (2)

Q17 I recommend the use of the following internet-resources in this Neuroanatomy module. (Select only the appropriate options)

▢ E-books (1)

▢ YouTube videos (2)

▢ Blog articles (grey literature) (3)

▢ Scientific journal articles (4)

▢ Applications on electronic devices (5)

▢ I do not encourage these resources (6)

▢ Anatomy-related websites (7)

▢ Other (Please elaborate) (8)

_____

Q18 How often do you include the use of the following devices, by students, in your facilitation sessions? (Select only the appropriate options)

Smartphone (1)	All contact sessions (1)	Most contact sessions (2)	Few contact sessions (3)	Never (4)
Tablet (2)	All contact sessions (1)	Most contact sessions (2)	Few contact sessions (3)	Never (4)
Laptop (3)	All contact sessions (1)	Most contact sessions (2)	Few contact sessions (3)	Never (4)
Desktop computer (4)	All contact sessions (1)	Most contact sessions (2)	Few contact sessions (3)	Never (4)
Audio response system (clickers) (5)	All contact sessions (1)	Most contact sessions (2)	Few contact sessions (3)	Never (4)

Q19 Which of the following core Neuroanatomy topics (as identified by FIPAE) are included in this Neuroanatomy module? (Select only the appropriate options)

- ▢ Development of the nervous system (1)
- ▢ Histology of the nervous system (2)
- ▢ Spinal cord (3)
- ▢ Brainstem (4)
- ▢ Cranial nerves (5)
- ▢ Diencephalon and the pituitary gland (6)
- ▢ Cerebral hemispheres, limbic system and reticular formation (7)
- ▢ Autonomic system (8)
- ▢ Ventricular system (9)
- ▢ Meninges (10)
- ▢ Blood vessels (11)

Q20 Does your module have a hybrid or blended approach?

- o No (1)
- o Yes (Please elaborate) (3)

_____

Q21 The teaching method(s) included in this Neuroanatomy module is (Select all the appropriate options)

	Lectures with PowerPoint (1)	Lectures without PowerPoint (2)	Practical-lectures (3)	Problem-solving scenarios (4)	Dissections of human cadavers (5)	Dissection video demonstrations (6)	Computer-based practicals / tutorials (7)	Wet specimen / model practicals (8)	Wet specimen / model demonstrations (9)	Self-study (10)	Other (11)	Not applicable (12)
Development of the nervous system (1)												
Histology of the nervous system (2)												
Spinal cord (3)												
Brainstem (4)												
Cranial nerves (5)												
Diencephalon and pituitary gland (6)												
Cerebral hemispheres, limbic system and reticular formation (7)												
Autonomic system (8)												
Ventricular system (9)												
Meninges (10)												
Blood vessels (11)												

Q22 If 'other' is selected, please elaborate.

_____

Q23 The time allocated for the following Neuroanatomy topics is adequate. Also indicate the amount of time spent (in hours) for each topic. (Select only the appropriate options)

	Enough time allocated to topic			Time allocated to topic
	Yes (1)	No (2)	Not applicable (3)	(in hours) (1)
Development of the nervous system (1)				
Histology of the nervous system (2)				
Spinal cord (3)				
Brainstem (4)				
Cranial nerves (5)				
Diencephalon and the pituitary gland (6)				
Cerebral hemispheres, limbic system and reticular formation (7)				
Autonomic system (8)				
Ventricular system (9)				
Meninges (10)				
Blood vessels (11)				

Q24 During assessment, if the Neuroanatomy forms part of a greater anatomy module, which percentage (%) does the Neuroanatomy component contribute to the final mark of this anatomy module?

_____

Q25 I include the following type(s) of assessments in this Neuroanatomy module. (Select all the relevant options)

- ▢ Summative assessment(s) (1)
- ▢ Formative assessment (2)
- ▢ Continuous assessment (3)
- ▢ Portfolios (4)
- ▢ Peer-assessment (5)
- ▢ Programmatic assessment (6)
- ▢ Other (Please elaborate) (7)_____

Q26 In which format(s) is the Neuroanatomy assessment(s) for this course? (Select all the relevant options)

- ▢ Theory MCQ question paper (1)
- ▢ Theory short question written paper (2)
- ▢ Practical (spot) test (3)
- ▢ Computer-based theory test (4)
- ▢ Computer-based practical test (5)
- ▢ Computer-based test (theory and practical combined) (6)
- ▢ Oral assessment (7)
- ▢ Peer-assessment (8)
- ▢ Other (Please specify below) (9) _____

Q27 Indicate your level of agreement. (Select only the appropriate options)

	Strongly agree (1)	Agree (2)	Disagree (3)	Strongly disagree (4)
Neuroanatomy is an important component in my student's medical training. (1)				
Neuroanatomy is necessary for safe medical practice. (2)				
Neuroanatomy is of some use in the clinical setting, but its importance may be exaggerated. (3)				
Neuroanatomy is only of beneficial in certain medical specialities. (4)				
Neuroanatomy is so old-fashioned that it has no importance in contemporary Medicine. (5)				
Neuroanatomy is time wasted in the medical curriculum. (6)				
Neuroanatomy needs to modernise if it is going to be really useful in Medicine. (7)				
A very good doctor must have a good knowledge of Neuroanatomy. (8)				
It is impossible to conceive a good medical training without a major Neuroanatomy component. (9)				
It is not possible to make a reasonable medical diagnosis without a sound knowledge of Neuroanatomy. (10)				
Medicine could not exist without Neuroanatomy. (11)				
Only a limited neuroanatomical knowledge is required for safe medical practice. (12)				
Rather than studying Neuroanatomy, medical students should concentrate on clinical sciences. (13)				
Without a knowledge of Neuroanatomy, the doctor is of limited effectiveness. (14)				

Q28 Please write any suggestions/comments regarding your experience of this Neuroanatomy module in the box below.

