CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

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DECLARATION

I hereby declare that the compilation of this dissertation is the result of my own, independent investigation. I have endeavoured to use the research sources cited in the text in a responsible way and to give credit to the authors and compilers of the references for the information provided, as necessary. I have also acknowledged those persons who have assisted me in this endeavour. I further declare that this work is submitted for the first time at the University and Faculty for the purpose of obtaining a Master's degree in Health Professions Education and that it has not previously been submitted to any university or faculty for the purpose of obtaining a degree. I also declare that all information provided by study participants will be treated with the necessary confidentiality.

21/01/2020

Ms M Louw Date

I hereby cede copyright of this product in favour of the University of the Free State.

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DEDICATION

I would like to dedicate this dissertation to my family, my husband and children for giving me the time and support to work on my master's degree and achieving my dream.

" *I cannot teach anybody anything, I can only make them think"*

Socrates

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LIST OF ACRONYMS AND ABREVIATIONS

AHP	Allied health professions
AHPCSA	Allied health professions Council of South Africa
BMAT	Biomedical Admissions Test
CAPTE	Commission on Accreditation of Physical Therapy Education
CCTDI	California Critical Thinking Disposition Inventory
CCTST	California Critical-Thinking Skills Test
CSL	Community Service Learning
CT	Critical-thinking
DTI	Diagnostic Thinking Inventory
HEQC	Higher Education Quality Committee
HOD	Head of department
HPCSA	Health Professions Council of South Africa
HSRT	Health Sciences Reasoning Test
ND	Nutrition and Dietetics
OPTOM	Optometry
OT	Occupational Therapy
PT	Physiotherapy
SAHP	School for Allied Health Professions
SAQA	South African Qualifications Authority
TSA	Thinking Skills Assessment
UFS	University of the Free State
WGCTA	Watson-Glaser™ Critical Thinking Appraisal

LIST OF DEFINITIONS AND TERMINOLOGY

Analysis: "Analytical reasoning skills enable people to identify assumptions, reasons and claims, and to examine how they interact in the formation of arguments. We use analysis to gather information from charts, graphs, diagrams, spoken language and documents. People with strong analytical skills attend to patterns and to details. They identify the elements of a situation and determine how those parts interact. Strong interpretation skills can support high quality analysis by providing insights into the significance of what a person is saying or what something means" (Insight Assessment 2016:online).

Clinical reasoning: Clinical reasoning is the thinking and decision-making process used during examination and management of a patient (Huhn, Black, Jensen & Deutsch 2013:26).

Clinical year: The timeframe from the start to the end of the clinical rotations (February to September) in one year.

Critical thinking: Critical-thinking (CT) is defined by the National Council for Excellence in Critical Thinking Instruction (Scriven & Paul 1987; cited by Howard, Tang and Austin 2015:134) as,

> *the intellectually disciplined process of actively and skilfully conceptualizing, applying, analyzing, synthesizing or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness.*

CT is defined by Peter Facione (1990:2) as, "purposeful, self-regulatory judgment that results in interpretation, analysis, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which judgment is made". Thus, CT can also be defined as "clinical decision making, critical judgment and diagnostic judgment" (Brudvig, Dirkes, Dutta & Rane 2013:12), or a "process of purposeful, self-regulatory judgement. This process gives reasoned consideration to evidence, contexts, conceptualizations, methods and criteria" (Facione & Facione 2008:2). CT is defined by

Watson and Glaser (2011:3) as, "the ability to identify and analyse problems, as well as seek and evaluate relevant information in order to reach an appropriate conclusion". Facione and Facione (2008:2) describe CT, specifically in health sciences, as, "the process we use to make a judgment about what to believe and what to do about symptoms our patient is presenting for diagnosis and treatment". The Association of American Colleges and Universities (AAC&U, 2011) defines CT as "a habit of mind characterised by the comprehensive exploration of issues, ideas, artefacts, and events before accepting or formulating an opinion or conclusion". For health professionals to make the quick decisions that are needed, CT skills have to be a habit of mind. This habit will improve the process of clinical reasoning, leading to improved patient care. This definition has been identified as the benchmark for the development of CT in students at the University of the Free State; therefore, it will be the guiding definition for this research (Strydom & Oosthuizen 2019).

Deduction: "Decision making in precisely defined contexts where rules, operating conditions, core beliefs, values, policies, principles, procedures and terminology completely determine the outcome depends on strong deductive reasoning skills. Deductive reasoning moves with exacting precision from the assumed truth of a set of beliefs to a conclusion which cannot be false if those beliefs are true. Deductive validity is rigorously logical and clear-cut. Deductive validity leaves no room for uncertainty, unless one alters the meanings of words or the grammar of the language" (Insight Assessment 2016:online).

Evaluation: "Evaluative reasoning skills enable us to assess the credibility of sources of information and the claims they make. We use these skills to determine the strength or weakness of arguments. Applying evaluation skills, we can judge the quality of analyses, interpretations, explanations, inferences, options, opinions, beliefs, ideas, proposals, and decisions. Strong explanation skills can support high-quality evaluation by providing the evidence, reasons, methods, criteria, or assumptions behind the claims made and the conclusions reached" (Insight Assessment 2016:online).

Explanation: "Explanatory reasoning skills, when exercised prior to making a final decision about what to believe or what to do, enable us to describe the evidence, reasons, methods, assumptions, standards or rationale for those decisions, opinions, beliefs and conclusions. Strong explanatory skills enable people to discover, to test and to articulate the reasons for beliefs, events, actions and decisions" (Insight Assessment 2016:online).

Inference: "Inference skills enable us to draw conclusions from reasons and evidence. We use inference when we offer thoughtful suggestions and hypotheses. Inference skills indicate the necessary or the very probable consequences of a given set of facts and conditions. Conclusions, hypotheses, recommendations or decisions that are based on faulty analyses, misinformation, bad data or biased evaluations can turn out to be mistaken, even if they have been reached using excellent inference skills" (Insight Assessment 2016:online).

Interpretation: "Interpretative skills are used to determine the precise meaning and significance of a message or signal, whether it is a gesture, sign, set of data, written or spoken words, diagram, icon, chart or graph. Correct interpretation depends on understanding the message in its context and in terms of who sent it, and for what purpose. Interpretation includes clarifying what something or someone means, grouping or categorizing information, and determining the significance of a message" (Insight Assessment 2016:online).

Wiki: "Type of website that allows the users to create and edit content using their web browsers" (Snodgrass 2011:563).

SUMMARY

Keywords: Critical-thinking skills, Thinking Skills Assessment (TSA), Undergraduate allied health professions students, Graduate attributes

In the health professional's world, decisions have to be made in an instant, and because these decisions influence the lives of the patients that health care professionals treat – wrong decisions can be fatal. These decisions need to be based on solid knowledge and have to be adapted to the patients or the situations and, in order to make unique, knowledge-based decisions, the health care professional must apply critical reasoning. Decision-making is dependent on inductive and deductive reasoning processes, and critical thinking (CT) has been found to be one part of the clinical reasoning process (Vendrely 2005:55). Watson and Glaser (2011:3) define CT as "the ability to identify and analyse problems, as well as seek and evaluate relevant information in order to reach the appropriate conclusion". By entrusting allied health professions (AHP) students with higher-order thinking skills and the ability to make sound clinical decisions, students are provided with the tools they need to be successful in their careers.

CT forms part of the exit-level requirements for AHP, for example, physiotherapists need to work autonomously and in interdisciplinary teams, and have to demonstrate accountability. In turn, occupational therapists should be able to use basic science, social science and arts, as well as information technology, effectively and critically (Velde, Wittman & Vos 2006:49). A curriculum usually combines didactic learning and clinical placements, to ensure a competent practitioner that applies CT skills (Reed 2014:1). However, no CT skills tests are currently administered at the University of the Free State (UFS) to test the actual level of critical thinking of undergraduate AHP students.

Worldwide, a few tests exist that test CT skills at different levels of education, from school to postgraduate level. The only research articles that could be found in relation to testing CT skills in AHP used the California Critical-thinking skills Test (CCTST), the California Critical Thinking Disposition Inventory (CCTDI), the Health Sciences Reasoning Test (HSRT) and the Watson-Glaser™ Critical Thinking Appraisal (W-GCTA). Most of these tests only test the CT skills of Master's and PhD-level students, with a select few including undergraduate students. The research that was found did not indicate that one test was superior, but suggests that a

test of which the questions could be adjusted to a particular health profession would give a better indication of CT skills (Ennis 1996:174; Velde *et al.* 2006:58). These CT skills tests are all quite costly to apply, and this led the researcher to search for alternative CT tests, and to investigate whether any other universities, in South Africa and beyond, use CT skills tests.

The University of Cambridge developed the Thinking Skills Assessment (TSA) test for admission testing of CT and problem-solving skills, to assess the applicants' suitability for their chosen course (Admission Testing Services 2016:2). Other universities that use the same test for admission are Oxford University and University College London. A free online TSA specimen test is available, for applicants to complete to prepare for the TSA test. The TSA tests the following abilities: Summarising the main conclusion, drawing a conclusion, identifying an assumption, assessing the impact of additional evidence, detecting reasoning errors, matching arguments and applying principles.

The aim of this study was to determine the CT skills that undergraduate AHP students at the UFS, possess in their clinical rotation years, and to determine if these skills change over a period of one clinical rotation year of study. Secondly, the type of activities that lecturers in the different departments in the School for Allied Health Professions (SAHP), excluding the Department of Exercise and Sport Science, use to develop CT skills in their undergraduate students was investigated in this study.

This study was conducted in the field of health professions education. The study is interdisciplinary, as it forms a bridge between health professions education and allied health education.

This study consisted of two parts. Part 1 was a quantitative research study that was experimental in nature, with a one-group pretest-posttest design. A literature study was done to conceptualise and contextualise CT skills and determine the CT skills in undergraduate AHP students. A CT skills test (TSA-Modified) was used to test the CT skills of undergraduate AHP students who were at the point of completing their third and fourth years of study in 2018. The TSA-Modified was completed at the beginning and end of one year, to determine if changes had taken place in CT skills over this period. Part 2 was a descriptive study, using a self-constructed questionnaire to investigate the types of teaching activities lecturers in the different departments of the SAHP employed to develop CT skills in their students. The data

gathered in this study can be used for further research by the researcher to determine the need for and feasibility of a CT skills test for undergraduate AHP students at the UFS.

Part 1 included a target population of 227 undergraduate allied health professions students at the University of the Free State, of whom 136 completed the pretest, but only 106 completed the pretest and posttest, and who were consequently included in the study (55,5% and 43,3% response rates respectively). This study found no statistically significant development of overall CT skills over the study period. Interestingly, occupational therapy students showed a statistically significant difference in median test scores compared to the other groups, though this finding needs further investigation. This study highlights the need for more extensive research on the CT skills of different health care professionals, to build a stronger foundation regarding thinking, and to improve clinical reasoning skills, which could lead to better patient care

Part 2 of this study include lecturers in four of the departments (Physiotherapy, Occupational Therapy, Nutrition and Dietetics, and Optometry) of the SAHP at the UFS completed a self-designed questionnaire, to determine which strategies they used to develop students' CT skills. A response rate of 60% of the target population was achieved. Lecturers indicated problem-based learning and experiential learning as the teaching strategies applied most often to develop CT skills. This study identified how these strategies were scaffolded in 2018 in the four curricula of the different allied health professions disciplines to develop well-rounded graduates who engage in CT.

This research study will provide feedback to the SAHP about the CT skills of its undergraduate AHP students in their clinical rotation years, and make recommendations, if necessary, about incorporating CT skills in the different departments' teaching methods, to improve the level of CT skills in undergraduate students. This dissertation contains information about the research study, including the research design and methodology.

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CHAPTER 1

OVERVIEW AND ORIENTATION TO THE STUDY

This section will present the overview and orientation to the study.

1.1 INTRODUCTION

The focus of this research project entailed an in-depth study in two parts; the first part was to determine the critical-thinking (CT) skills of undergraduate allied health professions (AHP) students in the clinical rotation years at the University of the Free State (UFS). This was done by administering a CT skills test, the Thinking Skills Assessment (TSA), 2015 version of the specimen test, for each undergraduate in the third and fourth years of study during a timeframe of one clinical year. This test was done at the beginning (pretest in January/February) and end (posttest in September/October) of the year 2018. The score of each individual student in the first test was compared to that of the second, to determine if any change in CT had taken place in the specific undergraduate student in that specific year. In this study, the researcher set out to determine if CT skills improve in undergraduate AHP students during the clinical rotation years.

The second part of this study investigated the type of teaching strategies used by lecturers in the different departments of the School for Allied Health Professions (SAHP) to develop CT of undergraduate students in the different years of study. This part of the study was only done at the end of the year (2018), to determine what strategies the lecturing staff had used to improve the CT of the students in the specific year, and if different teaching strategies where incorporated for different year groups to enhance CT skills. This information could assist in determining if teaching strategies are scaffolded in the curriculum.

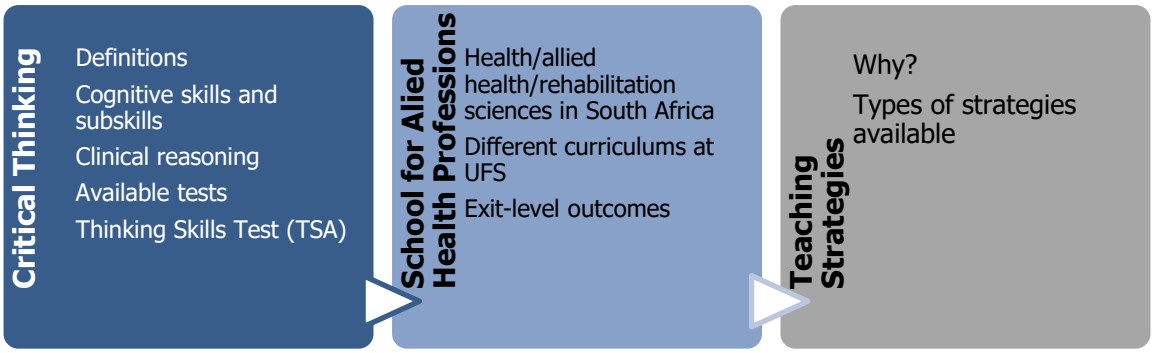
In the world of a health professional, decisions have to be made in an instant and, because these decisions influence the lives of patients, mistakes can lead to fatalities. These decisions need to be based on solid knowledge and have to be adapted to patients or

situations. In order to make unique, knowledge-based decisions, the health care professional must apply clinical reasoning. By entrusting AHP students with foundational thinking skills, students are given the ability to make sound clinical decisions using higher-order thinking. This gives students the tools they need to be successful in their careers (Reale, Riche, Witt, Baker, & Peeters 2018:828). The aim of this chapter is to orient the reader to the research that was conducted for this study.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Research into CT skills has been conducted by various fields, and many publications are available on the topic. Though much has been written on CT, especially in nursing, the researcher found few studies on the evaluation/testing of CT skills of undergraduate AHP students. A few studies have been done in each individual profession, but only two had an interdisciplinary approach to AHP (Sharp, Reynolds & Keisha 2013:1; Vogel, Geelhoed, Grice & Murphy 2009:152). Sharp *et al.* (2013:1) included a wide variety of AHP, but not any profession that currently forms part of the SAHP at the UFS. Vogel *et al.* (2009:152) included occupational therapy (OT) and physiotherapy (PT) students, but the population was small (n=50) and consisted of only Master's students.

CT skills, to date, have not been tested in any form, except for the use of Bloom's taxonomy in written test and examinations, at the SAHP of the UFS. Furthermore, at the time of writing, no research had been done to determine if the CT skills of students changed during the clinical rotation years of study in the field of AHP. Figure 1.1 gives a schematic overview of the background to the research problem.



Source: Compiled by the researcher (Louw 2019)

Figure 1.1: Schematic overview of the background to the research problem

1.2.1 Definitions of critical thinking

CT is defined by the National Council for Excellence in Critical Thinking Instruction (Scriven & Paul 1987:online) as,

> *the intellectually disciplined process of actively and skilfully conceptualizing, applying, analyzing, synthesizing or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness*

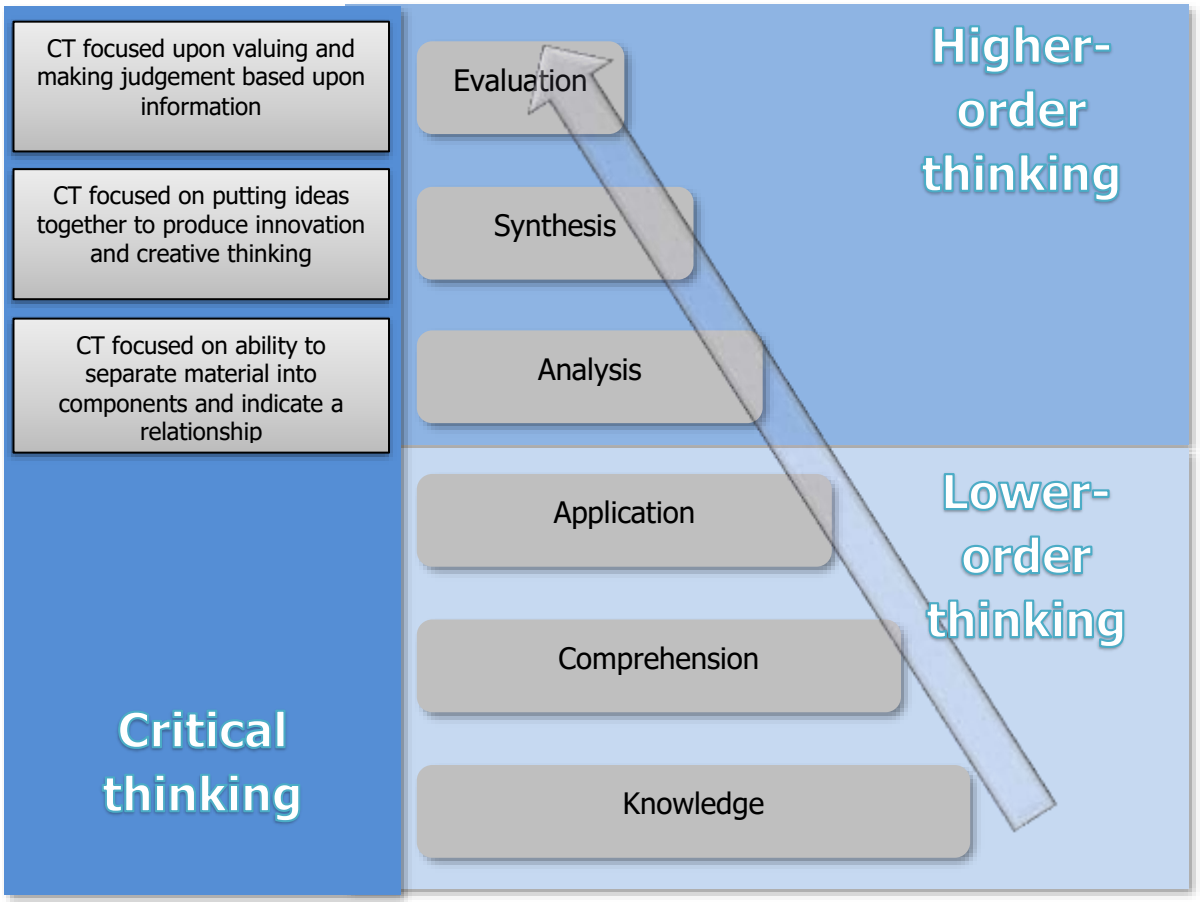
Peter Facione (1991:2) and an expert panel derived consensus regarding the definition of CT as, "*purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which judgment is based*". The definition of CT has been evolving since Socrates (Saeger 2014:24) and Dewey (Sharples, Oxman, Mahtani, Chalmers, Oliver, Collins, Austvoll-Dahlgren & Hoffmann 2017:1), and is still evolving; some researchers have even stated that each profession should have a discipline-specific definition for CT (Thonney & Montgomery 2019:175).

The Association of American Colleges and Universities defines CT as "*a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion*" (AAC&U 2011:1). This definition of CT will be used as preference in this dissertation, as this definition has been identified as the benchmark for the development of CT at the UFS (*cf.* Chapter 2) for student success (Strydom & Oosthuizen 2019:4).

Agreeing on a definition of CT is not a simple matter, due to the literature originating from three different disciplines, namely, philosophy, cognitive psychology and education (Thonney & Montgomery 2019:170). In this dissertation, the approach to the definition will be focused on the field of education. The education approach was introduced by John Dewey in the early 1900s, from which Benjamin Bloom developed a taxonomy of information processing skills (Thonney & Montgomery 2019:170).

1.2.1.1 Bloom's taxonomy

Bloom's taxonomy was designed by Benjamin Bloom in 1956 to assist educators to assess and determine teaching and learning objectives. Bloom's taxonomy includes six levels in the cognitive domain: knowledge, comprehension, application, analysis, synthesis and evaluation (Aviles 2000:3-4; Zaidi, Grob, Monrad, Kurtz, Tai, Ahmed, Gruppen & Santen 2018:856). The upper three levels of Bloom's taxonomy of educational objectives (*cf.* Figure 1.2) are generally considered to involve CT, however, these levels are interdependent regarding CT (Duron, Limbach & Waugh 2006:161). Forrester (2008:102) states that "both evaluation and synthesis depend on analysis, evaluation requires a comparison while synthesis requires re-arranging", while Ennis (1993:179) describes this interdependence as follows: "although synthesis and evaluation generally do require analysis, analysis generally requires synthesis and evaluation". Figure 1.2 gives a schematic overview of Bloom's taxonomy and where critical thinking fits into the higher-order cognitive domains.



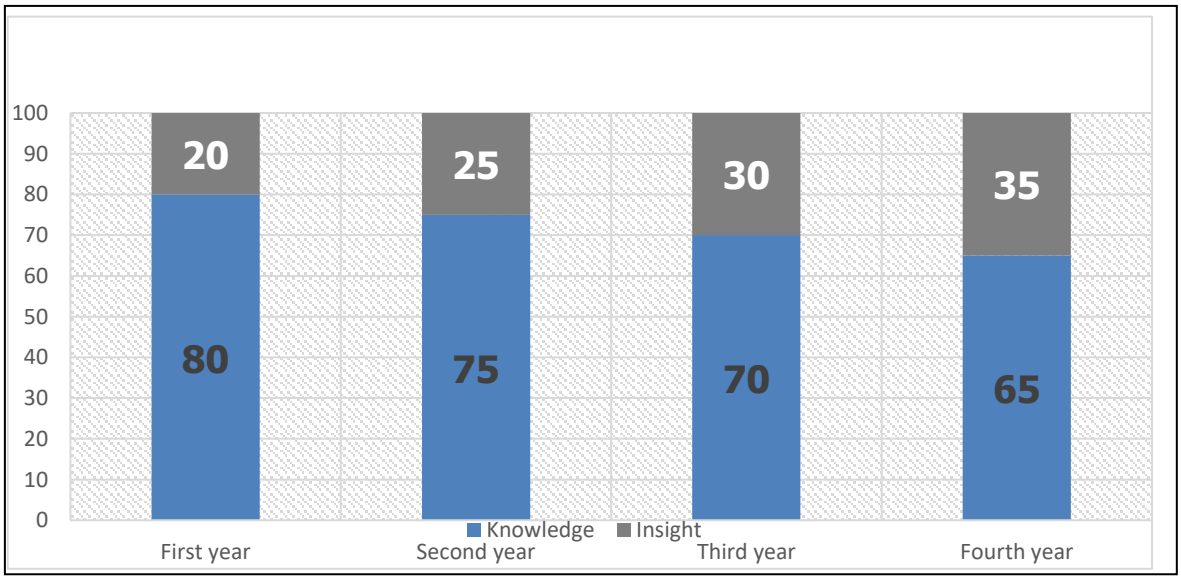
Source: Compiled by the researcher (Louw 2019) from Aviles (2000:3-4); Duron *et al.* (2006:160); Dwyer (2017:13); Forrester (2008:102)

Figure 1.2: Critical thinking and Bloom's taxonomy

It is expected of students to be able to function on all six levels of thinking, and critical thinkers should be able to function at the highest level. Creative thinking ("evaluation" in the revised Bloom's taxonomy) and CT are considered "two sides of the same coin", thereby demanding a student-centred approach to learning and inspiring independent thinkers (Forrester 2008:100; Thomas 2011:28). Students benefit the most from applying the skills in the upper levels of Bloom's taxonomy, and lecturers are responsible for providing sufficient opportunities for students to master these skills (Duron *et al.* 2006:161).

Bloom's taxonomy was revised in 2001 by Anderson and Krathwohl; they updated the taxonomy from one dimension to a two-dimensional framework, which includes knowledge and cognitive processes. Synthesis was also renamed "create" in this taxonomy and it switched places with evaluation. All the other category names were also changed from nouns to verbs (Krathwohl 2002:214-218).

Bloom's taxonomy is used by various departments at the UFS for written testing and examination purposes, and students are tested on increasingly higher percentages of higher-order skills as they progress from first to fourth year (*cf.* Figure 1.3). It should be noted that Bloom's taxonomy can be applied to all walks of life, and not just later years of study. In the fourth year, more emphasis is placed on "analysing" and "synthesising" knowledge in practice. Guiding students through this process, which involves progression from "knowledge" (i.e., remembering facts) to "application" to "analysing and synthesising", requires lecturers to apply teaching strategies that involve CT skills.



Source: Compiled by the researcher (Louw 2017) from Department of Physiotherapy (2019:69-73)

Figure 1.3: Department of Physiotherapy's approach to the testing of knowledge and insight in relation to Bloom's taxonomy

1.2.2 Cognitive skills and subskills of critical thinking

The American Philosophical Association Delphi Report reports that consensus was achieved by an interactive panel of 46 experts about the nature of CT (Facione 1990:12). The panel concluded that CT consists of six cognitive skills and subskills (*cf*. Table 1.1). This expert panel defined CT as the "*process of purposeful, self-regulatory judgement. This process gives reasoned consideration to evidence, contexts, conceptualizations, methods and criteria*" (Facione & Facione 2008:2).

Table 1.1: Cognitive skills and subskills

Interpretation •Categorisation •Decoding significance •Clarifying meaning	**Analysis** •Examining ideas •Identifying arguments •Analysing arguments	**Evaluation** •Asssessing claims •Assessing arguments
Inference •Querying evidence •Conjecturing •Alternatives •Drawing conclusions	**Explanation** •Stating results •Justifying procedures •Presenting arguments	**Self-regulation** •Self-examination •Self-correction

Source: Facione (1990:12)

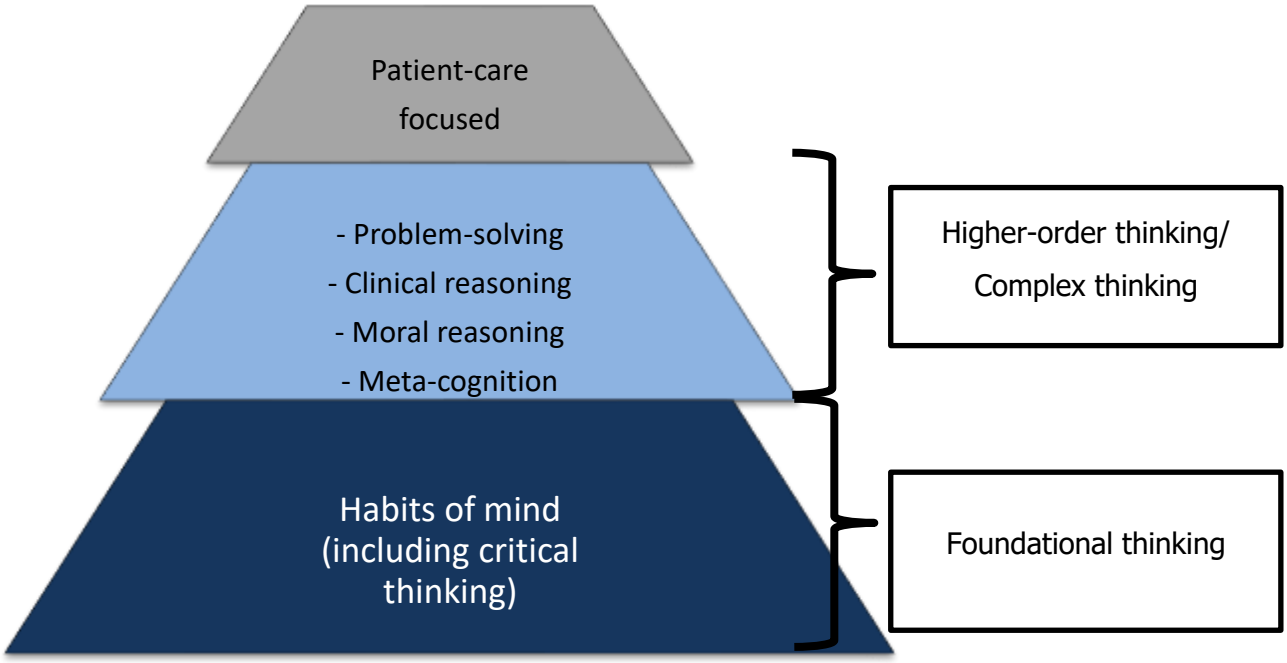
Thonney and Mongomery (2019:175) suggest that it should be considered that different professions have different dimensions of thinking, with some levels are higher or lower for different professions. Furthermore, to have a positive impact on student learning, instructional approaches should be adjusted for the different dimensions. Research indicates that physiotherapy students score higher on the subscales of deduction than on the other subscales (Bartlett & Cox 2002:64; Brudvig, Mattson, & Guarino 2015:9; Brudvig, Mattson & Guarino 2016:7; Huhn, Black, Jensen, & Deutsch 2013:26), induction (Brudvig *et al.* 2015:9; Brudvig *et al.* 2016:7; Huhn, Black, Jensen, & Deutsch 2011:184), evaluation (Huhn *et al*. 2011:184) and analysis (Huhn *et al.* 2013:26). When tested on the California Critical Thinking Skills Test (CCTST), OT students scored statistically significantly higher on the subscales for evaluation, inductive and deductive reasoning, compared to the other subscales (Coker 2010:283). Optometry students did not achieve significant scores on any subscales (Elam 2001:265); this finding was also reported by Vendrely (2005:57) for Master's level physiotherapy students. Registered dieticians were found to have strong inductive, explanation, analysis and inference CT sub-skills (Goodman, Redmond, Elia,

Harris, Augustine & Hand 2018:2351). In biomedical sciences, analysis and evaluation where found to be the most common skills (Puig, Blanco-Anaya, Bargiela, & Crujeiras-Pérez 2019:866).

