EVALUATING THE IMPACT OF ADJUNCTIVE INTEGRATED CASE-BASED DENTAL TEACHING AND LEARNING ON CLINICAL REASONING IN A DISCIPLINE-BASED TEACHING AND LEARNING ENVIRONMENT

by

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Submitted in fulfilment of the requirements for the degree

DOCTOR OF PHILOSOPHY

In the Faculty of Health Sciences

University of Pretoria

PRETORIA

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2013

ACKNOWLEDGEMENTS

I hereby acknowledge the following people and organisations for their direct or indirect support during this research project:

- My wife Marinda, for her love and support and for taking a "backseat" in terms of her own professional career for many years to allow me to pursue my academic career.
- My supervisors, Professor George White and Professor Willie Snyman, for their expert input and encouragement.
- The lecturing and support staff of the Department of Dental Management Sciences, who contributed to the teaching and training of students in Comprehensive Patient Care.
- The third-, fourth- and fifth-year dental students, who participated in the research project.
- The Southern Africa-FAIMER Regional Institute (SAFRI), for its immense contribution to my scholarship in medical education.
- Doctor Piet Becker from the Medical Research Council, for the statistical analyses.
- Mrs Rika Weiss, for editing this dissertation.

ABSTRACT

Problem-solving and integration of knowledge are key objectives of the undergraduate dental curriculum of the School of Dentistry, University of Pretoria, which aims to develop the clinical reasoning skills of students. For practical reasons the School provides discipline-based teaching and learning, which, according to the literature, might limit a student's ability to integrate knowledge during clinical reasoning processes. The literature suggests that problem-solving by means of case studies – an active teaching and learning strategy– might be a useful method to develop and integrate knowledge at undergraduate level, and that earlier exposure to clinical cases might assist in the attainment of clinical reasoning skills at an earlier stage. Hence, this action research study describes the planning, design, implementation and evaluation of a "new" Comprehensive Patient Care curriculum over a three-year period (2009 - 2011) based on Kern's "six-step approach to curriculum development". The new curriculum employs an adjunctive integrated case-based approach according to the principles described in the "Four Component Instructional Design Model" and a new variant of the so-called "progress test", starting already in the preclinical (third) year of study, to develop and test students' clinical reasoning skills over time.

The exit-level progress test results of dental students who had been taught by following an adjunctive integrated case-based approach were statistically analysed, using mixed model statistics, and were compared with the clinical decision-making skills of cohorts who had been taught by following the traditional discipline-based approach. These analyses were complemented by bivariate and multivariate quantitative analyses and qualitative student feedback (mixed methods). The validity of the progress test results was also examined by comparing the results of different cohorts.

The fifth-year cohort who had been exposed to integrated case-based teaching and learning from their preclinical year performed significantly better in the progress test at exit level than the cohorts who had received only discipline-

based teaching and learning, even when controlling for previous academic performance. These findings were supported by the quantitative and qualitative feedback that students gave about the educational processes that were followed. The progress test performed reasonably well as a measurement tool and all the differences that were measured between the different cohorts could be explained logically. Case specificity posed the biggest threat to the reliability of the test.

The results suggest that integrated case-based teaching and learning, commencing in the preclinical study years, might be a useful intervention to improve clinical reasoning ability at exit level in dental schools such as the School of Dentistry, University of Pretoria that follow a discipline-based approach. The results of this action research study provided particularly useful information, which will allow further improvements to the educational intervention. The results of this study require further research to substantiate the findings beyond doubt.

Keywords: Clinical reasoning, problem-solving, dental education, teaching methods, curriculum development, progress test, cognitive load, constructive alignment, case studies.

OPSOMMING

Probleemoplossing en die integrasie van kennis is sleuteldoelwitte van die voorgraadse Tandheelkunde-kurrikulum van die Skool vir Tandheelkunde, Universiteit van Pretoria vir die ontwikkeling van studente se kliniese beredenering. Om praktiese redes bied die Skool dissipline-gebaseerde onderrig aan, en dit kan moontlik die student se vermoë om kennis tydens die kliniese-beredeneringsproses te integreer, beperk. Die literatuur stel voor dat probleemoplossing deur middel van gevallestudies ’n bruikbare metode kan wees om kennis op voorgraadse vlak te integreer en dat vroeër blootstelling aan kliniese gevalle kan help om kliniese-beredeneringsvaardighede vroeër te bemeester. Hierdie studie beskryf die ontwerp, implementering en evaluasie van ’n “nuwe” kurrikulum vir Omvattende Pasiëntsorg oor ’n driejaartydperk (2009 - 2011) gebaseer op Kern se “ses-stap benadering tot kurrikulum-ontwikkeling”. Die benadering in die nuwe kurrikulum is die blootstelling van die student aan bykomende geïntegreerde gevallestudies geskoei op die beginsels van die “Vier-komponent Instruksionele Ontwerpmodel” en ’n nuwe variant van die sogenaamde “vorderingstoets” vanaf die voorkliniese studiejaar ten einde die student se kliniese-beredeneringsvaardighede te ontwikkel.

Gemengde statistiese modelle is gebruik om die vorderingstoetsresultate ten opsigte van die kliniese-beredeneringsvaardighede van uittreevlak tandheelkunde studente wat volgens die benadering van bykomende geïntegreerde gevallestudie opgelei is, statisties te ontleed en te vergelyk met die vorderingstoetsresultate ten opsigte van die kliniese-beredenerings-vaardighede van kohorte wat volgens die tradisionele dissipline-gebaseerde benadering onderrig is. Hierdie analises is aangevul deur die kwantitatiewe en kwalitatiewe terugvoer van die studente. Die geldigheid van die vorderingstoetsresultate is ook ontleed deur die resultate van die verskeie kohorte te analiseer.

Studente wat aan bykomende geïntegreerde gevallestudie-onderrig en leer vanaf die voorkliniese jaar blootgestel was, het beter in die vorderingstoets op

uittreevlak gevaar in vergelyking met studente wat slegs dissipline-gebaseerde onderrig ontvang het. Hierdie bevinding is ondersteun deur die kwantitatiewe en kwalitatiewe terugvoer van die studente aangaande die onderwysprosesse wat gevolg is. Die bevorderingstoets het redelik gevaar as ŉ meetinstrument en al die verskille wat uitgewys kon word tussen die verskillende kohorte kon verduidelik word. Gevalspesifisiteit hou die grootste gevaar in vir die betroubaarheid van die toets.

Die benadering dat studente reeds in hul voorkliniese studiejaar aan geïntegreerde gevallestudies blootgestel word, blyk ŉ bruikbare intervensie te wees vir die verbetering van die kliniese-beredeneringsvaardighede van studente wat dissipline-gebaseerde tandheelkundige onderrig en leer ontvang. Die resultate van hierdie studie benodig verdere navorsing om die bevindinge onteenseglik te bewys.

Sleutelwoorde: Kliniese-beredenering, probleem-oplossing, tandheelkundige onderwys, onderrigmetodes, kurrikulumontwikkeling, vorderingstoets, kognitiewe lading, konstruktiewe belyning, gevallestudies.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
4C/ID-model	Four Component Instructional Design Model
BChD	Baccalaureus Chirurgiae Dentium
BDS	Bachelor of Dental Surgery
BMS	basic medical science
CBT	case-based training
CI	confidence interval
CPC	Comprehensive Patient Care
DI	discrimination index
DoDMS	Department of Dental Management Sciences
Dx	diagnostic
HIV	Human immunodeficiency virus
HPCSA	Health Professions Council of South Africa
JIT	just-in-time
M: CPM	Module: Comprehensive Patient Management
MCQs	multiple-choice questions
n	number
ns	not significant
P	probability
SD	standard deviation
SE	standard error

Abbreviation	**Description**
Rx	treatment
WHO	World Health Organisation
X	mean
X dif	mean difference

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Chapter 1

CHAPTER 1: CONTEXT AND SCOPE OF THE STUDY

1.1 Context and Origin of the Study

This research project involves the development, implementation and evaluation of a curriculum that deals with the development of clinical reasoning skills in a discipline-based undergraduate dental curriculum.

The clinical reasoning skills referred to in this thesis are diagnostic reasoning and treatment planning skills, taught in a classroom setting.

1.1.1 Introduction

Clinical reasoning is one of the most important skills any health care worker has to master.[1-3] Defective clinical reasoning teaching and learning will increase the probability of incorrect clinical decision-making, for instance as regards diagnosis and clinical treatment, which can be detrimental to society. Deficiencies in clinical decision-making are indeed reported in local literature.[4]

Tertiary educational institutions have an obligation to ensure that health care workers exit their undergraduate teaching and learning with skills and competencies that will benefit society.[5] During the 1990s, the School of Dentistry at the University of Pretoria in South Africa became aware that the discipline-based undergraduate dental curriculum might be suboptimal in terms of its ability to develop integrated clinical reasoning skills.[6,7]

1.1.2 Background of the Undergraduate Dental Curriculum

Figure 1.1 (below) provides a basic diagrammatical representation[*] of the discipline-based undergraduate dental curriculum presented at the University of Pretoria.

Basic Medical Sciences – Joint Medical Curriculum					
Year 1	BMS 1	BMS 2	BMS 3	BMS 4	BMS 5
Year 2	BMS 6	BMS 7	BMS 8	BMS 9	Introduction to Clinical Dentistry
Discipline-based Teaching and Learning					
	Oral Biology	Clinical Discipline 1	Clinical Discipline 2	Clinical Discipline 3	Clinical Discipline n
Year 3					
Year 4					
Year 5					

BMS: Basic Medical Science

Figure 1.1 The discipline-based structure of the undergraduate dental curriculum of the School of Dentistry, University of Pretoria*

* The intention of the diagrammatical representation of the undergraduate dental curriculum is to provide the reader with a broad concept of what the organisation of a discipline-based curriculum entails rather than an exact replica of the outlay of the curriculum

During the first two years of study, the students participate in a joint medical curriculum. The focus in the first two years of study (Figure 1.1, page 2) is on the acquisition of knowledge in basic medical sciences (BMSs) such as Anatomy, Physiology, Microbiology, Pathology, Pharmacology, and others.[8,9] Students are introduced to clinical dentistry (mainly didactic) only at the end of their second year of study.[9]

Oral Biology and the various dental disciplines – for example, Odontology, Periodontology, Orthodontics, Prosthodontics, Orofacial Surgery – commence with didactic teaching in the third year of study.

Most of the preclinical teaching and learning in the clinical dental disciplines take place during the third year of study while the discipline-based clinical teaching and learning officially begins at the start of the fourth year of study. The clinical disciplines continue until the final examination at the end of the fifth year of study.

A typical problem encountered in a discipline-based teaching and learning environment is that the clinical disciplines tend to focus on their own area of interest, which may lead to situations where other important aspects of care are not appropriately integrated and assessed.[6,7]

The discipline-based structure of the undergraduate dental curriculum (Figure 1.1, page 2) is, however, unlikely to change because of financial and infrastructural reasons considered by the School of Dentistry.[6,7,10] As a result, alternative integration strategies had to be investigated.[6] For this purpose a subject called Comprehensive Patient Care (CPC) (Figure 1.2, page 4) was implemented in the early 1990s as part of the clinical teaching and learning in the fourth and fifth years of study.

The main purpose of CPC is to encourage the use of comprehensive patient assessments and treatment plans in order to foster holistic, real-life patient care, across disciplines.[10]

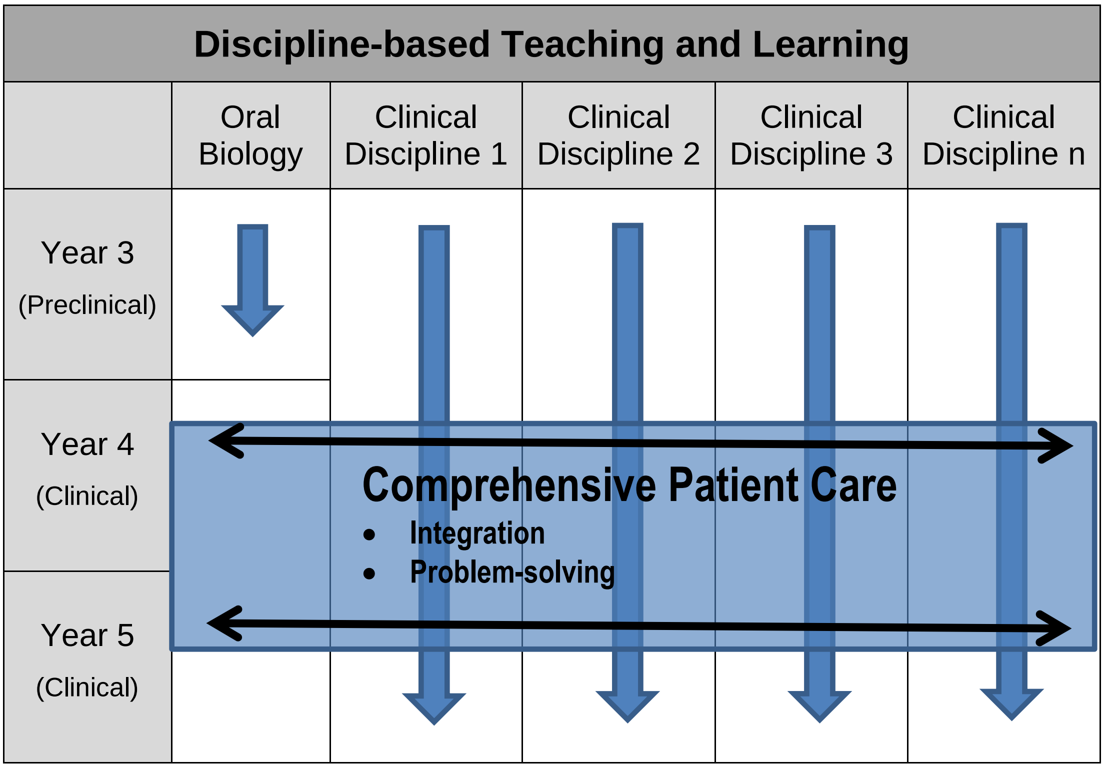

Figure 1.2 The position of CPC in the discipline-based undergraduate dental curriculum of the School of Dentistry, University of Pretoria (until 2007)

Over the years CPC has been practised in the fourth and fifth years of study in the Restorative Dentistry and Crown- and Bridgework clinics – now, respectively, called Odontology and Fixed Prosthodontics.