_____

APPENDIX C: Student questionnaire

Participant's information & informed consent document

STUDY TITLE: A multi-method study to explore perceptions and attitudes towards neuroanatomy in an undergraduate medical curriculum

PRINCIPAL INVESTIGATOR: Mrs Gerda Venter, Student number: 23082471
SUPERVISORS: Dr JC Lubbe and Prof MC Bosman
INSTITUTION: Department of Anatomy, University of Pretoria

Dear Student

I am a PhD student in the Department of Anatomy, University of Pretoria. You are invited to volunteer to participate in my research project, by completing the following questionnaire regarding the exploration of perceptions and attitudes of both staff and students towards neuroanatomy in the South African undergraduate medical curriculum. This letter provides you with information to help you decide whether you want to take part in this study. Before you agree you should fully understand what is involved. You should not agree to take part unless you are completely happy about what we are requesting from of you.

The aim of this study is to investigate the attitudes of anatomy lecturers, undergraduate and postgraduate students towards the teaching and learning of neuroanatomy in the medical curriculum. This study will further examine the perception of students on the importance of neuroanatomy as it relates to their future careers as well as the current teaching and assessment practices used by anatomy lecturers at South African Universities.

This study involves answering some questions regarding your personal opinion on the facilitation and learning of neuroanatomy and the relevance of neuroanatomy as part of your medical curriculum.

We would like you to complete an anonymous online questionnaire. This may take about 10 minutes. This will ensure confidentiality and anonymity. The Research Ethics

Committee of the University of Pretoria, Faculty of Health Sciences granted written approval for this study (nr 587/2018). This study has been structured in accordance with the Declaration of Helsinki, of which a copy may be obtained from the primary investigator, should you wish to review it.

This questionnaire consists of the following two parts:

- Section A: General information which involves answering some questions about your age, current year of studies etc.
- Section B: Perceptions and attitudes towards neuroanatomy which involves answering some questions about your personal view on neuroanatomy and its place in the medical curriculum

Your participation in this study is voluntary. You can refuse to participate, omit questions or stop at any time without providing any reason. As you do not write your name on the questionnaire, you give us the information anonymously. Once you have submitted the questionnaire, you cannot recall your consent as we will be unable to trace (identify) your information-sheet. Therefore, you will also not be identified as a participant in any publication that results from this study.

There is no foreseeable physical discomfort or risk involved. If there are questions that are too sensitive for you to answer, you do not need to answer them. This study may help to make key recommendations towards the formation of a framework for a revised neuroanatomy module for undergraduate medical students, specific to the South African context.

Note: The implication of completing the questionnaire is that informed consent has been obtained from you. Thus, all information derived from you and all records from this study will be regarded as confidential (which will be depersonalised and anonymous) may be used for e.g. publication, by the researchers. If you have any questions concerning this study, you should contact the primary investigator, Mrs Gerda Venter at (+27)12 319 2536 or gerda.venter@up.ac.za.

We sincerely appreciate your help.
Gerda Venter

Consent to participate in this study:

- I confirm that the person requesting my consent to take part in this study has informed me about the nature and process, any risks or discomforts, and the benefits of the study.
- I have received, read and understood the attached written information leaflet about the study.
- I am aware that the information obtained in the study, including personal details, will be anonymously processed and presented in the reporting of results.
- I am participating willingly.

o I agree (1)
o I do not agree (2)

Q2 The gender I identify with:
o Male (1)
o Female (2)
o Prefer not to answer (3)
o Other (4) _____

Q3 My current age in years:
_____

Q4 I am currently completing the _____ of my medical degree.
o First year (1)
o Second year (2)
o Third year (3)
o Fourth year (4)
o Fifth year (5)
o Final year (6)

Q5 The neuroanatomy module(s) that I am currently registered for / completed:
_____

Q6 I am repeating this Neuroanatomy module.

o Yes (1)

o No (2)

Q7 Have you done any other Neuroanatomy course(s), excluding the ones in your medical degree?

o Yes (Please specify) (1)_____

o No (2)

Q8 Did you receive a study-guide for your Neuroanatomy modules in your medical degree?

o Yes (1)

o No (2)

o Not in all of the modules (please elaborate) (3) _____

Q9 Did you find the study-guide useful for: (Select the most relevant options)

	Extremely useful (1)	Useful (2)	Somewhat useful (3)	Not useful (4)
Administrative information (1)				
Assessments (2)				
Preparation for contact sessions (3)				
Overview of the syllabus (4)				

Q10 How often did you make use of the following types of study materials to study Neuroanatomy. (Select the most relevant options)

	All the time (1)	Most of the time (2)	Almost never (3)	Never (4)
Prescribed literature (1)				
Recommended literature (2)				
Lecture notes (3)				
Internet resources (4)				
Applications on electronic devices (5)				

Q11 How often did you make use of the following types of electronic devices to study Neuroanatomy. (Select the most relevant options)

	All the time (1)	Most of the time (2)	Almost never (3)	Never (4)
Smartphone (1)				
Hand-held devices (2)				
Laptop (3)				
Desktop computer (4)				

Q12 Indicate your liking / interest in the following Neuroanatomy topics.

(Select the most relevant options)

	Do not like at all (1)	Like a little (2)	Like (3)	Like a lot (4)	Was not covered in this module (5)
Development of the nervous system (1)					
Histology of the nervous system (2)					
Spinal cord (3)					
Brainstem (4)					
Cranial nerves (5)					
Diencephalon and pituitary gland (6)					
Cerebral hemispheres, limbic system and reticular formation (7)					
Autonomic system (8)					
Ventricular system (9)					
Meninges (10)					
Blood vessels (11)					

Q13 Which Neuroanatomy topic is your MOST favourite?

- o Development of the nervous system (1)
- o Histology of the nervous system (2)
- o Spinal cord (3)
- o Brainstem (4)
- o Cranial nerves (5)
- o Diencephalon and pituitary gland (6)
- o Cerebral hemispheres, limbic system and reticular formation (7)
- o Autonomic system (8)
- o Ventricular system (9)
- o Meninges (10)
- o Blood vessels (11)

Q14 Please supply the reason for choosing this specific topic as your MOST favourite (in the box below).

_____

Q15 Which Neuroanatomy topic is your LEAST favourite?