1.2.3 Clinical reasoning versus critical thinking

Clinical reasoning is a "complex mechanism, within the domains of a professions expertise that makes use of basic scientific knowledge, clinical competence, ability to self-reflect and critical thinking skills" (Huhn *et al.* 2013:26). In health care education, clinical reasoning, CT, and clinical judgment are sometimes, wrongly, used to mean the same, and doing so could lead to confusion (Faucher 2011:141). Clinical reasoning is described as a "non-linear problem solving process that is influenced by models of practice" (Gilliland & Wainwright 2017:500). Clinical reasoning involves contextual factors (health and life circumstances, emotional and social factors and clinical skills and experience) and cognitive factors, which include judgement, reflection and CT (Huhn *et al.* 2011:181). In summary, clinical reasoning is "the thinking and decision-making of a health care provider in clinical practice" (Christensen & Nordstrom 2013:183-199; Furze, Black, Hoffman, Barr, Cochran & Jensen 2015:22) or, stated simply, the application of CT skills (LaMartina & Ward-Smith 2014:156). As to where CT actually fits into clinical reasoning, it can be considered as a cognitive component of the clinical reasoning process and does not involve judgement or reflection (Huhn *et al.* 2011:181). CT skills involve inductive and deductive reasoning, as well as evaluation and analysis (Furze *et al.* 2015:23). A practitioner needs to use higher-order thinking skills to link knowledge with experience in order to provide patient-specific care (Velde, Wittman & Vos 2006:57). Didactic learning (Huhn *et al.* 2013:29), clinical rotations (Hunter, Pitt, Croce, & Roche 2014:814), or both (Bartlett & Cox 2002:68) have been proven to facilitate the development of CT skills, thus, undergraduate students of the SAHP at the UFS in their third and fourth years were included in this study, due to the fact that they start working in clinical settings in these years.

CT is considered as the foundation of thinking and a precursor for clinical reasoning; clinical reasoning is complex thinking that is built upon foundational thinking. As CT is considered a "habit of mind" (*cf.* Figure 1.4), it involves the interpretation and analysis of knowledge that, then, leads to evaluation or judgment (clinical reasoning).



Source: Lane and Stone (2006:391); Marzano, Pickering, & McTighe (1993:4) ; Peeters and Boddu (2016:272); Reale *et al.* (2018:827)

Figure 1.4: Cognitive framework for cognitive abilities, including critical thinking

Habits of mind are described by Costa and Kallick (2000, cited by Peeters, Zitko & Schmude 2016:1) as a set of behaviours that intellectuals exhibit when they are challenged by problems that cannot be resolved immediately. CT is embedded within habits of mind, but it should be noted that it is not mentioned by Costa and Kallick as a single habit. The 16 habits of mind of Costa and Kallick (2000) are listed in Table 1.2. These habits of mind are needed to form the foundation of thinking, upon which complex thinking is built to assist in problem-solving and decision-making (Peeters *et al*. 2016:4-5).

The framework presented in Figure 1.4 illustrates the progression of cognitive skills that is needed for the development of undergraduate AHP students, and it indicates the importance of CT for the development of students.

Table 1.2: List of the 16 habits of mind

1 .	Persisting	**9.**	Thinking and communicating with clarity and precision
2.	Managing impulsivity	**10.**	Gathering data through all senses
3.	Listening with understanding and empathy	**11.**	Creating, imaging, innovating
4.	Thinking in a flexible way	**12.**	Responding with wonderment and awe
5.	Thinking about thinking (metacognition)	**13.**	Taking responsible risks
6.	Striving for accuracy	**14.**	Finding humour
7.	Questioning and posing problems	**15.**	Thinking interdependently
8.	Applying past knowledge to new situations	**16.**	Remaining open to continuous learning

Source: Costa and Kallick (2000, cited by Peeters *et al*. 2016:2)

1.2.4 Critical-thinking skills tests

Several tests have been validated and are available to test CT skills. Two of these are the Watson-Glaser™ Critical Thinking Appraisal (W-GCTA), and CCTST. However, these two tests report conflicting findings for physiotherapy students (Brudvig, Dirkes, Dutta & Rane 2013:14; Vendrely 2005:55), possibly because these questionnaires were not designed specifically to test health science professionals (Huhn *et al.* 2011:181; Vendrely 2005:58). The Health Sciences Reasoning Test (HSRT) was designed by Peter Facione in 1994 – he also designed the CCTST. The questions on the HSRT are formulated in a health sciences context, thus, making it an effective and applicable test to measure CT skills of undergraduate AHP students (Huhn *et al.* 2013:29-30). This claim was contradicted by a study that found that the HSRT did not appear responsive to change in CT skills in health professions; however, it should be noted that physiotherapy and occupational therapy students were not included in the results of the longitudinal studies included with regard to the HSRT (Reale *et al.* 2018:830). Carter, Creedy and Sidebotham (2015:864) report that 60% of studies that utilised one of the four standardised, commercially available CT measures (CCTST, HSRT, WGCTA, CCDTI) could not consistently repeat reliability and validity results. An extensive search for articles on assessment of CT skills and valid tools to test CT in AHP students yielded only a few articles, and most research was in the field of physiotherapy (*cf.* Table 1.3).

Table 1.3: Review of available research on critical thinking testing in allied health professions

Test	Study	Population	Country	Statistically significant	Timeframe
California Critical Thinking Skills Test (CCTST)	Bartlett & Cox (2002)	28 PT 2nd year students (of a three-year undergraduate programme)	Canada	YES, on total scores and all subscales (with deduction the highest)	1 year
	Coker (2010)	25 OT students	South Carolina, USA	YES	3 semesters
	Denial (2008)	36 OPTOM students in 4th year	USA	NO, though found a correlation between CT skills and clinical experience.	1 year
	Domenech and Watkins (2015)	68 first year Doctoral PT students	Texas, USA	Students below national average	Only tested on entering programme
	Elam (2001)	1st and 3rd year OPTOM students	USA	NO for class level and gender	Only tested once
	Velde *et al.* (2006)	64 senior-level OT students	USA	NO	15 weeks
	Vendrely (2005)	42 entry-level Master's PT students	USA	NO, but a positive development of CT skills	27 months
	Wessel and Williams (2004)	PT students in Year one (n=50) and two (n=44) of Master's programme	Canada	NO major change in CT abilities	8 months
	Wilson (2000)	54 first-year PT students	USA	NO (found CCTST to be inappropriate for health professionals)	1 year
	Zettergen and Beckett (2004)	200 Master's PT students (3-5th years)	USA	YES, between 3rd and 5th year and between 4th and 5th year	Only tested 1x
Health Science Reasoning Test (HSRT)	Brudvig *et al.* (2015)	18 post-Master's PT students	Indian nationals studying in the USA	YES	1 year
	Brudvig *et al.* (2016)	61 entry-level Doctoral PT students	USA	YES	2 and a half years
	Goodman *et al.* (2018)	19 registered, experienced dieticians	USA	Found a strong CT ability	No timeframe indicated
	Huhn *et al.* (2011)	79 entry-level Doctoral PT students at two institutions	USA	YES, between experts and novice CT skills	Only tested with admission to programme
	Huhn *et al.* (2013)	63 Doctoral PTS students at 2 institutions	USA	YES, higher in subscales of deduction and analysis.	3 times from entry to exit of programme
	Sharp *et al.* (2013)	57 allied health professions students (cytotechnology, dental hygiene, HIIM, medical technology)	USA	YES based on programme type	Only tested once

Test	Study	Population	Country	Statistically significant	Timeframe
Watson-Glaser critical thinking assessment (WGCTA)	Slaughter, Brown, Gardner, Perritt (1989)	31 first-year PT students	USA	NO, but found students had a high CT ability	4 weeks
	Vogel *et al.* (2009)	50 OT students and PT students in first year of Master's degree	Texas, USA	OT = YES, significant increase PT = NO (no significant difference between OT and PT)	20 months
	Wessel and Williams (2004)	PT students in Year one (n=50) & two (n=44) of Master's programme	Canada	NO major change in CT abilities	8 months
	Wilson (2000)	54 first-year PT students	USA	NO (Found WGCTA was not appropriate for health professionals)	1 year
Diagnostic Thinking Inventory (DTI)	Keiller and Hanekom (2014)	Two cohorts (n=14 & n=24) of 4th year students	South Africa	NO	1 year
Student self-reports	Crabtree (2001) *Self-assessment of learning and Participation (SALP)*	9 post-professional Doctoral OT students	USA	Positive experience of learning through discussion, found positive engagement in CT	9 weeks
	Ikiugu and Rosso (2003)	30 graduate class OT students	USA	Developed an understanding of connection between theory and practice. Students believed that CT skills improved significantly.	No timeframe indicated
NOTE: HIIM = Health informatics and information management; OT = Occupational Therapy; OPTOM = Optometry; PT= Physiotherapy					

Source: Compiled by the researcher (Louw 2019)

Only six studies testing CT skills in undergraduate AHP students were found at the time this dissertation was being written (*cf.* Table 1.3). The results were that health professions students have a higher level of CT skills than the average population (Goodman *et al.* 2018:2351; Slaughter *et al.* 1989:445; Velde *et al.* 2006:56; Vendrely 2005:57; Wessel & Williams 2004:86). It is interesting that only one of the six studies indicated a significant change in the results regarding the total score and the subscales, however, this study had a very small sample (Bartlett & Cox 2002:64). One study using a pretest-posttest was found; that had been done in South Africa, with fourth-year physiotherapy students using the Diagnostic Thinking Inventory (DTI) (Keiller & Hanekom 2014:8). The DTI was, however, developed to test complex thinking or clinical reasoning skills, and not CT skills, specifically (Hamzeh, Madi, & Hensman 2016:e169; Peeters, Zitko & Schmude *et al.* 2016:3). A study by Domenech and Watkins (2015:199) contradict these findings, and state that their population had moderate CT skills.

The University of Cambridge developed the TSA to test CT and problem-solving skills for admission testing, to assess applicants' suitability for their chosen course (Admission Testing Services 2016:2). Due to the financial implications of the CCDTI, CCTST, HSRT and W-GCTA, the TSA was found to be the most feasible test to use in this study.

1.2.5 Health, allied health and rehabilitation sciences studies in South Africa

AHP are "involved with the delivery of health or related services pertaining to the identification, evaluation and prevention of diseases and disorders; dietary and nutrition services; rehabilitation and health system management, among others" (Association of Schools of Allied Health Professions 2018:online). The Allied Health Professions Council of South Africa (AHPCSA) consists of a variety of professional boards, for example, Chinese medicine, aromatherapy, therapeutic massage therapy, therapeutic reflexology, chiropractic and osteopathy (AHPCSA n.d.:online). In contrast, the Association of Schools of Allied Health, in America, covers professions such as audiology, cytotechnology, dental hygiene, dietetics, occupational therapy, physical therapy, radiography, respiratory therapy and speech-language pathology (Association of Schools of Allied Health Professions 2018:online). Allied health professionals in Australia include similar professions, stating that AHP are "all health professionals who are not doctors, dentists or nurses" (HealthTimes 2017:online; Smith & Pilling 2007:265). This indicates that AHP have a different meaning in different settings across South Africa and globally, but at UFS it only includes five different cohorts (*cf.* 1.2.5.1).

A number of universities in South Africa offer courses in nutrition and dietetics, occupational therapy, optometry and physiotherapy. Most of these professions fall under similar school names, with the exception of the UFS (*cf.* Table 1.4). It should be noted that the UFS is in the process of changing the name of the SAHP, to correspond with the other universities in South Africa. Worldwide, these professions in the SAHP fall into similar schools/faculties or departments.

The Health Professions Council of South Africa (HPCSA 2016:2, Booklet 1) requires undergraduate health professions students to work autonomously, which requires the student to consider all aspects of a patient's health by analysing information critically, then applying techniques that have been adapted for the working environment, and making informed decisions. Autonomy and evidence-based decision-making skills are just some of the undergraduate requirements set by South African Qualification Authority (SAQA) that involve clinical reasoning skills and, in particular, CT skills (SAQA$_{1-4}$ n.d.:online).

Various professions incorporate CT skills into their model of an ideal practitioner as a "key component of their professional abilities and performances" (Papp, Huang, Clabo, Delva, Fischer, Konopasek, Schwartzstein & Gusic 2014:715); CT is also a specific expectation of SAQA as a critical cross-field outcome (SAQA 2009:53; SAQA$_{1-4}$ n.d.:online). CT is also among expected graduate attributes, which are competencies that are expected by employers and higher education institutions (Strydom & Oosthuizen 2019:2-4), especially in the AHP, because practitioners and students need to think on their feet, and be able to apply the best judgement under the specific circumstances (Wijbenga, Bovend'Eerdt, & Driessen 2019:127). Educators are challenged to design curricula, and to develop and plan their teaching strategies in ways that promote CT (Brudvig *et al.* 2013:12; Coker 2010:280; Faucher 2011:141; Huhn *et al.* 2013:26; Lederer 2007:519; Smith & Pilling 2007:266; Velde *et al*. 2006:49; Zettergren & Beckett 2004:73).

Research articles identify a need to determine if students' CT skills developed during their years of study (Abrami, Bernard, Borokhovski, Wade & Persson 2008:1122; Elam 2001:265; Huber & Kuncel 2016:431; Persky, Medina, & Castleberry 2019:161; Roksa & Arum 2011:37; Sharp *et al.* 2013:6). The ability to think critically assists students to make sound clinical judgements and decisions and to deliver quality patient-centred care (*cf.* Figure 1.3).

Table 1.4: Health sciences universities in South Africa

University	Faculty	School	Professions/Departments/Divisions
University of Cape Town	Faculty of Health Sciences	Department of Health and Rehabilitation Sciences	Communication Sciences and Disorders, Disability Studies, Nursing and Midwifery, **Occupational Therapy, Physiotherapy**
	Faculty of Health Sciences	Department of Human Biology	**Human Nutrition**
University of the Free State	Faculty of Health Sciences	School for Allied Health Professions	Exercise and Sport Sciences, **Nutrition and Dietetics, Occupational Therapy, Optometry, Physiotherapy**
University of KwaZulu-Natal	College of Health Sciences	School of Health Sciences	Dentistry, **Optometry**, Speech Language Therapy, Pharmaceutical Sciences, Audiology, **Physiotherapy**, **Occupational Therapy**, Biokinetics, Exercise and Leisure Sciences
	College of Agriculture, Engineering and Sciences	School of Agriculture, Earth and Environmental Sciences	**Dietetics and Human Nutrition**
Sefako Makgatho Health Sciences University		School of Health Care Sciences	**Human Nutrition and Dietetics**, Nursing Science, **Occupational Therapy, Physiotherapy,** Public Health, Speech-Language Pathology and Audiology
University of Pretoria	Faculty of Health Sciences	School of Health Care Sciences	**Occupational Therapy, Physiotherapy**, Radiography, Nursing Sciences, **Human Nutrition**
University of Stellenbosch	Faculty of Medicine and Health Sciences	Health and Rehabilitation Sciences	**Occupational Therapy, Physiotherapy,** Speech-Language and Hearing Therapy
	Faculty of Medicine and Health Sciences	Global Health	**Human Nutrition**
University of the Western Cape	Faculty of Community and Health Sciences		Human Ecology and **Dietetics and Nutrition, Occupational Therapy**, **Physiotherapy**, Psychology, Social Work, Sport, Recreation and Exercise Sciences
University of the Witwatersrand	Faculty of Health Sciences	School of Therapeutic Sciences	Nursing, **Occupational Therapy,** Pharmacy, **Physiotherapy**, Biokinetics, Exercise sciences and Sport Medicine
University of Limpopo	Faculty of Health Sciences	School of Health Care Sciences	**Human Nutrition and Dietetics,** Nursing Sciences, **Optometry**, Pathology and Medical Sciences, Pharmacy, Public Health and Pre-Clinical Sciences
Cape Peninsula University of Technology	Faculty of Health and Wellness Sciences		**Ophthalmic Sciences**, Biomedical Sciences, Dental Sciences, Emergency Medical Sciences, Medical Imaging and Therapeutic Sciences, Nursing, Wellness Sciences
University of Johannesburg	Faculty of Health Sciences		Biomedical Technology, **Optometry,** Nursing, Podiatry, Somatology, Sport and Movement Sciences
North West University	Faculty of Health Sciences	School of Physiology, Nutrition and Consumer Sciences	Human Movement Sciences, Psychosocial Health, Nursing Sciences, Pharmacy, Physiology, Consumer Sciences, Occupational Hygiene, **Dietetics**
Nelson Mandela University	Faculty of Health Sciences	School of Lifestyle Sciences	**Dietetics,** Human Movement Sciences

Source: Compiled by the researcher from the webpages of the various universities and universities of technology (Louw 2019)

The programmes of prospective health care professionals needs to assist them to develop these skills throughout their years of study, so that they will, ultimately, be optimally competent professionals, who are capable of making ethical clinical decisions based on cognitive processes (Brudvig *et al.* 2013:19; Velde *et al.* 2006:52).

1.2.5.1 Background information on the School for Allied Health Professions at the University of the Free State

The focus of this study was on CT skills of undergraduate AHP students during their clinical rotation years at the UFS. The SAHP currently consists of five departments: Nutrition and Dietetics, Exercise and Sport Sciences, Physiotherapy, Occupational Therapy and Optometry (SAHP 2017:4). There are three departments namely Occupational Therapy, Physiotherapy, and Nutrition and Dietetics that share common traits regarding their clinical programmes (Van Vuuren 2017:9). The Department of Optometry was included in this study, and the Department of Exercise and Sport Sciences was excluded, due to its recent inclusion in the SAHP. This Bachelor's degree was introduced by the Department of Exercise and Sport Sciences in the Faculty of Health Sciences in 2017, and no students were in their third and fourth years of study at the time of testing. The gains in CT skills are extremely small, to non-existent, in the first two years of study (Sharp *et al*. 2013:3). Thus, only students in their clinical years (third and fourth years) where included in this study.

The curricula of the different departments of the SAHP at the UFS are completed in a timeframe of four years, if the student completes each year successfully. During the four years of study, students are expected to think more critically as the years progress (by making use of Blooms taxonomy, *cf.* Figure 1.2), however, CT is not measured directly in any of the four programmes. Formal written assessments are based on Bloom's taxonomy, which are adjusted for each year group to test more of the higher-order skills (*cf.* Figure 1.3). Fourth-year students are expected to integrate knowledge to a greater extent than third-year students – fourth-year students are tested on the higher levels of Bloom's taxonomy (create, evaluate and analyse), or on more complex thinking skills.

Undergraduate AHP students at the UFS are exposed to a wide variety of other subjects in their first few years of study, for example, physics, chemistry, anatomy, physiology and biostatistics, and attend classes with medical students. Most of these subjects are taken in the first and second years. The medical subjects (e.g. Obstetrics and Gynaecology,

Pharmacology etc.) presented by the Health Science faculty (PCTS3704), are the only subjects that fall in the third year of study, in the years that clinical rotations take place. The lecturers of the medical departments were not included in this study, because most lecturers make use of pre-recorded videos for lectures.

1.2.5.2 Bachelor of Science in Physiotherapy

At the end of the four-year physiotherapy programme, the exit-level outcome that is expected of students is that they should be "competent in rendering a professional service by having acquired knowledge, skills and clinical reasoning abilities to pursue their profession as physiotherapists" (Department of Physiotherapy 2015:10). A physiotherapy student should achieve a minimum of 1 000 hours of clinical practice over four years of study (Krause, Viljoen, Nel & Joubert 2006:38). The 1 000 hours of clinical practice are done in the third and fourth years of study: the third year comprises 400 hours (about 20 weeks) and the fourth year 600 hours (about 24 weeks). The third year is divided into four five-week clinical blocks and the fourth year into six four-week clinical blocks, and a extra week in the southern Free State as part of community-based education (Eygelaar, M. Personal communication per email: 5 December 2019, 16:17).

1.2.5.3 Bachelor of Science in Occupational Therapy

The Bachelor of Occupational Therapy at the UFS consists of four years of study. An occupational therapy student should obtain a minimum of 1 000 hours of clinical practice in the four years of study (De Witt, Rothberg & Bruce 2015:28).

An academic year runs from February to November for the SAHP where exposure to clinical areas takes place in the students' first year (about 200 hours) and the second year (about 300 hours). The third year is divided into three clinical blocks (February to end of March, May to June and July to end of August) amounting to about 375 hours. The fourth year is divided into four clinical blocks (February to end of March, May to June and August to September amounting to about 600 clinical hours (Swanepoel, A., Personal communication per email:29 October 2019, 12:38). A further week is spent in the southern Free State as part of community-based education (Henderson, A., Personal communication per email: 17 July 2017, 8:46).

1.2.5.4 Bachelor of Science in Nutrition and Dietetics

The Bachelor in Nutrition and Dietetics is also a four-year degree, during which a small percentage of the clinical exposure takes place during the third year, and most clinical exposure is in the fourth year (Mitchell, C. Personal communication per email: 13 July 2017, 10:26). A Nutrition and Dietetics student should obtain a minimum of 500 hours of clinical practice in a community and public health setting in the four years of study (HPCSA 2005:16). The practical training should consist of 48 weeks, that include 26 weeks of internship at a teaching hospital (HPCSA 1995:2-3).

1.2.5.5 Bachelor of Science in Optometry

The Bachelor in Optometry comprises a four-year curriculum, with clinical exposure in the third and fourth years of study (Rasengane, T. Personal communication per email: 13 July 2017, 7:15). Optometry students need a minimum of 500 hours of clinical experience to achieve the exit-level outcomes in their fourth year. These 500 hours include a maximum of 75 hours of observation of clinical investigation and case analysis and a maximum of 50 hours of clinical or practice administration. Optometry students also need to include a minimum of 120 supervised optometric examinations of patients; binocular vision, low vision, paediatric cases, pathology cases and contact lenses (HPCSA 2019:4).

1.2.6 Teaching strategies to develop critical-thinking skills

Teaching strategies at the UFS have moved from a teacher-centred to a learner-centred approach, and from a teacher-managed to a student-self-directed learning focus (Krause *et al.* 2006:37). The student takes up a more active role in teaching by using teaching strategies like debate or learning management systems (LMS) like Blackboard (Duron *et al.* 2006:160), which means students direct their own learning by creating their own knowledge, and lifelong learning is encouraged. This approach will optimise the students' ability to function in the workplace and in a personal capacity (Hanrahan & Isaacs 2001:53).

Self-directed learning is a holistic approach, and it forces health professionals to master skills such as clinical reasoning, problem-solving, needs assessment and communication, which are necessary for excelling in a professional career (Krause *et al.* 2006:38; Phillips, Turnbull, & He 2015:e1). Self-directed learning relates to a student-centred approach to learning, in which students have greater responsibility for their own learning, though the

process is still guided by the curriculum. Smith and Pilling (2007:266) raised a question, namely, how to adapt teaching and learning strategies to ensure the transfer of knowledge into clinical practice. Lecturers need to teach students to transfer the knowledge they have obtained by including metacognition ("thinking about one's thinking") in their teaching (Fisher 2005:3) by applying knowledge in practice and improving the students ability to reason clinically. This need for knowledge transfer emphasises the importance of including activities that develop CT skills in teaching strategies. Table 1.5 lists research into teaching strategies of AHP, as known in the SAHP of the UFS.

Table 1.5: Research on teaching strategies in allied health professions

Department	Teaching strategies research
Nutrition and Dietetics	Research conducted into the types of teaching activities used by dietetics courses indicate that double-entry journals (Nahikian-Nels & Nelms 1994:93) and case-based learning/problem-based learning (Harman, Bertrand, Greer, Pettus, Jennings, Wall-Bassett & Babatunde 2015:378) encourage CT skills. CT skills are deemed essential to ensure diagnostic accuracy by the Academy of Nutrition and Dietetics (Charney & Peterson 2013:1). Simulations are a strategy that enhance learning outcomes (Thompson & Gutschall, 2015:191).
Occupational Therapy	A variety of instructional methods are used to teach CT skills in occupational therapy programmes, to develop the entry-level occupational therapy practitioner: case studies, problem-based learning and experiential learning (Coker 2010:280). Active learning activities, applying clinical reasoning skills in classrooms and assignments assist occupational therapy students to solve complex problems. Guided peer reciprocal peer questioning (Velde *et al.* 2006:50) and problem-based learning (Velde *et al.* 2006:52) are examples of strategies occupational therapy lecturers use to encourage the development of CT skills in the undergraduate occupational programme (Lederer 2007:520). Learning through discussion facilitates deeper learning (Crabtree 2001:243).
Optometry	Research into the types of teaching activities used by optometry courses indicate that visual mapping increases recall, comprehension and CT skills in optometry students (Santiago 2011:137).
Physiotherapy	Problem-based learning and concept mapping have been indicated as beneficial for developing CT skills (Keiller & Hanekom 2014:11). Simulations have also been found to increase clinical decision-making in one experience (Macauley 2018:278).

Sources: Compiled by the researcher (Louw 2019)

Ennis (1989:4-5) classifies CT strategies into four approaches: general, infusion, immersion and mixed. Tiruneh, Verburgh and Elen (2014:18) indicate that 49% of the studies included in their systematic review applied the immersion approach, indicating that most of the strategies were integrated into the discipline and that general CT principles were not applied. Payan-Carreira, Cruz, Papathanasiou, Fradelos and Jiang (2019:837) indicate that over 80% of studies in their systematic review used the immersion approach, and they

report significant improvements of both general and specific CT skills. Even though the immersion method caused significant gains in CT skills, it was not as effective as the other three methods (Tiruneh *et al.* 2014:18). A meta-analysis done by Abrami *et al.* (2008:1121) indicated that mixed methods had the greatest effect on developing CT skills, achieving educational goals and applying the skill in a wide variety of contexts. The immersion method was also identified as the least effective approach (Abrami *et al.* 2008:1119). Tiruneh *et al.* (2014:25) identified the general or mixed approach as the most effective for developing CT skills. Ennis (2013:34-35) states that, from his experience, infusion is more successful than immersion, because, if students know the principle of CT, it will promote learning. This claim is contradicted by Persky *et al.* (2019:164), who did not find a big difference between infusion and immersion in their study. Saeger (2014:85), in her dissertation for a Doctoral degree in education, favoured the use of a mixed approach as the most beneficial for achieving the goal of education, developing CT skills and applying these skills in a wide variety of contexts. Niu, Behar-Horenstein and Garvan (2013:117) identified an "holistic approach" as another type of intervention – this approach applies CT strategies in an entire academic programme. It should be noted that research on the general and mixed approaches is limited compared to the infusion and immersion approaches, and that health professions rely on degree programmes to develop CT skills (Puig *et al.* 2019:865; Tiruneh *et al.* 2014:25).

Explicit instruction of CT skills (infusion approach), teacher questioning (use of Bloom's taxonomy) and active and cooperative learning strategies (group discussions, debating, group research, role play, simulations and peer evaluations) have also been found to be effective in promoting CT skills (Zhao, Pandian, & Mehar Singh 2016:15).

Problem-based learning, concept mapping and simulations where identified as the most effective and most commonly used strategies in health education (Carter *et al.* 2016:217; De Oliveira, Díaz, Carbogim, Rodrigues, & Püschel 2016:356; Ennis 2018:172). Carter *et al.* (2016:217) report a variety of results in relation to simulations, and declare that it needs further investigation. Lecture-discussion teaching was also identified as a common approach used to develop CT skills, but the effectiveness of this strategy remains unclear (Ennis 2018:172). The Commission on Accreditation in Physical Therapy Education (CAPTE) indicates that clinical education should amount to about a third (33,3%) of a curriculum's hours, because the didactic part of the curriculum does not give students the opportunity to apply what they have learned (CAPTE 2014:iii). Two research studies indicated that didactic learning facilitates CT skills (Huhn *et al.* 2013:29; Williams, Klamen, White, Petrusa,

Fincher, Whitfield, Shatzer, McCarty & Miller 2011:1153). Other teaching strategies that incorporate CT include debate (Hall 2011:7), and experiential learning that involves hands-on treatment (Coker 2010:280). Visual mapping (especially argument mapping) has also been found to enhance learning and CT skills (Santiago 2011:137). Appropriate teaching activities can assist students, over time, to learn and demonstrate effective CT skills (Castle 2009:70). Different types of teaching strategies that could be used in a four-year undergraduate curriculum to improve CT skills are peer and self-assessments, and Schön's reflective practice (reflection-on-action and reflection-in-action) (Brudvig *et al.* 2015:9). Other strategies that could be incorporated are Bandura's social cognitive theory (observational learning) (Brudvig *et al.* 2015:9), according to which teaching is more student-centred, and requires innovative instruction, such as modelling, simulations, role play and self-directed learning (Brudvig *et al.* 2015:9; Reed 2014:126). Vogel *et al.* (2009:153) suggest that problem-based learning, case studies, small-group discussions, experiential learning and evidence-based practice assignments are some of the teaching strategies that could be used to develop CT.

Behar-Horenstein and Niu (2011:30) and Zhao *et al.* (2016:19) found that no single teaching strategy was more effective than another, while Payan-Carreira *et al.* (2019:833-834) determined that, in general, simulations and reflective writing were the most effective strategies, followed by concept mapping, problem-based learning and case-based learning. Payan-Carreira *et al.* (2019:840) conclude their study by stating that there is no "magic recipe" to develop CT skills, and that each lecturer/educator should carefully design each activity. This leads to the question, what teaching strategies do the lecturers at the UFS employ to develop CT skills in their undergraduate students?