In 1997 the School of Dentistry implemented a revised version of the undergraduate dental curriculum.[7] Shortly after the implementation a case-based instructional design system[10] was proposed for CPC, which offered a potential solution to improve the development of clinical reasoning through a problem-solving approach. This case-based instructional design system required students to report a number of actual clinical cases in writing and focused on diagnosis and treatment planning.[10]

In 2007 CPC became the responsibility of the newly established Department of Dental Management Sciences (DoDMS) when it was incorporated into the Module Comprehensive Patient Management (M: CPM).

M: CPM was introduced to overarch and integrate CPC, Risk Management (Ethics and Jurisprudence) and Dental Practice Management[11] (Figure 1.3, below).

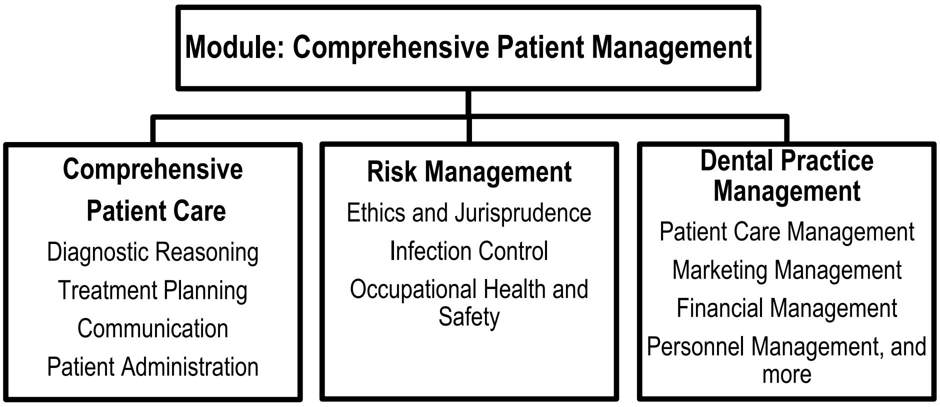

Figure 1.3 Structure and content of the Module: Comprehensive Patient Management

M: CPM was created to meet the changing needs in the external environment.[12] A lack of comprehensiveness and of continuity of care,[13] as well as poor communication[14] with patients, have been identified as global concerns in the health care environment. Furthermore, changing disease patterns, changing population demographics, increasing consumerism, technological advances, and the need for dental care that exceeded the demand for services by far, all of which required changes in the way dental students should be trained in South Africa.[12]

Guided by the overarching principles of the M: CPM, that sought to address the above-mentioned problems in the market, CPC was redefined as an approach that endeavours to solve some of the problems associated with typical "problem-specific" visits frequently encountered in the South African dental market.[12] The CPC approach, as it applies to the teaching and learning in the M: CPM is demonstrated in Figure 1.4, below.

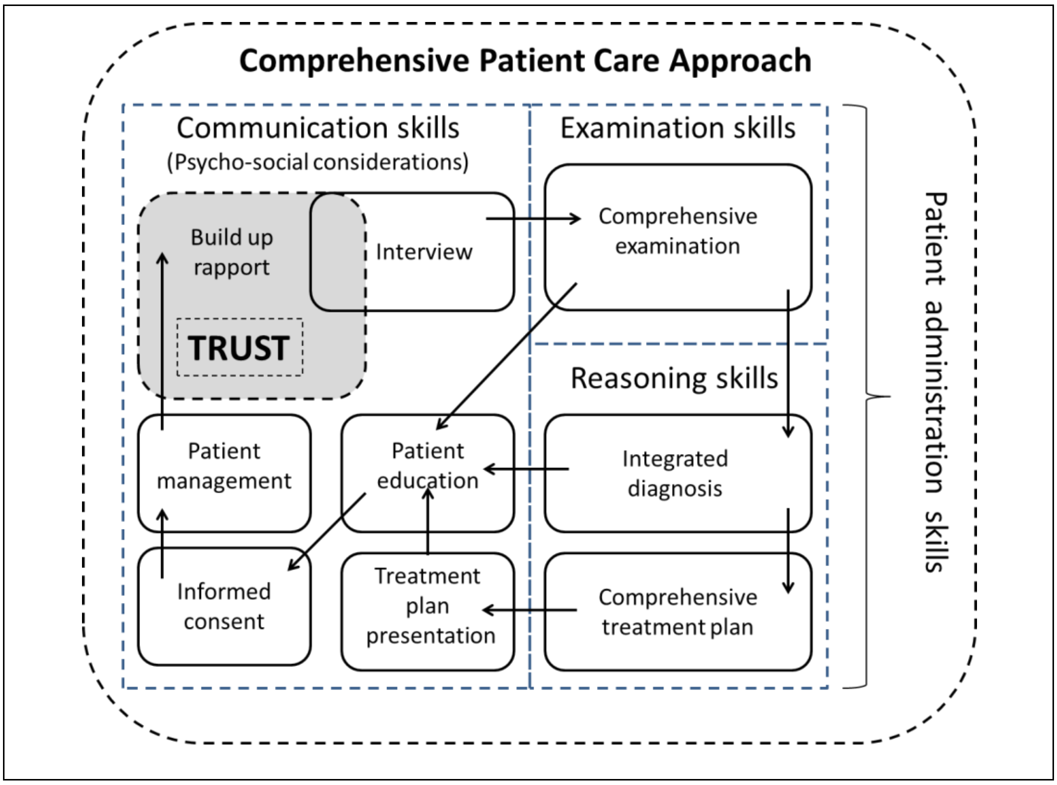

Figure 1.4 The comprehensive patient care approach[12,15,16]

The comprehensive patient care approach (Figure 1.4, above) includes building rapport with and earning the trust of a patient, doing a comprehensive examination, diagnosing, and formulating a comprehensive treatment plan based on the bio-psychosocial status[†17] of the patient. In the process the patient is educated about existing treatment needs and is informed of various treatment options in order to obtain the patient's informed consent.[12,15,16] CPC was didactically introduced to the third-year students during 2008, complemented by communication role-play exercises, covering all the communication aspects displayed in Figure 1.4, above. Besides practicing CPC in the Odontology

[†] A psychosocial approach is based on the notion that the patient's social circumstances and psychological behaviour often influence the development of diseases and conditions. The clinician must therefore take these factors into consideration when managing the patient (Humphris G, Ling MS. Behavioural sciences for dentistry. Edinburgh: Churchill Livingston; 2000).

clinics of the School, the fourth-year cohorts of 2007 and 2008 received lecture-based teaching and learning in CPC.[11]

1.2 Identification of the Problem

After its inception in 2007, the M: CPM was in a developmental phase. During this process the teaching and learning in CPC had to be transformed to be aligned with the above-mentioned comprehensive care approach (Figure 1.4, page 6). This requirement indicated a need for proper planning to establish a new curriculum for CPC.

1.2.1 2007 HPCSA accreditation report

Coincidentally, it was during this transition period that the School of Dentistry was paid an accreditation visit by the Health Professions Council of South Africa (HPCSA),[18] acting as an Education and Training Quality Assurance body.

Despite the inclusion of CPC in the undergraduate dental curriculum, the 2007 accreditation report of the HPCSA questioned the quality of integration in the clinical teaching and learning programme of the School.[18] The undergraduate dental curriculum had been accredited, but this report implied that the integration achieved during teaching and learning was not yet optimal and could be improved.[18] Integration strategies to improve vertical and horizontal integration within curricula are one of the key aspects in the quality assurance guidelines for the accreditation of medical and dental curricula in South Africa.[19]

As an additional comment, the 2007 HPCSA accreditation report[18] also proposed that earlier clinical exposure should be considered in the programme, probably on the strength of general medical education guidelines[1,19] that clinical teaching and learning must start as early as possible to provide a better context for learning. These suggestions by the HPCSA gave further impetus to re-evaluate and redesign the teaching, learning and assessment practices in CPC.

Indeed, to date, no empirical evidence exists that CPC is able to achieve the goal of developing integrated clinical reasoning skills, such as diagnosis and treatment planning, in a discipline-based environment. This shortcoming served as catalyst for the researcher to engage in scholarly activity in order to improve the teaching, learning and assessment practices in CPC, which started with an analysis of the educational practices followed in CPC during 2007 and 2008.

1.2.2 Analysis of the Educational Principles followed in CPC (2007/2008)

The aim of CPC has been to develop clinical reasoning skills – diagnostic and treatment planning skills – through a problem-solving approach that would facilitate critical thinking and integration across disciplines (Figure 1.5, page 9).

At the time of the HPCSA's accreditation visit in 2007, CPC had an outcomes-based curriculum[11] which, on paper, appeared to be aligned[20] with the exit-level outcomes of the undergraduate curriculum.[21]

1.2.2.1 Identification of a content-based approach

An analysis – conducted by the researcher himself – of the teaching and learning[22,23] and assessment[24] in CPC revealed a content-based approach[25] (Figure 1.5, page 9) The analysis indicated that lectures,[11,22,23] based on a set of lecture notes[22] that covered factual knowledge regarding the principles of diagnosis, treatment planning and patient management,[22] formed the bulk of the CPC teaching and learning (Figure 1.5, page 9). An analysis of the 2008 fourth-year CPC assessment[24] subsequently showed that the assessment was based of the content of the lecture notes.[22]

1.2.2.2 Identification of a lack of constructive alignment

Having identified a content-based approach,[25] it was deduced that the teaching, learning and assessment was not aligned (Figure 1.5, page 9) with the exit-level outcomes of the undergraduate dental curriculum. The teaching, learning and assessment did not conform to the School's vision and aim to develop clinical reasoning skills through outcomes-based methods[26] and active learning approaches.[6,7,10]

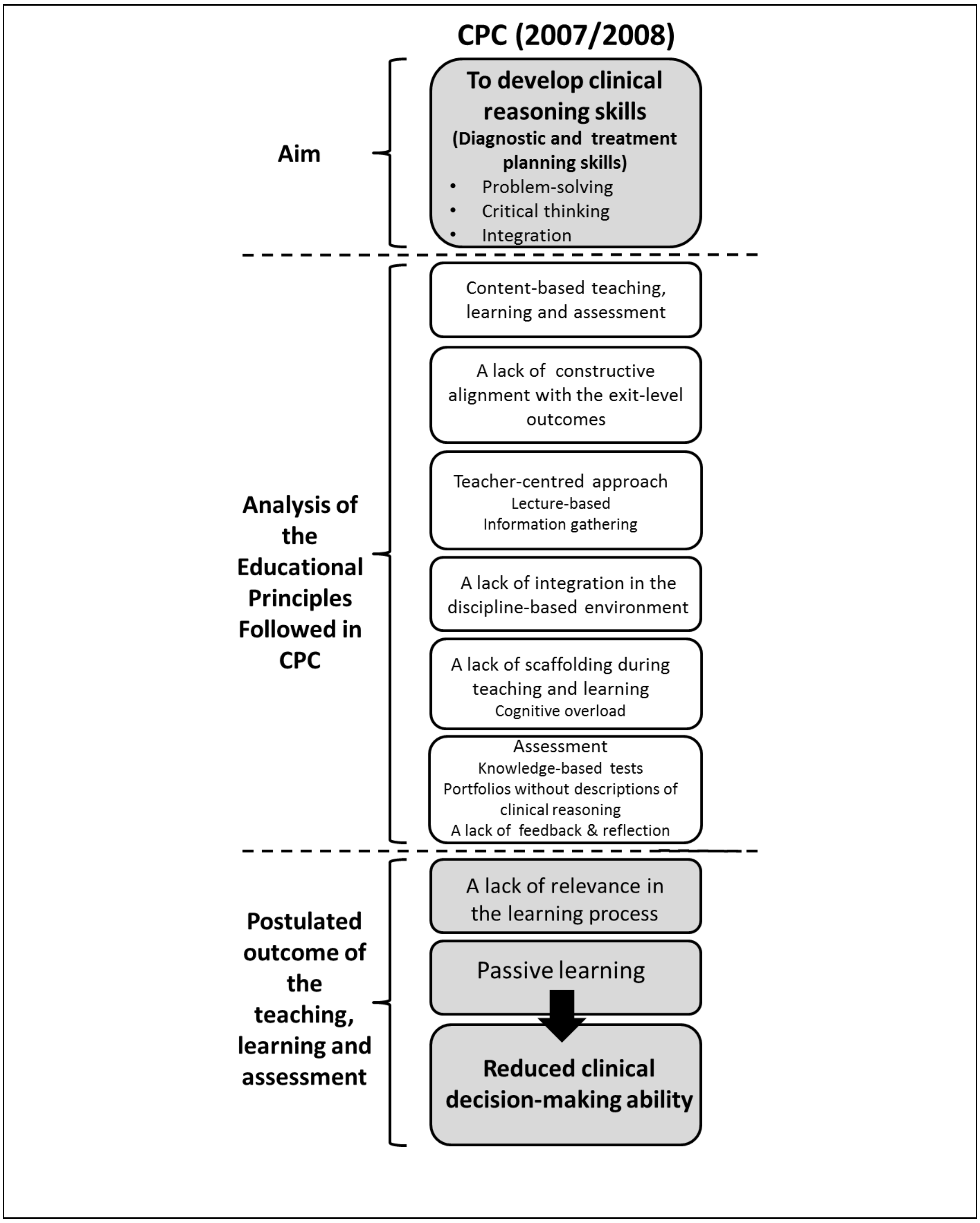

Figure 1.5 Identified problem – educational principles followed in CPC in 2007/2008

1.2.2.3 Identification of a teacher-centred approach

Using lectures – primarily based on content – as the main resource for teaching and learning, the educational process in CPC reflected a teacher-centred approach[25] (Figure 1.5, above), which according to the literature, contributes to so-called "information gathering" and rote learning approaches[25] amongst the students.

1.2.2.4 Identification of a lack of integration across disciplines

The analysis also indicated that the proposed case-based instructional design system[10] (mentioned on page 4), which had the potential to facilitate integrated clinical reasoning through a problem-solving approach, was only functional in the Module: Odontology[27,28] during the fourth study year. Furthermore, the emphasis of teaching by means of case studies was on primary prevention,[27,28] and the method did not cater for broader integration. This finding implied that the educational process in CPC did not contribute much to the integration of knowledge across disciplines in an authentic context[10,25-27] and that the development of clinical reasoning skills in the undergraduate dental curriculum remained discipline-based (Figure 1.5, page 9).