- o Development of the nervous system (1)
- o Histology of the nervous system (2)
- o Spinal cord (3)
- o Brainstem (4)
- o Cranial nerves (5)
- o Diencephalon and pituitary gland (6)
- o Cerebral hemispheres, limbic system and reticular formation (7)
- o Autonomic system (8)
- o Ventricular system (9)
- o Meninges (10)
- o Blood vessels (11)

Q16 Please supply the reason for choosing this specific topic as your LEAST favourite (in the box below).

_____

Q17 In your opinion, was enough time allocated to the following Neuroanatomy topics? (Select only the appropriate boxes)

	Yes (1)	No (2)
Development of the nervous system (1)		
Histology of the nervous system (2)		
Spinal cord (3)		
Brainstem (4)		
Cranial nerves (5)		
Diencephalon and pituitary gland (6)		
Cerebral hemispheres, limbic system and reticular formation (7)		
Autonomic system (8)		
Ventricular system (9)		
Meninges (10)		
Blood vessels (11)		

Q18 Please evaluate the following teaching approaches for Neuroanatomy according to your liking / interest. (Select only the appropriate boxes)

	Do not like at all (1)	Like a little (2)	Like (3)	Like a lot (4)	Not used in this module (5)
Lectures with PowerPoint presentations (1)					
Lectures without PowerPoint presentations (2)					
Video demonstrations (3)					
Wet specimens / models demonstrations by a staff member (4)					
Computer-based practicals / tutorials (5)					
Dissection of human cadavers (6)					
Wet specimens / models practicals (7)					
Practical and lecture combined into a single session (8)					
Problem-solving scenarios (9)					
Self-study (10)					
Tutor classes (11)					
Other (12)					

Q19 If 'other' was selected, please specify. (Write your answer in the box below)

_____

Q20 Which teaching approach, for Neuroanatomy, was your MOST favourite? (Select only the appropriate box)

- o Lectures with PowerPoint presentations (1)
- o Lectures without PowerPoint presentations (2)
- o Video demonstrations (3)
- o Wet specimens / models demonstrations by a staff member (4)
- o Computer-based practicals / tutorials (5)
- o Dissection of human cadavers (6)
- o Wet specimens / models practicals (7)
- o Practical and lecture combined into a single session (8)
- o Problem-solving scenarios (9)
- o Self-study (10)
- o Tutor classes (11)
- o Other (please specify) (12) _____

Q21 Please supply the reason for choosing this specific approach as your MOST favourite (in the box below).

_____

Q22 Which teaching approach was your LEAST favourite? (Select only the appropriate box)

- o Lectures with PowerPoint presentations (1)
- o Lectures without PowerPoint presentations (2)
- o Video demonstrations (3)
- o Wet specimens / models demonstrations by a staff member (4)
- o Computer-based practicals / tutorials (5)
- o Dissection of human cadavers (6)
- o Wet specimens / models practicals (7)
- o Practical and lecture combined into a single session (8)
- o Problem-solving scenarios (9)
- o Self-study (10)
- o Tutor classes (11)
- o Other (please specify) (12) _____

Q23 Please supply the reason for choosing this specific approach as your LEAST favourite (in the box below).

_____

Q24 Regarding your attendance in this Neuroanatomy module: (Tick only the appropriate boxes)

	All the time (1)	Most of the time (2)	Half the time (3)	Almost never (4)	Never (5)	Not applicable for this module (6)
How often did you attend the Neuroanatomy lectures? (1)						
How often did you attend the Neuroanatomy practicals? (2)						
How often did you attend the Neuroanatomy practical-lectures? (3)						
How often did you attend the additional tutor classes / supplementary instruction sessions? (4)						

Q25 Indicate your level of agreement. (Select only the appropriate options)

	Strongly agree (1)	Agree (2)	Disagree (3)	Strongly disagree (4)
Neuroanatomy is an important component in my medical training. (1)				
Although Neuroanatomy is interesting, this subject needs selective understanding in the clinical setting. (2)				
Neuroanatomy is necessary for safe medical practice. (3)				
Neuroanatomy is of some use in the clinical setting, but its importance may be exaggerated. (4)				
Neuroanatomy is only beneficial in certain medical specialities. (5)				
Neuroanatomy is so old-fashioned that it has no importance in contemporary Medicine. (6)				
Neuroanatomy is time wasted in the medical curriculum. (7)				
Neuroanatomy needs to modernise if it is going to be really useful in Medicine. (8)				
A very good doctor must have a good knowledge of Neuroanatomy. (9)				
It is impossible to conceive a good medical training without a major Neuroanatomy component. (10)				
It is not possible to make a reasonable medical diagnosis without a sound knowledge of Neuroanatomy. (11)				
Medicine could not exist without Neuroanatomy. (12)				
Only a limited neuroanatomical knowledge is required for safe medical practice. (13)				
Rather than studying Neuroanatomy, medical students should concentrate on clinical sciences. (14)				
Without a knowledge of Neuroanatomy, the doctor is of limited effectiveness. (15)				

Q26 Please write comments regarding your Neuroanatomy experience in the box below.

_____

Q27 Please write any suggestions for the Neuroanatomy lecturers in the box below.

_____

APPENDIX D: Interview guide (Chapter 5)

1. Did you receive additional formal educational training?
2. How long have you been teaching anatomy (neuroanatomy)?
3. Do you teach students at basic sciences level?
4. Do you provide your students with lecture notes?
    a. Why? / Why not?
5. Do you recommend internet resources to your students, besides their textbooks?
    a. YouTube videos, anatomy websites, scientific journals, apps etc
    b. Why / why not?
6. Do you encourage the use of electronic devices, by your students, during contact sessions?
    a. Smartphones, tablets, laptops, clickers
7. How do you teach anatomy (neuroanatomy) to your students?
    a. Lectures in PPT, practicals in DH, practical-lectures, near-peer teaching
8. What is your favourite neuroanatomy topic to teach?
    a. Why?
9. How do you currently feel about neuroanatomy in the medical curriculum at your institution?
    a. Enough time allocated
    b. Enough emphasis
    c. Do you experience it at your institution?
10. Advice for me for this study?
11. Can you recommend anyone that I can contact for an interview?