For students to transfer knowledge into application in real-world situations, it is essential that teaching strategies support students' development of CT skills (Huang, Newman & Schwartzstein 2014:95; Tiruneh *et al.* 2014:10). Research on the teaching of CT skills is severely lacking, and very few lecturers have been trained to teach or are experienced in teaching CT skills (Halx & Reybold 2005:313; Stedman & Adams 2012:9). Another concerning factor identified by research is that faculty members are unsure of what CT is and how to teach it to their students (Cargas, Williams, & Rosenberg 2017:25; Halx & Reybold 2005:313; Stedman & Adams 2012:9).

Abrami, Bernard, Borokhovski, Waddington, Wade and Persson (2015:275) found dialogue (especially discussions) and authentic instruction (especially problem-solving and role play)

to be the most effective in teaching students to think critically. It is interesting that this study found that mentoring generated a significantly larger effect size when it was combined with dialogue and authentic instruction. No approach in isolation achieved the same effect size as a combination of different instructional approaches. A systematic review by Puig *et al*. (2019:865) found that self-study and authentic instruction were the most frequent interventions in biomedical sciences, followed by dialogue. Table 1.6 provides a summary of different teaching strategies used in health professions education.

Research on the effect of blended learning in developing CT skills indicated mixed results. E-learning, the learning management system, e.g. Blackboard, and virtual learning did not have a statistically significant effect on CT skills (Alotaibi 2013:184); Wiki activities combined with in-class activities promoted CT (Snodgrass 2011:563). Self-directed learning was found to be less effective for first-year groups of nursing students, because they are still learning to pace their studies and to cope with what is expected of them (Phillips *et al*. 2015:e1).

Bezanilla, Fernández-Nogueira, Poblete and Galindo-Domínguez (2019:8) list three types of methodology university teachers use to develop CT, 1) oral and written communication, 2) active methodologies and 3) other methodologies (e.g. individual study and mentoring). The researchers state that lecturers found oral communication to be the most important and effective, followed by case studies (Bezanilla *et al.* 2019:8). Abrami *et al.* (2015:289) also propose a classification of more defined approaches based on Bloom's taxonomy; these classifications include individual study, dialogue, authentic or anchored instruction, and coaching. These two studies mostly found overlapping factors, for which, in the view of the researcher, Abrami *et al.* (2015:289) provide the most comprehensive classification (*cf.* Table 1.6).

Table 1.6: Teaching strategies identified for the lecturer questionnaire using research on health professionals

Category 1: Individual study		Category 2: Dialogue/oral and written communication		Category 3: Authentic or anchored instruction/active methodologies		Category 4: Coaching/mentoring	
Teaching methodology	*Authors*	*Teaching methodology*	*Authors*	*Teaching methodology*	*Authors*	*Teaching methodology*	*Authors*
Self-directed learning	Brudvig *et al.* (2015); Phillips *et al.* (2015	**Thinking out loud and asking questions**	Facione and Facione (2008); Goodman *et al.* (2018)	**Applied problem-solving/ problem-based learning/ social learning**	Chan (2016); Ganesh and Smith (2017); Gholami, Moghadam, Mohammadipoor, Tarahi, Sak, Toulabi and Pour (2016); Keiller and Hanekom (2014); Kong, Qin, Zhou, Mou and Goa (2014); De Oliveira *et al.* (2016); Tiwari, Lai, So and Yuen (2006); Vogel *et al.* (2009)	**One-on-one teacher student interaction (feedback)/ debriefing/reflection (Schön's reflective practice)**	Brudvig *et al. (*2015); Patton,Higgs and Smith (2013), Plack and Santasier (2004)
Self-assessments/ self-monitoring	Hewson (2019)					**Peer-led dyads (peer assessments/ Peer assisted learning)**	Maas, Sluijsmans, Van der Wees, Heerkens, Nijhuis-van-der Sanden, Van der Vleuten (2014); Velde *et al.*, (2006); Van Vuuren (2017)
Student-centred learning (Bandura)	*Brudvig et al. (2015)*	**Structured research activities**	Kramer, Ideishi, Kearney, Cohen, Ames, Shea, Schemm and Blumberg (2007)	**Concept mapping**	Keiller and Hanekom (2014); Senita (2008), Kaddoura, Van-Dyke & Yang (2016), Lee, Chiang, Liao, Lee, Chen and Liang (2013)		
Reflecting/ reflective logs/visual and argument mapping	Griffiths and Ursick (2004); Santiago (2011)	**Small-group discussions**	Vogel *et al.* (2009)			**Internships/ experiential learning/service learning/real-world activities**	Bartlett and Cox (2002); Coker (2010); Kramer *et al.* (2007); Zettergren and Beckett (2004)
		Whole-class discussions/ group discussions/ formal debates	Crabtree (2001); Hall (2011); Hewson (2019); Kramer *et al.* (2007);	**Simulations**	Brudvig *et al.* (2015); Lapkin, Levett-Jones, Bellchambers and Fernandez (2010); Macauley, Brudvig, Kadakia and Bonneville (2017); Shin Ma, Park, Ji and Kim (2015)		
Blended learning (Wikis, e-learning, Blackboard, virtual learning)	Hsu and Hsieh (2014); Rowe, Frantz and Bozalek (2012); Snodgrass (2011)			**Role play**	Brudvig *et al.* (2015)	**Didactic learning**	Huhn *et al.* (2013); Williams *et al.* (2011)
				Team-based problem-solving activities	Kramer *et al.* (2007)		
				Evidence-based practice assignments	Aglen (2016); Profetto-McGrath (2005); Schoonees, Rohwer, & Young (2017); Vogel *et al.* (2009)	**Tutor**	Palese, Saiani, Brugnolli and Regattin (2008)
				Case studies/ clinical based assignments	Popil (2011); Vogel *et al.* (2009)		

Source: Compiled by researcher, based on Abrami *et al.* (2015); Bezanilla *et al.* (2019)

1.3 PROBLEM STATEMENT AND RESEARCH QUESTIONS

The problem that needed to be addressed was that, prior to this study, CT had not been tested in students in any year of study in the SAHP at the UFS.

As far as could be ascertained after a complete academic literature search had been done via the UFS library (CINAHL, PsycINFO, MEDLINE, ERIC, Academic Search Complete), Google Scholar and National Research Foundation NEXUS database, in the last 10 years, only two studies had been undertaken on this topic in AHP in South Africa. The one study investigated the teaching and learning approaches in one problem-based learning module for undergraduate physiotherapy students (Keiller & Louw 2013:1), and the other study considered concept maps as a strategy to develop CT skills and clinical reasoning (Keiller & Hanekom 2014:8). Only one other, older study, a dissertation for a Master's degree in education, could be found that was done in South Africa, in the area of physiotherapy. This study developed a framework for CT skills for teaching and learning in physiotherapy. It involved interviews with and a workshop for teachers and clinical educators at one institution (Ramklass 2000:28).

Zettergren and Beckett (2004:77) conclude that CT skills should be tested in the first year of study, and followed up in each year of study, up to the public-service year. However, when testing CT skills across a curriculum, it should be noted that not every education programme automatically promotes the building of CT skills, though each programme should at least try to facilitate the development of CT skills (Domenech & Watkins 2015:197). This study, therefore, assessed the CT skills of undergraduate AHP students during their clinical rotation years at the UFS, and assessed whether their skills had changed over a period of one clinical year, according to the TSA-Modified (*cf.* Chapter 2, Article 1).

A second aspect that was investigated by this study (*cf.* Chapter 3, Article 2) was the types of CT teaching activities AHP lecturers included as teaching methods in the year of this particular research study. This investigation was done for all four years of each curriculum, because a large number of research studies state that CT should be addressed from the first year of study at university level, to assist students in coping with the years of study and ensure development of the best possible practitioner (Thomas 2011:26). Students' knowledge should progress hierarchically over years of study, and the lecturer should plan teaching strategies accordingly (Harman *et al.* 2015:378). Thus, in this study, the

researcher looked into what types of activities where seen as appropriate for each year group in the different departments of the SAHP. The researcher also set out to determine if these strategies were scaffolded during the different years.

1.4 AIMS AND OBJECTIVES OF THE STUDY

This section will present the aims and objectives of this study.

1.4.1 Aims of the study

The aim of the study was twofold: Firstly, to determine the CT skills of undergraduate AHP students at the UFS during their clinical rotation years, and whether CT skills change over a period of one clinical year of study in each profession.

Secondly, this study aimed to investigate the types of teaching activities lecturers in the various departments of the SAHP used to develop CT skills in undergraduate students in the different years of study.

1.4.2 Objectives of the study

To achieve the aim of this study, the objectives were formulated as follows:

1. To conceptualise and contextualise CT skills, with a specific focus on undergraduate AHP students in clinical rotation years **(a literature review was conducted**);
2. To determine the CT skills of students in the various AHP at the UFS during the clinical rotation years, and whether the level changed over one year for each profession **(TSA-Modified administered at the beginning and end of the year of study)**; and
3. To investigate how and when CT skills are taught by the lecturing staff of AHP departments at the UFS **(a questionnaire directed at the educators of the various AHP was administered)**.

1.5 RESEARCH DESIGN OF THE STUDY

The following section will provide a description of the research design and methodology.

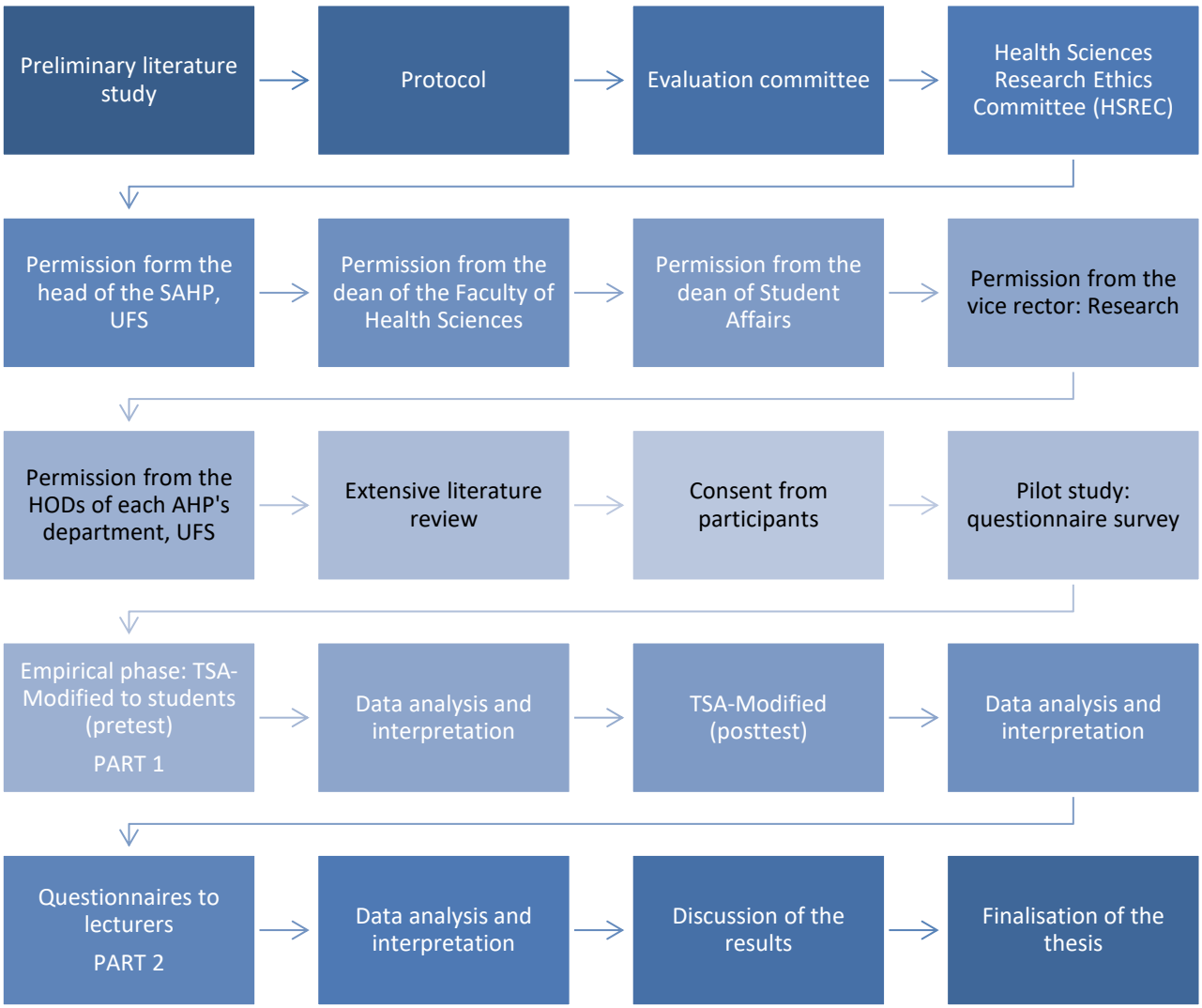
1.5.1 Research design

Research design can be defined by comparing it to the design of a building by an architect. Research design involves processes of planning, designing and acting, and focusing on the end product and the steps needed to achieve the outcome (De Vos, Strydom, Fouché & Delport 2011:142-143). Polgar and Thomas (2013:12) describe both qualitative and quantitative research as the perception of matter, that is, the way we see things. Quantitative research is based on natural-science traditions, and qualitative research is focused more on social sciences. Quantitative researchers are more "reductionistic" – they simplify fundamental elements and search for relationships between variables. Quantitative research is more objective than qualitative research, and limits personal bias by using instruments such as questionnaires (Creswell 2014:247). Quantitative research has two other important elements: numerical data and generalisability, which were both important in this study. Using questionnaires enforces objectivity by the researcher. By performing the measurements in a controlled environment, the researcher can explain how the variables interrelate (Maree & Pietersen 2016:162; Polgar & Thomas 2013:12-15).

Quantitative research can be classified as having either an experimental or a non-experimental design. With an experimental design involving two or more groups and measurement of a variable, an intervention or manipulation of a variable takes place and the group is measured again at a later time. There are three categories of experimental design types: pre-experimental, quasi-experimental and true experimental. Variables are not controlled in pre-experimental designs, making determining of cause and effect of the intervention difficult. A one-group pretest-posttest design is one type of pre-experimental design that measures a variable in one group and, after an intervention is introduced, the variable is measured again (De Vos *et al.* 2011:147). Quasi-experimental and true experimental designs involve a control group, and is not relevant to this particular study. With non-experimental designs, units are selected and all the relevant variables are measured at a specific time.

This study was conducted in two parts. Part 1 of this study was a one-group pretest-posttest design quantitative study, which made use of the TSA-Modified test as research tool (*cf.* Appendix E1). Part 2 utilised a descriptive design to investigate the types of teaching activities AHP lecturers used to improve CT skills in their undergraduate students during the year this study was conducted (*cf.* Figure 1.5). This behaviour was investigated by means of a self-designed questionnaire *(cf.* Appendix E2).

A schematic overview of the study is provided in Figure 1.5.



Source: Compiled by the Researcher (Louw 2019)
Figure 1.5: Schematic overview of the study

1.6 METHODS OF INVESTIGATION

The research methods that were used in this study will be described and discussed in the following section.

1.6.1 Literature overview

A literature overview is described as "a search and evaluation of the available literature in your given subject or chosen topic area" (Royal Literary Fund 2019:online). The four main

objectives of a literature review are to, firstly, survey literature available in the specific area and, then, secondly, to synthesise the information into a summary, thirdly, to analyse the information critically by identifying gaps in knowledge, indicating possible limitations and looking at areas of possible further research, and, lastly, to present the information in an organised manner to justify the significance of the study (De Vos *et al.* 2011:93,109; Maree & Pietersen 2016:28; Royal Literary Fund 2019:online).

A literature review, thus, provides an indication of the researcher's own knowledge on the research subject, shows how the research will fit into the bigger picture of the knowledge available at the time of study, and indicates the relevance of the research (De Vos *et al*. 2011:109). The literature review of this study focused on two aspects. The first aspect of the literature review identified the concepts currently in use in relation to CT skills. CT is a skill that can be taught (Butler, Pentoney, & Bong 2017:38; Ennis 2018:176; Kahlke & White 2013:24; Sharples *et al.* 2017:2) and enhanced with specific teaching methods (Macauley *et al.* 2017:73; Niu *et al.* 2013:126). It is, thus, important to determine if the AHP curriculum promotes CT sufficiently to prevent difficulties when students reason clinically (Mulnix 2012:478; Payan-Carreira *et al.* 2019:830), which could lead to diagnostic errors when working with patients, or worse, unsafe patient care (Carvalho, Azevedo, Cruz, Mafra, Rego, Vitor, Santos, Cogo & Ferreira Júnior 2017:104). The second aspect of the literature review assessed the types of teaching activities that enforce CT skills in the AHP (*cf.* Table 1.5).

The literature overview that was completed for the purpose of the first part of the study (*cf.* Table 1.3) revealed that there is no specific CT test for each profession, and that the professions could benefit from a profession-specific tool being designed (Brudvig *et al.* 2013:19). The CCTST, CCTDI and W-GCTA were indicated as being unsuitable for measuring CT in health care professionals (Peeters & Boddu 2016:276; Vendrely 2005:58 Vogel *et al*. 2009:156; Wilson 2000:27-31), because the questions are applicable to a general population. The CCTDI also tests the disposition (beliefs and attitude) to think critically, and not the CT skill (Lederer 2007:520). Research shows that the HSRT addresses concerns raised about the questions being written in a health care context (Vogel *et al*. 2009:156); however, it is contradicted by other studies (Cox & McLaughlin 2014:1; Peeters & Boddu 2016:276). Students tend to score high on the tests (CCTS, W-GCTA and HSRT), leaving very limited space for CT skill improvement of the students (Goodman *et al.* 2018:2351; Velde *et al*. 2006:56; Vendrely 2005:56; Wessel & Williams 2004:86). This could indicate that the tests are not challenging enough for students (Peeters & Boddu 2016:276). The DIT was helpful to measure complex thinking (Peeters & Boddu 2016:271), though the

test did not correlate with subsequent academic performance (Kelsch & Friesner 2014:1; Lobb, Wilkin, McCaffrey, Wilson & Bentley 2006:1). The HSRT was indicated to have limited usefulness as an admission screening tool (Kelsch & Friesner 2014:1). Differences between the clinical reasoning processes of experts and novices were identified with the HSRT, but its clinical and educational relevance was questioned (Huhn *et al.* 2011:182). It should be noted that the HRST, furthermore, is not based on domain-specific knowledge (Huhn *et al.* 2011:185). According to the researcher's literature review, and to date of this dissertation (*cf.* Table 1.3), the HSRT has not been used to test any undergraduate AHP. The researcher wanted to identify a CT-specific test for undergraduate students that would assist in predicting graduate success. By considering the literature, and after considering the pros and cons of each test, the TSA-Modified was chosen for application in this study. The TSA-Modified will be discussed in Section 1.6.2. It should also be noted that administering the WGCTS, HSRT and CCTST involves considerable financial resources.

1.6.2 Part 1: Critical-thinking skills tests

In this section, the TSA-Modified test will be discussed. The test forms a portion of Part 1 of the research process.

1.6.2.1 Theoretical aspects of the Thinking Skills Assessment

The University of Cambridge developed the TSA test in collaboration with the University of Cambridge Local Examinations Syndicate (UCLES 2015) over the last 37 years, for the purpose of admission testing of CT and problem-solving skills of students applying for higher education courses. This test was designed by British universities to assist with, specifically, skilful and fair selection of the best applicants for admission. This test was piloted by 22 universities in five disciplines at the University of Cambridge in 2005 (Fisher 2005:10). Other universities that currently use the TSA tests for admission are Oxford University (for studies in economics and management, experimental psychology, geography, human sciences, philosophy and linguistics, philosophy, politics and economics, psychology and linguistics, psychology and philosophy) and University College London, for European social and political studies (Admission Testing Services 2017:2).

Universities in the United States of America developed the Scholastic Aptitude Tests (SAT) for the process of university admissions in 1926; the test has expanded in the last 90-odd years (Fisher 2005:9). The SAT is seen as "objective measure of intelligence" (Fisher

2005:10), indicates a good academic aptitude and assists with the admission process at universities. The big difference between the SAT and the TSA is that the TSA assesses skills that can be taught in higher education, whereas the SAT only measures innate abilities (Fisher 2005:12). Fischer (2005:12) states that the TSA questions are intended to reflect university-level work, and represent the type of questions admission officers would have liked to ask candidates.

A free online version of the TSA (specimen test of 2015) and Biomedical Admissions Test (BMAT), with answer keys, exists. The TSA test includes questions for problem-solving skills (including numerical and spatial reasoning) and CT skills (including understanding of arguments and reasoning, in a British context), while the BMAT tests problem-solving, understanding arguments, data analysis and inference in Section 1, and scientific knowledge and applications of biology, chemistry, physics and mathematics in Section 2. The questions of the BMAT test give no specific indication of the skills the questions test; the questions are not framed in a medical context, and the test only has 18 questions in Section 1 of the test. Section 1 is the only part of the test that is applicable to this study's research questions and aims.

The TSA specimen test of 2015 compromises 50 multiple-choice questions (25 problem-solving questions and 25 CT questions). The time for completing the test is 90 minutes. Each question on the TSA test counts 1 mark and a percentage is calculated (0-100) at the end, which is indicative of the test-takers' ability. The total of the correct answers are multiplied by two to calculate a percentage mark for the test.

The researcher completed the HSRT and CCDTI, and found that the TSA-test was a feasible combination of all the CT tests for the following abilities: summarising the main conclusion, drawing a conclusion, identifying an assumption, assessing the impact of additional evidence, detecting reasoning errors, matching arguments and applying principles (Admission Testing Services 2016:1-19; Cambridge Assessment Admission Testing 2017:online). The TSA was, however, modified by the researcher (*cf.* Appendix E1), and only the CT questions (25 questions) were used, while the problem-solving questions were omitted. Furthermore, the questions were modified for a South African context, for example, where reference is made to a European country, it was altered for the South African context (*cf.* Article 1). The questionnaire is freely available online, but the researcher contacted Cambridge Assessment Admission Testing Services to obtain permission to,

firstly, use the questionnaire and, secondly, make the required changes to it. An email was received, giving permission to use the specimen TSA (*cf.* Appendix F1).

1.6.2.2 Target population

A population is defined as "totality of persons, events, organisation units, case records or other sampling units with which the research problem is concerned" (De Vos *et al.* 2011:223). The population could also be referred to as a collection of all the sample units applicable to the research questions (Maree & Pietersen 2016:164).

Target population refers to "any inference from a sample [that] refer[s] only to the defined population from which the sample has been properly selected" (Banerjee & Chaudhury 2010:60). This indicates that the target population is the part of a group that the researcher wants to investigate further, to assist the researcher to make generalisations about the population due to common characteristics (Banerjee & Chaudhury 2010:60).

The target population of this study was all the AHP students in their clinical rotation years (third and fourth years) in 2018 who decided to participate in this study. The Department of Exercise and Sport Sciences was excluded from this study, because the Department had no third-year or fourth-year students in 2018 (see Section 1.2.5.1).

Participants were excluded from the study if they declined to participate in the testing of CT skills, had decided to discontinue their education, or were absent on the days of testing. Whole-group sampling was utilised in this study, meaning all the undergraduate students of the SAHP, excluding those in the Department of Exercise and Sport Sciences, in their clinical rotation years (third and fourth years) were included in this study.

1.6.2.3 Population size

The target population size of the third- and fourth-year AHP students for 2018 is indicated in Table 1.7. The number of students who consented to participate voluntarily (the sample) is indicated in brackets. See Chapter 2, Article 1 for more information.

Table 1.7: Student population size of the various departments of the School for Allied Health Professions in 2018

	Physiotherapy	Occupational Therapy	Nutrition and Dietetics	Optometry
Year three	39 (25)	40 (15)	12 (12)	18 (3)
Year four	39 (33)	41 (0)	7 (7)	31 (12)

Source: Information compiled by the researcher from information received from each department in the SAHP (see personal communication list).

1.6.2.4 Data instrumentation

The TSA-Modified was used in this study (*cf.* Appendix E1). Details of the TSA specimen test was provided in Section 1.7.4. Modifications where limited to localisation of European references. These changes are indicated in red in Appendix E1. The specific changes are listed in Chapter 2, Article 1.

1.6.2.5 The pilot study

A pilot study is defined as "a preliminary study where the procedures and protocols are tested" (Polgar & Thomas 2013:214).

In 2017, one student in each AHP department in their fourth year of study was approached to participate in the pilot study; these students did not take part in the study in 2018. A pilot study using the TSA-Modified was done to determine if 45 minutes (*cf.* Appendix E1) was sufficient time to complete the test, and whether they understood all the questions, or if further explanation was needed. This pilot test was only conducted once. No changes were made to the TSA-Modified after the pilot study.

1.6.2.6 Data gathering

Polgar and Thomas (2013:13) refer to data as "results which are analysed to provide the evidence required for theory formation and evidence-based health care". In this study, data was collected by means of the TSA-Modified from all undergraduate students who consented to participate. The TSA-modified was administered during the first week of the first semester of 2018, at a time and place set for each year group, after being discussed and confirmed with the head of each AHP department at the UFS. The same test was repeated at the end of the year during the last week of class (September 2018), after all

the students had completed their clinical blocks, at the same time and place for each year group. These tests where completed in a paper-and-pencil format using score sheets provided by the researcher. Each student was assigned a unique research number (*cf.* Appendix B1) that was indicated on the questionnaire; this was done to limit bias at both test administration events. The fieldworker was the only person with access to the list of the assigned unique research numbers. The data collected from each student was compared to determine if changes had taken place in CT skills during the clinical year of testing.

The researcher was assisted by a fieldworker, who was present in the allocated venue to distribute the test and collect the forms after the students completed them in the allocated time frame, on the same day. The same fieldworker was used for all the tests in each department in the SAHP.

The test was administered in English, as this is the most commonly spoken language in official and commercial public life in South Africa (SAinfo reporter and MediaClubSouthAfrica.com 2015:online). Since 2017, English has also been the official language of instruction at the UFS for all first-year students (UFS Council 2016:2). Therefore, in the case of this study, conducted in 2018, the first and second-year students received their education in English. Although the third- and fourth-year students were still being taught in English and Afrikaans, the test was only made available in English.

1.6.2.7 Data analysis

The principles of probability are applied in the analysis of quantitative data to test the researcher's hypotheses and analysis confidence intervals (Polgar & Thomas 2013:19). Quantitative data contains more inherent properties than qualitative data, thereby, increasing the complexity of summarising the variables. Each respondent (or student) has one value, "distributed across a certain range of values" (Maree & Pietersen 2016:207).

The data was coded on an answer sheet (*cf.* Appendix G2) by the researcher. The Department of Biostatistics at the UFS analysed the data obtained from the TSA-Modified, using SAS Version 9.4 (*cf.* Appendix E1). Each student received a unique research number (*cf.* Appendix B1). The data on the test was transformed into a numerical code by preparing an answer sheet with correct answers. One mark/point was allocated for each correct answer and a zero for incorrect answers. All possible answers where coded, even non-responses (De Vos *et al.* 2011:252).

Data analysis of Part 1 of this study will be discussed in detail in Chapter 2, Article 1.

1.6.2.8 Data interpretation and reporting

Interpreting quantitative research means that the researcher uses the research questions, hypotheses and findings about the significance of the study as the basis for conclusions about these results (Creswell 2014:244). This means that the researcher made sense of the data obtained (De Vos *et al.* 2011:416).

Though four different AHP's departments participated in this study, the population sizes for some of the professions were very small. This caused a limitation in the study, and made any comparison between the different cohorts very difficult. Thus, the researcher refers to the AHP and not to the specific professions.

In Chapter 2, Article 1, the median score differences between the different professions indicate a statistically significant difference in total score, but due to the small population, further research is needed in this cohort.

1.6.3 Part 2: Questionnaire for allied health professions lecturers about incorporating critical-thinking skills in the curriculum

Administering the questionnaire to all the AHP lecturers who consented to participate, formed Part 2 of this study. For the purpose of this study, only the lecturers at the various AHP departments, except the Department of Exercise and Sport Sciences, were included, to determine the type of teaching activities involved in their teaching strategies to incorporate CT skills in 2018, and to determine if different activities were incorporated for different year groups for each profession.

A researcher-developed questionnaire was used for this part of the study (*cf.* Appendix E2). The questions in the questionnaire were developed on the basis of the researcher's knowledge of the physiotherapy undergraduate curriculum and the literature study that had been completed for the purpose of conducting this part of the research (*cf.* Table 1.6). The literature review conducted for the lecturer questionnaire will be discussed in more detail in Chapter 3, Article 2.

1.6.3.1 Target population

All lecturers in the various departments of AHP in 2018, were targeted for this study. Lecturers were only excluded from this study if they choose not to participate, or were in the Department of Exercise and Sport Science. If lecturers where on leave or absent on the day of administration, the questionnaire was administered at a later time to those specific individuals. The demographics of the target population will be discussed in Chapter 3, Article 2.

1.6.3.2 Population size

All lecturing staff of the various AHP departments that were willing to participate in this study, were targeted for inclusion in this study. See Table 1.8 for a summary of the total lecturing staff in each department in the SAHP. The number who actually participated is given in brackets for each department.

Table 1.8: Target population size of the lecturers in the various departments in the School for Allied Health Professions

	Physiotherapy	Occupational Therapy	Nutrition and Dietetics	Optometry
Lecturers (academic and session staff members)	14 (16)	11(4)	8 (4)	5 (2)

Sources: UFS staff telephone list of 2018 and UFS website

1.6.3.3 The pilot study

A pilot study was done with one lecturer in the SAHP, to determine the time it takes to complete the questionnaire and whether there was a possibility of misunderstanding some of the questions. No changes where required after the pilot study, and the completed questionnaire was included in the final data set.