1.2.2.5 Identification of a lack of scaffolding

Moreover, it is pertinent to note that educational theory suggests that the cognitive development of students happens in stages[29,30] and that students generally find it challenging to move from one learning context to another,[29,31] such as the transfer from preclinical to clinical teaching and learning.[32-34] The literature contains multiple examples[32-35] where fourth-year students struggle with the transition from preclinical teaching and learning to the clinical environment where they have to deal with the intricacies of complex clinical cases. It was therefore not surprising that the researcher observed that the fourth-year dental students found the transition phase between preclinical and clinical teaching and learning to be overwhelming during his involvement as a clinical tutor at Odontology in 2006 and 2007. This problem relates to a lack of scaffolding[31] during the transition to a more complex situation. Scaffolding can be defined as the systematic provision of phased learner support[31] in order to assist cognitive development over time and to prevent cognitive overload during the learning process.[31,36] Cognitive overload refers to a state where the working memory cannot handle the amount of knowledge the learner is bombarded with at one time, which leads to a breakdown in learning processes.[31,36] The management of cognitive load during teaching and learning has indeed become an important intervention to consider in contemporary education practice.[30,35]

1.2.2.6 Identification of knowledge-based assessment and a lack of feedback

At the time of the researcher's analysis of the CPC educational practices in 2008, fourth- and fifth-year performance in CPC was assessed by means of knowledge-based[37](Figure 1.5, page 9) written tests[24] and also clinical portfolios.[11]

Using a revised version of Bloom's taxonomy[37] as reference, the analysis of the written tests indicated that the questions in the final 2008 CPC test were formulated on a knowledge level that required the recall of facts,[37] exactly as provided to the students in the study notes.[22] Furthermore, little or no application of the knowledge to an authentic context were required from the students in the test, which corroborated the researcher's perception of a content-based approach.[25]

The clinical portfolios[11] consisted of records of real-life cases. The validity of the clinical portfolios was difficult to assess, since they were compiled at various clinics in the discipline-based environment of the School. Students' clinical portfolios differed considerably due to students' exposure to dissimilar clinical cases. Therefore, the researcher concluded that the portfolios' reliability[5] as an assessment tool was questionable. The researcher also concluded that it is doubtful whether the portfolios contributed to the learning of clinical reasoning, since they tended to be mere compilations of artefacts, such as patient records,[11] without detailed descriptions of clinical reasoning processes. This implied that students received feedback about their clinical reasoning processes only during clinical teaching and learning in the discipline-based environment.

The problems with regards to the teaching, learning and assessment in CPC were identified in the sections above. This analysis, which took place at the end of 2007 and during 2008, suggests that the teaching, learning and assessment of diagnostic reasoning and treatment planning were not conducted in an authentic way at that point in time. It has been postulated that teaching, learning and assessment methods that are not presented in authentic context are likely to be perceived as irrelevant[31,38] (Figure 1.5, page 9), resulting in lower motivation among students and their adoption of passive learning strategies.[39] Passive learning[39] through the memorisation of facts, and knowledge-based assessment[40,41] with minimal feedback[5] are unlikely to develop critical thinking and problem-solving skills.

It is conceivable that such methods of teaching, learning and assessment might even impact negatively on the outcome of the development of clinical reasoning skills.

1.2.3 Analysis of the Educational Outcomes for CPC (2007/2008)

An analysis of the educational outcomes (test marks)[42,43] in CPC for 2007 and 2008 showed that variable performance amongst the students in CPC. Differences in student performance can partially be explained in the literature by the fact that the academic development of the student is not only reliant on the inputs of the teacher but is also dependent on multiple factors related to the students themselves.[29,44] Student learning is dependent on self-regulation[44] in the learning process. Students who display a lack of interest and focus, as well as self-handicapping behaviour,[45] such as poor time management, might not perform as they should. For example, differences in academic performance have been recorded for the different genders.[46,47] These differences could be attributed to observations that showed that females sometimes tend to be more diligent compared to males.[46,47] Learning is also dependent on academic skills[48] and previously gained knowledge.[49] In a medical education context learning in the clinical disciplines may be influenced by the acquisition of knowledge in the BMSs. [49]

Inequalities in the primary and secondary schooling system in South Africa have resulted in variable academic performance amongst students from different ethnoracial origins in South Africa.[50] The difference in academic performance between students from different ethnoracial origins has become a controversial and sensitive issue.[51,52] This controversy stems directly from the Apartheid political system,[50,52,53] which discriminated against the majority of the citizens of South Africa on the basis of race. [‡50] White South Africans as a result gained an advantage[50] over their, so-called, Black, Coloured and Indian/Asian[54] counterparts because they had access to a superior schooling system, which is reflected in the academic outcomes on a tertiary education level, even today after considerable redress have been made in the recent past.[52,53]

A recent article in "Medical Education"[55] highlights the importance of controlling for "ethnoracial biases" in educational research projects. This article[55] argues that mainstream approaches that do not consider "ethnoracial" issues will fail to explain many of the important social dilemmas the teacher are confronted with, and where redress is necessary. It is therefore important to take the impact of disparities in the country's schooling system into consideration by giving due consideration to disadvantaged students when developing a curriculum.[52]

Although some of the above-mentioned factors maybe beyond the direct control of a teacher at a tertiary education level, the teacher has a responsibility to provide support to the learners in order to address social, behavioural and academic problems that may arise during the course of their studies.[56]

Therefore, in order to gain a broader understanding of the underlying issues, the above-mentioned factors, related to the targeted learners themselves, had

[‡] The people of South Africa were categorised as either, Black, Coloured, Indian/Asian or White during the Apartheid political system. This categorisation was the basis of racial discrimination in the country. White South Africans as a result gained a socio-economic and educational advantage over their so-called Black, Coloured and Indian/Asian counterparts. Despite the demise of Apartheid in 1994, the current Government of South Africa still uses this controversial racial classification, in order to monitor and manage socio-economic redress in South Africa (Statistical Release P0301.4, Census 2011. Pretoria: Statistics South Africa. URL: http://www.statssa.gov.za/Publications/P03014/P030142011.pdf accessed 18 August 2013)

to be taken into account during the design and evaluation a new curriculum for CPC.

1.2.4 Summary of the Problem

On the basis of the deliberations above, it has been established that the CPC curriculum lacked authenticity due to the –

- content-based teaching, learning and assessment;
- lack of constructive alignment between the teaching learning and assessment in CPC and the exit-level outcomes of the undergraduate dental curriculum of the School of Dentistry;
- discipline-based undergraduate curriculum may not naturally allow for the integration of knowledge across disciplines; and
- predominant teacher-centred teaching and learning in CPC as opposed to a student-centred problem-solving approach.

It has also been established that the transition between the preclinical year of study and clinical teaching and learning was not optimal with the students finding the transfer challenging.

Moreover, the quality of the assessment and feedback in CPC was questioned.

Finally, a need was established to take student-dependent factors into consideration during the design and evaluation of a curriculum.

These findings became the main focus for the development and evaluation of a new curriculum for CPC.

1.3 Aim of the Study

The aim of the study is to design, implement and evaluate a new CPC curriculum for third-, fourth- and fifth-year students that is constructively aligned with the exit-level outcomes of the undergraduate dental curriculum of the School of Dentistry, University of Pretoria.[21] The ultimate aim of the new CPC curriculum would be to ensure improved clinical reasoning outcomes at the exit-level of the undergraduate curriculum.

1.4 Objectives of the Study

The objectives of the study are to –

- align the teaching, learning and assessment of the CPC curriculum with the exit-level outcomes of the undergraduate dental curriculum of the University of Pretoria[21];
- improve the authenticity of the teaching learning and assessment in CPC through the development and implementation of an educational intervention in CPC with the aim of developing integrated clinical reasoning skills – specifically focussed on diagnosis and treatment planning – through a student-centred problem-solving strategy;
- reduce the knowledge and skills gap between the preclinical and clinical teaching and learning stages by exposing the students to an authentic context at an earlier stage in the curriculum;
- analyse and report student-dependent factors related to the development of clinical reasoning skills; and
- evaluate the effectiveness of the newly designed intervention to ensure improved clinical reasoning outcomes at the exit level of the curriculum.

1.5 Methodology

This research originated in an institution where "positivism"[57] has been dominating research practices. A positivistic approach to research can be defined as an approach where the researcher attempts to solve the research question, usually by means of quantitative methods, through the creation of a well-defined controlled experiment, in order to derive an objective conclusion.[57] Positivism requires the researcher to stand outside the experiment and requires the elimination of all sources of bias that may arise during the research process.[57]

The current project, however, involved an evaluation, by the teacher himself, of the effectiveness of real life educational practices in a complex environment. Such a situation does not allow for perfectly controlled experiments, as required by a pure positivistic approach. The multifaceted nature of this research project rather required a research philosophy that is able to accommodate the complexities of real life, and allows for the participation of different role players, including the researcher himself, to be involved in the research process.

On the basis of these requirements, the researcher defines his research philosophy before providing a broad specification of the methods followed to conduct and report the research.

1.5.1 Research Philosophy

This research project adopted action and evaluation research principles[57] in dealing with real life problems in a tertiary educational environment. Action research can be defined as a strategy that is used to continuously evaluate and improve one's own performance for the betterment of society.[57] In this instance "own performance" refers to the educational practices of the researcher and his co-workers.

Action research strategies are often utilized in the educational environment.[57] Action research principles[57] require "teachers" to consider the needs, perceptions and opinions of the students they teach.[57] In other words the "teacher" and the students collectively attempt to enhance the educational process as "equal partners".[57] Therefore, the opinions and perceptions of the students have been taken into consideration as part of the evaluation process in this research project.

Since this research can also be defined as a reactive evaluation "to make sense" of a complex teaching and learning situation, the research can also be categorised as a form of evaluation research.[58]

In order to perform the evaluation a mixed-methods approach[59] was followed whereby qualitative data gathered from student feedback was used in an attempt to gain a deeper understanding of the variability of some of the quantitative findings.[58,59]

Although the adoption of action- and evaluation research principles may affect the generalisability of parts of this project, the results may be useful in terms of informing further improvement in the educational environment under scrutiny.[58]

The reflective and scholarly processes the “teacher” goes through in order to continuously improve the teaching and learning environment have great potential towards making a contribution to the building of educational theory.[57]

Having elaborated on the research philosophy followed in this project, the next section addresses the organisation of the project, provides a broad specification of the methods that were followed, and describes the structure and flow of the thesis.

1.5.2 Methods, Structure and Flow of the Study

Kern *et al*[60] proposed a model (Figure 1.6, below), namely the “six-step approach to curriculum development”, that can be applied in a medical education context to review a course or a curriculum.

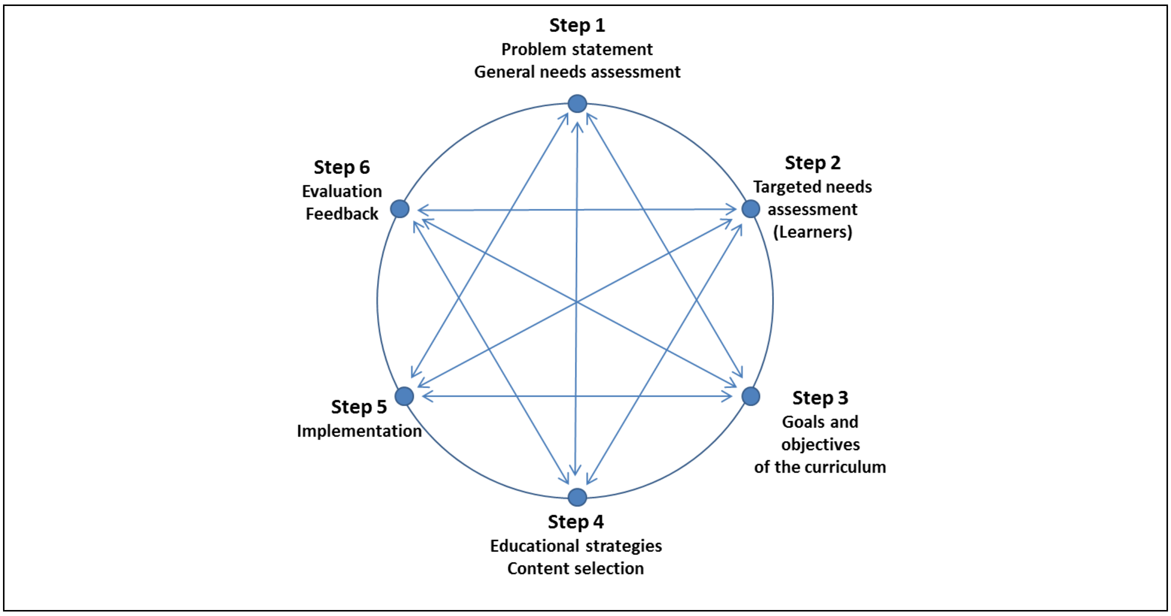

Figure 1.6 A six-step approach to curriculum development[60]

Source: Kern DE, Thomas PA, Howard DM, Bass PH, Bass EB. Curriculum development for medical education. A six-step approach. Baltimore: Johns Hopkins University Press; 1998. p. 5. Figure 1.1©. Reprinted with permission of the Johns Hopkins University Press.

Although Kern's model[60] (Figure 1.6, page 17) has not been evaluated extensively, it is deemed to be logical and systematic in the way it deals with the development and evaluation of a curriculum.[61,62] The model requires that a needs assessment be carried out to inform changes to an existing programme. The implemented changes are subsequently evaluated for effectiveness.[60]

It should be noted that although Kern's model[60] (Figure 1.6, page 17) might appear to be rigid, it represents a dynamic process in which the different steps continuously inform each other,[60] and which results in the refinement of the educational strategies. At the end of the evaluation process the cycle repeats itself, and in this way allows further improvement of the curriculum.[60] This flexibility of Kern's model[60] therefore allows for the use of action research[57] and evaluation research[58] principles.

On the basis of the above-mentioned considerations, the action research project and thesis were structured according to Kern's "six-step approach to curriculum development" (Figure 1.6, page 17).[60] By adopting Kern's model the research process automatically became part of the research methods. Therefore, the following sections contain a synthesis between the structure and flow (Figure 1.7, below), as well as the methods of the study.