Appendix E: Medical Teacher Journal guidelines (Chapter 2)

Medical Teacher considers all manuscripts on the strict condition that they are the property (copyright) of the submitting author(s), have been submitted only to Medical Teacher, that they have not been published already, nor are they under consideration for publication, nor in press elsewhere. Authors who fail to adhere to this condition will be charged all costs which Medical Teacher incurs, and their papers will not be published. Copyright will be transferred to the journal Medical Teacher and Taylor and Francis, if the paper is accepted. Medical Teacher considers all manuscripts at the Editors' discretion; the Editors' decision is final.

Manuscript Categories

Medical Teacher invites the following types of submissions;

Articles*

Articles are the primary presentation mode of communication in the Journal, and are usually between 2500–5000 words in length. All articles must include abstracts, practice points and notes on contributors. Glossary terms should be added if appropriate (see below for further details).

Short Communications

Short communications are brief articles on matters of topical interest or work in progress, limited to a maximum of 1700 words to include title, notes on contributors, abstract, text, references and one small table (optional).

Letters to the Editor

Letters should be a maximum of 400 words in length, including title, text, name and address of author(s), and maximum two references. Tables and figures are not permitted.

Personal View

Personal View articles address a topic in the area of medical/healthcare professions education that is likely to be of interest to Medical Teacher readers. They present and reflect the author's personal experience or viewpoint relating to the topic.

Around the World

Each paper in this feature area focuses on a particular country or region to look at medical education worldwide. The aim is to describe medical education from a wide group of countries; to demonstrate the positive and negative attributes of each country's educational system, from the perspectives of undergraduate, postgraduate and continuing professional development perspectives and to provide a starting point for future discussions. They should enable the reader to gain a greater knowledge of the problems faced and hopefully encourage a more structured and supportive approach to the globalisation of medical education. Papers should be around 3000 - 4500 words in length.

Commentaries

Commentaries/editorials are usually invited but we welcome unsolicited submissions too. Editorials are meant to reflect the views of the author, while reflecting what has already been written on the topic.

Manuscript Submission

All submissions should be made online at Medical Teacher's ScholarOne Manuscripts site. New users must first create an account. Once a user is logged onto the site, submissions should be made via the Author Centre. For assistance with any aspect of the site, please refer to the User Guide which is accessed via the 'Get Help Now' button at the top right of every screen.

A covering letter or email should be included indicating that the submission is made on behalf of all authors, although it is not necessary for each author to sign the letter. On receipt, the manuscript will be immediately acknowledged by email.

Manuscript preparation

Style Guidelines Please refer to the quick style guidelines when preparing your paper, rather than any published articles or a sample copy.

References

The reference style for Medical Teacher is T&F Standard CSE.

Title page

The first page of the manuscript should contain the following information:

i) the title of the paper

ii) a short title not exceeding 45 characters for use as a running head

iii) names of authors

iv) names of the institutions at which the research was conducted

v) name, address, telephone and fax number, and email address of corresponding author.

Abstract

All papers should be accompanied by an abstract of up to 200 words. The abstract should reflect the content of the paper including methods used, results, and conclusions drawn.

Text

This should in general, but not necessarily, be divided into sections with the headings: ‘Introduction’, ‘Methods’, ‘Results’, ‘Discussion’ and ‘Conclusion’.

Practice Points

Up to 5 short bullet points which summarise the key messages of the article should be included (not required for short communications). ‘Practice Points’ will be included in a box at the end of the article.

Notes on Contributors

All articles should be accompanied by ‘Notes on contributors’, short biographical notes on each contributor to a maximum of 50 words per contributor.

Glossary Terms

If you feel that there are terms or concepts central to your paper that the reader may not be familiar with, please include definition of these terms, giving if possible a reference. Your definitions will then be added in a box at the end of your paper and added to the MedEdWorld glossary.

Illustrations and tables Illustrations and tables should not be inserted in the appropriate place in the text but should be included at the end of the paper, each on a separate page.

Tables should be given Arabic numbers (e.g. Table 3), and their desired position in the text should be indicated. Tables should be used only when they can present information more efficiently than running text. Care should be taken to avoid any arrangement that unduly increases the depth of a table, and the column heads should be made as brief as possible, using abbreviations liberally. Lines of data should not be numbered nor run numbers given unless those numbers are needed for reference in the text. Columns should not contain only one or two entries, nor should the same entry be repeated numerous times consecutively. Units should appear in parentheses in the column heading but not in the body of the table. Words or numerals should be repeated on successive lines; 'ditto' or 'do' should not be used. Tables should be typed using single-spacing.

All photographs, graphs and diagrams should be referred to as Figures and should be numbered consecutively in the text in Arabic numerals (e.g. Figure 3). A list of captions for the figures should be submitted on a separate sheet (or where figures are uploaded as separate files, captions can be entered during the electronic submission process) and should make interpretation possible without reference to the text. Captions should include keys to symbols. Avoid the use of colour and tints for purely aesthetic reasons. Figures should be produced as near to the finished size as possible. All files must be 300 dpi or higher. Please note that it is in the author's interest to provide the highest quality figure format possible.

Any part of the manuscript labelled 'Appendix' or any table that is likely to take up more than one page in the journal will be published online as Supplemental Material, and will not appear in the print version of the journal. Supplemental Material is not typeset but is published in the form submitted by the author.

Please do not hesitate to contact the Publisher’s Production Department if you have any queries.

Acknowledgments and Declaration of Interest sections

Acknowledgments and Declaration of interest sections are different, and each has a specific purpose. The Acknowledgments section details special thanks, personal assistance, and dedications. Contributions from individuals who do not qualify for authorship should also be acknowledged here. Declarations of interest, however, refer to statements of financial support and/or statements of potential conflict of interest. Within this section also belongs disclosure of scientific writing assistance (use of an agency or agency/ freelance writer), grant support and numbers, and statements of employment, if applicable.

Acknowledgments section

Any acknowledgments authors wish to make should be included in a separate headed section at the end of the manuscript preceding any appendices, and before the references section. Please do not incorporate acknowledgments into notes or biographical notes.