1.6.3.4 Data gathering

A self-administered questionnaire that was developed by the researcher was used in this study (*cf.* Appendix E2). This questionnaire was administered at the end of the year

(October 2018), when all the classes had ended. The researcher originally planned to disseminate the questionnaires to the different departments via sealed envelopes, but because the lecturers were off-campus for examinations, pregnancy leave, study leave, etc., the researcher decided to email the questionnaires to all the staff. A box was placed at the Departments of Occupational Therapy and Physiotherapy, and lecturers where informed that they could either email the completed questionnaire back or place it in the box. The researcher then assigned a research number to the questionnaires as they were received back. No person-identifying information was requested from any participants. A timeframe of two weeks was allocated for the completion of the questionnaire. A follow-up email was sent to the lecturers after two weeks, to remind them to complete the questionnaire. After two weeks, the box was collected, even though all questionnaires that where received back had been either hand delivered to the researcher or sent back via email. No questionnaires were received back from the box. Data collection will be discussed in Chapter 3, Article 2.

1.6.3.5 Data analysis

Descriptive research presents "a picture of the specific details of a situation, social setting or relationship, and focuses on the 'how' and 'why' questions". Descriptive research, in quantitative research, typically refers to the populations' characteristics by describing them accurately (De Vos *et al.* 2011:96). Loeb, Dynarski, McFarland, Morris, Reardon and Reber (2017:1) state that descriptive analysis involves data simplification, which identifies patterns to answer questions asking about "who, what, what, when and to what extent".

The data on the questionnaire was transformed into a numerical coded by preparing a list of possible answers (code sheet) that code into numerical data. All possible answers were coded, even non-responses (De Vos *et al.* 2011:252), and manually entered into a Excel spreadsheet by the researcher. Data analysis of the lecturer questionnaire will be discussed in Chapter 3, Article 2.

1.6.3.6 Data interpretation and reporting

The data interpretation of this part of the study will be presented in a descriptive form.

Even though four different departments' AHP lecturers/academics participated in this study, the population sizes were very small in most of the cohorts. This caused a limitation in the study and made any comparison between the different academic cohorts very difficult. Thus, the researcher refers to the AHP lecturers in general, and not to specific cohort lecturers.

In Chapter 3, Article 2, the data interpretation and reporting will be discussed. The data was analysed by the Department of Biostatistics and will be reported as frequencies (medians) and percentages. Due to the small population, further research is needed in these different cohort lecturers.

1.7 DEMARCATION OF THE FIELD AND SCOPE OF THE STUDY

This study was interdisciplinary in that it was conducted in the field of health professions education and has its application in the field of AHP education. This study had a specific focus on determining the CT skills of undergraduate AHP students in the clinical rotation years, and to determine if their CT skill level changed during one clinical year. Another focus of this study was to investigate the different types of teaching strategies lecturers used in the different professions to improve students' CT skills.

The study was conducted from February 2018 to September 2018, with the pilot study conducted in November 2017. The empirical research phase took place in February and September 2018. Ethics clearance (HSREC 131/2017, UFS-HSD2017/1276) was granted in November 2017 by the Health Sciences Research Ethics Committee at the UFS.

1.8 SIGNIFICANCE, VALUE AND CONTRIBUTION OF THE STUDY

The value and significance of this study will be discussed in the next sections, and will be followed by the study contribution and ethical considerations.

1.8.1 Value

Research is valuable if it increases knowledge, assists in transferring knowledge from researchers to practitioners/organisations and could promote the development of new scientific questionnaires or measurement instruments and methodologies (Georghiou

2015:4). Measurements of the CT skills of AHP students at undergraduate and postgraduate levels are rarely available (*cf*. Section 1.2). By administering CT tests, such as the CCTST, predictions can be made about the outcomes of higher education performance, especially if the tests are used with higher-performing students (O'Hare & McGuinness 2015:169).

Sharp *et al.* (2013:5) report that 64,9 percent of allied health professionals have weak CT skills, 31,6 percent have moderate skills, and only 3,5 percent have strong CT skills. It must be stated that none of the AHP students who participated in Sharp *et al.* (2013) study, were representative of the SAHP at the UFS. These findings correspond with findings reported in a book by Roksa and Arum (2011, cited in Sharp *et al.* 2013:4). This alarming result regarding weak CT skills in AHP, indicates that testing students' CT skills, and a deep investigation into the curriculum and the type of teaching strategies and activities applied by lecturers, could enhance student performance in the long run, resulting in improved student success (Facione & Facione 2008:iii; Sharp *et al.* 2013:5).

The value of this study will be to fill a gap in the knowledge that currently exists in the field of AHP and to add value to research in this field. The extent of CT skills demonstrated by the undergraduate students in this study will also be communicated to the SAHP, which can use it according to its discretion. Results from this study could possibly provide a foundation for changes to the different departments' curricula to improve CT skills of undergraduate students.

This research process will involve providing feedback to the SAHP at the UFS about the CT skills of undergraduate AHP students in their clinical rotation years and, if necessary, will recommend incorporation of activities in teaching methods, thereby to improve the CT skills of undergraduate students.

1.8.2 Significance

Clinical significance is defined by Jacobson, Follette and Revenstorf (1984, cited by Jacobson and Truax 1991:12) as something that motivates a move, either away from a dysfunctional population or closer to a functional population. This indicates that, if a study is to be significant, it should make an impact on the population and it should be done for the betterment of the population (Jacobson & Truax 1991:12).

CT is identified by the American Physical Therapy Association as a necessary and desirable attribute for physiotherapists and physiotherapy students alike. It is, thus, important that educators play an active role in developing CT skills in students, to teach students to think, and not just memorise information (Zettergren & Beckett 2004:74).

If CT can be enhanced and developed in all the years of study, students will gain clinical reasoning skills, which will have lifelong benefits for them (Brudvig *et al.* 2013:19). Thus, designing and administering a CT skills test could benefit the SAHP, which could use it either as a pre-admissions test, or to test students yearly to determine if teaching strategies should be changed.

This research could inspire future research. CT skills could be tested in all four years of study, which could determine if there is a gap in the curriculum. This gap can be investigated more deeply by analysing the curriculum itself. By measuring CT skills at the start of the curriculum (first year) it can be determined where students need additional assistance or workshops to enhance these skills. It should also be considered whether students who are selected to study in the health professions have higher levels of CT skills, and that a pre-admission test in the different professions could be more financially viable than investing financial resources on developing good critical thinkers into a great critical thinkers (Reale *et al.*, 2018:830).

Pre-admission tests that test CT have been found to be successful in identifying students with strong CT skills and the potential to achieve academic success (Campbell 2017:30; Fisher 2005:10; Willmott 2005:5) and using a CT skills test (e.g., CCTST or HSRT) was, thus recommended (*cf.* 1.2.4).

1.8.3 Contribution

The word contribution has its origins in Latin and means bring together (Oxford Dictionaries n.d.:online). Measurements of the CT skills of undergraduate AHP students can be compared to determine if the exit-level outcomes have been achieved in terms of CT. A norm could be developed, and this could help to identify areas that the students need to focus on to improve their CT skills. This finding was the main output of this study.

This study's focus was to contribute to the body of knowledge on CT skills of undergraduate AHP students.

1.9 ARRANGEMENT OF THE STUDY

This chapter, Chapter 1, **Overview and orientation to the study**, presented background to the research problem, the problem statement and research questions, and the aim and objectives of the study. This chapter demarcated the field and scope of the study, explained the significance and value of the study, described the research design of the study and methods of investigation, and referred to the implementation of the findings. The chapter also included a summary of the research methodology, followed by an overview of the main research findings.

Chapter 2 is the first research article in the format of a publishable paper. The publishable paper that will be submitted is titled, ***Critical-thinking skills of undergraduate allied health professions students: a pretest-posttest study.*** The paper was written according to the author guidelines of the journal, *Critical Thinking and Creativity*.

Chapter 3 will present the second research article in the format of a publishable paper. The publishable paper that will be submitted is titled, ***Allied health professionals climbing the steps of critical-thinking education.*** The paper was written according to the author guidelines of *The Journal of Higher Education*.

Chapter 4, **Conclusion, recommendations and limitations of the study,** will provide an overview of the study, identify the significance and limitations of the study, and make suggestions for further studies and research that are needed in relation to the research problem.

1.10 CONCLUSION

Chapter 1 provided an orientation to the study, and will be followed by two publishable articles, in Chapters 2 and 3.

CHAPTER 2

ARTICLE 1:

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS: A PRETEST-POSTTEST STUDY

The article was prepared according to the submission guidelines for the journal, *Thinking Skills and Creativity* (*cf.* Appendix H1).

ARTICLE TITLE: CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS: A PRETEST-POSTTEST STUDY

- **Significance of work:** Critical-thinking (CT) skills is one of the most essential graduate attributes that undergraduate students need to require to be successful in their careers of choice, and to succeed at university level. CT skills are particularly important in healthcare practitioners, because, if health care professionals lack critical-thinking skills, it could affect their clinical practice. Not all universities make use of pre-admissions testing or, more specifically, test CT skills to determine if students experience a shift in CT during any year of study. In this research study, the researcher set out to determine whether CT skills developed in undergraduate students studying towards an allied health degree at the University of the Free State. The pretest-posttest study was performed during the clinical rotation years of these undergraduate students, over a time frame of nine months.

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    - Principal researcher and first author: Ms. M. Louw
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- **Statistician:** Staff of the Department of Biostatistics at the University of the Free State analysed the data used in this study.

- **Summary:**
    - Number of words: 6 562 (total document)
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    - Tables
        - **Table 1**: Example of changes made to the TSA-Modified
        - **Table 2:** Analysis of the response rate per department
        - **Table 3:** Test results of the TSA-Modified
        - **Table 4:** Critical-thinking skills classification according to TSA-Modified total scores per year and per department
        - **Table 5:** Individual result per profession per year group
        - **Table 6**: Direction of change according to the results on the TSA-Modified test total results (from pretest to posttest)
    - Figures : None
    - Supplementary material : None

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS: A PRETEST-POSTTEST DESIGN

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Highlights:

- Thinking Skills Assessment (TSA) was modified and administered to undergraduate allied health professions students at the University of the Free State to determine their level of critical-thinking skills.
- Statistically significant differences were found in the pretest-posttest scores of occupational therapy students.
- Statistically significant differences were found in median differences of “matching arguments” on the total scores on the TSA-Modified test.

Abstract

Critical thinking (CT) is a valuable attribute and a prerequisite for succeeding in most occupations, especially in health care professions. Health care professionals are required to make decisions that could have a serious influence on the lives of others; these decisions have to be made quickly, and should be consistent. Decisions are based on knowledge that has been integrated into clinical practice, CT skills make this process of integration possible. The objective of this research study was to determine if CT skills develop in undergraduate allied health professions students over a period of nine months. A one-group pretest-posttest design was used for this quantitative study. CT skills were tested using a modified version of the 2015 Thinking Skills Assessment (TSA). The target population was 227 undergraduate allied health professions students at the University of the Free State, of whom 136 completed the pretest, but only 106 completed the pretest and posttest, and who were consequently included in the study (55,5% and 43,3% response rates respectively). This study found no statistically significant development of overall CT skills over the study period. Interestingly, occupational therapy students showed a statistically significant difference in median test scores compared to the other groups, though this finding needs further investigation. This study highlights the need for more extensive research on the CT skills of different health care professionals, to build a stronger foundation regarding thinking, and to improve clinical reasoning skills, which could lead to better patient care.

***Keywords*: Critical-thinking skills, allied health professions, graduate attributes, Thinking Skills Assessment (TSA)**

1. INTRODUCTION

Critical thinking (CT) is currently a focus area in higher education, not only in relation to the preparation of graduates for the impact of the fourth industrial revolution on the future world of work, but also in health care education, as a graduate attribute for student success within this domain (Ross, Loeffler, Schippe, Vandermeer & Allan 2013; Strydom & Oosthuizen 2019). CT skills are needed to ensure the transfer of knowledge into clinical practice by health care students, through higher-order thinking skills, to reach the best possible clinical decision for each patient (Fitzpatric, 2005). Considering that it takes 11-16 seconds to interpret a problem and formulate a rudimentary reflective response (Facione & Facione, 2008), it is crucial for the health care professional to complete this thinking process and make a decision, especially in life-threatening situations. Even though there has been a realisation that students are lacking in CT skills (Roksa & Arum, 2011; Sharp, Reynolds, & Keisha, 2013), little research has been done on this subject, especially in the field of allied health professions (AHP). Articles have focused mostly on postgraduate students and/or on a specific group/profession within the AHP. Better insight into CT skills, especially as related to clinical practice amongst undergraduate AHP students, could benefit the long-term understanding and development of CT skills and support student success.

A moderate correlation has been found in health professionals between CT and clinical judgement (Brudvig, Dirkes, Dutta, & Rane, 2013; Goodman, Redmond, Elia, Harris, Augustine & Hand, 2018); clinical competence (Distler, 2007); clinical reasoning (Facione & Facione, 2008); real-world decision-making and positive life events (Butler, Dwyer, Hogan, Franco, Rivas, Saiz & Almeida 2012; Butler, Pentoney, & Bong, 2017); learning styles (Brudvig, Mattson, & Guarino, 2016); diagnostic accuracy (Brunt, 2005; Charney & Peterson, 2013); patient-centred care (Reale, Riche, Witt, Baker, & Peeters, 2018); degree performance (O'Hare & McGuinness, 2015; Pitt, Powis, Levett-Jones, & Hunter, 2015) and student success (Charney & Peterson, 2013; Fong, Kim, Davis, Hoang, & Kim, 2017; Liu, Frankel, & Roohr, 2014; Ross et al., 2013). A gap exists, particularly in the area of AHP and, more importantly, undergraduate students; it is, thus, important to determine if students' CT skills improve during the clinical years of study, as would be expected.

This research study aimed to fill a gap in the knowledge in the field of AHP, especially regarding CT skills. CT skills have been ranked globally, and by the University of the Free State (UFS), as the second-most-important skill needed for the profession of teaching, and for employment in general (AAC&U, 2009; Liu et al., 2014; Strydom & Oosthuizen, 2019). By investing in research on the development of CT skills at the UFS, it is expected that future graduates will move up the ladder of employability, thereby making the UFS the institution of first choice for higher education.

The concept of CT is still under development in healthcare; consequently multiple variations in the definition of CT exist due to the complexity of the subject (Kahlke & White, 2013). The Association of American Colleges and Universities (AAC&U, 2011) defines CT as “a habit of mind characterised by the comprehensive exploration of issues, ideas, artefacts, and events before accepting or formulating an opinion or conclusion”. For health professionals to make the quick decisions that are needed, CT skills have to be a habit of mind. This habit will improve the process of clinical reasoning, leading to improved patient care. This definition has been identified as the benchmark for the development of CT in UFS students; therefore, it will be the guiding definition for this research (Strydom & Oosthuizen, 2019).

There are a vast number of tests available in different formats to assess CT skills, but most of them are costly, especially for a third-world country, such as South Africa. Except for the financial implications, there is not a common, reliable and valid tool available to assess CT skills consistently in health professions (Paul, 2014). Firstly, it should be determined if a need exists to develop undergraduate AHP students’ CT skills (Hutton & Hutton, 2012), before the effort is made to spend financial resources on this skill with the aim of enhancing student success (Peeters & Boddu, 2016). The Thinking Skills Assessment (TSA) test was developed by University of Cambridge Local Examinations Syndicate (UCLES) to assist with university admissions, and it is based on 25 years of experience (Willmott, 2005). The TSA assesses the CT and problem-solving skills of university applicants and is administered mainly by the University of Cambridge, University of Oxford and the University College London for various degrees, but does not include health sciences (Hutton & Hutton, 2012). Cambridge Assessment Admission Testing developed the BioMedical Admission Test

(BMAT) in 2001 for medical and veterinary student admission testing; however, this test does not test CT specifically. Instead, it tests aptitude and skills, which include a CT skills component (Fisher, 2005).

The aim of the research reported in this article was twofold: Firstly, to determine the CT skills of undergraduate AHP students in their clinical rotation years, and, secondly, to determine if any change took place in the CT skills of these students during a time frame of nine months (clinical rotation year).

2. MATERIAL AND METHODS

A quantitative study, pretest-posttest design, was done using a specimen version of the TSA test of 2015, with permission from UCLES. The specimen version is freely available online as a pretest to prepare students who want to apply for admission. The comparison of TSA scores was limited due to lack of available research regarding the TSA test.

The test was modified and adjusted for a South African context – only terminology changes were made, as shown in Table 1. This test has 25 multiple-choice questions that test test-takers' ability to summarise a conclusion (5 items); draw a conclusion (3 items); identify assumptions (5 items); assess the impact of additional evidence (3 items); detect reasoning errors (5 items); match arguments (2 items); and apply principles (2 items). In this article, the test that was used will be referred to as the TSA-Modified test.

The University of Cambridge has done extensive research with various stakeholders to support the validation of the TSA, which students use in preparation for admission testing for the University of Cambridge. Face validity was determined by changing some of the questions for a South African demographic. The questions included "everyday" as well a "medical background" type questions.

Table 1: Example of changes made to the TSA-Modified

TSA (2015) specimen test words	Question on test	TSA – Modified words
miles	1	kilometres (km)
Britain	2, 8	South Africa
England	3	Bloemfontein
Widgett and Co	7	De Beers Mining
London Marathon race	29 (in answer options)	Comrades Marathon

Approval to conduct this research study was obtained from the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the UFS (UFS-HSD2017/1276). Consent was obtained from Cambridge Assessment Admission Testing to use the specimen TSA (USCLES 2015 version) and to make the necessary modifications to the specimen test.

This study held no potential physical, psychological or any form of danger to the researcher or the study population. Student participation was voluntary and involved no remuneration.

This study was conducted at the UFS in South Africa on all third- and fourth-year undergraduate AHP students (N=136) who consented to participate in the year 2018. The Departments of Physiotherapy (PT), Nutrition and Dietetics (ND), Optometry (OPTOM) and Occupational Therapy (OT) were included in this study. A suitable time was identified with the student coordinators for each year group per department. The student class leaders where then sent an invitation to the testing which explained the research objective, and they were asked to forward it to all the students in their class. The class captains where reminded of the testing the day before it took place, via email.

The TSA-Modified was administered twice (i.e., pretest and posttest). The pretest was completed at the beginning of the year 2018 (January and February), and the posttest in September 2018, after students had completed the clinical rotations. The test was completed in paper and pencil/pen format using a scoring sheet that had been

developed by the researcher. A fieldworker distributed and collected the test papers. Informed consent was obtained from the students to participate in the study at the initial testing. The test venues were kept as quiet as possible to limit distractions whilst students completed the test.

Numerous attempts were made by the researcher to increase the population of the pretest and posttest participants, but class scheduling issues impacted negatively on the number of participants recruited. The researcher scheduled a session for each year group per department, and then gave an additional testing opportunity for the different year groups per department (if needed). The pretest was administered over a period of eight days. For the posttest, a week of additional testing times were identified during which the participants could complete the test at a time that suited them. This led to the posttest testing times differing by up to two weeks. A field worker collected the consent forms and blinded the identity of the students from the researcher.

No demographic data was collected, as the researcher aimed to determine the current level of CT skills in AHP students, and not demographic factors that could influence the level of CT skills. The test score data was also protected by using a unique nine-digit participant number for each student. The same number was used for the pretest and the posttest, to enable pairing of the test scores – doing so ensured that the researcher remained blind to the participants' identity.

The data was captured by the researcher on an Excel worksheet within one week of testing. This meant that smaller groups of data were captured, ensuring accuracy, consistency and making it possible to correct mistakes. The data was checked and rechecked by the researcher to ensure validity. Reliability was achieved by testing the students in the shortest time frame (one to two weeks); in the same place, by giving standard instructions, by using an answer key template for marking tests, and rechecking tests. The final data analysis (SAS Version 9.4) was done by the Department of Biostatistics, UFS.

3. RESULTS

A total of 136 students (59,9% of the population) completed the pretest and 106 students (46,7% of the population) completed both the pretest and posttest (cf. Table 2). Table 2 includes a more detailed exposition of the participant details according to their study year and department. One student completed the pretest on the test itself, and the test was discarded by the fieldworker, thereby excluding that student from the study.

Table 2: Analysis of the response rate per department

	Total in **third-year** class	Completed pre- and post-test (% of class)	Completed pre-test	Total in **fourth-year** class	Completed pre- and post-test (% of class)	Completed pre-test
OT	40	15 (37.50%)	15	41	0 (0%)	0
OPTOM	18	3 (16.67%)	3	31	12 (38,70%)	30
ND	12	11 (91.67%)	12	7	7 (100%)	7
PT	39	25 (64.10%)	32	39	33 (84,61%)	35
TOTALS	**109**	54 (49,54%)	62(56,88%)	**118**	52 (43,22%)	74 (62,71%)

Note: PT = undergraduate physiotherapy students in third and fourth years of study, OT = undergraduate occupational therapy students in third year of study; ND = undergraduate nutrition and dietetics students in third and fourth years of study; OPTOM = undergraduate optometry students in third and fourth years of study.

Reasons for failing to complete the posttest included dropping out from the programme (n=1), absence on the day(s) of data collection (n=4), class scheduling issues (n=18), inconsistencies (the test was not written under the supervision of the fieldworker) (n=4) and withdrawal from the study (n=3). The OT fourth-year group decided to not give consent to participate in this study.

The pretest and posttest median results were obtained by means of the signed rank test, since the data was skew between the different professions, and a p-value was derived from the data (cf. Table 3). The data in Table 3 also indicates the maximum and minimum scores for each section of questions as achieved by individual students.

The total scores indicated no statistically significant change in the total score for CT from the pretest to the posttest, in any of the professions.

Table 3: Test results of the TSA-Modified: (n=106)

	Median		Lower quartile		Upper quartile		Minimum		Maximum		p-value for change
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	
Total (25 items)											0.32
3rd years	**11.0**	**12.5**	**10**	**10**	**14**	**14**	**4**	**2**	**22**	**19**	**0.78**
4th years	**11.0**	**12.0**	**10**	**9**	**14.5**	**14.5**	**6**	**5**	**19**	**21**	**0.28**
Applying principles (2 items)	2.0	**1.0**	1.0	1.0	2.0	2.0	0.0	0.0	2.0	2.0	0.34
Detecting reasoning errors (5 items)	3.0	3.0	2.0	2.0	4.0	4.0	0.0	0.0	5.0	5.0	0.28
Identifying assumptions (5 items)	2.0	2.0	1.0	2.0	3.0	3.0	0.0	0.0	5.0	5.0	0.45
Summarising conclusions (5 items)	2.0	2.0	1.0	1.0	3.0	3.0	0.0	0.0	5.0	5.0	0.07
Assessing impact (3 items)	1.0	1.0	1.0	1.0	2.0	2.0	0.0	0.0	3.0	3.0	0.49
Drawing conclusion (3 items)	1.0	1.5	1.0	1.0	2.0	2.0	0.0	0.0	3.0	3.0	0.41
Matching arguments (2 items)	1.0	**0.0**	0.0	0.0	1.0	1.0	0.0	0.0	2.0	2.0	**0.00****

Note: **p < 0.01

The data of the third and fourth-year students were separated to determine if there was a statistically significant difference between these two groups. The median scores of both the groups was 11 for both the pretest and posttest, and had a minimum, non-statistically significant positive development, to 12 and 12.5 respectively. The only statistically significant ($p<0.01$) finding on the TSA-Modified is the median difference of the section Matching arguments. The total score decreased from 1 (pretest) to 0 (posttest).

After data analysis, the researcher classified the CT skills as weak, average or strong. If the score was lower than 10 out of 25, the students' CT skills were classified as weak, a score between 11 and 15 meant a classification as average and above 16 as strong CT skills (Table 4). This was based on statistics on the TSA results of 2015 (UniAdmissions, 2015). This classification was done per department and per year group.

Table 4: Critical-thinking skills classification according to TSA-Modified total scores per year group and per department

	Weak (<10)			**Average (11-15)**			**Strong (>16)**		
	Pre	**Post**	**Unchanged**	**Pre**	**Post**	**Unchanged**	**Pre**	**Post**	**Unchanged**
PT 4	13	14	9	15	14	7	5	5	2
ND 4	2	6	2	7	4	2	3	2	1
OPTOM 4	3	3	1	3	3	2	1	1	2
PT 3	12	11	10	11	11	9	2	3	2
OT 3	1	1	1	7	9	7	7	5	5
ND 3	4	6	3	6	4	3	1	1	1
OPTOM 3	2	1	1	1	2	1	0	0	0
Totals:	**37**	**42**	**27**	**50**	**47**	**31**	**19**	**17**	**13**

Note: PT 4 = physiotherapy fourth years, PT3 = physiotherapy third years, OT3 = occupational therapy third years, ND4 = Nutrition and Dietetics fourth years, ND3 = Nutrition and Dietetics third years, OPTOM 4 = Optometry fourth years; OPTOM 3 = Optometry third years

Upon classifying the CT scores, the results indicated that most students had average CT skills. Unexpectedly, the number of ND students with weak and average CT skills had increased in the posttest. The results also indicate that the OT students were

mainly classified as average or strong critical thinkers, but that during the testing timeframe the number of average critical thinkers increased (n=2) and those with strong CT skills decreased, indicating a negative development for ND. The rest of the professions remained generally unchanged. The classification stayed unchanged for 71 of the students (66,98% of the study population): weak (n=27), average (n=31) and strong (n=13).

The different professions where grouped to determine if there was a difference between the professions and year groups (cf. Table 5).

Table 5: Individual result per profession per year group

Profession	**Median pretest score**	**Median posttest score**	**Difference**	**Maximum score**		**Minimum score**		**p-value** (pre- to post-test)
				Pre	**Post**	**Pre**	**Post**	
PT4 (n=33)	11	12	+1	18	18	6	6	0.31
PT3 (n=25)	11	12	+1	22	18	4	6	0.11
OT3 (n=15)	**15**	**14**	-1	21	19	7	9	**0.04***
ND4 (n=7)	11	12	+1	16	15	8	9	0.22
ND3 (n=11)	11	10	-1	19	18	8	7	0.86
OPTOM4 (n=12)	12	11	-1	19	21	9	5	0.26
OPTOM3 (n=3)	10	11	+1	15	11	6	2	0.50

Note: PT 4 = physiotherapy fourth years, PT3 = physiotherapy third years, OT3 = occupational therapy third years, DN4 = Nutrition and Dietetics fourth years, DN3 = Nutrition and Dietetics third years, OPTOM 4 = Optometry fourth years; OPTOM 3 = Optometry third years

* $p<0.05$

It should be noted that the OT students exhibited a statistically significant difference ($p<0.05$) when compared to the different year groups per department. OT students also had a higher median score on both the pretest and posttest, even though the score had negative growth during the timeframe. The other departments' students had comparable median scores for the pretest and posttest (cf. Table 5).

The direction of change in the results of the TSA-Modified for the total group indicates that 40,57% of the student population that completed the test showed an increase in CT skills on the modified TSA, whilst 15,09% had no change in their scores (cf. Table 6).

Table 6: Direction of change according to the results on the TSA-Modified test total results (from pretest to posttest)

Change	Total group		Third-year group			Fourth-year group		
	f	%	f	% of third year group	% of total group	f	% of the fourth year group	% of total group
Increase	43	40,57%	22	(40,74%)	20,75	21	(40,38%)	19,81
Decrease	47	44,34%	23	(42,59%)	21,7	24	(46,15%)	22,64
No change	16	15,09%	9	(16,67%)	8,5	7	(13,46%)	6,6
Total	**106**	**100%**	**54**	**(100%)**	**50,95%**	**52**	**(100%)**	**49,05%**

Note: f = frequency, % = percentage

The third and fourth-year groups were then separated in the total group, to determine if there was a difference in the change in CT for the third and fourth-year groups. The results indicate no statistical significance (p=0.88) with the chi-square test, indicating that the two groups had comparable results regarding the increase, decrease and no change in CT skills.

4. DISCUSSION

CT skills form the foundation on which higher-order thinking skills are built. If students struggle with CT, they could, therefore, also struggle with higher-order thinking skills, such as clinical reasoning and problem-solving (Velde, Wittman, & Vos, 2006). CT is, thus, the foundation for the transfer of knowledge into practice, and directly influences the quality of patient care.

This study indicated that undergraduate AHP students in their third and fourth years of study had average CT skills. These results are in contrast to a study that indicated that most AHP had weak CT skills, but it should also be noted that a different student population (it included cytotechnology, dental hygiene, health informatics and information management and medical technology students) and the Californian Critical Thinking Skills Test was used, making any comparison impossible in this study (Sharp et al., 2013). In contrast to these results, other studies found that health professions students have good CT abilities (Goodman, et al., 2018; Slaughter, Brown, Gardner & Perritt, 1989). These studies also used different CT skills tests (e.g., Health Science Reasoning Test and the Watson-Glaser Critical Thinking Assessment) and populations differed, including practicing dietitians and first-year physiotherapy students.

Furthermore, this study indicated that no significant change in CT skills occurred in the timeframe of nine months. These findings correlate with previous studies, but it should be noted that the students who participated in these other studies were not undergraduate students, and that the timeframes differed, from only testing on admission, to over 27 months (Domenech & Watkins, 2015; Vendrely, 2005). The median total on the TSA-Modified did improve minimally in three of the groups in this study, correlating with other research findings (Reale et al., 2018). It is important to note that clinical rotation or exposure did not automatically improve CT skills in this study. The expectation is that CT skills are improved by practicing these skills in the clinical setting (Zettergren & Beckett, 2004).

These results could, on the one hand, indicate that no dedicated educational initiatives are applied to include CT skills in the teaching strategies in the School for Allied Health Professionals (Franco & Vieira, 2019); that the timeframe of testing was too short compared to other studies that indicated a statistically significant change (Bartlett & Cox, 2002; Brudvig, Mattson, & Guarino, 2015; Vogel, Geelhoed, O.Grice, & Murphy, 2009), or that undergraduate students are not explicitly taught principles of CT skills (Smith, Rama, & Helms, 2018). Findings by Reale et al. (2018) could possibly explain why some of the professions and year groups showed negative growth in CT skills. The authors indicate that developing CT skills is a time-consuming process and

considerable financial resources are needed to develop “very good” into “great” critical thinkers. The study also indicates that resources should rather be used to improve problem-solving abilities and moral reasoning, than improving the “analytical critical thinking ability” (Reale et al., 2018).