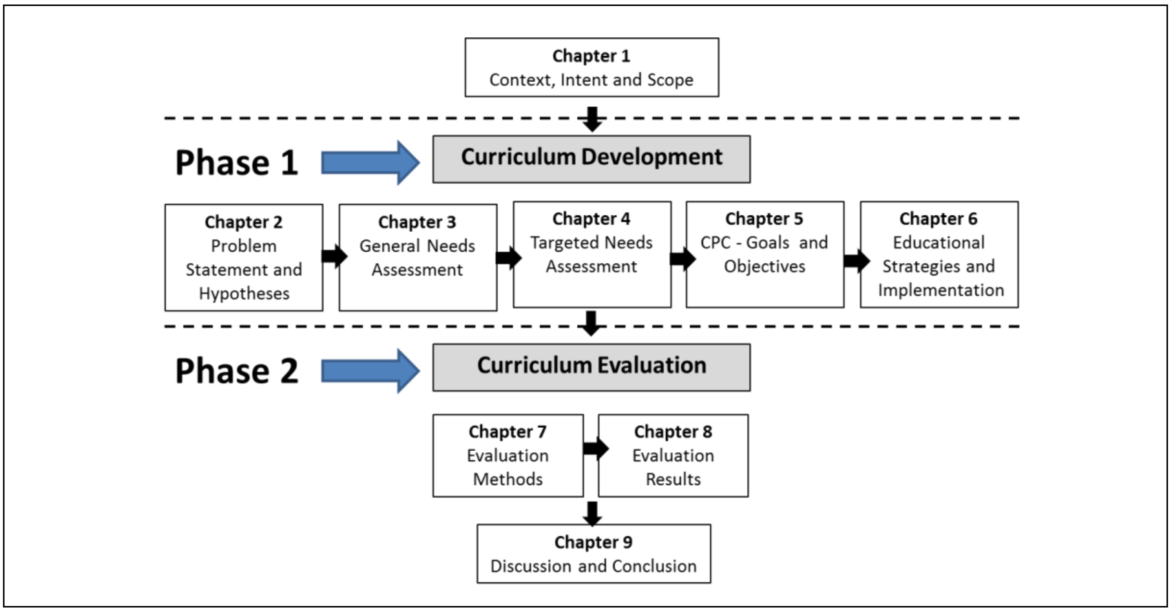

Figure 1.7 Structure and flow of the study

The current chapter (Chapter 1 of the thesis, Figure 1.7, page 18) describes the context, intent and scope of the project.

The subsequent chapters contain a report of the action research project, which was conducted in two distinct phases (Figure 1.7, page 18). Logically, the curriculum development phase (Phase 1) preceded the curriculum evaluation phase (Phase 2) described in the following paragraphs.

1.5.2.1 Phase 1: Curriculum Development Phase

The curriculum development phase started with the identification of the problem (paragraph 1.2, page 7) and the requirement for a new curriculum for CPC at the end of 2007. The curriculum development phase is addressed in Chapters 2 to 6 of the thesis (Figure 1.7, page 18).

- Chapter 2 articulates the problem statement and proposes an intervention to remedy the situation. The chapter also formulates the research hypotheses (Step 1 in Kern's model,[60] Figure 1.6, page 17).
- Chapter 3 continues with a general needs assessment (second part of Step 1 in Kern's model,[60] Figure 1.6, page 17) in the form of a literature review (performed during 2008)[§] with the aim of gaining external support for the arguments and proposals put forward in Chapters 1 and 2.
- Chapter 4 explores issues that might affect the targeted learners' performance (Step 2 in Kern's model,[60] Figure 1.6, page 17). This chapter is also written in the form of a literature review and identifies influences and needs related to the learners themselves.
- Based on the identified needs, Chapter 5 outlines the newly developed goals and objectives for CPC (Step 3 in Kern's model,[60] Figure 1.6, page 17), which were formulated in 2008.
- Chapter 6 starts off by determining the unit content and the design of the educational strategies (Step 4 in Kern's model,[60] Figure 1.6,

[§] The bulk of the literature review was conducted during 2008. The literature review continued throughout the duration of the study to ensure that current viewpoints are taken in to account during the evaluation phase of the research page 17) in order to address the identified needs. The chapter concludes with the implementation (Step 5 in Kern's model,[60] Figure 1.6, page 17) of the newly developed curriculum in 2009.

The implementation of a newly developed curriculum is followed by the second phase of this project, namely the curriculum evaluation phase.

1.5.2.2 Phase 2: Curriculum Evaluation Phase

The curriculum evaluation phase includes the development of research methods used to conduct the evaluation as well as a report and discussion of the research findings. The curriculum evaluation phase is addressed in Chapters 7 to 9 of the thesis (Figure 1.7, page 18).

- Chapter 7 elaborates on the *methods* used for the evaluation of the programme. The effectiveness of the educational intervention in improving clinical reasoning outcomes at exit-level was measured by comparing the clinical reasoning outcomes of a standardised progress test[63] of student cohorts who were exposed to the intervention, with the outcomes of preceding cohorts who received lecture-based CPC teaching and learning. These comparisons were made for participating third-, fourth and fifth year students for the period 2009 to 2011.[**] Mixed-model statistics and linear regression methods were employed to control for confounding factors such as demographic traits of the learners as well as previous academic performance. The discrimination properties[64] of the progress test were also evaluated during this process in order to determine the validity of the assessment tool. The evaluation of the intervention was complemented by an assessment of quantitative data obtained from a standardised student feedback questionnaire regarding relevance, curriculum alignment, course organisation, integration and the management of complexity during the teaching and learning process.

[**] Please note that this part of the study design will be dealt with in much greater detail in Chapter 7 of the thesis. The reader is specifically referred to Figure 7.1 on page 143 for a diagrammatical illustration of the study design for the quantitative evaluation.

Two additional focus group discussions were recorded in audio, transcribed and analysed to examine possible reasons for the variable progress test outcomes over time.

- Chapter 8 presents the *results* of the evaluation.
- Chapter 9 contains a *discussion* of the results and puts the findings into context by elaborating on the limitations, strengths and weaknesses of the study. The chapter ends with the *conclusions* and with the proposals for the way forward.

It should be noted that the evaluation of the educational practices in CPC is a broad and complex exercise by default. Therefore, the evaluation will be limited to specific elements in the curriculum.

1.5.3 Delimitations of the Study

This study is limited to the CPC unit of the M: CPM.

An evaluation of a curriculum is an ongoing process.[60] The evaluation of the "new" curriculum in its entirety would constitute a major exercise that is beyond the scope of the current action research project.

Therefore, the evaluation will mainly focus on the development of cognitive, clinical reasoning skills – especially diagnostic reasoning and treatment planning skills – in the CPC unit.

1.6 Conclusion to the Chapter

A need was identified to improve the development of clinical reasoning skills in the discipline-based undergraduate dental curriculum of the University of Pretoria. To achieve this improvement, the teaching and learning in the CPC unit had to be aligned with the strategic direction provided by the School. Following the identification of the inefficiencies in the educational processes of CPC, the researcher embarked on an action research project, which involved the design, implementation and evaluation of a new curriculum for CPC.

1.7 Summary of the Chapter

Chapter 1 provided the context and origin of the study. The chapter also outlined the scope, aims and objectives, as well as the methods and flow of the study (Figure 1.7, page 18). The delimitations of the study were also mentioned towards the end of the chapter.

Chapter 2 will proceed with the problem statement and a proposed educational intervention, followed by the research hypotheses.

CHAPTER 2: PROBLEM STATEMENT AND HYPOTHESES

2.1 Introduction

Chapter 1 gave an overview of the context, origin, structure and scope of the study.

As part of the curriculum development phase (Figure 1.7, page 18), Chapter 2 continues with the first part of Step 1 of Kern's six-step model[60] (Figure 1.6, page 17), namely the problem statement.

2.2 Problem Statement

A description of the problem, identified in Chapter 1 (paragraph 1.2, pages 7-14), highlighted specific deficiencies – identified by the researcher himself – in the educational process in CPC during 2007 and 2008. These deficiencies included content-based teaching and learning approaches that were not aligned with the exit-level outcomes of the undergraduate dental curriculum of the School of Dentistry. The perception was that the teaching and learning in CPC was teacher-centred and was unlikely to develop problem-solving and critical thinking skills. Furthermore, integration, in the context of the development of clinical reasoning skills, was questioned in the discipline-based teaching and learning environment.

The researcher's identification of deficiencies in the educational processes of CPC, as well as the identified need to manage and support the cognitive development of the students, especially, between the preclinical- and clinical years of study, indicated a need for an educational intervention in CPC, taking the abilities and behaviours of the targeted students into account.

2.3 Proposed Intervention and its Envisaged Outcome

The proposed intervention (Figure 2.1, below) contains proposals that are in direct response to the identified problems (Figure 1.5, page 9) related to the educational principles followed in CPC during 2007 and 2008. The following illustration demonstrates the relationship between the identified problems and the proposed intervention.

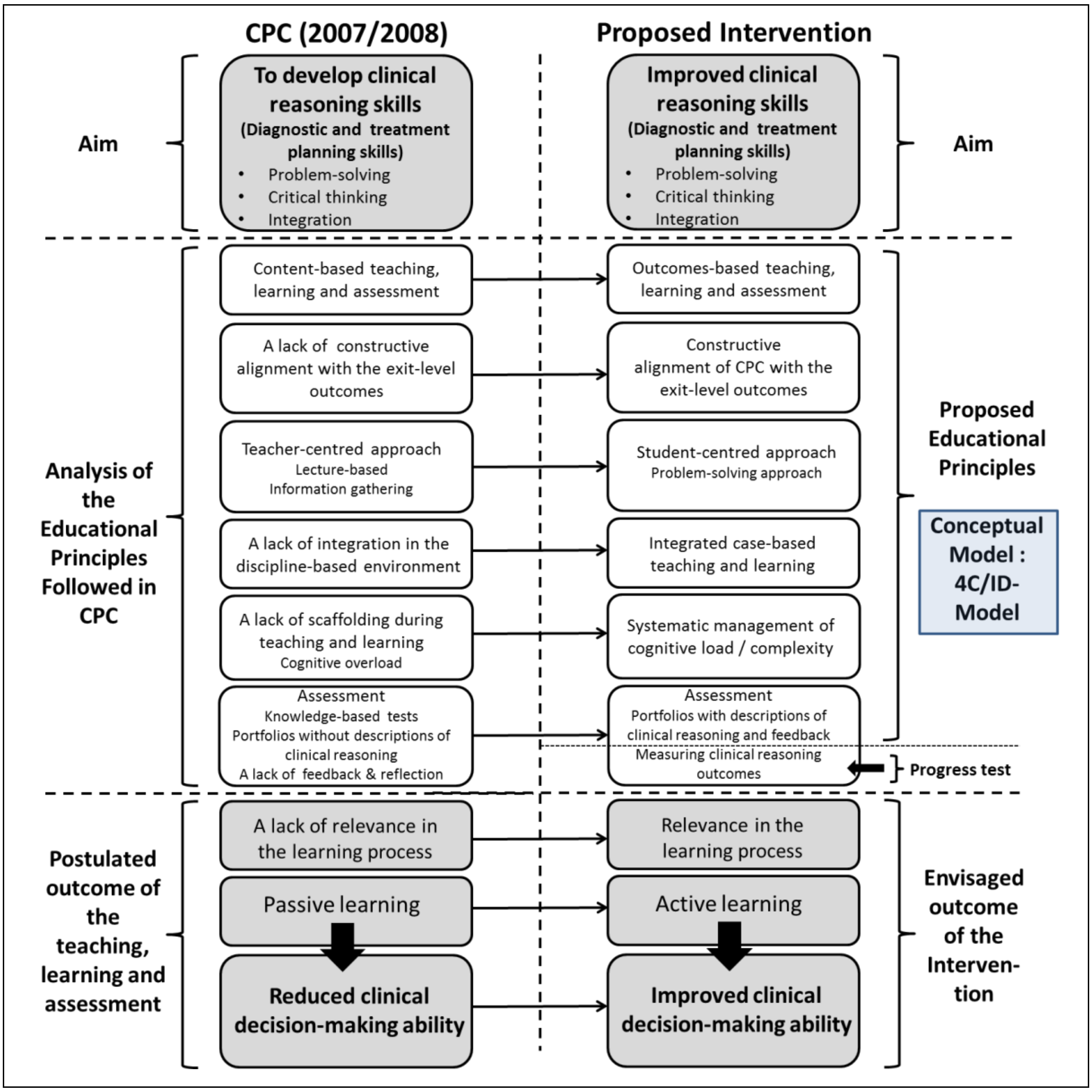

Figure 2.1 Educational principles of the proposed intervention

2.3.1 Aim of the Proposed Intervention

The aim of the proposed intervention was to improve the development of integrated clinical reasoning skills, namely, diagnostic reasoning and treatment planning skills, by means of teaching and learning in an authentic context.

2.3.2 Educational Principles of the Proposed Intervention

For this purpose an outcomes-based approach (Figure 2.1, page 24), which had to be aligned with the exit-level outcomes of the undergraduate dental curriculum of the School of Dentistry, University of Pretoria, was recommended for CPC. It was proposed that a student-centred approach be combined with problem-solving teaching and learning strategies to foster critical thinking skills. To achieve this, it was suggested that a case-based instructional design system, similar to the proposal on page 4 of this thesis be used to compile integrated cases with the aim to improve the integration across disciplines in the discipline-based teaching and learning environment. It should be noted that the proposed case-based instructional design did not replace the discipline-based teaching and learning but merely served as an adjunct method to develop and integrate clinical reasoning skills in the discipline-based teaching and learning environment. Furthermore, the assessment had to be designed to support the development[5] of clinical reasoning skills. Repeated exercise[31] in diagnosis and treatment planning accompanied by formative assessment and feedback[5] were required to achieve this objective.

Making provision for integrated learning in an authentic context and the provision of feedback through student-centred approaches, the Four Component Instructional Design Model (4C/ID-model)[††] for complex learning[31] (Figure 2.1, page 24) was identified to serve as conceptual model to manage the students' development of clinical reasoning skills in CPC. The 4C/ID-model[31] propounds that the human memory is only able to handle a limited amount of information at a given point in time.[31] If the necessary knowledge structures are not in place, exposure to a complex case will result in cognitive

[††] The principles of the 4C/ID-model will be explored in detail in Chapter 3

overload[31] and a breakdown in learning or thinking processes. The model proposes that repeated exposure to a complex problem in an authentic way, together with proper learner support, will reduce the load on the memory, which will enhance the development of integrated knowledge structures.[31] For this reason the 4C/ID-model[31] was deemed to be suitable to systematically manage and support the students' cognitive development of clinical reasoning skills, especially between the preclinical and clinical stages of teaching and learning. It was therefore proposed that the intervention should commence in the preclinical study year[65] to develop students' knowledge structures in preparation for the clinical teaching and learning years. The intention of this intervention was to reduce the immense complexity at the start of clinical teaching and learning, as well as to scaffold the cognitive development of the students with the aim of improving clinical reasoning outcomes at the exit-level of the undergraduate dental curriculum.