Declaration of Interest section

All declarations of interest must be outlined under the subheading “Declaration of interest”. If authors have no declarations of interest to report, this must be explicitly stated. The suggested, but not mandatory, wording in such an instance is: The authors report no declarations of interest. When submitting a paper via ScholarOne Manuscripts, the “Declaration of interest” field is compulsory (authors must either state the disclosures or report that there are none). If this section is left empty authors will not be able to progress with the submission.

Please note: for NIH/Wellcome-funded papers, the grant number(s) must be included in the Declaration of Interest statement.

Additional Information Upon Acceptance

Electronic proofs When proofs are ready, corresponding authors will receive email notification with a password and Web address from which to download a PDF. Hard copies of proofs will not be mailed. To avoid delays in publication, corrections to proofs must be returned within 48 hours, by electronic transmittal, fax or mail.

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Contacting the Editorial Office

For further clarification on any of the above, contact the Editorial Office at medicalteacher@dundee.ac.uk or Pat Lilley, Managing Editor, Medical Teacher

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APPENDIX F: Anatomical Sciences Education guidelines (Chapter 3)

Anatomical Sciences Education offers an international forum for the exchange of ideas, opinions, innovations, and evidence-based research on topics related to education in the anatomical sciences of gross anatomy, embryology, histology, neurosciences, biomedical and life sciences. The journal covers all levels of anatomical sciences education including, undergraduate, graduate, post-graduate, allied health, veterinary, medical (both allopathic and osteopathic), and dental. The journal welcomes submissions from these fields of study:

- general education as it relates to anatomical sciences
- education technology, pedagogical advancements, and innovations
- ethics and humanity as it relates to anatomical sciences and body donation
- teaching of non-technical skills in anatomy sciences education
- assessments of knowledge and skills in anatomical sciences
- application of anatomical knowledge in clinical training/education

Submission of manuscripts

All submissions are required to be made online at the Anatomical Sciences Education Manuscript Central site (http://mc.manuscriptcentral.com/ase). If you are submitting for the first time, and you do not have an existing account, create a new account. Returning users should check for an existing account.

Once you are logged onto the site, submission should be made via the Author Center page. Submit your manuscript and all figures as separate files. You do not need to mail any paper copies of your manuscript. At the end of a successful submission, a confirmation screen with manuscript number will appear and you will receive an e-mail confirming that the manuscript has been received by the journal. If this does not happen, please check your submission and/or contact technical support at ts.mcsupport@clarivate.com .

Only manuscripts written in acceptable English (US spelling) will be considered. If the author does not have English-writing skills equivalent to that of a native English speaker, the manuscript should be appropriately edited prior to submission to avoid rejection based on unacceptable writing. Manuscripts should be as concise as possible, and all

authors must approve submitted manuscripts. Manuscripts must be original and must not have been published previously either in whole or in part, except in abstract form, and must not be under consideration by any other journal.

Notice of Wiley's Compliance with NIH Grants and Contracts Policy. Recently, the National Institutes of Health (NIH) has requested that its grantees submit copies of manuscripts upon their acceptance for publication to PubMedCentral (PMC), a repository housed within the National Library of Medicine. On behalf of our authors who are also NIH grantees, Wiley will deposit in PMC, at the same time that the article is published in our journal, the peer-reviewed version of the author's manuscript. Wiley will stipulate that the manuscript may be available for ''public access'' in PMC 12 months after the date of publication. By assuming this responsibility, Wiley will ensure that authors are in compliance with the NIH request, as well as make certain the appropriate version of the manuscript is deposited. When an NIH grant is mentioned in the Acknowledgments or any other section of a manuscript, Wiley will assume that the author wants the manuscript deposited into PMC, unless the author states otherwise. The author can communicate this via email, or a note in the manuscript. The version of the manuscript that Wiley sends to PMC will be the accepted version; for example, the version that the journal's Editor-in-Chief sends to Wiley for publication. Wiley will notify the author when the manuscript has been sent to PMC. Wiley reserves the right to change or rescind this policy. For further information, please get in touch with your editorial contact at Wiley, or see the NIH Policy on Public Access, located at https://publicaccess.nih.gov/policy.htm.

Review and Publication We strive for speedy review and rapid publication of accepted papers. On the average, the first decision on a submitted manuscript occurs within about 4 weeks of initial submission. Publication online occurs about 6–8 weeks after acceptance and in print copy within 2 months. Manuscripts requiring revisions must be resubmitted within three months of the decision date, to be considered as a revised manuscript rather than as a new manuscript requiring full review.

Ethical approval for studies involving human participants

Anatomical Sciences Education adheres to the policies regarding the treatment of human participants endorsed by the International Committee of Medical Journal Editors

(ICMJE) (http://www.icmje.org/). Research carried out on human participants must be in compliance with the Helsinki Declaration (https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human subjects/). Therefore for any research studies or evaluations involving human participants (including students, residents, fellows and faculty members), authors need to provide information regarding ethical approval for the research presented in the manuscript. A statement to this effect must be incorporated into the ‘‘Materials and Methods’’ section and should include the name of the approving committee (e.g., Institutional Review Board, Ethics Committee on Human Research, etc.), the name of the institution at which approval was granted and a reference number where appropriate. At many institutions in the United States, a decision of ‘‘exempt’’ is made by an Institutional Review Board (IRB) or by an individual designated by the institution.

Types of manuscripts considered for publication

Research Report.*

These can be of any length, ranging from short communications to comprehensive studies. The text of the manuscript should be organized with an introduction, material and methods, results, discussion (containing limitation to the study), conclusions, and literature cited section. The Abstract and Notes on Contributors sections are required.

Descriptive Articles.

Descriptive articles cover topics of general interest and concern to educators in the anatomical sciences. Such topics include descriptions of innovative programs, advances in educational technologies and discussions of activities affecting anatomical sciences education. The text of these articles should include an introduction, a description and a discussion. Descriptive articles are typically 4 to 6 journal pages (950 words per page) in length. The Abstract and Notes on Contributors sections are required.

Relevant Reviews.