Overall, the test scores could have been influenced by numerous factors, including the students’ busy schedules, small population that participated, motivation of the students to complete the test (Bensley, Rainey, Murtagh, Finn, Maschiocchi, Bernhardt & Kuehne, 2016), and student cognitive fatigue (Domenech & Watkins, 2015), all factors that were not investigated by this study. Another possible limitation could be that the test consisted of multiple choice questions, and did not include reference to the process of applying CT skills, the thinking process behind the choice, or the moral reasoning behind answers (Zaidi, Grob, Monrad, Kurtz, Tai, Ahmed, Gruppen & Santen, 2018).

Numerous attempts were made to increase the pretest and posttest population by providing additional testing times, but due to the test being voluntary, very few students arrived for the additional testing opportunities. It is clear that many students (13.2%) were lost from the pretest to posttest; this could be attributed to the lack of motivation to take the test. It is also clear that there is a skew representation of the different professions and, thus, no conclusion can be drawn regarding any one specific profession. Because several students could not be included in the study (*cf.* Results), the study population was reduced greatly, and this could be identified as a limitation of this study.

OT students had a statistically significant higher median score on both the pretest and posttests, even though the score had negative growth during the timeframe. Deeper investigation into the different curricula and the level of AHP students’ CT skills is needed to determine why the OT students in the research population scored higher on the test than other professions. A larger cohort of OT students should be tested to determine if the higher score is merely due to a small number of students, who happened to have better CT skills, being tested. The results of this study is also from one institution with a limited sample group, and cannot be considered a true

representation of AHP as a whole. Further research is needed in this area and cohort to determine generality.

Research suggests that clinical exposure (Patton, Higgs, & Smith, 2013) and development into adulthood (Flores, Matkin, Burbach, Quinn, & Harding, 2012) are linked to increased CT skills, thus, it is interesting to note that the third and fourth-year groups indicated no statistically significant change in CT skills between the two groups, contrary to expectation. The demographics of the population was not investigated, thus, the researchers suggest that future studies gather information on demographics, such as gender, age, previous studies and ethnicity (Fong et al., 2017), to determine if there are significant factors that affect CT. This was not the aim of this current study.

The main focus of this study was to determine if CT skills develop during the clinical rotation years of undergraduate AHP students at the UFS. A few limitations could have had an influence on these results. The researchers recommend that a longer timeframe be used, and that students are tested from their first to final years to determine development in CT skills. Doing so will provide a bigger picture of when and where CT skills actually develop in AHP students at the UFS (Brudvig et al., 2013; Huber & Kuncel, 2016). The students' motivation to complete the test (Bensley et al., 2016; Butler et al., 2017) and attitudes and beliefs about CT testing (Stupple, Maratos, Elander, Hunt, Cheung & Aubeeluck, 2017) should also be investigated further.

The question that arises is how the average and weak CT skills of the population that was tested will affect the patient care they render and clinical reasoning skills, compared to the way the good CT skills would. A study stretching over the entire period of the curriculum, with an added focus on the effect of CT skills on clinical reasoning, will provide a clearer picture of CT skills and how they inevitably influence patient care.

5. CONCLUSION

The results of this study indicate the need for a shift in the current way of teaching and learning in health care education, especially considering changes caused by the fourth industrial revolution, which has upscaled the need to develop CT skills. Undergraduate students' foundational thinking skills need to be nurtured and developed, to provide

students with tools to reason clinically. During the third and fourth years, students need to incorporate foundational thinking skills during their clinical experiences, so that they can reason clinically about the best patient-centred care. If this does not happen, we should be concerned about the outcome of patient care. Continued research on the CT skills of this cohort needs to be done to ensure that graduating students have the best chance of succeeding in their chosen professions.

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CHAPTER 3

ARTICLE 2:

ALLIED HEALTH PROFESSIONSAL CLIMBING THE STEPS OF CRITICAL-THINKING EDUCATION

The article was prepared according to the journal submission guidelines for the journal, *The Journal of Higher Education* (*cf.* Appendix H2).

Allied health professionals climbing the steps of critical-thinking education

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Allied health professionals climbing the steps of critical-thinking education

Abstract

In this era of the fourth industrial revolution and a new generation of students, lecturers need to adjust their teaching strategies, to actively engage the students they teach. One of the graduate attributes that is most desired, and which should be developed in students, is critical-thinking (CT) skills. Graduates who possess CT skills have better chances of having successful careers. This relates to the aim of this study, namely, investigating the teaching strategies lecturers use to develop these sought-after CT skills, and determining if different strategies are used for different year groups. Lecturers in four of the departments (Physiotherapy, Occupational Therapy, Nutrition and Dietetics, and Optometry) of the School for Allied Health Professions at the University of the Free State completed a self-designed questionnaire, to determine which strategies they used to develop students' CT skills. A response rate of 60% of the target population was achieved. Lecturers indicated problem-based learning and experiential learning as the teaching strategies applied most often to develop CT skills. This study identified how these strategies were scaffolded in 2018 in the four curricula of the different allied health professions disciplines to develop well-rounded graduates who engage in CT.

Keywords: Critical-thinking skills strategies, allied health professions, lecturers, teaching strategies, health professions education

Introduction

Lecturers need to adjust their teaching strategies to adjust for the fourth industrial revolution and the new generation of students they teach, to ensure facilitation of learning (Amin & Adiansyah, 2018; Ernstzen & Bitzer, 2012). CT skills are considered to be valuable skills for succeeding in life, and for having successful careers of choice, thus, it is essential that students acquire these skills during higher education (Dunne, 2015; Elder & Paul, 2007; Ennis, 2018; Franco & Vieira, 2019; Lai, 2011; Lederer, 2007; Roksa & Arum, 2011). CT skills are, thus, considered to be one of the graduate attributes that is

most desired in higher education in general, and health professions education in particular (AAC&U, 2018). Health professions students are expected to progressively build on their foundational thinking skills (e.g., CT skills) to develop more complex thinking. Better CT skills enables undergraduate students to reason clinically and improve their problem-solving abilities, and to provide the best and most effective patient care (Reale, Riche, Witt, Baker, & Peeters, 2018).

The development of CT is important in the allied health professions (AHP), to ensure that undergraduate students develop into well-rounded graduate students who are able to cope with the real world, and who have the best possible chance of achieving the exit-level outcomes of their chosen degree (Ganesh & Smith, 2017; Tiruneh, Verburgh, & Elen, 2014). Studies indicate that health professions students already have higher CT skills than the average student (Goodman, Redmond, Elia, Harris, Augustine, & Hand, 2018; Velde, Wittman, & Vos, 2006; Vendrely, 2005; Wessel & Williams, 2004). These findings lead to this enquiry, into the way this student attribute influences the teaching strategies that lecturers use to develop CT skills, and whether the skills can be developed further.

A widely supported standpoint is that CT skills are teachable and can be developed through specific teaching strategies (Butler, Pentoney, & Bong, 2017; Ennis, 2018; Niu, Behar-Horenstein, & Garvan, 2013), either embedded (infused or immersed) in the subject-specific curriculum (Cargas, Williams, & Rosenberg, 2017; Ennis, 2018; Flores, Matkin, Burbach, Quinn, & Harding, 2012; Niu et al., 2013; Persky, Medina, & Castleberry, 2019; Puig, Blanco-Anaya, Bargiela, & Crujeiras-Pérez, 2019; Tiruneh et al., 2014), or in general (Abrami et al., 2015; McPeck, 1990; Tiruneh et al., 2014). Systematic reviews of teaching strategies indicate that lecturers in higher education have shifted their teaching strategies to embedding CT skills within the curriculum. However,

not all research reports portray the embedded approach as effective (Abrami, Bernard, Borokhovski, & Wade, 2008; Behar-Horenstein & Niu, 2011; Tiruneh et al., 2014). Saeger (2014) found no statistically significant difference between general and embedded CT strategies, and that embedded CT strategies (immersion) actually indicated a higher mean value. This finding is supported by Brunt (2005), who states that merely teaching CT is not enough – it has to be applied and integrated consistently.

Another question raised regarding discipline-specific teaching strategies is that, if the CT skill is taught within a discipline, will the student be able to apply it to real-life situations, or will the skills development be limited to the discipline-specific knowledge (Jones, 2015; McPeck, 1990; Thonney & Montgomery, 2019). Teaching a student general principles of CT skills does not guarantee that the skill will be transferred to the discipline (Saeger, 2014). An advantage of teaching CT skills within a discipline is that students' clinical reasoning and CT develop within the discipline being taught, ensuring that the graduate is able to apply skills to different contexts of the discipline and in general (McPeck, 2016; Tiruneh, Weldeslassie, Kassa, Tefera, De Cock, & Elen, 2016). It is clear from the research that there is no blanket agreement about the best approach, though it is clear that higher education has moved towards immersion and infusion. The reason for this shift is not the aim of this article; instead, this study wished to engage in further investigation into the "how" of this shift taking place.

Researchers indicate that teaching strategies are a variable that develops CT skills when the strategies engage the students actively (Payan-Carreira, Cruz, Papathanasiou, Fradelos, & Jiang, 2019; Tiruneh et al., 2014). The suggestion is that students are made aware of the CT process and principles early in the curriculum, to assist them to apply these skills when certain teaching strategies are used during the years of study (Brookfield, 2012; Vogel, Geelhoed, Grice, & Murphy, 2009). Longer intervention by

means of teaching strategies has been found to be more effective in developing CT skills, by allowing students to apply and integrate the skills they have been taught (Behar-Horenstein & Niu, 2011; Bernard et al., 2008; Huang, Newman, & Schwartzstein, 2014; Lipman, 1988; Niu et al., 2013; Tiruneh et al., 2014).

Because there are so many teaching strategies available that can be embedded in a curriculum, the process of choosing effective strategies is not easy. Time is a precious commodity in higher education; thus, lecturers need to focus on the most effective teaching strategies for developing CT skills in their undergraduate students (Huber & Kuncel, 2016; Ramklass, 2000; Saeger, 2014); these strategies must be relevant for diverse student populations and different professions (Niu et al., 2013). Research findings are inconsistent and inconclusive about the best strategies for developing CT skills, especially in health education (Carter, Creedy, & Sidebotham, 2016; Carvalho, Azevedo, Cruz, Mafra, Rego, Vitor, Santos, Cogo & Ferreira Júnio, 2017; Payan-Carreira et al., 2019).

Systematic reviews of higher education have identified two methodologies as being the most effective for teaching at university level: oral and written communication (Ennis, 2018; Shim & Walczak, 2012), and active methodologies (Bezanilla, Fernández-Nogueira, Poblete, & Galindo-Domínguez, 2019; Loes & Pascarella, 2017). Lecturers indicate that they consider the strategies that they use most to be the most effective strategies (cf. Table 1). Traditional lectures and “assessment, follow-up and feedback” are considered to be the least effective strategies to develop CT skills (Bezanilla et al., 2019).

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Table 1: Teaching strategies identified by research as having a positive effect on critical thinking development in higher education

Approach	Teaching strategy						Author
Category 1: Individual study	**Reflecting**	**Reflective logs**	**Assignments**	**Research**			
		√					Payan-Carreira et al. 2019
	√						Tiruneh et al., 2014
	√	√	√				Amin & Adiansyah, 2018
				√			Bezanilla et al. 2019
Category 2: Dialogue/ oral and written communication	**Questioning/ Thinking out loud**	**Argumentation/ Discussions/ Debates**	**Reading, analysis and synthesis of resources**	**Integration of ideas with assignments**	**Small group discussions**		
	√	√			√		Tiruneh et al., 2014
	√	√	√				Bezanilla et al. 2019
		√					Niu et al. 2013
	√			√			Shim & Walczak, 2012
		√					Ennis, 2018
	√						Amin & Adiansyah, 2018

Approach	Teaching strategy								Author
Category 3: Authentic/ active methodologies	**Case studies**	**Collaborative learning**	**Real world / clinical based assignments**	**Problem-Based Learning**	**Flipped classroom**	**Role playing**	**Simulations**	**Concept mapping**	
	√			√			√	√	Payan-Carreira et al., 2019
	√			√					Niu et al., 2013
				√		√		√	Tiruneh et al., 2014
				√			√	√	Carvalho et al., 2017
				√			√	√	Carter et al. 2016
	√	√	√	√	√	√			Bezanilla et al. 2019
		√							Loes & Pascarella, 2017
Category 4: Coaching/ mentoring	**Follow-up**	**Feedback**	**Peer assessments**	**Tutor**	**Experiential learning**				
		√	√						Tiruneh et al., 2014
				√					Carvalho et al., 2017
		√							Duron, Limbach & Waugh, 2006
	√	√							Bezanilla et al. 2019
					√				Niu et al., 2013

Note: Used most/most effective, average use, used least

Source: Bezanilla et al., 2019; Carter et al., 2016, Carvalho et al., 2017; Duron et al., 2006; Niu et al., 2013; Payan-Carreira et al., 2019; Tiruneh et al., 2014

Cargas et al. (2017) identified critical dialogue and discussion, authentic problems, and mentoring as the three main strategies for developing CT skills in health professions education. De Oliveira, Díaz, Carbogim, Rodrigues, and Püschel (2016) state that active methodologies (cf. Category 3 in Table 1) show better efficacy in CT development. This finding was confirmed by other research studies, which indicate that problem-based learning, concept mapping, case studies and simulations are promising teaching strategies (Carter et al., 2016; Carvalho et al., 2017; Macauley, Brudvig, Kadakia, & Bonneville, 2017; Payan-Carreira et al., 2019). Individual study is not generally mentioned in higher education, though reflective writing was identified as an effective strategy in health education (Payan-Carreira et al., 2019). Oral and written communication regularly features in research in health professions education, especially debates and critical questioning. Mentoring is also reported repeatedly (Chan, 2016). Chan (2016) identified a trend by lecturers in developing new and innovative teaching strategies to promote CT skills in the students they teach. A comprehensive list of research found on the different teaching strategies in health professions education is given in Table 2.

Some researchers claim that there is no magic recipe for developing CT skills, and that each lecturer should design each activity carefully (Abrami et al., 2015; Behar-Horenstein & Niu, 2011; Payan-Carreira et al., 2019) and tailor the strategies to the students (Niu et al., 2013). Traditional teaching methods (e.g. lectures) could prevent the development of CT skills, because the learning environment prevents students from actively engaging with the material (Amin & Adiansyah, 2018; DeWaelsche, 2015). These teaching methods could cause students to absorb knowledge passively, and could lead to inability by students to integrate knowledge in practice (Pieterse, Lawrence, & Friedrich-Nel, 2016).

Table 2. Teaching strategies identified for the lecturer questionnaire using research on health professionals

Category 1: Individual study		**Category 2: Dialogue/ Oral and written communication**		**Category 3: Authentic or anchored instruction/ Active methodologies**		**Category 4: Coaching/Mentoring**	
Teaching methodology	*Authors*	*Teaching methodology*	*Authors*	*Teaching methodology*	*Authors*	*Teaching methodology*	*Authors*
Blended learning (Wikis, e-learning, Blackboard, virtual learning)	Coyne et al. (2018); Hsu and Hsieh (2014); Rowe, Frantz, and Bozalek (2012); Snodgrass (2011); Swart (2017)	**Thinking out loud and asking questions**	Facione and Facione, (2008); Goodman et al., (2018)	**Applied problem-solving/problem-based learning/ social learning/**	Chan (2016); De Oliveira et al (2016); Ganesh and Smith (2017); Gholami et al. (2016); Keiller and Hanekom (2014); Kong, Qin, Zhou, Mou and Gao (2014); Tiwari, Lai, So and Yuen (2006); Vogel et al. (2009)	**Schön's reflective practice**	Brudviget al. (2015); McLeod, Barr, and Welch (2015); Patton, Higgs, and Smith (2013); Plack and Santasier (2004); Ziebart and MacDermid (2019)
Self-directed learning	Brudvig, Mattson, and Guarino (2015); Phillips, Turnbull, and He (2015)	**Discussions and formal debates**	Crabtree (2001); Hall (2011); Hewson (2019); Kramer et al. (2007)	**Simulations**	Brudvig et al. (2015); Lapkin, Levett-Jones, Bellchambers, and Fernandez (2010); Macauley et al. (2017); Shin, Ma, Park, Ji, and Kim (2015)	**Peer-led dyads (peer assessments/ peer-assisted learning)**	Maas et al. (2014); Velde et al. (2006); Van Vuuren (2017)
Student-centred learning (Bandura)	Brudvig et al. (2015)			**Case studies**	Popil (2011); Vogel et al. (2009)	**Experiential learning**	Bartlett and Cox (2002); Coker (2010); Kramer et al. (2007); Zettergren and Beckett (2004)
				Role playing	Brudvig et al., (2015); De Oliveira et al., (2016)		
Self-assessments/ self-monitoring	Hewson (2019); Pope (2005)	**Small-group discussions**	Vogel et al. (2009)	**Team-based problem-solving activities**	Kramer et al., (2007)		
Reflecting/ reflective logs/ visual and argument mapping	Griffiths and Ursick (2004); Lee et al.(2013); Santiago (2011))	**Structured research activities**	Kramer et al. (2007)	**Evidence-based practice assignments**	Aglen (2016); Profetto-McGrath (2005); Schoonees, Rohwer, and Young (2017); Vogel et al. (2009)		

Compiled by the researcher, based on Bezanilla et al. (2019), Abrami et al. (2015).

No research could be found reporting on when, in a four-year curriculum, a particular strategy should be applied to best effect, only that it has to be gradually introduced to the student, or that the teaching strategy should be scaffolded, to encourage students to develop CT skills (Persky et al., 2019).

Persky et al. (2019) describe scaffolding as a general teaching method that is used to facilitate CT development, and involves students being supported temporarily by teaching strategies; as the students become more proficient at the tasks, the support is decreased. This gives a student time to improve self-confidence, and decrease their own anxieties and apprehension about learning (Ganesh & Smith, 2017). It can also be hypothesised that, as students' CT skills develop during the years of study, the lecturer should adapt teaching strategies accordingly. This leads to questions about what teaching strategies lecturers in AHP use to promote and develop CT skills, and if and how AHP lecturers scaffold teaching strategies.

To achieve this aim, the researcher asked questions about lecturers' own understanding of CT skills (Lloyd & Bahr, 2010) and their own abilities to teach CT skills if they don't understand the general principles of CT (Brunt, 2005). If lecturers do not conceptualise CT skills, it might be difficult for them to teach CT skills and to develop skills in the students they teach (Bezanilla et al., 2019). Dunne (2015) references a statement by a former president of Harvard University (Bok, 2006), who stated that lecturers consider CT skills to be a "principle aim of undergraduate education", but that lecturers fail to help students to develop CT skills. This failure could be the result of, as Ennis (2018) states, teachers teaching what they know.

The aim of this study was to determine which teaching strategies lecturers use to develop CT skills when they teach the curriculum at the University of the Free State. Secondly, the study wished to determine if these strategies are scaffolded during the four

years of study, and thirdly, what the opinions were of the participants regarding the definition of CT skills. These opinions were analysed to determine the perspectives of the participants regarding CT skills.

Materials and methods

A questionnaire was designed by the researcher for use in this study. Teaching strategies where identified by doing a literature review, and by referring to systematic reviews (Bezanilla et al., 2019; Carter et al., 2016; Carvalho et al., 2017; Macauley et al., 2017; Payan-Carreira et al., 2019; Tiruneh et al., 2016) and from a meta-analysis (Niu et al., 2013). The researcher then identified other teaching strategies by doing manual searches (cf. Table 2).

The validity of the questionnaire was ensured by developing a well-constructed questionnaire that was carefully piloted and reviewed by fellow researchers and the staff at the Department of Biostatistics. A Likert scale, ranging from zero to four, was added to ensure reliability. Content validity was determined by doing a pilot study, which involved one lecturer completing the questionnaire. No changes were made to the questionnaire; thus, the pilot questionnaire was included in the results. The questionnaire also included open-ended questions (“other”), so that participants could identify any other teaching strategies not listed in the options and which the lecturer believed encouraged the development of CT skills; this gave the questionnaire a broader spectrum of answers and ensured an adequate sample of items. Face validity was determined by the Department of Biostatistics and a panel of lecturers, who served as an evaluation committee that oversaw the questionnaire. This study was conducted at the University of the Free State in October 2018, once all the clinical rotation and academic classes had been completed for the year. A descriptive design was used by this study to investigate

the different types of teaching strategies used in the different year groups over the timeframe of one year.

Participants were identified using the institution's telephone list of 2018 that is circulated to personnel, and which contains the names, numbers and email addresses of staff. Participation was voluntary and lecturers could withdraw at any time. The participants were given two weeks to complete the questionnaire, and were sent a reminder if no response had been received at the end of this period. After one week, the departments were contacted to remind lecturers who still wanted to participate to send the questionnaires or place the responses in the box provided.

The questionnaire was emailed to each lecturer (including clinical session staff), because many lecturers were either away on leave, busy with exams or off-campus due to other reasons. A unique research number was assigned to each questionnaire as it was received back from the participants. To ensure the best response rate, participants could place the completed questionnaires in a box, email the questionnaire back to the researcher, or personally hand it back to the researcher. Informed consent was obtained from each participant in the study.

Ethical clearance for this study was obtained from the Health Science Ethics Committee at the University of the Free State (UFS) (UFS-HSD2017/1276). All the heads of the different departments of the School for Allied Health professions were informed of the research study by means of a letter.

This study held no potential physical, psychological or any other form of danger to the researcher or the participants. Lecturing staff participated voluntarily and received no remuneration. Identification of the participants was only possible by the researcher, and each participant was allocated a unique research number to protect their identity.

The data from the questionnaires was transformed into numerical codes. All the possible answers where coded, even non-responses. The data was then manually entered into an Excel spreadsheet by the researcher, and re-checked for correctness. The data was sent to the Department of Biostatistics for analysis. The data is reported as frequencies (medians) and percentages.

No formal interviews were conducted with lecturing staff of the School for Allied Health Professions, Instead, the researcher identified general concepts using a coding method as described by Creswell (2014) to code the open questions related to lecturing staff's views on CT skills. The open question on the definition of CT was coded through initial word-for-word colour coding, and by coding all the concepts and words, by the first author. Categories and sub-categories of the conceptions of CT were then identified by the first author. The second author co-coded the definitions and achieved similar results.

Results

The questionnaire was sent to 40 lecturers, of whom 24 returned completed questionnaires (60% response rate). The majority of the respondents were female (95.83%) and had a median age of almost 40 years. The median lecturing period was just more than seven years, and ranged from three months to almost 32 years (cf. Table 3).

Table 3. Demographics of lecturing staff who participated in this study

Variable (n=24)	Median	Lower quartile	Upper quartile	Minimum	Maximum
Age	39,42	34,33	47,29	29,08	58,00
Lecturing period	7,21	4,29	11,92	0,33	31,83
Previous experience period	0,00	0,00	0,5	0,00	7,00

Nine lecturers (37,5%) had more than 10 years lecturing experience at the time the questionnaire was distributed. The results, thus, included both novice and expert input (Ericsson & Pool, 2016; Thonney & Montgomery, 2019). Of this population, 12 lectured first-year students, 17 lectured second years, 19 lectured third years, and 24 fourth years, while eight assisted with postgraduate studies.

The highest response rate were received from the Department of Physiotherapy, and the other three departments had a response rate ranging from 36 to 50 percent (cf. Table 4). From the questionnaires, the researcher identified 18 different teaching strategies. Even though there was an "Other" option for each year group, only one participant added "research" in this category.

Table 4. Percentages of lecturing staff that participated in the study

Department	Frequency	Percent (%)	Cumulative frequency	Total lecturers in the department	% of personnel in each department
Nutrition and Dietetics	4	16,67%	4	8	50%
Occupational Therapy	4	16,67%	8	11	36%
Optometry	2	8,35%	10	5	40%
Physiotherapy	14	58,33%	24	16	87,50%

Most teaching strategies were used seldom (n= 8) or sometimes (n=6) in teaching first-year students. The highest median, of 2, was for thinking out loud, clinical-based practice, experiential learning, evidence-based learning, role playing, Schön's reflective practice, and small-group discussions. It must be noted that these activities are used seldom, while, for teaching second-year students, experiential and evidence-based learning had the highest median, of 3, indicating that it is used a great deal.

Table 5. Staircase of the different teaching strategies investigated (full data table available in Appendix A)

	Category 1: Individual study					**Category 2: Dialogue/oral and written communication**				**Category 3: Authentic or anchored instruction/active methodologies**							**Category 4: Coaching/ mentoring**		
	Self-directed learning	**Self-assessments**	**Student-centred learning (Bandura)**	**Reflective logs**	**Blended learning**	**Thinking out loud**	**Discussions/debates**	**Small-group discussions**	**Structured research activities**	**Problem-based learning**	**Simulations**	**Case studies**	**Role playing**	**Team solving activities**	**Evidence-based practice assignments**	**Clinical-based practice assignments**	**Schön's reflective practice**	**Peer assessments**	**Experiential learning**
1st year	1	1	0	1	0	2	1	2	0	1	0	1	2	1	2	2	0	1	2
2nd year	2	2	2	1	1	2	1	2	0	2	2	2	1	2	3	2	1	1	3
3rd year	2	2	2	2	1	3	1	3	0	3	2	3	1	2	3	3	1	3	3
4th year	3	3	3	2	2	3	3	3	1	4	2	3	1	3	3	3	3	3	4
Note: Likert scale medians: 0=never, 1=seldom, 2= sometimes, 3= a lot, 4=always																			

In teaching third-year students, eight strategies, namely, thinking out loud, case studies, clinical-based practice, experiential learning, evidence-based practice, peer assessments, problem-based learning, and small-group discussions had a median of 3. In the fourth year, only two strategies were used “always”, namely, problem-based learning and experiential learning (cf. Table 5).

In this study, 21 (87,5%) lecturers who participated indicated that it was necessary to teach CT skills in the curriculum, and one lecturer was unsure if it was necessary. Furthermore, 14 (58.33 %) of the lecturers indicated that CT testing could be useful as a pre-admission test for selecting students. Only 6 (25%) of the lecturers were not sure if it would be a useful initiative as a selection tool.

In an open-ended question, the lecturers were also asked to provide an opinion on what CT skills meant. The researcher categorised the words/concepts that the participants used to define CT skills, and discovered that many of the terms used actually covered higher-order thinking skills of Bloom's taxonomy, and the core skills of CT, as seen in Table 6 (Dwyer, Hogan, & Stewart, 2014; Facione, 1990).

The concepts of understand and evaluate were identified by 15 (62,50%) participants, followed by apply and analyse (cf. Table 6). Problem-solving ability and reflection were identified by eight (33,33%) participants as forming part of the definition of CT skills. All three the core concepts of CT skills were identified by almost a third of the participants (cf. Table 6). Evidence-based practice was identified by seven (29,17%) participants, and nine (37,50%) of the lecturers linked knowledge to CT skills, either the integration of knowledge (five participants), seeking or gathering of information (three participants) or transformation of knowledge (one participant).

Table 6. Terms identified by lecturers in explaining their understanding of CT skills (n=24)

**Core cognitive CT skills	n	%	Bloom's taxonomy (2001)	n	%
Interpretation (categorisation, decoding significance, clarifying meaning)	3	12,50	Remember (recognising, recalling)	1	4,17
**Analysis (examining ideas, identifying arguments, analysing arguments)	7	29,17	Understand (interpreting, exemplifying, classifying, summarising, inferring, comparing, explaining) Words: identify information, integrate knowledge	15	62,50
**Evaluation (assessing claims, assessing arguments)	8	33,34	Apply (executing, implementing) Words: judge, identify problems, transform knowledge	10	41,67
**Inference (querying evidence, conjecturing alternatives, drawing conclusions)	7	29,17	Analyse (Differentiating, organising, attributing), Words: organize, structure, explain, adaption	11	45,83
Explanation (stating results/justifying procedures/presenting arguments) Words: form an opinion	3	12,50	Evaluate/synthesise (checking, critiquing) Words: hypothesising, grade, interpret, choose, gathering/seeking information	15	62,50
Self-regulation (self-examination, self-correction) Words: reflection	8	33,34	Create (generating, planning, producing) Words: reason	3	12,50
NOTE: Other terms given were • Problem-solving skills (n=8): 33,33% • Evidence-based practice (n=7): 29,16%					

The following are examples of participant answers to the open-question on the questionnaire with regards to the understanding of CT skills:

> These are important skills that involve identifying relevant information, analysing (considering all the different areas/aspects/angles involved) and interpreting the information after which it should then be applied. It also involves evaluating and reflecting on the outcome. (Participant 10)
>
> Ability to analyse a situation or problem, then evaluate all the appropriate options available, while weighing the risks and benefits of each, and then being able to choose the best option for the situation or problem at hand. (Participant 16)

Discussion

To achieve student success, students need to be engaged in the teaching strategies applied by the lecturer. If students and lecturers are not engaged and motivated to learn and teach respectively, the students are at risk of failing to complete their studies (Hewson, 2019). A lecturer needs to use multifaceted approaches to teaching, to stimulate the development of CT skills in diverse student populations (Abrami et al., 2015; Hewson, 2019), and should prevent using didactic teaching methods with little student engagement (Cottrell, 2017).

A survey by DeAngelo et al. (2009) in 2007-2008 (cited in Huber & Kuncel, 2016) identified CT as the most important goal of undergraduate education, with 99% of the participants describing the skill as very important or essential. These results correlate with the results of this study, in which 87,5% of participants indicated that CT is a skill that needs to be taught in AHP studies.

From the data in Table 5 it is clear that most of the different strategies identified by the researcher are being used increasingly as students progress from the first to the fourth year, indicating that the strategies are scaffolded during the curriculum. This correlates with the results of a study by Persky et al. (2019), which suggest that it is best to scaffold CT skills, to enable students to, first, learn the concept, before expecting them to apply and integrate knowledge. The gradual exposure to teaching strategies could assist in the development of the discipline-specific CT skills of undergraduate students, and contribute to student success (Tiruneh, De Cock, & Elen, 2018).