The assessment (Figure 2.1, page 24) also had to be designed to ensure acceptable levels of "competence"[41] in terms of clinical decision-making at exit-level. A standardised progress test[63,66,67] had to be designed to measure clinical reasoning outcomes on a knowledge-application level[40,41] as well as to measure the development of clinical decision-making over time.

2.3.3 Envisaged Outcome of the Proposed Intervention

It was envisaged that the use of integrated case studies and active learning strategies – such as problem-solving – would influence students' perceptions positively in order for them to perceive the learning as relevant (Figure 2.1, page 24).

It was further foreseen that a perception of relevance during teaching and learning would result in improved integrated clinical reasoning outcomes as opposed to the status of the CPC educational processes in 2008 as depicted under in Figure 2.1 (page 24).

Furthermore, it was expected that by exposing students earlier to an authentic context through case-based teaching and learning, the students' knowledge structures would start to develop earlier, which would reduce the complexity learners are faced with in their first clinical year, resulting in improved clinical reasoning and CPC outcomes at exit level.

Realistically, it was not expected that the proposed intervention on its own would be able to address all the learner-dependent factors such as academic ability and behaviors that may influence the outcome of the teaching and learning. Therefore it was anticipated that learner behaviour and academic ability would still influence the outcome of the teaching and learning.

The above-mentioned envisaged outcome of the proposed intervention was used as the point of departure for the formulation of the research hypothesis.

2.4 Research Hypotheses

The research hypotheses were formulated based on two assumptions. The first assumption was that the educational principles proposed for the educational intervention will result in improved clinical reasoning outcomes at the exit-level of the undergraduate dental curriculum. The second assumption was that student-behaviour and academic ability would influence the outcomes of the educational process. The former is addressed first.

2.4.1 The Effectiveness of the Proposed Educational Intervention and the Validity of the Progress Test

Educationalists often propagate that principles such as the constructive alignment of the curriculum, integration, active learning – for example, problem-solving in context by means of case studies – and valid assessment practices must be applied in educational practice.[20,25,60,68,69] It is expected that the adoption and strengthening of these fundamental principles have the potential to steer teaching and learning in CPC in the right direction, thereby improving the clinical reasoning skills (diagnostic reasoning and treatment planning skills) of students. Based on these assumptions, the following null hypotheses have been formulated:

- Adjunctive integrated preclinical case-based dental teaching and learning will not improve the clinical reasoning decision-making of dental students at exit level compared to the clinical reasoning decision-making of dental students who predominantly received lecture-based CPC and clinical reasoning teaching and learning in a discipline-based environment.
- A progress test as an assessment tool will not be valid.
- Students who received integrated case-based dental teaching and learning will not rate educational elements, such as relevance, constructive alignment, the contribution of assessment to learning, integration, lecturer competence and course organisation, as superior compared to students who received lecture-based CPC teaching and learning.
- Higher ratings of course relevance feedback will not correlate positively with positive perceptions of educational processes.

Furthermore, it is hypothesised that by exposing dental students to complex integrated clinical reasoning earlier (that is, during preclinical teaching and learning), knowledge will be accumulated in context and knowledge connections will be established earlier. Such an approach should reduce the overwhelming complexity of initial clinical teaching and learning. Based on this assumption the following null hypothesis was formulated:

- Adjunctive integrated case-based dental teaching and learning in the preclinical year will not reduce the students' perceptions regarding the knowledge and skills gap between the preclinical year and the first year of clinical teaching and learning.

The following section articulates the second group of hypotheses pertaining to the need to control for potential influence of student behaviour and academic ability on the outcomes of the educational process.

2.4.2 The Potential Association between Student-dependent Factors and Educational Outcomes

It should be noted that the proposed intervention focussed on the development of clinical reasoning skills. Although learner support is an integral part of the proposed intervention through the support and feedback processes of the 4C/ID-model,[31] this research did not focus on resolving all the social and behavioural problems the students encountered. In paragraph 1.2.3 (page 13) it was, however, highlighted that a student's race,[‡‡53] gender,[46,47] academic ability,[48] prior academic performance, for example, knowledge levels in the BMSs,[49] and behavioural aspects[44,48,70] might be associated with the outcome of educational processes, and should therefore be controlled for. The following null hypotheses have been formulated for this purpose:

- Students' gender and race will not be associated with the outcome of the development of clinical reasoning skills.
- Prior academic performance, in the form of possessing BMS knowledge, will not be associated with the outcome of the development of clinical reasoning skills.
- Students who progressed in terms of clinical reasoning will not display self-regulating behaviour, and students who did not progress will not display self-handicapping behaviour.

2.5 Conclusion to the Chapter

An educational intervention to facilitate the development of integrated clinical reasoning skills – namely, diagnostic reasoning and treatment planning skills – was proposed for the new curriculum for CPC. The 4C/ID-model[31] for complex learning was identified as conceptual model to create an authentic context for learning and to systematically develop clinical reasoning skills through a case-based approach while supporting the student's cognitive load during the learning process. A progress test was proposed to monitor clinical reasoning

[‡‡] Race labels, in this context, are statistical categories, which are merely intended to evaluate and inform redress.

outcomes over time. It was envisaged that the implementation of the proposed intervention would improve the development of clinical reasoning skills in the discipline-based environment.

2.6 Summary of the Chapter

Chapter 2 described the research problem in detail and proposed an educational intervention to remedy the situation.

Chapter 3 will continue with the second part of the first step in Kern's model[60] (Figure 1.7, page 18), namely, a general needs assessment. The general needs assessment will be in the form of a detailed literature review with the aim of gathering external support for the educational principles of the proposed intervention.

CHAPTER 3: DEVELOPING CLINICAL REASONING – GENERAL NEEDS ASSESSMENT

3.1 Introduction

Chapter 2 gave a detailed description of the problem statement and proposed an educational intervention (Figure 2.1, page 24).

Chapter 3 continues with the general needs assessment (Figure 1.7, page 18), which is the second part of Step 1 in Kern's six-step approach to curriculum development[60] (Figure 1.6, page 17). A general needs assessment can broadly be defined as an assessment of the requirements of society, patients, health care providers and educationalists in terms of the delivery of quality education.[60] Such an assessment concerns political influences, trends, guidelines, policies and resources in the external and internal environments that might support or enable the development and implementation of a curriculum[60] (Figure 3.1, page 32).

A general needs assessment can be conducted in various ways, for example, through direct consultation with the stakeholders.[60] Due to a lack of resources such as time, personnel and funding, this needs assessment was conducted is in the form of a literature review. This general needs assessment is an elaboration on the needs identified in Chapter 2. The focus of the general needs assessment will be on the educational principles suggested for the proposed intervention to develop clinical reasoning skills (Figure 2.1, page 24). Verifications of the needs identified related to the proposed educational intervention will be affirmed in the "Conclusion to the Chapter" on page 79.

The literature review will commence with an appraisal of the external environment (Figure 3.1, page 32) to gain support for the proposed educational intervention.

3.2 External Environment

For the purpose of this review, the scope of the external environment comprises political influences, trends, guidelines, policies and resources in health education (Figure 3.1, below). The discussion of the literature review focuses on reinforcing views from both global and local perspectives.

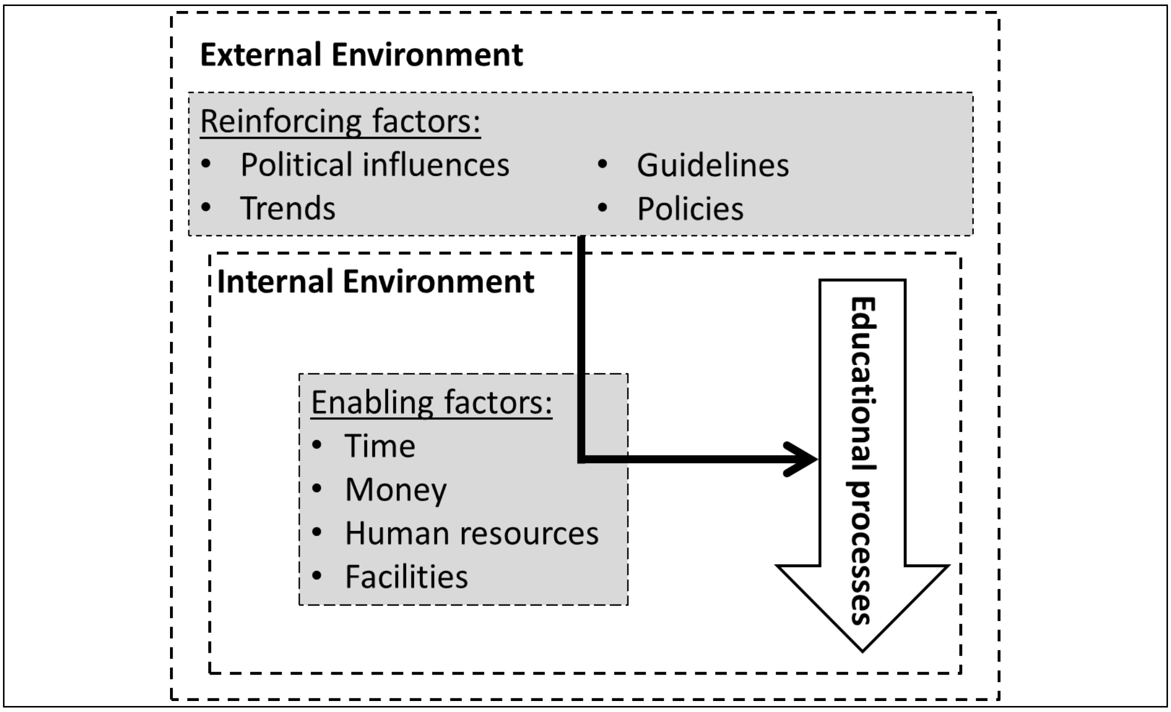

Figure 3.1 The influence of external and internal contexts on curriculum development[60]

3.2.1 Global Perspective

Early in the 20th century, the landmark Flexner report[71] suggested that the teaching and learning of medical doctors should be underpinned by science, and that medical training should be driven by active learning processes. Worldwide, this report led to the incorporation of the BMSs, such as Anatomy, Physiology, Microbiology, Pathology, and Pharmacology into medical curricula. Contrary to the proposal in the report that called for active learning approaches, the explosion of knowledge that followed resulted in content-based, compartmentalised curricula that perpetuated, deemed by many to be, passive learning. To a large degree, the BMSs were divorced from each other, as well as from the clinical sciences, resulting in a distinct demarcation between preclinical and clinical teaching and learning.[14] Indications are that such information-gathering methods might not be adequate to prepare students sufficiently to follow careers as health professionals.[25,41] The need for BMS knowledge in clinical reasoning has not been tested on a broad scale, and a thorough understanding of this is lacking.[49] However, limited evidence indicates that an understanding of the BMSs might have a positive effect on clinical reasoning[2] in the long run.[49]

In an attempt to facilitate active learning in context, problem-based learning was established in the second half of the 20th century[72] and has since become one of the most significant[73] and widely debated innovations in medical education.[69] The theoretical grounding of problem-based learning will be discussed later in this chapter. The most profound effect of problem-based learning is probably the fact that the approach has drawn many educators away from content-based teaching methods such as lectures to the facilitation of active learning in small groups in a classroom setting.[69] The widespread acceptance of problem-based learning, or hybrid forms thereof, such as case-based teaching and learning,[69,73,74] might be an indication of a belief in the educational qualities of the approach.[69] When compared with conventional curricula, the additional resources required for problem-based learning in a classroom setting might, however, outweigh its educational benefits.[75] Problem-solving approaches to teaching and learning in a class room setting is generally more expensive than a content-based approach because it generally require more supervising staff who are adequately trained to support the students. Active learning approaches such as problem-solving also requires substantially more contact time with the students.[74]

According to Walton,[14] the Edinburgh Declaration, which was published in 1988, propounded that there was international consensus about the long-term aim of improving health care in general. Active learning methods and the integration of basic and clinical sciences were again proposed as key strategies. Additionally, there was a call for ensuring professional competence instead of relying on the mere recall of knowledge.[14,76] In the meantime, this declaration has been adopted widely by governments all over the world.[14]

A group of educationalists were recently commissioned to independently review the impact of health-related education and research on the global health care system. The commission's report[13] was quite substantial and a somewhat negative reflection of what medical education has achieved in the past century. It must be noted that most of the content of the report is beyond the scope of the current study, hence the somewhat selective quotation of the commission's findings and recommendations. It appears as if the report implied that medical education has to take responsibility for most deficiencies, such as the fragmentation of health care systems and the inequitable distribution of health care resources in health care systems over the world.[13] In a critique of the above-mentioned commission's work, Gordon and Karle[77] suggest that a lot of good work has been done over the years in the field of medical education and that a number of the deficiencies that the commission identified and the solutions they proposed[13] cannot be laid at the door of medical education only. Politicians and governments also have a role to play. Inefficiencies in medical education might, for example, be caused by government's under-investment in tertiary education.[77] This is indeed the case in South Africa, and can be ascribed to the country's complex political and socio-economic circumstances.[53,78]

The commission[13] suggested that content-based approaches should be replaced with strategies that would develop “critical reasoning” and “ethical conduct” with the aim of rendering high-quality integrated patient- and population-centred health care services. Interventions that are implemented in service delivery and/or in the educational environment should be evaluated for effectiveness, robustness and sustainability, and, most importantly, should be to the benefit of broader society. Instructional design should be outcomes based and should be aligned with changing conditions and needs in the local environment.[13]

To conclude the global perspective, it needs to be mentioned that in the recent past, societal pressure and the widespread adoption of the outcomes-based approach led to the re-evaluation of outcomes for health care professionals.[5] These redefined competencies include the demonstration of biomedical and clinical knowledge and the ability to apply that knowledge in the workplace, effective patient care, the continuous improvement of patient care through self-reflection, relational communication skills, professionalism, and responsiveness to service in the broader contexts of local health care systems.[5]

3.2.2 Local Perspective

All medical and dental training institutions in South Africa are part of the country's public health care system,[53] and they are often subjected to considerable financial restrictions and high pressures caused by the demand for service delivery due to the inequitable distribution of health care resources in the country. Academic institutions are regarded as national assets, and, as a result, form part of the public sector in South Africa.[53] Therefore, as a rule, academic staff are remunerated by the government, in return for which it demands high levels of service delivery.[53] Such arrangements might impact negatively on education and research.[53,79] Therefore, it is understandable that training institutions are often under-resourced in terms of their ability to ensure sustainable interactive small-group learning, such as problem-based learning in a classroom setting.