These can be short perspective-type reviews or longer comprehensive systematic reviews generally ranging from 3 to 15 journal pages (950 words per page). The text of the review should be organized appropriately for the topic and include introduction, short perspectives (conclusions) or future directions section at the end. The Abstract and Notes on Contributors sections are required.

Short Communications.

These can be in the form of a descriptive article or a research report and typically is 2 to 4 journal pages (950 words per page) in length. The text of these manuscripts should be organized appropriately and follow research report or descriptive article templates. The Abstract and Notes on Contributors sections are required.

Viewpoint Commentaries.

These are opinion pieces about issues that directly affect or influence anatomical sciences education. The text of these pieces should be organized appropriately for the topic and their length should be 1 to 3 journal pages (950 words per page).

Editorials.

These typically consist of 1 to 2 journal pages (950 words per page) and usually do not have subheadings. The Abstract and Notes on Contributors sections are not required.

Letters to the Editor.

These can be written as responses to articles published in the journal, replies to other letters, or to discuss issues of importance to anatomical sciences education. These letters are typically 1 to 2 journal page in length (950 words per page) and do not have subheadings, figures, or tables. The Abstract and Notes on Contributors sections are not required.

Manuscript preparation

The manuscript should have uniform style and the file be saved in the native format of the word processor software used. The text should be typed in single-column format using double-spacing (except tables), with margins of at least 1 inch (2.5 cm). All pages should be numbered. Manuscript should be as concise as possible without omitting relevant results. Literature surveys, overly detailed methods, or extensive bibliographies will not be published.

Use standard abbreviations and units. Abbreviations and style of references are contained in the current edition of the CBE style manual (sixth edition, 1994, Council of Biology Editors, Inc. Suite 230 N. Michigan Ave., Chicago, IL 60601). Spelling reference

is to the current edition of Webster's International Dictionary. If necessary to use, spell out all nonstandard abbreviations the first time used. In items of anatomical nomenclature, this journal adheres to the principles specified in Terminologia Anatomica, Terminologia Histologica, and Nomina Embryologica where appropriate. The manuscript should be subdivided into the following sequence with each section beginning on a new page:

Title page:

It should be the first page of the manuscript and should include:

- Title of paper. Title should be concise and informative to a general readership. Avoid abbreviations and formulas where possible.
- Full name of author(s). Clearly indicate the given (first) name(s), middle initials, and family (last) name(s) of each author and check that all names are accurately spelled.
- Current institutional affiliation for each author including name of department, university/ college, city, and state. For foreign affiliations add country of authors' home institution.
- Running title not to exceed 45 characters and spaces
- Individual to whom correspondence concerning manuscript should be sent that includes complete postal address and e-mail address of the corresponding author.
- All grant information in the following format: Grant sponsor _____; Grant number: _____.

Abstract:

It should concisely and briefly state the relevant background, purpose of the research, the principal results and major conclusions in a way that is accessible to a broad audience without reference to the rest of the paper.

- The abstract must be written in past tense, third person and in complete sentences. As the abstract is made available through other services, it should be a single paragraph of 250 words or less that will serve in lieu of a concluding summary. It should not contain author/date reference citations.
- Append three to eight key words at the end of the abstract for the purposes of citing your work by the secondary services.

Text:

It should be written in a scholarly scientific language in past tense and third person. Text should be divided into sections appropriate for the type of manuscript being submitted. Do not incorporate tables, figures or figure legends in the body of text. They should be submitted as separate files (see section below). Also all website (URL) addresses need to be placed in the format of bibliographical entries in the ‘‘Literature Cited’’ section with corresponding in-text citations. At acceptance of the manuscript, the authors must submit the final revised version of an accepted manuscript (text, tables, and illustrations) online. Text files must be submitted as .doc or .rtf files.

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Notes on Contributors:

This section should contain short biographical notes on each contributor to a maximum of 50 words per contributor. It should contain contributor’s first and last name (in capital letters), academic degree, title, affiliation and location of title and position in the organization/university (for US locations list town and spelled out name of the state; for international locations list town and country). Please use the format given below.

NIRUSHA LACHMAN, Ph.D. is a professor of anatomy in the Department of Anatomy at Mayo Clinic College of Medicine and Science, Mayo Clinic in Rochester, Minnesota. She teaches anatomy and histology to first year medical students and clinical anatomy to residents, fellows, and clinicians. Her research interest is in medical education and reconstructive surgery.

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Reference should be made only to articles that are published or in press. There is no limit on the number of citations allowed; cite recent literature comprehensively. Unpublished results and personal communications should not be cited. Authors are responsible for the accuracy of the references. Begin the list of references on a new page entitled ‘‘Literature cited.’’ In the final citation list, arrange references alphabetically listing all authors, then year of publication and abbreviated journal names. Complete author citation is required (use of ‘‘et al’’ is not acceptable).

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  Citations to articles in journals and periodicals should include all authors’ names (‘‘et al’’ is not acceptable); year of publication; article title; abbreviated title of journal or periodical according to IndexMedicus; volume number; and first and last page number. Please use the format given below.

  McMenamin PG, Quayle MR, McHenry CR, Adams JW. 2014. The production of anatomical teaching resources using three-dimensional (3D) printing technology. Anat Sci Educ 7:479–486.

  For articles in press authors should add immediately after the citation the following phrase in parenthesis: (in press; followed by the doi number of the article). Please use the format provided below.

  Zureick AH, Burk-Rafel J, Purkiss JA, Hortsch M. 2018. The interrupted learner: How distractions during live and video lectures influence learning outcomes. Anat Sci Educ (in press; doi: 10.1002/ase.1754).

- Book Chapters and Edited Collections

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collection; place of publication (for US publishers: town and abbreviated state; for international publishers: town and country); publisher and first and last page numbers.

Baldwin DC Jr, Daugherty SR. 2006. Using surveys to assess professionalism in individuals and institutions. In: Stern DT (Editor). Measuring Medical Professionalism. 1st Ed. New York, NY: Oxford University Press, Inc. p 95–116.

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  Citation to entire books should include the author's name; year of publication; title; edition number; place of publication (for US publishers: town and abbreviated state; for international publishers: town and country); publisher; and total number of pages. Please use the format given below.