Considering the individual teaching strategies listed in Table 5, problem-based learning is the only strategy that was progressively scaffolded during four years of study in the AHP curriculum. This indicates that the lecturers slowly introduced problem-based learning to the students, and progressively used it more in every subsequent year of study.

This approach is according to the proposed "scaffolding" recommendation, which advises slowly exposing students to teaching strategies, to enable them to master a skill before applying and integrating the skill (EL-Shaer & Gaber, 2014).

It is also interesting to note that role playing is sometimes used in the first year, but rarely in subsequent years (cf. Table 5). Role playing has been identified as the least preferred instructional strategy by medical students, and has been associated with student apprehension and anxiety (Ertmer et al., 2010; Nestel & Tierney, 2007). This could be the reason why lecturers limited the use of role playing as a teaching strategy. Ertmer et al. (2010) also indicate that role playing needs to be scaffolded, to build student confidence and to have a positive impact on learning.

Schön's reflective practice, peer assessment, and reflective logs are scaffolded during the four years, but there is a jump from limited exposure to "a lot" of exposure in the fourth year (cf. Table 5). The reason for this could be that undergraduate students mostly start clinical rotations in their third and fourth years at the UFS (Brudvig et al., 2015; Ziebart & MacDermid, 2019). Reflective practice in health professions education has shifted, from a written to a more dialogic approach (McLeod et al., 2015). This correlates with the findings of this study, where Schön's reflective practice and peer assessments were used "a lot", and reflective logs "sometimes" in the fourth year. Future research is needed to investigate the impact of the strategies that are only implemented in the clinical years and seldom during the foundational years (first and second year), and how the shift impacts the students.

Blended learning is not used at all in the first year, and then sometimes in the fourth year. These findings correlate with research that reveals that blended learning had rudimentary effects on clinical competencies (Rowe et al., 2012) and CT skills (Swart, 2017). Coyne et al. (2018) contradict these results, and indicate that knowledge and skills

improve with blended learning, and that students prefer the strategy due to its flexibility. When considering the drive towards the fourth industrial revolution in higher education, lecturers' failure to use this strategy is concerning. However, the UFS has placed a great deal of emphasis on this strategy recently, thereby motivating lecturers to act as a driving force to bring about change in education (Janse van Vuuren, 2019). Future research is suggested to determine the success of this drive to achieve change.

When analysing the data in Table 5, it can be concluded that not many strategies are incorporated in the first year of study. It might be beneficial to expose first-year students to the general principle of CT, which can be built upon further in the second, third and fourth years. Scaffolding teaching strategies across the curriculum could assist students to master CT skills before applying them to complex thinking, to ensure the best chances of developing successful practitioners (Ennis, 2018; Franco & Vieira, 2019; Zayapragassarazan, Menon, Kar, & Batmanabane, 2016).

Research on the teaching of CT skills is severely lacking in health education, and very few lecturers are trained/experienced to teach CT (Halx & Reybold, 2005; Stedman & Adams, 2012). Authors (Cargas et al., 2017; Halx & Reybold, 2005; Stedman & Adams, 2012) report that faculty members teaching various traditional core curricula are unsure of what CT is, and how to teach it to their students; it should be noted that faculties of health sciences were not specified in any of these studies. It could be hypothesised that lecturers plan their teaching strategies to correspond with students' hierarchical knowledge progression throughout their academic experience. This hypothesis can be illustrated by applying Bloom's taxonomy, according to which higher-order thinking skills are increasingly tested as students' progress through the years of study (Harman et al., 2015).

The participants identified a number of vital terms that are applied in the core skills of CT and Bloom's taxonomy, with the majority associating CT skills with Bloom's taxonomy terminology (Facione, 1990; Persky et al., 2019; Pieterse et al., 2016; Zapalska, Nowduri, Imbriale, & Wroblewski, 2018). Two of the levels of Bloom's taxonomy, understand and evaluate, were mentioned by most of the lecturers, closely followed by apply and analyse. This correlates with results that indicate that analysis and evaluate are the most-often-addressed CT skills (Puig et al., 2019). Reflection, as defined by the National Council for Excellence in CT Instruction as CT, was mentioned by seven of the participants (Howard, Tang, & Austin, 2015). This correlates with findings that state that CT is born from the practice of reflective thinking and is linked to self-regulation and habits of mind (Ertmer et al., 2010; Phan, 2010). Even though the participants identified reflection as a component of CT skills, the teaching strategy of reflection (reflective logs and Schön's reflective practice) is only applied "sometimes" in the first three years of study, it is only in the fourth year, that Schön's reflective practice is used a lot. Further investigation is needed into the application of Schön's reflective practice, to determine if lecturers only use it for clinical placements, and if that is the reason why it is used "a lot" in the fourth year of study. Research identifies problem-solving abilities as complex thinking skills, and a third of the lecturers linked it to CT skills (Reale et al., 2018). This study found that lecturing staff who participated in the study understood the concept of CT as it relates to Bloom's taxonomy, and were able to identify the higher-order thinking skills that contribute to CT. This finding could be linked to the fact that lecturers use Bloom's taxonomy to assess students on written tests. The results indicate that two thirds of the lecturers struggled to identify the core skills of CT. The perceptions of lecturers on CT skills could be indicative of how they teach CT skills to their undergraduate students (Ennis, 2018; Lauer, 2005; Rowles, Morgan, Burns, & Merchant, 2013; Stedman &

Adams, 2012). This finding raises the question of how lecturers are able to teach students CT skills, if lecturers do not fully or accurately conceptualise the skill themselves.

Lloyd and Bahr (2010) asked students and lecturers to define CT. Some lecturers (36,84%) perceived CT as a state of mind, while the majority (47,37%) defined CT in terms of techniques and processes. This correlates with the findings of this study, namely, that 37,5% to 50% of the lecturers identified terms that relate to Bloom's taxonomy.

At the time of this study, AHP curricula at the UFS did not have dedicated CT courses for undergraduate students, and to the knowledge of the researcher, lecturing staff are not trained on developing CT skills. Consequently, all the teaching strategies used are embedded in the curriculum through immersion. A concerning finding is that the embedded approach only showed significant development in CT in about 50% of the studies consulted, even though there has been a shift towards embedding the CT strategies in discipline-specific instruction (Tiruneh et al., 2014).

Limitations to the study

The researcher's self-designed questionnaire included only 18 different teaching strategies, which limited the strategies that can be found in literature. Even though the participants could propose other strategies not listed, only one participant specified an unlisted strategy, namely, research. A few important strategies indicated in the literature were not specifically listed, for example, concept mapping, mentoring, feedback, performance tasks and playing games. The researcher only listed the most evident strategies identified in the literature at the time the research proposal was written and the questionnaire was designed.

Information about the type of post that the lecturers held could also yield interesting data, especially because session staff also participated in the study. A serious limitation is that the questionnaire failed to identify whether the lecturers had had any

training in CT skills, and if they explained the concept of CT to their students before engaging in the CT teaching strategies. It has been found that the explanation of the general CT principles has the greatest impact on CT skills development (Abrami et al., 2008).

The main aim of this study was to identify which teaching strategies were used, however, the study could have provided a broader view of the strategies if the general principles had been identified by lecturers.

Conclusion

The role of a lecturer is to provide students with the tools (CT skills and habits of mind) necessary to apply the basic knowledge learned in higher education, and to climb the ladder of complex thinking, with the main destination being effective and focused patient care. At the UFS, CT teaching strategies are embedded in the curriculum ("holistic approach") and is mostly scaffolded during the curriculum by lecturers. To ensure that CT strategies are developed effectively, the strategies should be integrated into the curriculum in all the year groups, thereby giving students sufficient time to master the skills (Elder & Paul, 2007). More investigation is needed into the way these strategies can be scaffolded, to increase the effectiveness of the teaching strategies.

Lecturers had a relatively good understanding of the concept of CT, though some lecturers' understanding lacked certain critical elements. Faculty development that focuses on how to teach CT skills, scaffolded over a period of time, is recommended. Lecturers should be made aware of the impact of teaching strategies and the concept of CT skills through professional development activities. Professional education faces many challenges, and if lecturers do not evolve with the students they teach, graduates will be left ill-equipped for the future that awaits them.

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Appendix A:

Teaching strategy	Group	1st year (n=12)	2nd year (n=17)	3rd year (n=19)	4th year (n=24)
Thinking out loud	0	8,33	5,88	10,53	15,79
	1+2	**66,67**	**52,94**	21,05	15,79
	3+4	25,00	41,18	**68,42**	**68,42**
	median	**2**	**2**	**3**	**3**
Blended learning	0	**58,33**	47,06	36,84	36,84
	1+2	33,33	**41,18**	**42,11**	**31,58**
	3+4	8,33	11,76	21,05	31,58
	median	**0**	**1**	**1**	**2**
Case studies	0	16,67	11,76	5,26	5,26
	1+2	**58,33**	**41,18**	26,32	21,05
	3+4	25	47,06	**68,42**	**73,68**
	median	**1**	**2**	**3**	**3**
Clinical based-practical assignments	0	33,33	11,76	10,53	21,05
	1+2	**41,67**	**52,94**	10,53	10,53
	3+4	25	35,29	**78,95**	**68,42**
	median	**2**	**2**	**3**	**3**
Debates	0	25	35,29	21,05	10,53
	1+2	**66,67**	**47,06**	**52,63**	36,84
	3+4	8,33	17,65	26,32	**52,63**
	median	**1**	**1**	**1**	**3**
Experiential learning (hands on)	0	25,00	11,76	0	0
	1+2	**33,33**	29,41	10,53	21,05
	3+4	41,67	**58,82**	**89,47**	**78,95**
	median	**2**	**3**	**3**	**4**
Evidence based practice assignments	0	33,33	17,65	21,05	21,05
	1+2	**50**	29,41	21,05	21,05
	3+4	16,67	**52,94**	**57,89**	**57,89**
	median	**2**	**3**	**3**	**3**
Peer assessments	0	25,00	29,41	21,05	5,26
	1+2	**75,00**	**58,82**	21,05	36,84
	3+4	0	11,76	**57,89**	**57,89**
	median	**1**	**1**	**3**	**3**
Problem based learning	0	33,33	17,65	10,53	10,53
	1+2	**50**	**41,18**	21,05	21,05
	3+4	16,67	41,18	**68,42**	**68,42**
	median	**1**	**2**	**3**	**4**
Reflective logs	0	33,33	47,06	26,32	21,05
	1+2	**25**	**29,41**	**36,84**	**31,58**
	3+4	41,67	23,53	36,84	47,37
	median	**1**	**1**	**2**	**2**
Role-play	0	33,33	35,29	31,58	42,11
	1+2	**50,00**	**47,06**	**47,37**	**42,11**
	3+4	16,67	17,65	21,05	16,79
	median	**2**	**1**	**1**	**1**
Schön's reflective practice	0	**58,33**	47,06	36,84	26,32
	1+2	25,00	**35,29**	**31,58**	21,05
	3+4	16,67	17,65	31,58	**52,63**
	median	**0**	**1**	**1**	**3**
Self-assessment	0	33,33	17,65	15,79	15,79
	1+2	**41,67**	**70,59**	**47,37**	26,32

	3+4	25	11,76	36,84	**57,89**
	median	**1**	**2**	**2**	**3**
Self-directed learning	0	8,33	11,76	15,79	10,53
	1+2	**58,33**	**64,71**	**42,11**	36,84
	3+4	33,33	23,53	42,11	**52,63**
	median	**1**	**2**	**2**	**3**
Simulations	0	**50**	35,29	26,32	31,58
	1+2	33,33	**47,06**	**36,84**	**47,37**
	3+4	16,67	17,65	36,84	21,05
	median	**0**	**2**	**2**	**2**
Small group discussions	0	8,33	11,76	5,26	0
	1+2	**50,00**	**47,06**	26,32	31,58
	3+4	41,67	41,18	**68,42**	**68,42**
	median	**2**	**2**	**3**	**3**
Student centered learning	0	**58,33**	29,41	21,05	26,32
	1+2	16,67	**41,18**	**42,11**	21,05
	3+4	25	29,41	36,84	**52,63**
	median	**0**	**2**	**2**	**3**
Team solving activities	0	33,33	17,65	10,53	5,26
	1+2	**50,00**	**58,82**	**42,11**	31,58
	3+4	16,67	23,53	47,37	**63,16**
	median	**1**	**2**	**2**	**3**
Other: Research activities	median	**0**	**0**	**0**	**1**
NOTE:					

CHAPTER 4

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

4.1 INTRODUCTION

This study followed a dual approach. Firstly, the CT skills of undergraduate AHP students in their clinical rotation years were tested and, secondly, the teaching strategies AHP lecturers use to develop CT skills at the UFS were investigated.

The purpose of this study was to determine if the undergraduate students developed CT skills over a period of one clinical year and, also, to determine what strategies the lecturers used to develop CT skills.

The aim of this chapter is to provide a short overview of the study and to indicate the conclusions derived from the research that was conducted. This will be followed by a short discussion of the limitations and recommendations, and a conclusion.

4.2 OVERVIEW OF THE STUDY

During the year 2018, the researcher investigated the CT skills development of AHP students in their third and fourth years of study, by administering a pretest-posttest using a modified specimen version of the 2015 TSA. The researcher also investigated the teaching strategies that lecturers of the different departments in the SAHP use to develop CT skills in their undergraduate students during their application of the curriculum.

During four years of study, AHP students are expected to gain knowledge and then apply CT skills progressively, as a precursor for clinical reasoning skills, with the purpose of improving their clinical reasoning skills in order to provide safe and effective patient-focused care. Higher education plays a vital role in developing these sought-after skills in undergraduate students, and contributes to, among other benefits, improving student success, employability, patient care and clinical reasoning skills. Article 1 in Chapter 2 discussed this aspect in more detail. Most universities place a high premium on CT skill as a graduate attribute, though the skill is not currently tested explicitly at the UFS, except for the application of Bloom's taxonomy in compiling written tests. Literature reports that CT skills can be taught and should improve over time (*cf.* 1.2.6 in Chapter 1). This led the

researcher to the problem statement of this study and the investigation that was done in the specific setting (*cf.* 1.3 in Chapter 1).

Two interrelated, publishable articles were written to meet the requirements set by the UFS for a dissertation via the article option route. Articles were written according to the journal specifications of the journals *Thinking Skills and Creativity* (Article 1) and *The Journal of Higher Education* (Article 2) guidelines for authors (*cf.* Appendix H). This was done with the intent to submit the articles for publication once the dissertation had been examined and the required improvements made.

4.2.1 Research questions and objectives

The researcher investigated the development of CT skills in undergraduate AHP students in their clinical rotation years at the UFS, and the teaching strategies AHP lecturers use to develop these skills in the curriculum.

The research was carried out and completed based on two research questions. In Chapter 1 (*cf.* 1.3), an outline of the various research questions was given. The research questions guided the execution of the study.

This last chapter concludes the dissertation.

4.2.1.1 ***Research question 1***

The question was stated as follows:

What are the CT skills of undergraduate students in the various AHP at the UFS during clinical rotation years, and does this level change over a period of one clinical year in each profession?

The following objectives were pursued in relation to this research question:

i. To conceptualise and contextualise CT skills, with a specific focus on the undergraduate AHP students in clinical rotation years; and

ii. To determine the CT skills of students in the various AHP at the UFS during the clinical rotation years, and whether the level changes over one year for each profession.

Part 1 of research question 1 involved a literature review. This literature review was done in order to pursue both objectives ii and iii; for both parts of the research question.

The first research question aimed to provide the background to the study (*cf.* 1.2). This was done by examining definitions of CT (*cf.* 1.2.1), Bloom's taxonomy (*cf.*1.2.1.1) and the cognitive skills and subskills involved in CT (*cf.* 1.2.2). The difference between clinical reasoning and CT was also discussed (*cf.* 1.2.3). The different CT skills tests that are available, were described shortly (*cf.* 1.2.4). AHP in South Africa (*cf.* 1.2.5) and at the UFS (*cf.* 1.2.5.1) were then described. The teaching strategies that have been identified by research to develop CT skills were then discussed in detail, for higher education in general, and in health professions education in particular (*cf.* 1.2.6). The literature review, executed as a method of investigation, was discussed in Chapter 1 (*cf.* 1.6.1).

Part 2 of research question 1 was based the administration of the TSA-Modified as pretest-posttest at the beginning and end of one clinical year.

The research findings related to this objective were written up in a publishable article, as discussed in detail in Article 1, Chapter 2.

The results of this study indicate that there were no statistically significant changes in the CT skills of the undergraduate students who participated in this study over a year, though they do indicate that OT students had a statistically significantly higher median score than other AHP students. A limitation of this study was the small populations of the different AHP that participated, making it difficult to derive a conclusion from the data. It was, however, found that AHP students had average median CT test scores (*cf.* Article 1, Chapter 2). Deeper investigation into the test scores is needed to determine if these results apply only to the specific population that had been tested, or if it is a true reflection of the CT skills of all the undergraduate AHP students.

The researcher is of the opinion that the accomplishment of this objective addressed research question 1.

4.2.1.2 *Research question 2*

The question was stated as:

How and when are CT skills taught in undergraduate AHP curricula at the UFS?

The following objective was pursued:

iii. To investigate how and when CT skills are taught by lecturing staff of the AHP departments at the UFS.

Research question 2 was investigated using a questionnaire that was directed at the lecturers of the various AHP.

The research findings relating to this objective were written up in a publishable article, presented in Article 2, Chapter 3.

The researcher found that lecturers scaffolded most of the teaching strategies during the four years of study. Research suggests that teaching strategies should be introduced to students slowly, and then applied progressively during the years of study, thereby enabling students to master the skill before building on their ability to reason clinically (*cf.* Article 2). This approach was not always followed by the lecturers in all the teaching strategies, which could indicate a possible problem related to students being unable to master the skill first, before being expected to apply the skill. This finding could be an indication why the median score of AHP students was low. When considering specific teaching strategies, problem-based learning and experiential learning were used by most of the lecturers in the students' fourth year to facilitate the development of CT. This is in line with research by Huang *et al.* (2014), who state that action and problem-based strategies foster CT skills. The lecturers' perceptions of CT skills were also investigated, and the researcher found that two thirds of the lecturers use Bloom's taxonomy as a framework for their understanding of CT skills.

4.3 CONCLUSIONS

In order for universities to produce successful and employable graduates in the 21st century, the lecturer and the teaching strategies they use need to evolve as students evolve over their years of study. This evolution entails incorporating skills that enable students to think on their feet, integrating all the knowledge students acquire and determining the best possible patient care plan. If students have not mastered these skills, patient care and safety could be affected, which would not only be detrimental for the professions, but will also cause patients to lose trust in health professions. CT skills have been found to be a vital skill that employers require candidates to possess, thus, developing this skill in students could enhance their chances of finding employment and succeeding in their chosen professions.

University lecturers need to determine if the development of CT skills is achieved as an exit-level outcome, and to make curricular changes if the skill does not develop. At the UFS, the students' median CT score did improve marginally (*c.f.* Article 1, Table 5) in the one clinical year of 2018, though the researcher could not determine the CT skills "starting point" in the students' first year. Some research indicates that the development of CT skills follows a non-linear progression, thus, testing CT skills over the entire four years of study could give a better picture of the actual development of these skills. Furthermore, there was no statistically significant difference between students' CT skills in the third and fourth years of study, indicating that the clinical placement probably did not have a beneficial effect on the development of CT skills, as expected. However, as stated previously, the researcher did not determine the initial levels of CT scores, which makes reaching a conclusion from the data difficult. These result do correlate with findings of other studies, which indicate that foundational thinking did not improve significantly over a timeframe of two years (Peeters & Boddu 2016:271). One finding that is clear from the data is that OT students who participated in this study had a statistically significantly higher median score than the other cohorts. The researcher recommends that further studies be done on larger populations to determine the reasons for this finding. It should be noted that health professions students have been found to have higher CT skills than average students (Goodman *et al.* 2018:2351; Slaughter *et al.* 1989:445; Velde *et al.* 2006, Vendrely 2005:57; Wessels & Williams 2004:86), but the concept of improving "good" CT skill to "great" CT skills will prove much more difficult to achieve than improving poor or average skills, according to Reale *et al.* (2018:830).

One difficulty related to the assessment of CT skills is that measuring CT remains difficult, especially because of the "inherent difficulty in measuring a mental process and attitudes" (Huang *et al.* 2014:99). More research is needed to determine if the TSA-Modified is a valuable test for determining the development of CT skills, and to determine a baseline of CT test scores to use for comparability purposes.

Lecturers need to be made aware of the impact that active teaching and learning strategies have on the development of the CT skills of undergraduate students. Moving from a traditional, teacher-centred approach to a student-centred approach requires students to be more actively engaged in their own learning. CT skills need to be deliberately practised in different contexts to ensure that the skills develop. By scaffolding this practise of CT skills, students will be able to master the skills and increase their chances of applying the skills to complex thinking. Lecturers need to be the driving force in the development of CT skills, and not the stumbling blocks (Huang *et al.* 2014:100). Lecturers need to face the different CT teaching strategies head on, and have to keep pace with education if they are to prevent the development of ill-equipped graduates.

4.4 LIMITATIONS OF THE STUDY

The following limitations were recognised by the researcher in the study.

Part 1: Undergraduate student CT skills

- Several students could not be included in the study due to scheduling problems/changes in the programme at the beginning of the year; students also had to be excluded from the study because they failed to complete the last round of testing due to scheduling problems relating to the students' programmes, changes in classes, and, possibly, lack of motivation to participate in the study.
- Another possible limitation was that the test uses only multiple-choice questions, and does not include the process of how the application of CT skills led to specific answers. Students could have guessed the correct answers (Butler *et al*. 2012:113).
- Another limitation could be that the test is not discipline-specific, but rather based on everyday life occurrences. There are mixed results in this regard, though some researchers do indicate that using a discipline-specific CT test could be beneficial, even

though the financial resources and time required to develop such a test might not be worth the effort (*cf.* 1.2.4 in Chapter 1).

- CT skills could not truly be determined, due to the small student populations in each discipline. The findings of different disciplines could not be compared effectively, due to the small populations.
- No baseline or starting point of CT skills was determined, thus, making comparability of development difficult, especially because the pretest-posttest only spanned one clinical year.
- The TSA has not been used in any other published research, making it difficult to compare to other AHP, due to lack of comparable data. See Chapter 1 for more information regarding the TSA.
- No demographic information was collected from the students, thus, the student population could not be ideally investigated. There was no indication of participants' genders, cultures, previous years of study, or any previous training undergone to improve CT skills.
- It is difficult to discriminate between the subskills of CT skills. The subskills also had different numbers of questions, making the identification of strengths in a subskill difficult. Only the total score could actually be used in this study.

Part 2: Teaching strategies of AHP lecturers

- There was no indication of how many hours the lecturers teach in each year group.
- There was no indication in the demographic information whether lecturers had undergone previous professional development or training with regard to teaching strategies that contribute to the development of CT skills.
- There was no indication whether general CT principles are taught by lecturers during lessons, to determine whether lecturers use an infused, immersed of mixed approach.
- Only 18 teaching strategies where identified. A more comprehensive list could have been added (*cf.* 4.8 Recommendations and Chapter 1)

4.4.1 Critique of own research

The researcher believes that this study is of great value to the AHP, especially for the development of well-rounded graduates and skilled lecturers.

However, the lack of studies to compare the results of this study found on the TSA-Modified is a limiting factor for the researcher. However, using the HSRT or other CT skills tests were not financially viable for this study. The researcher believes that the development of a CT skills test that is freely available and that can be standardised and, perhaps, even meant for AHP students, may be the way forward

4.5 RECOMMENDATIONS

In order for this study to yield significant and valuable results, the following recommendations are made.

4.5.1 Recommendations from this study

The researcher recommends using CT skills tests as a pre-admissions tests, to determine the starting CT skills of prospective undergraduate students. This is recommended for the UFS, because other universities use these tests for these purposes (*cf.* 1.2.4), and 14 of the 24 lecturers expressed that it could be a useful part of the selection process for students (*cf.* Article 2). Doing so will also ensure that more comprehensive comparable data can be collected about the development of CT skills. It would also have been interesting to compare the data from this study with the National Benchmark Test (NBT) results of the respective students.

Faculty development, with the focus on how to teach CT skills and scaffold it over the curriculum, should be available to staff members, to equip them with accurate and the most up to date, best evidence on how to teach CT skills (*cf.* Article 2). It could also be beneficial for to teachers to develop by adjust their teaching strategies, in accordance to CT test results, to assist the development of CT skills. This motivates the yearly testing of CT skills in undergraduate students to determine if adjustments need to be made to teaching strategies.

4.5.2 Recommendations for further research

The implementation of a general CT course at the start of the curriculum could be beneficial and could assist students to master the necessary skills; then, each lecturer should implement the teaching strategies to develop CT skills in the lessons they teach.

It could be beneficial to include the Marlowe-Crowne Social Desirability scale as part of the CT testing, to determine the willingness of students to participate in the study and effectively complete the test.

A Delphi study (by lecturers and students) is suggested by the researcher, to fill knowledge gaps on the different teaching strategies used by the lecturers. Alternatively, lecturers could be requested to identify, from a comprehensive list, the teaching strategies they use for each year group. The Likert scale could be expanded to 10 options, which could give a broader image of the strategies used in AHP.

Further research on undergraduate AHP students is recommended, especially to determine if the higher median CT skills of the OT students is due to the small population tested, and if they truly have a higher CT skill than other undergraduate AHP students. Future research should also include the entire undergraduate programme students (year one to four) to determine a starting point of CT skills and to get a true reflection of the development in regards to CT skills.

4.6 CONCLUDING REMARKS

CT skills are valuable skills for the development of undergraduate students, so that they can complete their studies successfully, and to ensure their future effectiveness as practicing allied health professionals. In order for graduate students to provide patient-centred healthcare, students need to master CT skills, as the foundation of thinking and a precursor for clinical reasoning, to facilitate complex thinking skills (e.g., problem-solving skills and clinical reasoning) during their years of study.

Lecturers play a vital role in assisting undergraduate students to achieve this graduate attribute, by embracing the fourth industrial revolution and actively engaging different teaching strategies, providing the students with time to master the skills and, then, building progressively on the skills over the years of study.

The findings of this study may be of value to the SAHP at the UFS, to fill in gaps in the curriculum with regard to the scaffolding of teaching strategies. The results could also assist to provide comparable data for a future, in-depth study over all four years of study, to determine the development of CT skills in the different AHP.

It is hoped that the results of this study will lead to the implementation of a pre-admission CT skills test, which could be a valuable test to assist with the student selection process, and which could provide valuable data for future studies investigating student success and the development of CT skills.

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PERSONAL COMMUNICATIONS LIST

Eygelaar, M. personal communication per email: 5 December 2019, 16:17

Henderson, A., personal communication per email: 17 July 2017, 08:46

Mitchell, C., personal communication per email: 13 July 2017, 10:26

Rasengane, T., personal communication per email: 13 July 2017, 07:15

Swanepoel, A., Personal communication per email: 29 October 2019, 12:38

APPENDICES

APPENDIX A

APPROVAL DOCUMENTS

Appendix A1: Approval form UFS authorities (HSREC 17)

Appendix A2: Letter to notify HOD's of the School for Allied Health Professions (example: Head of Physiotherapy Department)

APPENDIX A1: APPROVAL FROM UFS AUTHORITIES (HSREC 17)

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

08 November 2017

MRS MARSHÉ LOUW
DEPT OF PHYSIOTHERAPY
FACULTY OF HEALTH SCIENCES
UFS

Dear Mrs Marshé Louw

HSREC 131/2017 (UFS-HSD2017/1276)
PRINCIPAL INVESTIGATOR: MRS MARSHÉ LOUW
PROJECT TITLE: CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

APPROVED

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this protocol after all conditions were met. This decision will be ratified at the next meeting to be held on 05 Desember 2017.

2. The Committee must be informed of any serious adverse event and/or termination of the study.

3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.

4. A progress report should be submitted within one year of approval and annually for long term studies.

5. A final report should be submitted at the completion of the study.

6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.

7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services-(HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

MS MGE MARAIS
HEAD: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE ADMINISTRATION

APPENDIX A2: LETTER TO HOD's of the School of Allied Health Professions (example: Head of Physiotherapy Department)

To: Dr. Roline Barnes
Head of the Department of Physiotherapy
University of the Free State
Bloemfontein

Dear Madam

Request for permission to conduct a Magister study with the title:
CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

I currently occupy the position of Junior Lecturer (units) (15 hours per week) at the Department of Physiotherapy at the School for Allied Health Professions. I have been appointed since 2014 and have been actively involved in teaching and learning activities within the Department by lecturing, clinical assisting students in clinical areas and completing Health Professional Education (HPE) courses in 2015 and 2016.

I am in the process of writing a thesis to obtain a Research Master's degree in Health Sciences Education in the Faculty of Health Sciences at the University of the Free State (Student number: 2002018501). The title of my research is **CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE**

My supervisor is:
Dr. C. van Wyk
Senior Lecturer: Division Health Sciences Education
Faculty of Health Sciences
University of the Free State

Critical thinking is defined by the Watson and Glaser as "the ability to identify and analyse problems, as well as seek and evaluate relevant information, in order to reach an appropriate conclusion.

As indicated in the title of this study, the **purpose** of this study is to test the critical-thinking skills of the undergraduate Allied Health Professions students at the University of the Free State in their clinical rotation years. There are three validated test to test critical thinking in health care professionals: The Health Sciences Reasoning Test (HRST), the California Critical Thinking Disposition Inventory (CCDTI) and the Watson-Glaser Critical Thinking Appraisal (W-GCTA). It is strongly advised that the HSRT and the CCDTI be tested in conjunction with each other, where the HSRT tests the actual critical thinking skill and the CCDTI tests the character or mindset of the test taker/student to think critically. The W-GCTA is a critical thinking test, but it was not designed for Health Science professionals, but is more time and cost effective to use than the CCDTI, CCTST and the HSRT. All these tests are expensive and this led the researcher to the Thinking Skills Assessment (TSA) specimen test. This test is used at the University of Cambridge and Oxford as a practice test for the admissions test and includes critical-thinking and problem-solving skills. This test is freely available as well as the answer key. For the purpose of this study only the critical-thinking skills questions will be used and will be changed to a South African context, where necessary.