Locally, regulatory guidelines probably provide the best indication of the strategic direction medical education has taken in South Africa. The HPCSA is the statutory body entrusted with quality assurance in medical education in the country. The Medical and Dental Professions Board of the HPCSA published quality assurance guidelines for the accreditation of undergraduate medical and dental training in 1999.[19] These guiding principles were informed by the Edinburgh[76] and Cape Town[80] declarations of the World Federation for Medical Education and were drafted based on British directives[81] and proposals in the database of the World Health Organization (WHO).[82] Key quality assurance guidelines for South Africa include the following:

- The reduction or elimination of unnecessary course content
- The facilitation of self-directed learning rather than passive knowledge transmission
- Problem-based learning as a preferred method of instruction
- Integration strategies to improve vertical and horizontal integration within curricula
- Valid and reliable assessment practices
- Communication teaching and learning
- The encouragement of socially accountable health care providers
- The development of independent clinical and ethical decision-making[1,19]

A recent study showed that clinically related complaints were the most common types of complaint lodged at the HPCSA against dentists between 2004 and 2009.[4] Poor clinical decision-making, such as misdiagnoses and incorrect treatment planning decisions, were frequently cited as the causes of complaints.[4]

Conclusion: These guidelines and trends support the notion that teaching and learning in clinical decision-making should be strengthened through active learning processes (for instance problem-solving strategies) included in undergraduate dental curricula in South Africa.

The above-mentioned need is indeed in line with the strategic direction that the School of Dentistry provides for in the undergraduate dental curriculum.[6,7,10]

The sections above addressed the recommendations and influence of the external environment on the educational processes from a global and a local perspective. The needs assessment regarding the internal environment will now be conducted by means of a literature review.

3.3 Internal Environment

For the purpose of this review, the internal environment is defined as the institutional context from an education perspective. Chapter 1 provided a broad description and historical overview[6,7,10] of the undergraduate dental curriculum at the University of Pretoria. The reader is referred back to this chapter for an understanding of the institutional context.

Chapter 1 also identified the research problem that prompted the proposal in Chapter 2 for an educational intervention (Figure 2.1, page 24). The educational principles listed in the proposed educational intervention form the basis of the general needs assessment.

The focus of the proposed educational intervention will therefore be on the development of clinical reasoning skills in a discipline-based environment through a problem-solving approach in CPC. Clinical reasoning as a concept will be explored first, after which the following educational principles will be explored:

- Outcomes-based education
- Constructive alignment
- Student-centred learning
- Problem-solving approaches
- Integrated case-based teaching and learning
- Systematic management of cognitive load and complexity
- Assessment and feedback

3.3.1 Development of Clinical Reasoning Skills – Focus of the Intervention

The introduction in Chapter 1 (page 1) highlighted the critical importance of the development of clinical reasoning skills to the benefit of society.[1-5]

Clinical reasoning is an ambiguous concept consisting of interactions between the patient and the clinician within the broader social environment.[83,84] Therefore, it is not surprising that no conceptual model exists that defines clinical reasoning unambiguously.[84-86] Even descriptions of clinical reasoning in the literature is somewhat confusing because of the interchangeable use of terms, such as problem-solving, critical thinking, reasoning, decision-making, and others.[86] This haziness is further complicated by variances in clinicians' personal and specialised knowledge, experience and personal values. These personal characteristics are by default transferred to and applied in the clinical reasoning process.[83] The fact of the matter is that human behaviour remains unpredictable, regardless of scientists' efforts to unravel and define processes of people's information processing.[87]

In the past, educators thought that cognitive information processing strategies such as problem-solving – which is an integral part of clinical reasoning – could be taught,[88] and perhaps they think this even today. This view is considered to be outdated since there is no proof that the successful solution to one problem will ensure the resolution of another similar problem.[88] Problem-solving predominantly depends on knowledge and experience that relate to the specific problem.[88] Clinical reasoning is, therefore, dependent on the integration of knowledge and the formation of relevant memory structures.[89]

Although some form of problem-solving know-how might exist, it generally remains undefined. In an attempt to map the sub-processes of clinical reasoning, Charlin *et al*[85] came up with complex, untested flowcharts, reiterating the nearly unmanageable complexities educators are faced with in terms of developing these ill-understood skills.[84] One of the greatest threats to reliability in clinical reasoning assessment is a phenomenon called "case specificity".[90] A student who has encountered a particular case before will more likely be able to answer questions related to that case than another student who has not been exposed to the same case.[90] The manifestation of case specificity in a clinical reasoning context confirms that knowledge is closely linked to problem-solving.[91] Case specificity exemplifies the weaknesses of a generalised approach to teaching problem-solving.[92]

Diagnosis is central to the practice of medicine[93] and is probably the most common problem clinicians are confronted with in the domain of clinical reasoning. The traditional view of clinical reasoning is often based on the conception that a diagnosis is made through the careful consideration of signs and symptoms.[94] The analysis of the clinical situation is viewed as a mental process of “hypothetico-deductive reasoning”, which is a validated concept.[95] Competing hypotheses are generated through interaction with the patient during a clinical encounter. The clinician consequently attempts to confirm or reject each of the hypotheses to arrive at a diagnosis.[95] This view requires the clinician to understand the relationship between the signs and symptoms and the manifestation of the disease. These methods might result in situations where more than one disease or condition comes into play. A differential diagnosis is subsequently generated. Each of the diseases or conditions included in the differential diagnosis will necessarily have a certain likelihood of being the definitive diagnosis. The above-mentioned method is referred to as “forward reasoning”.[94] Forward reasoning is indeed associated with expert clinical reasoning.[94,96,97] In reality, the clinician might interactively source more clinical information before adjusting the differential diagnosis. In other words, information might flow backward as well as forward in the clinical reasoning process.[98] Whatever happens, the forward and/or backward reasoning process remains analytical in nature.[94]

A second strategy associated with expert clinical reasoning is pattern recognition.[94] Pattern recognition is a non-analytical clinical reasoning strategy whereby the clinician recognises the condition based on the specific attributes, signs and/or symptoms of the disease or condition.[94] A very good example of this in dentistry is dental caries. The diagnosis of dental caries is often based on pattern recognition[99] because of the typical pattern-like presentation of the signs and symptoms of the disease. However, the exclusive use of non-analytical methods, such as pattern recognition, might not be beneficial as it might result in misdiagnoses if alternatives are not considered. This does not imply that methods such as pattern recognition are inferior to analytical approaches. A need exists to teach students to use a combination of analytical strategies and non-analytical strategies.[94] The modern view is that experts’ reasoning is partly based on their flexibility in decision-making.[94,100]

When working with students, it is important to recognise that they are novices and not experts. Crespo *et al*[101] showed varying levels of expertise in the observed clinical reasoning processes of oral health care workers. Novices apply clinical reasoning in different ways than experts do.[90,101-104] These differences can be attributed to the fact that novices possess fewer knowledge structures and that these knowledge structures are less developed than those of experts.[104] It has been proposed that learners go through four phases to establish rich knowledge networks, which eventually constitute clinical proficiency.[105] These rich knowledge networks are also called "schemas".[106] A schema starts off with the acquisition of textbook knowledge, and this is followed by the formation of simplistic mental models of diagnostic information through practice. Repeated experience leads to the development of so-called "illness scripts"[106] that are further elaborated on and refined and then stored.[105] Illness scripts are similar to schemas[106] in that scripts are defined as schemas associated with sequences of ordered information,[107] such as the linked attributes of a disease.[93] Accessing knowledge-rich structures requires forceful features.[90] Forceful features can be defined as distinct fragments of information – such as clinical observations or specific information received from the patient – that serve as the key to unlock memory structures that enable the interpretation of clinical information.[90] Students need to practise repeatedly in order to refine and access their knowledge structures, which should improve their skills and application of knowledge.[49,108-111]

Expert reasoning is related to learner-specific knowledge, the richness of the knowledge structures[104,112-114] and the accessibility thereof.[90,93,105]

Conclusion: The development of clinical reasoning skills should therefore be pursued through the repeated acquisition and application of knowledge, by the students themselves, with the aim of developing knowledge-rich structures that can be accessed easily to make accurate clinical decisions.

It must always be remembered that distinct variances will occur in clinical reasoning, even amongst so-called experts.[101] Individuals with different abilities learn and reason in different ways, resulting in large variances in clinical decision-making.[90] Ultimately, it is the learners themselves who determine the way knowledge is interpreted and applied.[115] McMillan[116] proposed a variety of strategies to develop clinical reasoning. Even if a variety of teaching strategies – perceived to be theoretically sound – exists to teach clinical reasoning, it would be impossible to match specific techniques with specific student preferences. That, however, does not mean that the various teaching strategies proposed by McMillan[116] do not have an application in teaching practice. In fact, these strategies might be very useful for opportunistic individual chair-side teaching. Charlin *et al*[85] made a similar remark about his graphic representations of the clinical reasoning process.

The remarks made in this section about clinical reasoning are profound. Clearly there is no universal method or recipe that would be appropriate to teach clinical reasoning to large diverse cohorts of students in a classroom setting. Provision should therefore somehow be made for individual learners to construct their own knowledge in an authentic context. The establishment of an authentic context could be achieved through an outcomes-based educational approach.

3.3.2 The Need for an Outcomes-based Approach

Up to the end of 2008, CPC generally followed a content-based approach (Figure 2.1, page 24) to teaching and learning. A content-based approach can be considered as the opposite of an outcomes-based approach. A content-based approach is unlikely to develop critical thinking and problem-solving skills.[25] These potential inefficiencies were discussed in Chapters 1 and 2 as part of the "problem identification" and the "problem statement". A content-based approach will thus not be considered any further.

The undergraduate dental curriculum of the University of Pretoria is outcomes-based with clearly defined exit-level outcomes.[21] As proposed, the CPC unit had to adopt an outcomes-based approach based on the strategic direction[7] provided by the School (Figure 2.1, page 24).

What makes outcomes-based education so attractive is its emphasis on the end product.[26] The approach requires that the requisite competencies of a health care provider be specified in the curriculum. It must be noted that the concepts of competencies and outcomes are considered to be similar,[117] and therefore no semantic distinction will be made between these terms.

Outcomes-based education places an obligation on the faculty to continuously consider and debate contentious issues, such as the product the institution intends to produce and the educational processes to be followed to achieve the end product.[26,118] In other words, outcomes-based education can be defined as the application of educational principles and processes that would result in the attainment of institutionally defined competencies required in order to be deemed a capable health care provider.

The architecture of outcomes-based education lends itself to being used as quality assurance and curriculum evaluation tools.[77] This is particularly relevant in the changing global and local environment. Health care delivery has become increasingly complex, and the public, patients and authorities demand value for money. In quality assurance processes, the specified end product is evaluated against that which is specified in the outcomes. The use of outcomes measures for quality assurance purposes has been criticised, as this might result in a situation of unwanted political control.[77] Despite its widespread use, outcomes-based education remains unproven as an effective quality assurance tool.[117]

It is important to note that outcomes-based education is flexible and not prescriptive in terms of the selection of teaching, learning and assessment methods, provided that proposed methods conform to the specified outcomes.[26] Outcomes might hence be knowledge-based or performance-based. Outcomes-based approaches allow for the construction of interim abilities, which are required for the next phase of learning.[119]

On the one hand, the structure provided by outcomes-based approaches is said to be conducive to facilitate self-directed learning, and might even promote integration and continuity between various aspects and stages in the curriculum.[26] On the other hand, claims have been made in the past that the outcomes-based approach is often not robust enough in many medical schools, resulting in graduates who are lacking in some areas of knowledge and skills.[26,120] This might be due to practical difficulties to accurately define outcomes in a medical education context. Comprehensive patient care and complex human behaviour, such as clinical reasoning, are so intricate that they can simply not be expressed accurately as outcomes.[117,121,122] Teachers' conceptions of authenticity might be based on selective or vague constructs of reality.[38] Tacit knowledge[123] will always be unaccounted for. Trained professionals make complex integrated decisions and solve problems in creative ways using their individual integrated knowledge structures. Health professionals are individuals who differ considerably in make-up and in experience. Therefore, decisions and the way they are made, vary considerably between individuals.[117,124]

Despite valid criticism from professional, political, philosophical, psychological and educational perspectives,[77,117,120,124,125] outcomes-based approaches are widely propagated and used in medical education.

Conclusion: Recognition and cognisance of the limitations of the outcomes-based approach are required in areas where it is enforced.

The use of outcomes might only be appropriate in the context of complex learning through the integration of knowledge, attitudes, and skills,[117,124] as required in an authentic situation, through a process of constructive alignment.[20,26,69,119]

3.3.3 The Need for Constructive Alignment in CPC

At the formulation of the research problem it was mentioned that CPC had an outcomes-based curriculum on paper that was aligned with the exit-level outcomes[21] of the undergraduate dental curriculum. The CPC teaching and learning, however, used a didactic content-based approach and knowledge-level assessment which did not align (Figure 2.1, page 24) with the exit-level outcomes.

The alignment of outcomes with teaching, learning and assessment is called constructive alignment.[20] In order to achieve constructive alignment in a curriculum the teaching should aim to develop the skills or embed the knowledge specified in the outcomes.[40] Furthermore, the teaching and learning should prepare the student adequately for the assessment. Obviously the assessment should be based on the outcomes – a process which is often referred to as "blueprinting".[40] If the outcomes are formulated on a knowledge-application level, then the assessment should test how knowledge is applied. Constructive alignment has indeed been shown to be beneficial in terms of educational outcomes.[20]

Conclusion: This review of the literature reinforces the previously expressed need to constructively align the course outcomes (learner objectives)[§§] – derived from the exit-level outcomes – with the teaching, learning and assessment strategies applied in the CPC unit.