  Greenhalgh T, Robert G, Bate P, Macfarlane F, Kyriakidou O. 2005. Diffusion of Innovations in Health Service Organisations: A Systematic Literature Review. 1st Ed. Oxford, UK: Blackwell Publishing Ltd. 328 p.

- Dissertations/Thesis

  Citation to scientific dissertations/thesis should include the author's name; year of defense; title of dissertation; name of the university, location (for US: town and abbreviated state; for international locations: town and country); type of dissertation or thesis, and total number of pages. Please use the format given below.

- Conference Abstracts and Proceedings

  Citations to abstracts or articles in conference proceedings should include the author's name; year of publication; abstract title; editor's name (if any); title of proceedings; conference place; conference date, first and last page numbers or abstract identification number; publisher and/ or organization from which the proceedings can be obtained; location of the office. Please use the format given below.

  Pawlina W, Blankers TR, Lachman N, Bhagra A. 2016. Collaborative ultrasound objective structural practical examination (OSPE) in gross anatomy. In: Abstracts of AMEE 2016 Conference; Barcelona, Spain, 2016 August 28–31. Abstract

9FF04. Association for Medical Education in Europe: Dundee, Scotland, UK.

For abstracts printed in journals and periodicals include the author's names; year of publication; abstract title; abbreviated title of the journal or periodical according to Index Medicus; volume number; and abstract identification number or inclusive pages. Please follow the format given below.

Brokaw JJ, Jones KJ. 2014. Outsourcing anatomists: A model for expanding educational outreach and providing supplemental revenue to anatomy departments. FASEB J 28:S721.22.

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  Non-periodical documents on the Internet, such as electronic catalogs, databases, electronic conference proceedings, abstracts and papers in electronic journals, and other stable (not continually updated) documents available online should be listed in the literature cited list in the same manner as other citation followed by the location (town and state) of the organization/publisher/university that owns the web site, the URL, and accessed date. Citations of electronic journals should follow normal journal format, omitting page number if none are used, followed by the URL and accessed date. For materials that appear in both electronic and print format, the citation information from the print format should always be used. It may be supplemented with electronic citation. Please use the format given below.

  Acland RD. 2013. Acland's Video Atlas of Human Anatomy. Wolters Kluwer Health/Lippincott, Williams & Wilkins, Baltimore, MD. URL: http://aclandanatomy.com/ [accessed 13 October 2016].

In-Text Citations

All references should be cited parenthetically in the text at least once, and include the first author's last name and publication year arranged chronologically, then alphabetically. When there are more than two authors, use the first author's name followed by ''et al''. Citations for published papers by different authors within the same parentheses should be separated by a semicolon. When references are made to more than one paper by the same author, published in the same year,

the reference, both in the text and in the citation list should be designated by consecutive lower case letters as a, b, c, etc.

Example: In the last few years, medical schools have been adopting TBL in preclinical courses (Siedel and Richards, 2001; McInerney, 2003; Nieder et al., 2005), clerkships, and resident training (Hunt et al., 2003a,b).

Footnotes: The only footnotes should be associated with tables. Do not use other footnotes; instead, place all textual information within the manuscript. All references should be placed in the proper form in the appropriate section of the manuscript.

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Each table must have a self-explanatory title, be numbered in order of appearance with Arabic numerals and be cited at an appropriate point in the text. Tables should be constructed in the simplest format possible, in black and white with all external and internal border lines visible for clear divisions between table cells. They are intended to show comparisons of data that are too cumbersome to describe in the text; they should not merely repeat text information. Every table column, including subcolumns should have a heading. All abbreviations used in the table should be explained in the table footnote. If a manuscript is accepted for publication, the tables will be reformatted by ASE's graphic designer. Tables must be submitted as separate (.doc) or (.rtf) files.

Figures:

At acceptance of the manuscript, the authors must submit the final revised version of illustrations online. Figures need to be cited at an appropriate point in the text.

- Figures must be submitted as .tif or .eps files. Do not submit PDFs, jpegs, or PowerPoint files. Please select LWZ compression (an option in the ''save'' process of programs such as Photoshop) when saving your figures. This is a lossless compression routine that reduces the size of your figures without compromising their quality.
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Supplementary Materials (if applicable):

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A cover letter must accompany the submission and should provide the following information:

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Contacting editorial offices

For further help in understanding and clarification on any of the issues discussed in the "Instructions to Authors" please contact the Anatomical Sciences Education Editor-in-Chief:

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APPENDIX G: Medical Education Journal guidelines (Chapter 4)

Medical Education is an international peer-reviewed, journal with distribution to readers in more than 80 countries. The journal seeks to enhance its position as the pre-eminent journal in the field of education for health care professionals and aims to publish material of the highest quality reflecting worldwide or provocative issues and perspectives. The contents will be of interest to learners, teachers and researchers. It aims to have a significant impact on scholarship in medical education and, ultimately, on the quality of health care by prioritising papers that offer a fundamental advance in understanding of educationally relevant issues. The journal welcomes papers on any aspect of health professional education.

In the interests of supporting authors, being as transparent as possible, and offering easy access to relevant information, we provide our author guidelines in two parts: (1) A quick and simple answer to frequently asked questions for those who are more familiar with publishing practices; and (2) A more complete set of answers that can be read by clicking on the hyperlinks. We encourage authors to read the more extensive information to maximize their chances of success when submitting to Medical Education, but hope that the brief responses below provide a foothold for those looking simply for the key details.

Things to know prior to submission

What types of papers do you publish?

We strive to be a research journal first and foremost and, as such, prioritize articles that argue from the basis of both strong empirical findings and conceptual grounding.

Original research*

Generally less than 3,000 words, but longer papers will be accepted if the context warrants the inclusion of more text (see Med Educ 2010; 44:432). An abstract, structured under subheadings, of no more than 300 words must be included and the paper should contain a maximum of five tables or figures with references included in the Vancouver style. The paper will usually be organised using the Introduction, Methods, Results, and Discussion (IMRAD) structure. The introduction should include a strong conceptual framework that indicates how publication of the paper can be expected to fill a gap in knowledge that is important for the field to fill. The context of the work and your choice

of methods must be made clear. Qualitative and quantitative research approaches are equally welcome. All papers must also clearly articulate how the findings should be interpreted and how they advance understanding of the issue under study. See Med Educ 2009; 43:294-6.