The **problem** that will be addressed in this research is to determine the level of critical-thinking skills in undergraduate Allied Health Professions students at the University of the Free State in their clinical rotation years. The problem that needs to be addressed is, prior to this study, critical thinking was not tested in any undergraduate profession. Critical thinking is a vital skill that Allied Health Professionals need in clinical reasoning to make educated decisions about patients and patient care. Critical thinking is the only part of clinical reasoning that can be measured, there are a few available questionnaires. In this study, the TSA test will be used.

In order to address the problem, the following **main research questions** will be asked:

1. What is the critical-thinking skills in undergraduate students in the various Allied Health Professions at the UFS during the clinical rotation years, and does this level change over a period of one year in each profession?

2. How and when are critical-thinking skills taught in the undergraduate Allied Health Professions curriculums at the UFS?

To achieve this aim, the following **research objectives** will be pursued:

1. To conceptualise and contextualise critical-thinking skills, with a specific focus on the undergraduate Allied Health Professions students in clinical rotation years **(a literature review will be conducted**);
2. To determine the critical-thinking skills of students in the various Allied Health Professions at the UFS during the clinical rotation years, and does the level change over one year for each profession? **(Critical Thinking Skills Test (TSA-Modified) administered at the beginning and end of the year of study)**;
3. To evaluate if there are differences between the critical thinking skills in the various Allied Health Professions **(Results of the TSA-modified will be compared)**; and
4. To investigate how and when critical-thinking skills are taught by the lecturing staff of the Allied Health Professions departments at the UFS **(a questionnaire directed towards the educators of the various Allied Health Professions will be administered)**.

The **aim of the study** is twofold, firstly, to determine the critical-thinking skills of undergraduate Allied Health Professions students at the UFS during their clinical rotation years, and investigate the change in critical-thinking skills over one year of study in each profession.

Secondly, this study aims to investigate the types of teaching activities lecturers at the different the different departments in the School for Allied Health Schools employ to enhance critical-thinking.

The **research design** is a quantitative, experimental study. A survey will be used to collect data by means of the two above mentioned questionnaires (TSA-modified and a questionnaire to the Allied Health Professions lecturers). A one group pre-test post-test design will be followed (part one) and a descriptive study will be done in part two.

The **methods** that will be used is a paper pen and pencil test and questionnaire, namely the Thinking Skills Assessment (TSA-modified) and a Questionnaire for the lecturing staff. The results of the TSA-modified and the lecturer questionnaire will be analysed by the Department

of Biostatistics at the University of the Free State. The findings will be communicated in such a way to address the research questions.

The TSA has been proven valid and reliable for testing and indicating critical-thinking skills in "High Ability Populations".

This protocol will be submitted to the Health Sciences Research Ethics Committee of the Faculty of Health Sciences at the University of the Free State. Informed consent will be obtained from all participants/undergraduate students before the study will be conducted.

The value and significance of this study: The value of this study will be fill the gap in the knowledge that currently exist in the field of Allied Health Professions education and to add value to the research in this field.

The findings of this study will be presented at conferences and published in appropriate journals.

I therefore kindly request your consent to execute the study in the Department of Physiotherapy, Faculty of Health Sciences at the University of the Free State.

Should you have any specific questions, my contact details are as follows:
Cellular number: 082 556 1878
Email address: LouwM@ufs.ac.za or marsheober@gmail.com

Yours Sincerely

_____ _____

Marshé Louw Date:

_____ _____

Dr Chantel van Wyk Date:

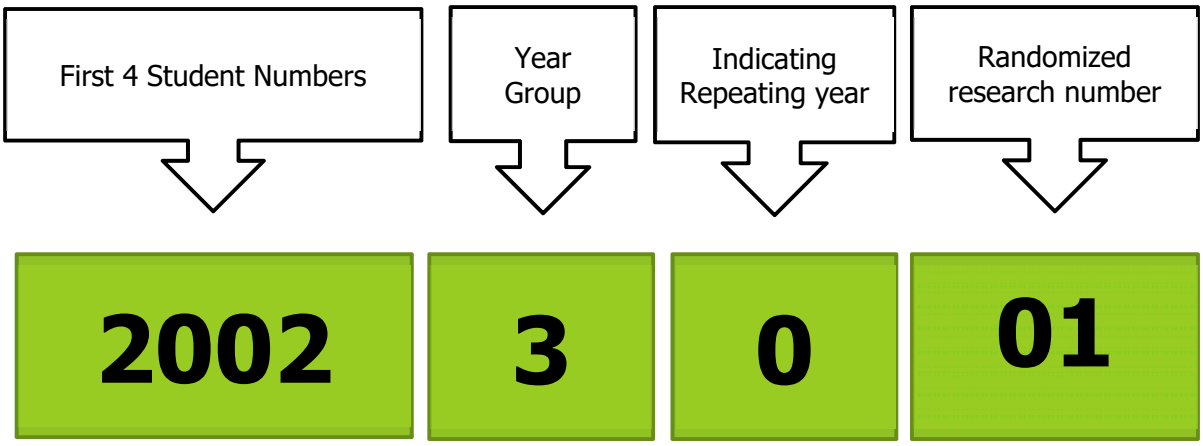
APPENDIX B

UNIQUE RESEARCH NUMBER

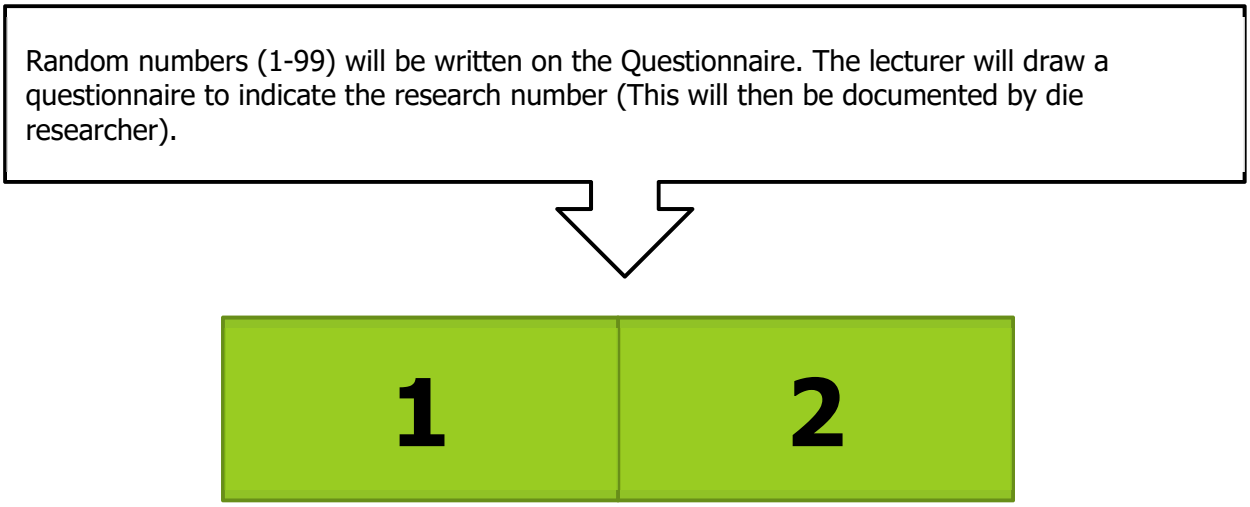
Appendix B1: Unique research number identification for students (example)

Appendix B2: Unique research number for lecturers (example)

APPENDIX B1: UNIQUE RESEARCH NUMBER IDENTIFICATION FOR STUDENTS (EXAMPLE)



APPENDIX B2: UNIQUE RESEARCH NUMBER FOR LECTURERS (EXAMPLE)



APPENDIX C

INFORMATION DOCUMENTS:

Appendix C1: Information documents to participants – students

Appendix C2: Information documents to participants – lecturers

APPENDIX C1: INFORMATION DOCUMENTS TO PARTICIPANTS - STUDENTS

Dear Participant

Request to participate in the Magister study titled:

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

I am currently pursuing a Magister degree in Health Professions Education at the University of the Free State. In this research study, I would like to measure critical-thinking skill in all undergraduate Allied Health Professions students in the year 2018.

Critical thinking is defined by the Watson and Glaser as "the ability to identify and analyse problems, as well as seek and evaluate relevant information, in order to reach an appropriate conclusion'.

Critical thinking is a vital skill that Allied Health Professionals need in clinical reasoning to make educated decisions about patients and patient care. Critical thinking is the only part of clinical reasoning that can be measured, there are a few available questionnaires. The Thinking Skills Assessment (TSA) was chosen due to financial constraints of the other available tests.

You are invited to take part in this study. Your participation will help to determine critical-thinking skills of the undergraduate Allied Health Professions students, as derived from the test. The information gained from this study may contribute to recommendations to the School for Allied Health Professions regarding types of teaching strategies that can be implemented or improved on to improve critical thinking in the different years of study.

Your participation in this study is voluntary and if you decide to decline involvement or decide to terminate participation in this study you will not be penalised or be disadvantaged in any way. You may decide to withdraw your participation at any time, without penalisation of any kind. You will not receive any additional benefits, compensation, academic gratification or special privileges for participation in this study.

Your participation in this study will involve no costs or risks and all information will be treated as confidential. The results of this study will be used for academic purposes to improve teaching and learning in the various Allied Health Professions undergraduate curriculums. The information gained in this study may also be used in research presentations and journal publications.

The questionnaire will be completed at a venue that will be confirmed at a later date as well as a specific allocated time. The questionnaire is in a paper and pencil format. A questionnaire book will be distributed for the test, as well as a score sheet, pencil and paper to write on. **Please do not make any notes in the test book**. The TSA takes approximately 45minutes to complete. The test will be completed at the beginning of the year and will then be repeated at the end of the year. It will not be scheduled in conflict with other tests, assessments or assignment.

You will be assigned a Research number that will be linked with your student number, to keep your test results private to anyone but the researcher. Please provide this **research assigned number** on the consent form as well as the questionnaire. This number will only be allocated to you for these two test times. No participants will be personally identified at any time. Although absolute confidentiality cannot always be guaranteed, the researcher will endeavour at all costs, to keep the information confidential and bias.

By signing this consent form the researcher accepts that you, the participant, gives permission to complete the two questionnaires and that the information and data gained from each testing can be compared to the participant self, other class participants as well as other year group participants.

You may contact me at (082) 556 1878 if you need any more information regarding this study or your rights as a participant.

Thank you for taking the time to read this letter. I truly believe that these results could benefit all Allied Health professions tremendously.

Yours sincerely

Marshé Louw
Department of Physiotherapy, School for Allied Health Professions
Faculty of Health Sciences, University of the Free State
Bloemfontein

HSREC contact detail:
Mrs M Marais Head: Administration
051-401 7795
Mrs J du Plessis Administration
051-401 7794
Fax number 051-4444359
Email ethicsfhs@ufs.ac.za
Office hours 07h45 – 16h30

APPENDIX C2: INFORMATION DOCUMENTS TO PARTICIPANTS – LECTURERS

Dear Colleague:

Request to participate in the Magister study titled:

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

I am currently pursuing a Magister degree in Health Professions Education at the University of the Free State. In this research study, I would like to measure critical-thinking skills in undergraduate Allied Health Professions students in the year 2018 as part one of my study. Part two of the study is aimed at the lecturers at the different Allied Health Professions departments to determine the type of teaching activities that are included in their teaching strategies to incorporate critical-thinking skills in 2018 and to determine if different activities are incorporated in different year groups in each profession.

Critical thinking is defined by the Watson and Glaser as "the ability to identify and analyse problems, as well as seek and evaluate relevant information, in order to reach an appropriate conclusion'.

You are invited to take part in this study. Your participation will help to assess the current teaching activities used in the different year groups in the School for Allied Health Professions to improve critical-thinking skills in undergraduate students by means of a questionnaire. The information gained from this study may contribute to recommendations to the different Department in the School of Allied Health Professions regarding types of teaching strategies that can be implemented or improved on to improve critical thinking in any year of study.

Your participation in this study is voluntary and if you decide to decline involvement or decide to terminate participation in this study you will not be penalised or be disadvantaged in any way. You may decide to withdraw your participation at any time, without penalisation of any kind. You will not receive any additional benefits, compensation, academic gratification or special privileges for participation in this study.

Your participation in this study will involve no costs or risks and all information will be treated as confidential. The results of this study will be used for academic purposes to improve teaching and learning in all Allied Health professions undergraduate curriculum. The information gained in this study may also be used in research presentations and journal publications.

By signing this consent form the researcher accepts that you, the participant, gives permission to complete the one questionnaire and that the information and data gained from each testing can be compared to the other lecturers to determine what type of activities they use in the different year groups.

The questionnaire will be completed on your own time and takes about 15-20 minutes to complete. A box will be placed in each department to return the completed questionnaires in.

You will be assigned a Research number (The HOD of each department will hand you a sealed envelope) that will be randomly allocated to you, to keep your test results private to everyone including the researcher. Please provide this **research assigned number** on the consent form as well as the questionnaire. This number will only be allocated to you. No participants will be personally identified at any time. Although absolute confidentiality cannot always be guaranteed, the researcher will endeavour at all costs, to keep the information confidential and bias.

You may contact me at (082) 556 1878 if you need any more information regarding this study or your rights as a participant.

Thank you for taking the time to read this letter. I hope that I have persuaded your participation in this study. I truly believe that these results could benefit all Allied Health professions tremendously.

Yours sincerely

Marshé Louw
Department of Physiotherapy
School for Allied Health Professions
Faculty of Health Sciences
University of the Free State
Bloemfontein

HSREC contact detail:
Mrs M Marais Head: Administration
051-401 7795
Mrs J du Plessis Administration
051-401 7794
Fax number 051-4444359
Email ethicsfhs@ufs.ac.za
Office hours 07h45 – 16h30

APPENDIX D

CONSENT FORMS:

Appendix D1: Letter to obtain consent from participants – students

Appendix D2: Letter to obtain consent from participants – lecturers

APPENDIX D1: LETTER TO OBTAIN CONSENT FROM PARTICIPANTS -STUDENTS

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

I

,_____,

RESEARCH ASSIGNED NUMBER:

Hereby confirm that I am willing to partake in the above-mentioned study.

I understand that my participation is voluntary, in this specific study. I also understand that I will not be penalized or disadvantaged in any way if decide to withdraw or terminate my participation. I also understand that I will not receive any compensation to participate in this study or that it will incur me any costs.

I understand that I can contact the researcher at (082) 556 1878 if I have any questions regarding my rights to partake in this study.

The researcher, Marshé Louw, explained the study to me verbally and I also received a printed information document.

I understand that my involvement in this study means I voluntary agree to participate and that information and data received from myself can be used to compare to myself, my peers, and other years of study.

_____ _____

Signature of **Participant** Date

_____ _____

Signature of **Researcher** Date

APPENDIX D2: LETTER TO OBTAIN CONSENT FROM PARTICIPANTS – LECTURERS

CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

I _____,

RESEARCH ASSIGNED NUMBER:

Hereby confirm that I am willing to partake in the above-mentioned study.

I understand that my participation is voluntary, in this specific study. I also understand that I will not be penalized or disadvantaged in any way if decide to withdraw or terminate my participation. I also understand that I will not receive any compensation to participate in this study or that it will incur me any costs.

I understand that I can contact the researcher at (082) 556 1878 if I have any questions regarding my rights to partake in this study.

The researcher, Marshé Louw, explained the study to me verbally and I also received a printed information document.

I understand that my involvement in this study means I voluntary agree to participate and that information and data received from myself can be used to compare to myself and my peers.

_____ _____

Signature of **Participant (LECTURER)** Date

_____ _____

Signature of **Researcher** Date

APPENDIX E

RESEARCH INSTRUMENT:

Appendix E1: Research instrument – TSA-Modified

Appendix E2: Research instrument – Questionnaire to lecturers

APPENDIX E1: RESEARCH INSTRUMENT –TSA-MODIFIED– JUSTIFICATIONS INDICATED IN RED FOR SOUTH AFRICAN CONTEXT)

CRITICAL-THINKING SKILLS (TSA) TEST

BASED ON THE SPECIMENT TSA TEST FROM CAMBRIDGE ASSESSMENT ADMISSIONS SERVICES (UCLES 2015)

THIS IS A MULTPLE-CHOICE TEST THAT WILL TAKE 30-45 MINUTES TO COMPLETE.

ADDITIONAL MATERIALS NEEDED: Answer sheet, Clean soft easer, Soft pencil (type B or HB)

INSTRUCTIONS TO CANDIDATES

Please read this page carefully.

Please write your Unique Research number in the space provided on the answer sheet.

Please write very clearly.

There are 25 questions on this paper. Please answer all questions. Five possible answers (**A, B, C, D or E**) will be provided. Please choose only **one** answer that you consider correct and record your choice on the answer sheet provided. If you make a mistake, please erase thoroughly and correct your answer clearly. Each answer will score one mark. A mark will not be deducted for incorrect answers. When you have finished the test, **please return this booklet and answer sheet to the researcher.**

Not all questions are equally difficult but each will account for one mark. If you find a question particularly difficult you could leave it and return at the end. There are no penalties for incorrect answers, only one point for correct answers. So please attempt to answer all the questions.

PLEASE NOTE: No writing in the TEST BOOKLET. (please write on the writing block provided)

CALCULATORS AND DICTIONARIES ARE NOT ALLOWED.

DO NOT OPEN THE PAPER UNTILL YOU ARE TOLD TO DO SO.

1. **Every motorist pays the same amount of road tax, regardless of how much they use the roads: someone who covers a little as 1 000 km pays the same as someone who covers 20 000. This is unfair. Road tax should be scrapped and the money raised by an increase in the tax on car fuel. Making this change would ensure that those who use the roads more would pay more. This would not only be a fairer system, but could also bring in more revenue.**

   Which of the following best illustrates the principles underlying the argument above?

   A. People should receive free medical treatment only if they cannot afford to pay for it.
   B. People you travel to work every day by train should pay a lower fare than those who travel only occasionally.
   C. People who earn more than double the average wage should be made to pay much higher charges for dental treatment.
   D. Television channels should be paid for by subscription so that only those people who watch them should be made to pay.
   E. Telephone charges should be higher for business customers than for domestic customers because they are using the system only to make money.

2. **Every year in South Africa there are nearly 25 000 car fires, yet it is estimated that only five percent of motorists travel with a fire extinguisher in their car. If more motorists could be encouraged to carry fire extinguishers then the number of car fires could be considerably reduced.**

   Which of the following is the best statement of the flaw in the argument above?

   A. It ignores the fact that millions of motorists never experience a car fire.
   B. It assumes that carrying a fire extinguisher will enable fires to be put out.
   C. It implies that the occurrence of car fires is related to the lack of an extinguisher.
   D. It overlooks the possibilities that fires might not be put out with an extinguisher.
   E. It ignores the fact that there are different extinguishers for different kinds of fires.

3. **School examination results in Bloemfontein this year reinforced the trend in improving pass rates. There is however, no other evidence of improvements in school leavers' abilities – such as the data coming from employers or universities. One can reasonably conclude, therefore, that teachers are simply succeeding in coaching their pupils better for examinations than in previous years.**

   Which one of the following is an underlying assumption of the above argument?

   A. School examination results are a reliable indicator of pupils' abilities.
   B. The level of difficulty of examinations has not been falling.
   C. Employers' expectations of school leavers are unrealistic.
   D. Teachers in previous years did not attempt to coach pupils for examinations.
   E. Abilities of school pupils vary from year to year.

4. **Some employers operate a three-shift system. This requires that, in any three-week period, an individual worker will have to work, for example, from 6am to 2pm in the first week, from 2 pm to 10pm in the second week, and from 10pm to 6am in the third week. It becomes very difficult to establish any kind of routine of eating and drinking under such a system. People working a three-shift system report a severe decline in their appetite, especially during the night-shift when they would normally be asleep. Therefore, anyone about to begin working shifts like this can be expected to lose weight.**

   Which one of the following is an underlying assumption of the argument above?

   A. All shift workers have to work during the night.
   B. Employees tend to dislike working shifts.
   C. People who feel less hungry generally eat less food.
   D. Shift work often pays better than working days only.
   E. Cafeteria facilities are not always available to the night shift.

5. **The motor-car, that at first brought such freedom of private travel, has become a monster that is damaging our cities. The motor-car used to be affordable only by the rich, but there are now 21 million cars in this country, and the number is still rising steeply. The huge number of cars in city centres has produced intolerable congestion and pollution. We have reached the stage where the use of private cars must be curbed. Otherwise, we will see a worsening of the current situation, where it is already becoming quicker to walk through a city in the rush hour than to drive through it.**

   Which of the following best expresses the main conclusion of the argument above?

   A. The motor car no longer gives us freedom of travel.
   B. Increasing provision of public transport would solve traffic problems in city centres.
   C. It is necessary to limit the use of motor cars by private individuals.
   D. Pollution and congestion are damaging our city centres.
   E. The number of people who can afford to own a motor-car has risen, and is continuing to rise.

6. **Only stakeholders are eligible to vote on the proposed take-over of the company by a large multi-national. They can either vote for or against, or abstain by not voting at all and the side with the more votes wins. So, if the majority vote in favour, the take-over will be approved. However, less than half the eligible voters are in favour of the proposal, which means that the take-over will not be approved.**

   Which of the following is the best statement of the flaw in the above argument?

   A. Some of those in favour might change their minds and vote against the take-over.
   B. The large multi-national could pull out of the take-over deal, whichever way the vote goes.
   C. Some voters may abstain, meaning that one side could win with less than half the votes.
   D. No-one can be sure how a ballot will turn out until after the votes have been counted.
   E. A majority of votes against the take-over would be enough to stop it being approved.

7. **If De Beers Mining does not increase wages then staff morale will continue to drop and the productivity will fall. This would lead to smaller profits and could mean the end of the business altogether. Either the company must pay better wages or run the risk of closing down.**

   Which of the following best expresses the conclusion of the argument?

   A. Staff morale has reached dangerously low levels.
   B. If wages are not increased the business could close down.
   C. The employers will have to accept a fall in productivity.
   D. A fall in productivity could mean the end of the business.
   E. If wages are improved the company will be saved.

8. **Level of financing health services in advanced industrial countries have little effect, statistically speaking, on the health of the population. There are countries which spend six times as much per head on health care as South Africa, and countries which spend only half as much: their populations end up with more or less the same life expectancy. Therefore, arguments about levels of financing South Africa's National Health services are largely irrelevant to the health of the population.**

   Which of the following is an underlying assumption of the above argument?

   A. The cost of health services in South Africa's Health Service is disproportional to its effectiveness.
   B. Spending is the most effective way of improving a health service.
   C. Advanced industrial countries have failed to improve the health of their population.'
   D. Governments have a responsibility to organise efficient heath care systems.
   E. Life expectancy is a reliable measure of the health of the population.

9. **Ever since Uranus was discovered in 1781, astronomers have thought there might be more planets to be discovered in the Solar System. Because of small deviations in the orbits of Uranus and Neptune – deviations which would occur if another planet existed – some astronomers think there must be an undiscovered planet – Planet X. But the search for Planet X is futile, because these deviations would occur if the orbits had been wrongly predicted. Since Uranus and Neptune take many decades to circle the sun, astronomers must rely on old data in order to calculate their orbits. If the data is inaccurate, the calculated orbits are wrong. If the calculated orbits are wrong, Uranus and Neptune will deviate from them even if there is no Planet X.**

   Which of the following is the best statement of the flaw in the argument above?

   A. From the fact that the old data is inaccurate, it cannot be inferred that the calculated orbits are wrong.
   B. From the fact that the data about the orbits is old it cannot be inferred that it is inaccurate.
   C. From the fact that deviations occur which would occur if Planet X existed, it cannot be inferred that Planet X exist.
   D. From the fact that the calculated orbits are wrong, it cannot be inferred that Uranus and Neptune will deviate from them.
   E. From the fact that Planet X has not been discovered, it cannot be inferred that the search for it is futile.

10. **According to a recent survey, people believe that about a quarter of the population will be victims of a violent crime in the next year, whereas crime statistics show that it is only about 1%. Furthermore, those with the greatest fear of crime are the least likely to be affected. The elderly are the most fearful, although victims are most likely to be young males. Over the last few years, there has been an increase in the number of television programmes which show re-enactments add to people's fear about violent crime by making it look more common than it is. It is time that we stopped making such programmes.**

    Which of the following, if true, would most weaken the above argument?

    A. Crime re-enactments are made to look more realistic than they used to be.
    B. Most elderly people are unaware of the statistics of violent crime.
    C. Some types of violent crime have declined over the last few days.
    D. The elderly are the group least likely to watch crime re-enactments on television.
    E. Attempts have been made to ensure that statistics of violent crime are accurate.

11. Many modern zoos have abandoned the idea of showing large number of animals in favour of programmes of conservation illustrated by a few examples of endangered species. However, the only way for a zoo to attract the public is to have lots of interesting animals, whether endangered or not- the sort that everybody flocks to see. Unless zoos attract the public, they are not likely to be profitable.

Which one of the following conclusions is the best supported by the passage above?

A. Endangered animals do not attract the public.
B. Zoos which have a lot of interesting animals make a profit.
C. Public interest in conservation programmes and endangered species is very limited.
D. Zoos which concentrate on conservation and a few endangered species are likely to make a profit.
E. Popular zoos are the only ones that can afford programmes of conservation.

12. Organic farming of animals and crops improves the environment through a reduced use of chemical fertilisers and pesticides but this does not go far enough. It would be preferable to have a totally vegetarian agriculture. Ninety percent of the vegetable matter fed to farm animals passes straight through with its calorific content intact. By eating vegetables directly, rather than feeding them to animals, substantially less land would have to be farmed. The remaining land could be returned to its historical state – mixed deciduous woodland, which is what the countryside needs most of all.

Which of the following best expresses the main conclusion of the above arguments?

A. Organic farming enhances the environment.
B. It would be preferable to have a totally vegetarian agriculture.
C. A totally vegetarian agriculture would reduce the need for pesticides.
D. There would be a need for less under cultivation if we ate vegetables directly.
E. Land could be turned to mixed deciduous woodland.

13. **In the 1960's the drug Cariokind after the usual period of carefully monitored clinical trials, was declared by its manufacturers to be unusually safe and very effective in lowering cholesterol levels in the blood. The World Health Organization carried out exactly the same kind of trail on the drug but for a much longer period than the usual five years. The results in 1980 showed that the mortality rate from all causes for those on Cariokind was 25 percent higher than those who, though similar in other respects, had not taken the drug.**

Which of the following is a conclusion that can be drawn from the above passage?

A. The five-year trial period may not be sufficient for all drugs.
B. Taking Cardiokind reduces the life expectancy by 25%.
C. Cardiokind is less effective at reducing cholesterol levels than was at first thought.
D. After the original trials, the manufacturers concealed the side-effects of Cardiokind.
E. The monitoring programme instigated by the World Health Organization was carried out efficiently.

14. **The treatment of unauthorised immigrants by many countries is often cruel and lacking in compassion. Even refugees from war-torn and famine-stricken regions can find themselves imprisoned on arrival or deported back to the place they have fled. It is a terrible decision to have to take, but if we make an exception to the law for one person, we ought to make the same exception for everyone. If some illegal entrants were allowed to stay, others would have to be treated equally, and no country – especially one that is already overpopulated – could physically accommodate the number that would then follow. The regulations have to be enforced rigidly, even if this means turning away people in great need.**

Which of the following best illustrates the principle underlying the argument above?

A. Because of the fire regulations, the number of people attending the concert will have to be strictly limited.
B. Growing urban traffic congestion means that in the future the numbers of cars entering some city centres will have to be restricted.
C. All shop-lifters must be prosecuted because if one is let off others would rightly expect the same leniency.
D. There is no one rule that can be applied for all prisoners seeking parole: every case is different and should be decided on its merits.
E. If there are not enough hospital places for all those who need them, the most urgent ones must be treated first even if others have waited a long time.

15. In this Senior Management post, we need someone who can keep a cool head in a crisis and react quickly to events. The applicant says he suffers from phobia about flying, and panics especially when an aircraft is landing and that therefore he would prefer not to travel abroad on business if it could be avoided. He is obviously a very nervous type of person who would clearly go to pieces and panic in an emergency and fail to provide the leadership qualities necessary for the job. Therefore, this person is not a suitable candidate for this post.

Which of the following is the best statement of the flaw in the argument above?

A. It assumes phobias are not treatable or capable of being eliminated.
B. It assumes that the person appointed to the job will need to travel abroad.
C. It assumes that a specific phobia indicates a general tendency to panic.
D. It assumes that people who stay cool in crisis will be good leaders.
E. It fails to take into account other qualities the person might have for the post.

16. If you want to earn a good salary these days, you have to gain considerable experience of working abroad. Since I've always wanted to earn a huge salary, it's obvious that I'm going to have to leave this country for some period of time.

Which of the following most clearly parallels the reasoning used in this argument above?

A. If I had more time to spend on this project, I know that it would be very successful. I've been told that I'm not going to be given enough time, so the project isn't going to succeed.
B. Sam knew that if he wanted to write a film script, he'd have to learn the special techniques needed for such scripts. He has enrolled on a course to learn how to write them, so he'll soon be writing his first script.
C. If the Foreign Secretary can bring the two sides together to talks, there's a good chance for peace. Peace is something that both sides want, so he'll be talking to both sides soon.
D. If the doctor thinks that you should be allowed out of bed for a short while, then you must be recovering well from your operation. You have recovered much quicker than she thought you would have, so you'll be out of bed a lot from now.
E. Annie says that if she really wants to win the Comrades Marathon race, she'll have to train very hard every day. She told me that she is determined to win the Comrades Marathon, so that means she'll be working hard on her training programme every day from now on.

17. There is a great concern about the threat to natural woodlands in the world, especially the rain forests of tropical areas such as Southern America. People are often urged to-recycle paper in order to save trees. However, the type of wood used for paper is softwood which is grown as a renewable crop areas where there is no remaining natural woodlands. Producing paper from these trees does not harm the natural environment any more than does the production of bread from wheat.