The exit-level outcomes of the undergraduate dental curriculum[21] require the students to be able to make integrated diagnoses and formulate a comprehensive treatment plan for their patients. Problem-solving approaches to teaching and learning have been recommended to develop these skills.[6,7,10,21] Based on this recommendation and the conclusion made at the end of paragraph 3.3.1 (page 41), that the students should develop their own knowledge structures through repeated practice, by implication, will require some form of student-centred learning.

3.3.4 The Need for Student-centred Teaching and Learning

A student-centred approach is preferable to a teacher-centred approach for the development of clinical reasoning skills (Figure 2.1, page 24). The educational benefit of a teacher-centred approach is demonstrated in Figure 3.2 (page 45).

A content-based didactic approach is often considered to be a teacher-centred approach[25] which does not give students autonomy in their learning (Figure 3.2, page 45). In other words, the learning process is dependent on what the

[§§] Learner objectives are written expressions of the course outcomes. The concept of learner objectives is addressed in more detail in Chapter 5, paragraph 5.3 (page 97).

teacher has to offer. A teacher-centred approach is often associated with lectures and information gathering.[25] Lectures, without elements of inter-activity, are considered to be a form of knowledge transmission that might result in passive learning.[25,39]

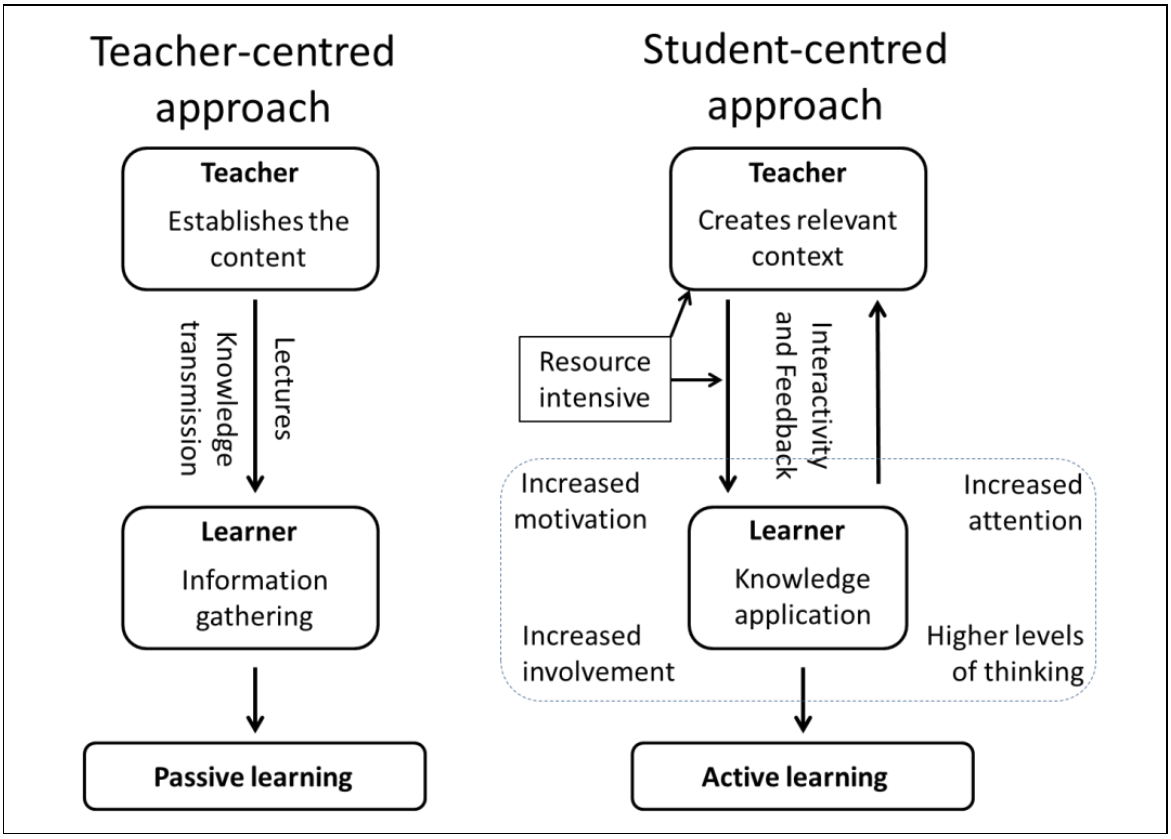

Figure 3.2 A teacher-centred approach versus a learner-centred approach

Students who are actively engaged in the learning process tend to learn more compared to those who listen passively to the information being transmitted.[39] Active learning requires increased motivation, attention, involvement and higher levels of thinking (Figure 3.2, above), which are likely to enhance deep learning.[39] Active learning is more likely to occur if the learner perceives the content to be relevant. Authenticity is indeed central to adult learning.[38] Authentic learning environments imitate the way knowledge and skills are applied in the real world. Such learning environments might include actual or simulated situations that resemble the complexities of life. It should, however, not be assumed that learners perceive the authenticity of a simulated learning environment in the same way that faculty members do.[126] In other words, learning processes are only enhanced when learners perceive the content to be meaningful,[26] and when they engage in authentic learning as part of their own being.[38]

Active learning is usually a two-way feedback process (Figure 3.2, page 45) in that a lecturer receives feedback about the needs of learners, and learners receive feedback about their performance and interpretation of knowledge. Active learning is said to result in increased satisfaction among students and their teachers.[39] However, the teacher-centred approach places fewer resource demands on the educational system than a student-centred approach.[25] Also, the teacher-centred method of instruction is often followed because faculty members are familiar with this teaching strategy.[25,39]

In contrast to a teacher-centred approach, a student-centred approach provides learners with choices, within a given context, in terms of what they want to learn and how they want to learn it.[25] In some instances, students who received teacher-centred education at secondary school might find a student-centred approach at a tertiary institution quite challenging.[25] It is, however, argued that a student-centred approach is more likely to ensure an active learning process when compared to a teacher-centred approach.[25]

Taken at face value it might appear that a pure student-centred approach is ideal to develop clinical reasoning skills. However, it is inconceivable that inexperienced junior dental students could be given autonomy to decide what and how they want to learn as far as teaching and learning in clinical reasoning in a discipline-based, large-group environment is concerned. Case and Swanson[64] point out that course content can be aligned with assessment when guidance is provided in a learning process, whereas a pure student-centred approach might be problematic in terms of assessment when students have to decide themselves what material to cover.[64]

Conclusion: Based on the deliberations above, it can be deduced that a need exists to develop clinical reasoning skills using active learning processes in an authentic context.

The undergraduate dental curriculum indeed recommends the use of active learning approaches, such as problem-solving, for the development of clinical reasoning skills.[6,7,10,21]

3.3.5 The Need for Problem-solving Approaches

Problem-based learning to facilitate problem-solving is a well-established approach in medical education.[69,73,74]

Problem-based learning is grounded in the science of cognitive psychology and is based on the theoretical construct that prior knowledge is activated and elaborated upon through student-centred engagement in the problem-solving of context-rich case studies.[88,127,128] Prior knowledge is retrieved when analysing a problem, which provides the opportunity for elaboration through discussion and the active processing and restructuring of newly acquired information. Since the learning takes place in a relevant context, it will stimulate curiosity, and the retrieval of information will be supported in similar contexts.[127]

Despite criticism of the theoretical basis of problem-based learning and the effectiveness of the strategy,[75,129] empirical evidence suggests that the approach has many educational advantages.[130]

It must be noted that there is no conclusive evidence that shows that problem-based learning significantly increases a student's knowledge base. In addition, evidence indicates only a marginal educational effect in terms of improved clinical reasoning ability when compared with conventional programmes.[75] It was mentioned before that the disadvantage of requiring additional resources for problem-based learning might outweigh its educational benefits.[75]

Harden and Davis[74] proposed a continuum for problem-based learning (Figure 3.3, page 49). They defined "information gathering" and an "authentic task-based approach as the bottom and top ends of the continuum. Using these end points as references,[25,74] Harden and Davis[74] defined a continuum of problem-solving instructional design applications.

Information gathering is considered the least appropriate method of instruction (Figure 3.3, page 49) to facilitate problem-solving, whereas authentic task-based learning is considered the most appropriate in terms of the educational effect.[74]

The other problem-solving instructional design applications lie between the above-mentioned end points[74] and are arranged in the sequence indicated from the bottom up in Figure 3.3 (page 49).

- *Problem-orientated learning* is situated just above the information-gathering approach. Problem-orientated learning employs a clinical context as part of the lecture. In problem-orientated learning, the emphasis is on the lecture, but practical information is conveyed to the learners.[74]

- The next least effective method on the continuum is *problem-assisted learning*. In problem-assisted learning the lecture is complemented by a problem or a case study to provide the student with some experience.[74]

- *Problem-solving learning* follows problem-assisted learning and includes activities such as case discussions without concentrating on the underlying theory.[74]

- *Problem-focused learning,* in turn, is similar to problem-assisted learning (lecture followed by a case), but includes a third step where students explore different contexts in which they could apply the newly acquired knowledge.[74]

- The *problem-based mixed approach* is the next methodology on the continuum. In this approach, students are given the option to decide whether they want to use the theoretical background or the problem as the starting point of the learning. This approach might be a logistical nightmare in a large-class context.[74]

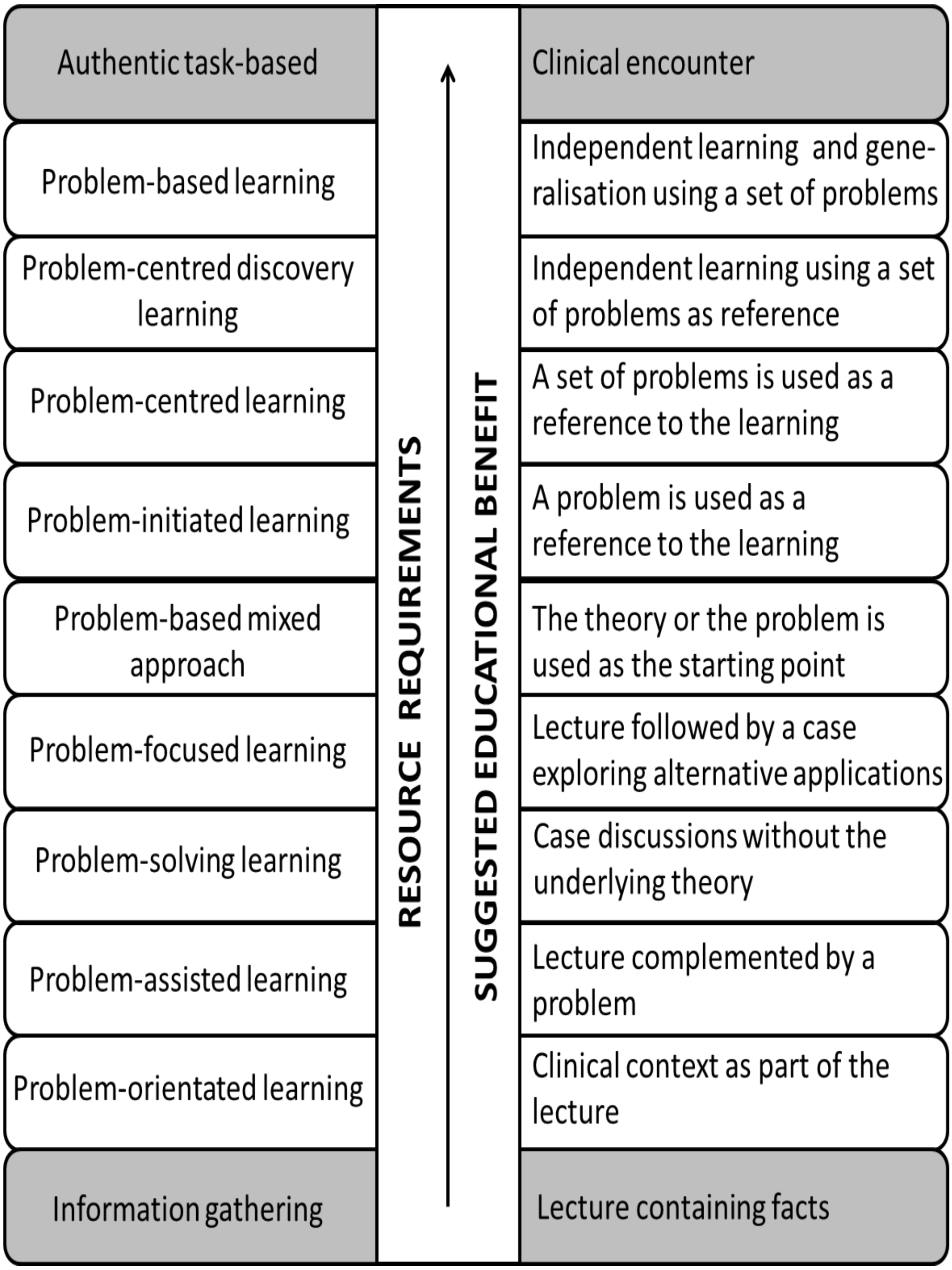

Figure 3.3 A continuum for problem-based learning[74]

- In *problem-initiated learning* a problem is deliberately used to promote interest in a certain topic and to kick-start the learning.[74]

- *Problem-centred learning* uses a set of problems as a reference to the learning, followed by an information session related to the problem.[74]

- *Problem-centred discovery learning* is similar to problem-centred learning, but affords the student the opportunity to explore learning in an independent fashion.[74]

- The last approach before authentic task-based learning is *problem-based learning*, which is similar to the two preceding methods, but additionally requires learners to generalise their learning by applying it in other situations.[74]

Harden and Davis[74] argue that by moving from information-gathering towards problem-based learning on the continuum (Figure 3.3, page 49), the problem becomes increasingly more relevant, thereby challenging the student to engage in discovery learning. Moving up the continuum towards problem-based learning places increased strain on resources, such as time and finances.[74] By moving up in the continuum students have to spend more time on the gathering of information resources and the interpretation thereof, which has to be supported by competent faculty members.[74] The selection of a method of instruction should therefore include an appraisal of what is practical and feasible in the internal context.

In terms of the proposed intervention in CPC, a need was expressed to increase the relevance and active participation of students in the learning process.

Conclusion: This literature review supports the view that the move should be away from the information-gathering approach in CPC (Figure 2.1, page 24), and that one of the “problem-based” teaching and learning applications higher up in Harden and Davis’s continuum[74] should be introduced, depending on the availability of institutional resources.

Learning through problem-solving in an authentic context, by default, means that information across disciplines should be integrated.