What do I need to do to prepare my manuscript?

Pay particular attention to your title and abstract. They alone should clearly make your case for why your manuscript is important, timely, and relevant to our broad readership. Double check the formatting requirements and prepare an anonymous version of your manuscript for submission to peer review.

A checklist to assist in the preparation of the manuscript for submission and the guidelines for authors are available by clicking 'instructions and forms' on http://mc.manuscriptcentral.com/medicaleducation

Formatting Requirements

Front Matter

Authors should restrict titles to 15 words or fewer (90 characters including spaces), and the editor reserves the right to edit titles. Most manuscripts should also include a structured (i.e., sub-titled) abstract of up to 300 words.

Main text

We encourage the use of the active voice, short sentences and clear sub headings throughout the text. The manuscript should include a wide margin (at least 3 cm) on either side. All pages should be numbered. Do not use abbreviations without first defining the abbreviation in full. All scientific units should be expressed in SI units. Both numbers and percentages should be given (not percentages alone) when relevant. Where statistical methods are used in analysis their use should be explained in the setting of the study and an appendix given if the method is particularly unusual or complex. For all research-oriented manuscripts a consideration of the strengths and weaknesses of the approach used should be included.

End-Matter

Where figures, tables or illustrations from other publications have been used, appropriate permissions should be obtained prior to submission. Referencing should be double spaced using the Vancouver style. Authors are advised to consult the BioMedical Editor (http://www.biomedicaleditor.com/vancouver-style.html) for details of the Vancouver reference style. Additional illustrations/appendices can be published on-line as supplementary material.

References

When citing articles available as preprints, which have not yet been published, the designation "[preprint]" should be included in the reference.

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As the ultimate goal is to get your work read, consider strategies for Search Engine Optimization. Enabling people to read your manuscript is critically important to raise the visibility of your work and to improve your claims of impact. To this end, you should take steps to maximize the discoverability of your manuscript in anticipation of its publication. Details regarding how to do so can be found here, but the key tips include: 1) Incorporate key phrases in the first 65 characters of your title; 2) Deliberately embed phrases others are likely to use to search for your manuscript in your abstract multiple times (when possible to do so naturally); 3) Use headings that provide guidance regarding the content of your article.

What are my responsibilities with respect to publication ethics?

Authors should take care to avoid duplicate submission, duplicate publication, 'salami slicing' (i.e., cutting one project into many pieces to increase publication rate), and plagiarism (self- or other-). If you are unsure, describe potential issues in your cover letter - transparency is your best protection. For detailed instructions click here

The submission process

What additional information will the journal require?

During the submission process, you must indicate how all authors meet the ICMJE criteria for authorship. It is insufficient to say that authors meet criteria 1, 2, 3 & 4.

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How do I submit my manuscript?

Once it is properly formatted and all authorship issues have been resolved, please submit through our author portal at https://mc.manuscriptcentral.com/medicaleducation

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APPENDIX H: Teaching and Learning in Medicine guidelines (Chapter 5)

Teaching and Learning in Medicine is an international, peer-reviewed journal publishing high-quality, original research. Please see the journal's Aims & Scope for information about its focus and peer-review policy. Please note that this journal only publishes manuscripts in English.

Teaching and Learning in Medicine accepts the following types of article:

- Groundwork
- Validation
- Investigations
- Educational Case Reports *
- Observations

TLM's final acceptance rate is approximately 9%. Manuscripts are first reviewed by the editors to determine prioritization for peer review. Approximately 30% of new submissions are sent out to review. To increase the likelihood that a manuscript will be prioritized for review, authors must compose manuscripts using the content and formatting guidelines provided in these instructions. Manuscripts not submitted in conformance with these guidelines will be returned without review.

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Preparing Your Paper

Educational Case Reports

- Should be written with the following elements in the following order: title page; abstract; keywords; main text; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual

pages); figures; figure captions (as a list)

- Should contain a structured abstract of 500 words. Abstract should be free of references or abbreviations, using the following format presented below. The body of the manuscript need not conform to the structure of the abstract.
  - Problem (Briefly state the practical learning or performance gap addressed by the intervention and how the present intervention addresses this gap in a novel way)
  - Intervention (Briefly describe the intervention, specifying why it addresses the practical problem and improves upon previous approaches)
  - Context (Briefly summarize the context in which the intervention was implemented)
  - Impact (Briefly describe what happened to BOTH educational process AND outcomes when the intervention was implemented)
  - Lessons Learned (Briefly summarize the lessons learned that other educators can use when attempting to address a similar practical problem – note this is not a summary of impact, but a reflection on what was learned about implementing the intervention)
- Should contain between 3 and 5 keywords. Read making your article more discoverable, including information on choosing a title and search engine optimization.
- The practitioner's personal experience with teaching and learning can provide valuable information about the context to which some researchers expect their findings to apply. Educational Case Reports present detailed reflections on educational interventions, including novel approaches to instruction, assessment, and admissions/selection. These articles document in-depth what was tried, why, and under what conditions and present a process and outcome analysis of impact as well as lessons learned. Taken together, Educational Case Reports should reveal trends in educational need and everyday factors that influence what and how health professionals learn. Educational Case Reports go beyond "Did it work?" to explore how interventions function and the boundaries of their scalability (see Haji, Morin, & Parker, 2013 – "Rethinking programme evaluation").

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The reporting of results from all statistical testing must conform to American Psychological Association (APA) formatting requirements. Asterisks should be used within the text for footnotes.

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TLM does not have a word limit for submitted manuscripts.

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For single agency grants

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8. Figures. Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for color, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PDF, PS, JPEG, TIFF, or Microsoft Word (DOC or DOCX) files are acceptable for figures that have been drawn in Word. For information relating to other file types, please consult our Submission of electronic artwork document.
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