Which one of the following is a conclusion which can be drawn from the above passage?

A. Re-cycling paper will not contribute directly to saving the world's natural woodlands.
B. There is no point in re-cycling paper for environmental reasons.
C. There is no need to be concerned about a threat to the world's natural woodlands.
D. The environment is not threatened by the cultivation of softwood forests.
E. There is no need to reduce the amount of paper being used in the modern world.

18. Peat is an organic matter which develops in wetland areas. It is the ideal growing medium for plants, and there is a tremendous demand for it from gardeners, both amateur and professional. But only three percent(%) of the earth's land surface is covered in peatland, and continued harvesting of peat will endanger these unique wetland habitats. Peat harvesting should be stopped immediately and gardeners should be encouraged to use an alternative.

Which of the following best expresses the main conclusion of the argument above?

A. Only three percent of the land on our planet is covered in peatland.
B. Taking too much peat will destroy the unique wetland areas in which it develops.
C. Peat cannot develop except in wetlands areas.
D. No more peat should be extracted and a different growing medium for plants should be promoted.
E. Peat is a very popular growing medium used by amateur gardeners and professional growers.

19. What causes the periods of strong and widespread stormy weather that Earth sometimes suffers? The answer is sunspots. Periodically, the sun develops relatively cool dark areas known as sunspots. Scientists have found that periods of high sunspots activity coincide with the stormy periods on Earth.

Which of the following is the best statement of the flaw in the argument above?

A. It disputes the fact that storms are the result of low pressure systems in the Earth's atmosphere.
B. It ignores the influence of periods of low sunspot activity on Earth's weather system.
C. It assumes that because two events coincide, one is the cause of the other.
D. It overlooks the fact that there is always a storm somewhere on Earth.
E. It ignores the fact that there are stormy periods in some areas but not in others while there is sunspot activity.

20. A painting in our local museum has just been shown, by using X-rays, to be recent and thus not the work of an old master as previously thought. This has caused its value to drop from millions to almost nothing. Yet no art experts were able to detect that this was not 'the real thing'. This means that the value of a painting is determined by who painted it rather than any intrinsic artistic merit.

Which of the following, if true, would most strengthen the above argument?

A. The works of some forgers of art now sell for very large amounts of money.
B. Many old masters changed their style during their career.
C. In controlled tests, art experts have been shown to be very good at identifying the painters of works they have not seen before.
D. Until its true origin was discovered, the painting in our museum was widely regarded as a masterpiece.
E. The works of the old masters fetch higher prices than modern paintings.

21. Calves farmed for veal are reared in extremely cruel conditions and have a short and miserable life. Other meats are available, such as lamb, and meat eaters who are concerned about cruelty to animals should avoid veal and consume one of these alternatives.

Which one of the following is an underlying assumption of the above argument?

A. Animals should be allowed to live as long as possible before being eaten.
B. Calves should not be reared for consumption of their meat.
C. The methods used to rear other animals for meat are not equally cruel.
D. Animals have a right to be treated humanely.
E. Meat eaters who are concerned with cruelty to animals do not eat veal.

22. Modern industrialised countries use far greater quantities per head of metals, water, petroleum, coal and wood-products than developing countries, much of it being imported from the developing countries. This is the natural consequence of the higher general standard of living in present-day industrial countries. Even assuming that, if the population of developing countries remains fixed at present levels, it follows that, if the standard of living in these counties is to reach those present-day industrialised counties, a considerable increase in production and hence considerably higher consumption of resources will be unavoidable.

Which of the following, if true, would most weaken the above arguments?

A. The population of developing countries is likely to increase substantially over the next decade.
B. Many of the resources needed for industrial production are increasingly expensive to produce.
C. New technological development in industrial processes are likely to reduce the need for high consumption of resources.
D. The population of modern industrialised countries is increasing at a much slower rate than that of developing counties.
E. The gap between the standard of living in modern industrialised countries and that in developing countries has increased in the last twenty years.

23. The company has been making large losses for some time. If it continues to make such large losses, a sizable number of workforce will lose their jobs. Unfortunately, the town's economy will suffer considerably if many of the employees are made redundant. So if the company continues to operate with such losses, the economy of the town will be badly affected.

Which of the following most closely parallels the reasoning used in the above argument?

A. If we do not pay nurses more, many of them will go and work in private hospitals. So there will be fewer of them to provide care in our public hospitals. Therefore, if we want to maintain high standards of nursing care in our hospitals, we must pay nurses more.
B. If this hot weather continues, the number of families taking foreign holidays will continue to fall. A number of travel companies will go out of business if fewer people book foreign holidays. Therefore, if this hot weather continues, we can expect many bargain holidays from travel companies.
C. If everyone was prepared to pay more taxes, we could afford to raise the level of pensions. If old people were given increased pensions, they could spend more on food and heating. So if we want old people to lead much happier and healthier lives, we must be prepared to pay higher taxes.
D. If house prices continue to fall, then more people will buy houses. The prices will then stop declining if more people are buying. So the fall in house prices must soon some to an end.
E. If the present drought does not end soon, water will have to be rationed in many areas. Once water rationing is brought in, people are going to complain about having to pay high water charges. So unless we get some rain soon, we are going to soon find people complaining about their water bills.

24. There has been a decline in the rate of many of the illnesses of old age. For example, arthritis, dementia, and stroke are all declining year by year. The causes of this decline include such medical advances as beta-blockers to control high blood pressure and the fitting of hip replacements. There is, however another factor. The present generation of 60- and 70-year-olds had much better nutrition as children than did their parents. Good nutrition in childhood is important in laying the foundation of good health in adulthood. Since improvements in nutrition have continues over the past sixty years, we can expect that many of the illnesses of old age will continue to decline.

Which one of the following best expresses the main conclusion of the above argument?

A. We can expect the improvements in nutrition will continue.
B. The rate of many of the illnesses of old age has declined.
C. Medical advances have significantly reduced the rate of diseases of old age.
D. The fall in the rate of many of the illnesses associated with old age will continue.
E. Improvements in nutrition have been very important in maintaining good health in old age.

25. **Many people claim that they have been abducted by aliens. But, however real the experience might have seemed, it is the product of dreaming caused by sleep paralysis. In such sleep, the dreamer might hear strange noises, see flashing lights or stars, and sense shaking and juddering. Some dreamers also feel that they are being turned in their beds. All of these experiences match those of people reporting supposed abduction of aliens. This type of sleep phenomenon is fairly common, being experienced by three out of ten people. In that sleep paralysis explains the sensations reported by everyone who claims to have been abducted by aliens, we can conclude that aliens have not come to Earth and abducted people.**

Which of the following is an underlying assumption of the argument above?

A. Abduction by aliens is much rarer than people think.
B. Dreaming about being abducted by aliens is unusual.
C. Those who believe they have been abducted by aliens report it.
D. People who are abducted by aliens rarely remember the experience.
E. People who dream of being abducted by aliens will always remember their dreams.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS TEST!

APPENDIX E2: RESEARCH INSTRUMENT – QUESTIONNAIRE TO LECTURERS

TOPIC: CRITICAL-THINKING SKILLS OF UNDERGRADUATE ALLIED HEALTH PROFESSIONS STUDENTS IN THE CLINICAL ROTATION YEARS AT THE UNIVERSITY OF THE FREE STATE

RESEARCHER: MARSHé LOUW

You have been selected to participate in this research study to assess the critical-thinking skills in undergraduate Allied Health Professions students at the UFS during their clinical years as well as looking at the type of teaching activities lecturers use in the different departments in the School for Allied Health Professions to improve critical-thinking skills in all year groups.

Critical thinking is defined by the Watson-Glaser™ test as "the ability to identify and analyse problems, as well as seek and evaluate relevant information in order to reach an appropriate conclusion" (Watson and Glaser 2011:3).

Please note that you are voluntarily completing this questionnaire and that this indicates your participation in this study. All data collected from your answers will be kept confidential at all times. You may withdraw from this study at any time without being penalised for doing so. You will not receive any benefits, compensation or special privileges if you participate in this research study. The result may be published or presented at congresses.

Please complete the appropriate answer.

DEMOGRAPHIC INFORMATION:

FOR OFFICE USE

Unique identification number (1-112)

1. RESEARCH NUMBER: [ ][ ] 1-2

2. DATE: (dd/mm/yy) [ ][ ][ ][ ][ ][ ] 3-8

3. GENDER:
   Male [ ] Female [ ] 9

4. AGE:

		years			months					10-13

5. PLEASE INDICATE WHICH DEPARTMENT YOU WORK IN

	Dietetics	14
	Occupational Therapy	
	Optometry	
	Physiotherapy	

6. YEARS AS A LECTURER AT THIS DEPARTMENT AND FACULTY?

		years			months					15-18

7. DO YOU HAVE PREVIOUS TEACHING EXPERIENCE ELSEWHERE?

YES	NO	19

8. IF YOU INDICATED YES TO THE PREVIOUS QUESTIONS, PLEASE INDICATE FOR HOW LONG:

		years			months					20-23

9. PLEASE INDICATE **ALL** YEAR GROUP/(s) YOU LECTURE?

	First year		Third year	24
	Second year		Fourth year	

CRITICAL-THINKING SKILLS:

FOR QUESTIONS 11-14 PLEASE **ONLY** COMPLETE THE QUESTIONS APPLICABLE TO YOU ON THE LIKERT SCALE (IF THE QUESTION IS NOT APPLICABLE TO YOU PLEASE INDICATE BY MARKING THE "**NOT APPLICABLE** BOX")

10. PLEASE INDICATE ON THE SCALE TO WHICH DEGREE YOU USE THE FOLLOWING TYPES OF CRITICAL THINKING SKILLS ACTIVITIES IN YOUR LECTURING OF **FIRST YEAR STUDENTS**?

never =0	seldom=1	some-times= 2	a lot = 3	always = 4	
Activities encouraging thinking out loud					25

0	1	2	3	4

Blended-learning activities (example wikis) ☐ 26

0	1	2	3	4

Case studies ☐ 27

0	1	2	3	4

Clinical-based practice assignments ☐ 28

0	1	2	3	4

Debates ☐ 29

0	1	2	3	4

Experiential learning (hands-on experience) ☐ 30

0	1	2	3	4

Evidence-based practice assignments ☐ 31

0	1	2	3	4

Peer assessments ☐ 32

0	1	2	3	4

Problem-based learning ☐ 33

0	1	2	3	4

Reflective logs ☐ 34

0	1	2	3	4

Role-play ☐ 35

0	1	2	3	4

Schön's reflective practice (reflection-on-action and reflection-in-action) ☐ 36

0	1	2	3	4

Self-Assessments ☐ 37

0	1	2	3	4

Self-directed learning ☐ 38

0	1	2	3	4

Simulations ☐ 39

0	1	2	3	4

Small Group discussions ☐ 40

0	1	2	3	4

Student-centred learning (Bandura's cognitive theory) ☐ 41

0	1	2	3	4

Team-solving activities ☐ 42

0	1	2	3	4

☐ **Not-applicable** ☐ 43

☐ Other types of activities: ☐ ☐ 44-45

11. PLEASE INDICATE ON THE SCALE TO WHICH DEGREE YOU USE THE FOLLOWING TYPES OF CRITICAL THINKING SKILLS ACTIVITIES IN YOUR LECTURING OF **SECOND YEAR STUDENTS**?

never =0	seldom=1	some-times= 2	a lot = 3	always = 4	
Activities encouraging thinking out loud					46
0	1	2	3	4	
Blended-learning activities (example wikis)					47
0	1	2	3	4	
Case studies					48
0	1	2	3	4	
Clinical-based practice assignments					49
0	1	2	3	4	
Debates					50
0	1	2	3	4	
Experiential learning (hands-on experience)					51
0	1	2	3	4	
Evidence-based practice assignments					52
0	1	2	3	4	
Peer assessments					53
0	1	2	3	4	
Problem-based learning					54
0	1	2	3	4	
Reflective logs					55
0	1	2	3	4	
Role-play					56
0	1	2	3	4	
Schön's reflective practice (reflection-on-action and reflection-in-action)					57
0	1	2	3	4	

Self-Assessments

0	1	2	3	4

58

Self-directed learning

0	1	2	3	4

59

Simulations

0	1	2	3	4

60

Small Group discussions

0	1	2	3	4

61

Student-centred learning (Bandura's cognitive theory)

0	1	2	3	4

62

Team-solving activities

0	1	2	3	4

63

☐ **Not-applicable** 64

☐ Other types of activities: 65-66

_____

_____

_____

_____

12. PLEASE INDICATE WHICH TYPES OF CRITICAL THINKING SKILLS ACTIVITIES YOU INCLUDE IN YOUR LECTURING/CLINICAL ASSISTING OF **THIRD YEAR STUDENTS**?

never =0	**seldom=1**	**some-times= 2**	**a lot = 3**	**always = 4**

Activities encouraging thinking out loud

0	1	2	3	4

67

Blended-learning activities (example wikis)

0	1	2	3	4

68

Case studies

0	1	2	3	4

69

Clinical-based practice assignments

0	1	2	3	4

70

Debates

0	1	2	3	4

71

Experiential learning (hands-on experience) 72

0	1	2	3	4

Evidence-based practice assignments 73

0	1	2	3	4

Peer assessments 74

0	1	2	3	4

Problem-based learning 75

0	1	2	3	4

Reflective logs 76

0	1	2	3	4

Role-play 77

0	1	2	3	4

Schön's reflective practice (reflection-on-action and reflection-in-action) 78

0	1	2	3	4

Self-Assessments 79

0	1	2	3	4

Self-directed learning 80

0	1	2	3	4

Simulations 81

0	1	2	3	4

Small Group discussions 82

0	1	2	3	4

Student-centred learning (Bandura's cognitive theory) 83

0	1	2	3	4

Team-solving activities 84

0	1	2	3	4

☐ **Not-applicable** 85

☐ Other types of activities: 86-87

_____

_____

_____

_____

13.

PLEASE INDICATE WHICH TYPES OF CRITICAL THINKING SKILLS ACTIVITIES YOU INCLUDE IN YOUR LECTURING/CLINICAL ASSISTING OF **FOURTH YEAR STUDENTS**?

never =0	seldom=1	some-times= 2	a lot = 3	always = 4	
Activities encouraging thinking out loud					88
0	1	2	3	4	
Blended-learning activities (example wikis)					89
0	1	2	3	4	
Case studies					90
0	1	2	3	4	
Clinical-based practice assignments					91
0	1	2	3	4	
Debates					92
0	1	2	3	4	
Experiential learning (hands-on experience)					93
0	1	2	3	4	
Evidence-based practice assignments					94
0	1	2	3	4	
Peer assessments					95
0	1	2	3	4	
Problem-based learning					96
0	1	2	3	4	
Reflective logs					97
0	1	2	3	4	
Role-play					98
0	1	2	3	4	
Schön's reflective practice (reflection-on-action and reflection-in-action)					99
0	1	2	3	4	
Self-Assessments					100
0	1	2	3	4	
Self-directed learning					101
0	1	2	3	4	
Simulations					102
0	1	2	3	4	
Small Group discussions					103
0	1	2	3	4	

Student-centred learning (Bandura's cognitive theory) ☐ 104

0	1	2	3	4

Team-solving activities ☐ 105

0	1	2	3	4

☐ **Not-applicable** ☐ 106

☐ Other types of activities: ☐☐ 107-108

14. In your opinion, what do you think are Critical Thinking Skills?

☐☐ 109-110

15. In your opinion, do you think there is a need to teach more critical thinking skills in the curriculum?

YES	NO	UNSURE

☐ 111

16. In your opinion, do you think that a pre-admission test, testing critical-thinking skills in undergraduate students are a good idea?

YES	NO	UNSURE

☐ 112

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE AND PARTICIPATING IN MY RESEARCH.

APPENDIX F

USER AGREEMENT:

Appendix F1: User Agreement from Cambridge Assessment Admission Testing (email)

APPENDIX F1: USER AGREEMENT FROM CAMBRIDGE ASSESSMENT ADMISSIONS TESTING (EMAIL)

FW: ATS Contact [#1027]

Cambridge Assessment Admissions Testing
<admissionstesting@cambridgeassessment.org.uk>

Wed, Apr 12, 2017 at 11:45 AM

To: "marsheober@gmail.com" <marsheober@gmail.com>

Dear Marshe

We confirm that we are happy for you to use and adapt the specimen critical thinking questions on our website for your research, but unfortunately we do not have any statistical information to share with you.

We wish you well in your research and in your studies.

Best wishes,
Cambridge Assessment Admissions Testing

D +44 (0)1223 553366
A 1 Hills Road, Cambridge, CB1 2EU, UK

www.admissionstestingservice.org

APPENDIX G

ANSWER KEY AND SCORE SHEET

Appendix G1: TSA-Modified score sheet

Appendix G2: Answer sheet

APPENDIX G1: TSA-MODIFIED SCORE SHEET

CRITICAL-THINKING SKILLS TEST

TSA (Modified)

SPECIMENT TEST PAPER ANSWER KEY

All correct answers score 1 mark. All wrong answers score 0.

Question	Correct Answer	Type of CT Question
1	**D**	Apply Principles
2	**C**	Detect Reasoning Errors
3	**B**	Identify an Assumption
4	**C**	Identify an Assumption
5	**C**	Summarising the Main Conclusion
6	**C**	Detect Reasoning Errors
7	**B**	Summarising the Main Conclusion
8	**E**	Identify an Assumption
9	**B**	Detect Reasoning Errors
10	**D**	Assessing the impact of additional evidence
11	**D**	Draw a Conclusion
12	**B**	Summarising the Main Conclusion
13	**A**	Draw a Conclusion
14	**C**	Apply Principles
15	**C**	Detect Reasoning Errors
16	**E**	Matching Arguments
17	**A**	Draw a Conclusion
18	**D**	Summarising the Main Conclusion
19	**C**	Detect Reasoning Errors
20	**D**	Assessing the impact of additional evidence
21	**C**	Identify an Assumption
22	**C**	Assessing the impact of additional evidence
23	**E**	Matching Arguments
24	**D**	Summarising the Main Conclusion
25	**C**	Identify an Assumption

APPENDIX G2: ANSWER SHEET: TSA-MODIFIED ANSWER SHEET

UNIQUE RESEARCH NUMBER:

Please mark your answer clearly using a soft pencil.

A ●
B ○
C ○
D ○
E ○

If you make a mistake, erase thoroughly and try again.

Q1	Q2	Q3	Q4	Q5
A ○	A ○	A ○	A ○	A ○
B ○	B ○	B ○	B ○	B ○
C ○	C ○	C ○	C ○	C ○
D ○	D ○	D ○	D ○	D ○
E ○	E ○	E ○	E ○	E ○

Q6	Q7	Q8	Q9	Q10
A ○	A ○	A ○	A ○	A ○
B ○	B ○	B ○	B ○	B ○
C ○	C ○	C ○	C ○	C ○
D ○	D ○	D ○	D ○	D ○
E ○	E ○	E ○	E ○	E ○

Q11	Q12	Q13	Q14	Q15
A ○	A ○	A ○	A ○	A ○
B ○	B ○	B ○	B ○	B ○
C ○	C ○	C ○	C ○	C ○
D ○	D ○	D ○	D ○	D ○
E ○	E ○	E ○	E ○	E ○

Q16	Q17	Q18	Q19	Q20
A ○	A ○	A ○	A ○	A ○
B ○	B ○	B ○	B ○	B ○
C ○	C ○	C ○	C ○	C ○
D ○	D ○	D ○	D ○	D ○
E ○	E ○	E ○	E ○	E ○

Q21	Q22	Q23	Q24	Q25
A ○	A ○	A ○	A ○	A ○
B ○	B ○	B ○	B ○	B ○
C ○	C ○	C ○	C ○	C ○
D ○	D ○	D ○	D ○	D ○
E ○	E ○	E ○	E ○	E ○

FOR OFFICE USE ONLY:

TOTAL SCORE: ____ /25

SUMMARISE CONCLUSION: ____ /5

DRAW A CONCLUSION: ____ /3

IDENTIFY ASSUMPTIONS: ____ /5

ASSESSING IMPACT OF ADD EVIDENCE: ____ /3

DETECTING REASONING ERRORS: ____ /5

MATCHING ARGUMENTS: ____ /2

APPLYING PRINCIPLES: ____ /2

APPENDIX H

GUIDELINES FOR ARTICLES

Appendix H1: Guidelines for the journal, Thinking Skills and Creativity

Appendix H2: Guidelines for the Journal of Higher Education

THINKING SKILLS AND CREATIVITY

AUTHOR INFORMATION PACK

TABLE OF CONTENTS

ISSN: 1871-1871

DESCRIPTION

This leading international journal, launched in 2006, uniquely identifies and details critical issues in the future of learning and teaching of creativity, as well as innovations in teaching for thinking. As a peer-reviewed forum for interdisciplinary researchers and communities of researcher-practitioner-educators, the journal welcomes papers that represent a variety of theoretical perspectives. In particular, the journal is interested in papers that advance new and existing methodological approaches, and are innovative works on the theories, practices and possibilities of creativity and thinking skills research. Papers may relate to any age level and any settings: formal and informal, education and work-based as long as they connect to the learning and teaching, facilitation and/or practice teaching for thinking and/or creativity.

While there is no universal agreement about the dimensions of thinking skills and creativity or their themes, debates and terms, we welcome methodological advancements and critiques that progress current thinking and stimulate developments about the naming and framing of boundaries and related fields of knowledge.

The journal particularly welcomes several types of research article:

Empirical studies which address critical issues in the future of learning and teaching, facilitation and practice, directly relevant to advancing thinking skills relevant to the enquiry and advancement of creativity; **Critical reports** of research practices and innovation in identifying major debates in advancing thinking skills and creativity; Synthetic **reviews;** New departures in **methodological, theoretical and conceptual case studies.**

Submissions to the journal are judged on the engagement of research and scholarship designed to advance creativity and thinking skills research. The major criteria for acceptance of a research article will be its relevance, its importance and its contribution to the field of teaching for thinking and creativity, and its persuasive, analytical and critical quality.

AUDIENCE

Those who conduct research on the teaching of thinking skills or teaching for creativity.

IMPACT FACTOR

2018: 1.655 © Clarivate Analytics Journal Citation Reports 2019

ABSTRACTING AND INDEXING

PsycINFO
Scopus

EDITORIAL BOARD

GUIDE FOR AUTHORS

Your Paper Your Way

We now differentiate between the requirements for new and revised submissions. You may choose to submit your manuscript as a single Word or PDF file to be used in the refereeing process. Only when your paper is at the revision stage, will you be requested to put your paper in to a 'correct format' for acceptance and provide the items required for the publication of your article.
To find out more, please visit the Preparation section below.

INTRODUCTION

Thinking Skills and Creativity is a journal providing a peer-reviewed forum for communication and debate for the community of researchers interested in teaching for thinking and creativity. Papers may represent a variety of theoretical perspectives and methodological approaches and may relate to any age level in a diversity of settings: formal and informal, education and work-based.

Types of Paper
The journal particularly welcomes several types of research article:

• studies of teaching and learning processes directly relevant to teaching thinking and fostering creativity;
• reports of research evaluating the efficacy of programmes, approaches, and innovations in teaching for thinking and creativity;
• synthetic review articles, and
• critical theoretical and methodological studies.

The major criteria for the acceptance of a research article will be its relevance, its importance to the field of teaching for thinking and creativity, and its analytical quality.

The journal will also publish 'Research Notes': short reports of interesting or important research being carried out in the field.

Contact details for submission
Authors are requested to submit their papers electronically by using online manuscript submission available at: https://www.evise.com/profile/#/TSC/login. This site will guide authors stepwise through the submission process. Authors, reviewers, and editors send and receive all correspondence by e-mail and no other paper correspondence is necessary. Should you be unable to provide an electronic version, please contact the Journal Mailbox at thinksc@elsevier.com . The Publisher and Editors regret that they are not able to consider submissions that do not follow these procedures.

Submission checklist

You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address

All necessary files have been uploaded:
Manuscript:
• Include keywords
• All figures (include relevant captions)
• All tables (including titles, description, footnotes)
• Ensure all figure and table citations in the text match the files provided
• Indicate clearly if color should be used for any figures in print
Graphical Abstracts / Highlights files (where applicable)
Supplemental files (where applicable)

Further considerations
• Manuscript has been 'spell checked' and 'grammar checked'
• All references mentioned in the Reference List are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Internet)
• A competing interests statement is provided, even if the authors have no competing interests to declare
• Journal policies detailed in this guide have been reviewed
• Referee suggestions and contact details provided, based on journal requirements

For further information, visit our Support Center.

BEFORE YOU BEGIN

Ethics in publishing

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Edited	VandenBos, G. R. (Ed.). (2007). *APA dictionary of psychology*. Washington, DC: American Psychological Association.
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Online (e-book)	Schiraldi, G. R. (2001). *The post-traumatic stress disorder handbook: A guide to healing, recovery, and growth* [Adobe Digital Editions version]. doi: 10.1036/0071393722 O'Keefe, E. (n.d.). *Egoism & the crisis in Western values*. Retrieved from http://www.onlineoriginals.com/showitem.asp?itemID=135
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Paper in proceedings	Lee, D. J., Bates, D., Dromey, C., Xu, X., & Antani, S. (2003, June). An imaging system correlating lip shapes with tongue contact patterns for speech pathology research. In M. Krol, S. Mitra, & D. J. Lee (Eds.), *CMBS 2003. Proceedings of the 16th IEEE symposium on computer-based medical systems* (pp. 307–313). Los Alamitos, CA: IEEE Computer Society.
Symposium contribution	Muellbauer, J. (2007, September). Housing, credit, and consumer expenditure. In S. C. Ludvigson (Chair), *Housing and consumer behavior*. Symposium conducted at the meeting of the Federal Reserve Bank of Kansas City, Jackson Hole, WY.
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Newsletter article, no author named	Six sites meet for comprehensive anti-gang initiative conference. (2006, November/December). *OJJDP News @ a Glance*. Retrieved from http://www.ncjrs.gov/html/ojjdp/news_at_glance/216684/topstory.html Alphabetize works with no author by the first significant word in the title. In the text, use a short title (unless the full title is short) enclosed in quotation marks: (“Six Sites Meet,” 2006).
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Submitted manuscript	Ting, J. Y., Florsheim, P., & Huang, W. (2008). *Mental health help-seeking in ethnic minority populations: A theoretical perspective.* Manuscript submitted for publication. Do not give the name of the journal or publisher to which a manuscript has been submitted. Use the same format as above for a draft or a work in progress, substituting "Manuscript in preparation" for the final sentence. Use the year of the draft you saw (*not* "submitted" or "in preparation") in the in-text citation.
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Collected letters (in an archive)	Allport, G. W. (1930–1967). Correspondence. Gordon W. Allport Papers (HUG 4118.10), Harvard University Archives, Cambridge, MA. Specific letters from such a collection are cited in the text as, for example: (Allport, G. W., 1930–1967, Allport to E. G. Boring, March 1, 1939)
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Corporate document	Subcommittee on Mental Hygiene Personnel in School Programs. (1949, November 5–6). *Meeting of Subcommittee on Mental Hygiene Personnel in School Programs.* David Shakow Papers (M1360). Archives of the History of American Psychology, University of Akron, Akron, OH.
Limited-circulation publication	Sci-Art Publishers. (1935). *Sci-Art Publications* [Brochure]. Cambridge, MA: Author. A. A. Roback Papers (HUGFP 104.50, Box 2, Folder "Miscellaneous Psychological Materials"), Harvard University Archives, Cambridge, MA.
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Message posted to an electronic mailing list	Smith, S. (2006, January 5). Re: Disputed estimates of IQ [Electronic mailing list message]. Retrieved from http://tech.groups.yahoo.com/group/ForensicNetwork/message/670
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Review	Reviewer, R. R. (Year). Title of review [Review of the publication *Title of the publication*, by A. A. Author]. *Periodical Title, Volume*(issue), pages. Schatz, B. R. (2000, November 17). Learning by text or context? [Review of the book *The social life of information*, by J. S. Brown & P. Duguid]. *Science*, *290*, 1304.
Patent	Inventor, A. A. (Year of issue). *Patent Number.* Place: Office Issuing the Patent. Smith, I. M. (1988). *U.S. Patent No. 123,445*. Washington, DC: U.S. Patent and Trademark Office. In the text, cite the patent number and the year of issue: (U.S. Patent No. 123,445, 1988) *or* U.S. Patent No. 123,445 (1988)

Map (published as independent sheet)	Cartographer. (Cartographer). (Date). Title of map [Map type]. Place of publication: Publisher. *or* Retrieved from URL Lewis County Geographic Information Services. (Cartographer). (2002). Population density, 2000 U.S. Census [Demographic map]. Retrieved from http://www.co.lewis.wa.us/publicworks/maps/Demographics/census-pop-dens_2000.pdf
Audiovisual media	American Psychological Association. (Producer). (2000). *Responding therapeutically to patient expressions of sexual attraction* [DVD]. Available from http://www.apa.org/videos/ Egan, D. (Writer), & Alexander, J. (Director). (2005). Failure to communicate [Television series episode]. In D. Shore (Executive producer), *House*. New York, NY: Fox Broadcasting. Producer, P. P. (Producer), & Director, D. D. (Director). (Year). *Title of motion picture* [Motion picture]. Country of origin: Studio. Van Nuys, D. (Producer). (2007, December 19). *Shrink rap radio* [Audio podcast]. Retrieved from http://www.shrinkrapradio.com/ Writer, W. (Copyright year). Title of song [Recorded by A. A. Artist if different from writer]. On *Title of album* [Medium of recording, i.e. CD, record, cassette, etc.]. Location: Label. (Date of recording if different from song copyright date)
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APPENDIX I

TURNITIN REPORT

Appendix I1: Turnitin report for entire article

CT skills of undergraduate AHP students

by Marshe Louw

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by Marshe Louw

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DECLARATION FROM THE LANGUAGE EDITOR

Appendix J: Declaration from the language editor