3.3.6 The Need for an Integrated Case-based Approach

The need for the improvement of integration in the discipline-based undergraduate dental curriculum was established earlier in the thesis (Figure 2.1, page 24).

According to the literature, integration of knowledge takes place on two conceptual planes,[10,25,68,131] namely horizontal and vertical. Horizontal integration – indicated by the horizontal arrow in Figure 3.4 (below) – refers to the integration of knowledge gained in different disciplines more or less at the same time. Vertical integration – indicated by the vertical and diagonal arrows in Figure 3.4 – refers to the integration of prior knowledge with current knowledge, and to the addition of new knowledge as time progresses.[10,25,68,131]

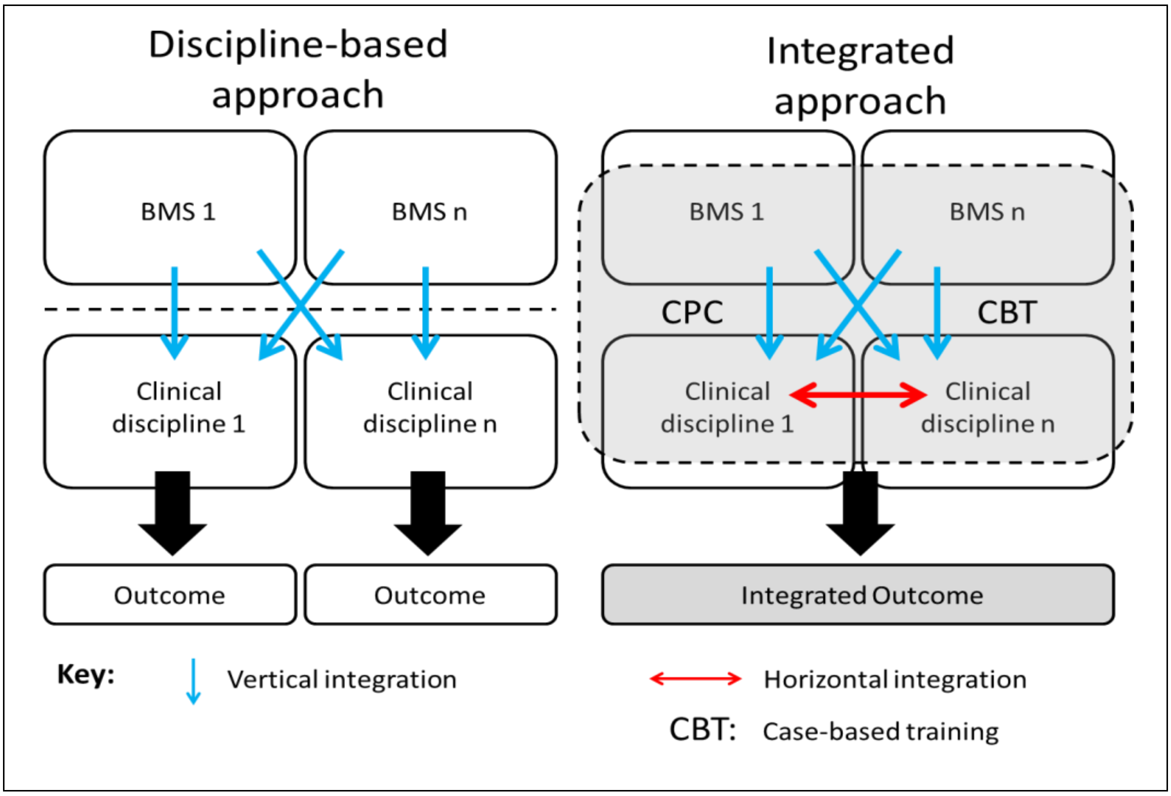

Figure 3.4 A discipline-based approach versus an integrated approach

The case-based instructional design system,[10] which was proposed when discussing the context of the study in Chapter 1 (page 4), would, for example, provide an ideal opportunity for students to apply their clinical reasoning skills through an integrated approach in a relevant context. The fact that the case-based instructional design system was not implemented in CPC as a problem-solving knowledge integration strategy[6,7,10] meant that the development of clinical reasoning skills still remained the responsibility of the various discipline-based modules (Figure 1.1, page 2) – a situation that might be problematic as far as knowledge integration is concerned. Inherently, discipline-based clinical teaching and learning tends to focus on the outcomes of the applicable subject only (Figure 3.4, page 51). This fragmented way of learning might result in the loss of the "bigger picture"[31] when clinical treatment decisions are made.

Conclusion: The need to improve the integration of knowledge across disciplines[10] in the undergraduate dental curriculum has therefore been corroborated by this literature review.

The proposed case-based instructional design[10] – indicated by the grey overlay in Figure 3.4 (page 51) – would be an ideal platform for integrated learning in the undergraduate dental curriculum, using a student-centred approach.

Case-based teaching is commonly used in dental education to integrate different disciplines in dental curricula.[132,133] Empirical evidence suggests that dental students who are exposed to interdisciplinary case-based dental teaching and learning have a better comprehension of the complexities of clinical decision-making compared to students who do not have the same exposure.[134]

"Good" case studies are constructed to be realistic, relevant, challenging, engaging and educational.[135] One of the big differences between case studies and authentic clinical cases is the fact that virtually all the information is provided in a case study,[136] whereas the information in an authentic case has to be sourced. Only parts of the information might therefore be available in the authentic case, requiring the student to investigate further.

Although case-based teaching and learning will be second best to true clinical experience, it is recognised as a useful alternative to teach clinical reasoning mainly because of the fewer demands it places on resources.[133,137] This is particularly relevant in the relatively resource-constrained undergraduate dental curriculum.

Conclusion: The previously expressed view that "authentic" case studies can be employed in CPC to develop clinical reasoning skills has therefore been corroborated by the literature review.

It has indeed been suggested in the literature that case-based teaching and learning can foster critical thinking and develop decision-making skills through student-centred teaching and learning.[138] Such methods of teaching and learning will however require appropriately designed learner support to assist the cognitive development of the students and to systematically overcome complexity in the learning process.[31,36]

3.3.7 The Need to Manage and Support Cognitive Development

The theory that the cognitive development of students happens in stages[29,30] was highlighted during the identification of the problem in Chapter 1. This theory implies that students generally find it challenging to move from one learning context to another,[29] especially between the preclinical year and the first year of clinical teaching and learning.[32-34] The uncertainty of the transfer between the two contexts arises from the different skill requirements for preclinical and clinical teaching and learning.[29,32] Inherently, clinical teaching and learning will place higher demands on clinical reasoning compared to preclinical teaching and learning. These theories are supported by previous reports in the literature that fourth-year medical[32,35] and dental[32-34] students find it hard to apply their acquired knowledge when they are suddenly confronted with complex clinical cases.

Ideally inexperienced students should first be exposed to less complicated cases. Unfortunately, there is no reliable source of simple cases available in the

School of Dentistry. The patients who attend the clinics at the School are often unable to afford health care[78] and are consequently dependent on state services such as the services provided by the School of Dentistry.[53] Epidemiological evidence shows that the most common dental diseases are not only most prevalent among lower socio-economic classes,[139-141] but that the disease levels also tend to be more severe.[140,141] The reality therefore remains that fourth-year dental students will have to be prepared for complex clinical cases during preclinical teaching and learning.

A typical CPC patient encounter in the fourth year of study requires the integration of multiple complex skills, such as relational communication-, interviewing-,[12,15,16] comprehensive clinical examination-,[12] diagnostic-, patient administration- and treatment planning skills[21] (Figure 1.4, page 6). The application of these complex skills – without prior practice – might be challenging to a novice. To exacerbate the inherent complexity of the situation even further, a dental disease or condition rarely occurs in isolation. An adult person potentially has from nought to 32 teeth (Figure 3.5, page 55), and each tooth can be divided into five crown surfaces which contain one or multiple roots. Even the surrounding soft tissues can be demarcated into different anatomical structures or sites.

Each of these sites, or combination of sites, might be affected by dental disease in varying degrees. The completion of records as illustrated in Figure 3.5 (page 55), is inherently a complex psychomotor exercise, and its interpretation is not easy either. Furthermore, the treatment plan decisions based on these records might depend on the psychosocial status of the patient.[84,142] Typically, a learner has to integrate all of the above-mentioned information to effectively manage the patient comprehensively.

The literature indicates that it is not the aggregate of knowledge that separates the expert from the novice, but rather the depth of the knowledge.[92] The loose strands of information in the mind of the novice must first be connected in a long and slow process to eventually lead to the attainment of “clinical wisdom”.[143]

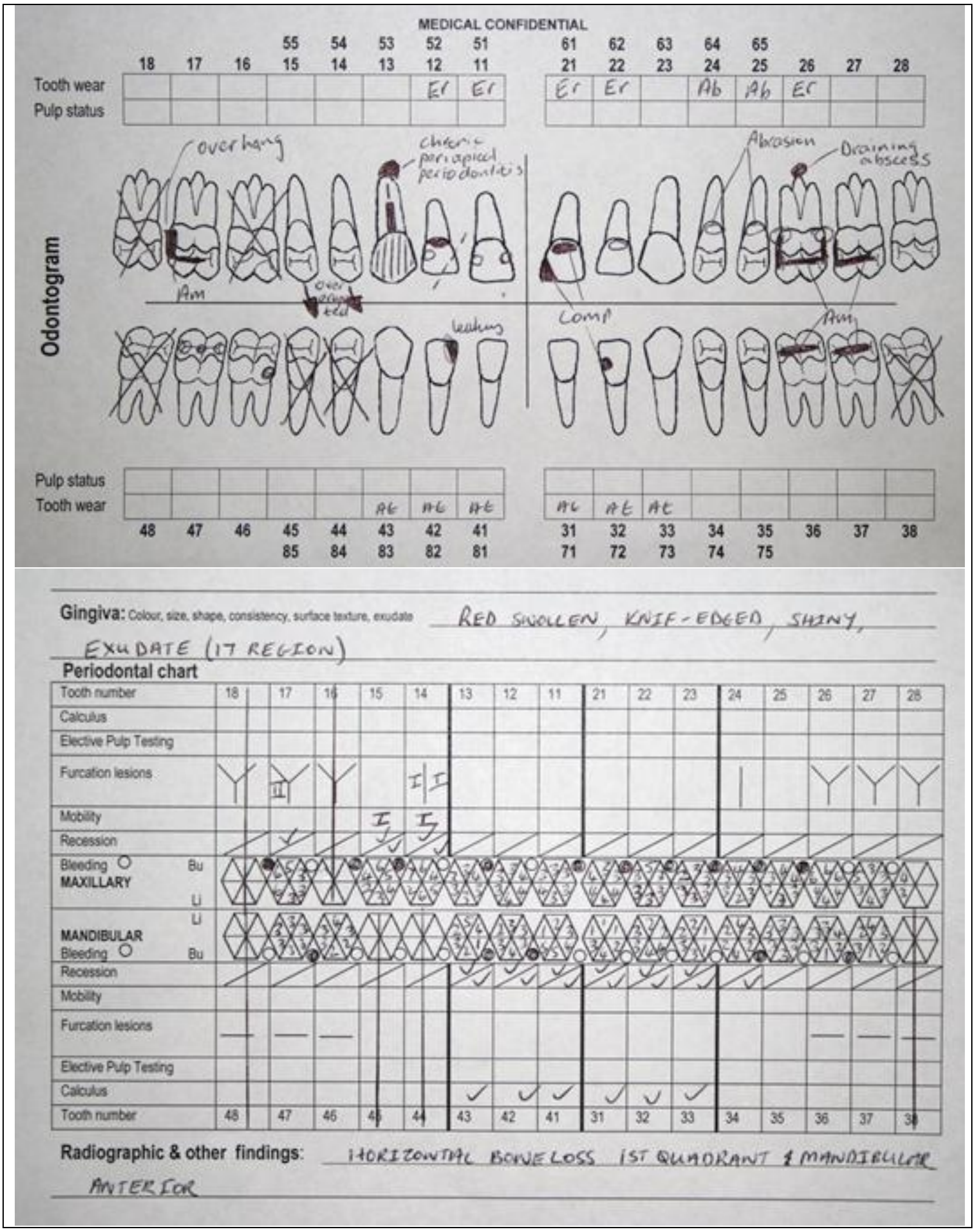

Figure 3.5 A typical CPC patient record with complex disease patterns

The decisions that health care workers have to make on a daily basis are inherently complex,[121,122,144-147] and a novice, such as a dental student engaging in complex clinical reasoning for the first time, will find this overwhelming by default. For years, students have been trained in a preclinical setting to perform technical dental procedures that are guided by strict sets of rules. The question should therefore be asked why dental students are not exposed to clinical reasoning in context at an earlier stage. Certainly clinical reasoning is substantially more complex than most technical procedures. The literature indeed recommends that students be given recurrent and broad exposure to similar clinical situations to enable them to apply clinical reasoning meaningfully in a real-life context.[49,65,108-110,116]

Conclusion: A need therefore exists to repeatedly expose students to authentic clinical cases, and to put appropriate learner support measures in place to prepare preclinical third-year students for clinical teaching and learning in the fourth year of study.

Educational theory related to cognitive development indeed suggests that educational interventions may be necessary that would enable the development of knowledge structures, appropriate for the next level of learning.[29,31,36]

Models employed to develop complex skills, such as the skills required in CPC, should therefore make provision for the growth of a novice – in this case the third-year dental student – to eventually become an expert dentist. Two such models were found in the literature, namely, the spiral curriculum[148,149] and the 4C/ID-model for complex learning.[31]

Teaching and learning strategies designed in the form of a spiral curriculum can accommodate complex learning. The design makes provision for skills development by reinforcing and integrating existing knowledge through a logical sequence of instruction that can be systematically aligned with the different study years of the course.[148,149] The application of a spiral curriculum has been reported frequently in a medical education context.[150-154] The design can be particularly useful for case-based or problem-based teaching and learning.[148]

Van Merriënboer *et al*[31] proposed the 4C/ID-model for complex learning based on instructional design and learning theory. The 4C/ID-model[31] has all the properties of a spiral curriculum,[148] but offers considerably more detail to the instructional designer than the spiral curriculum does. The model provides instructional design strategies[31] that could be employed to develop complex skills in logical and structured ways.

Figure 3.6, below, demonstrates the four fundamental components of the 4C/ID-model, namely a whole-task approach, a part-task approach, just-in-time (JIT) information and supportive information. The JIT and supportive information components provide scaffolding during the learning process, which acts as support to the student.

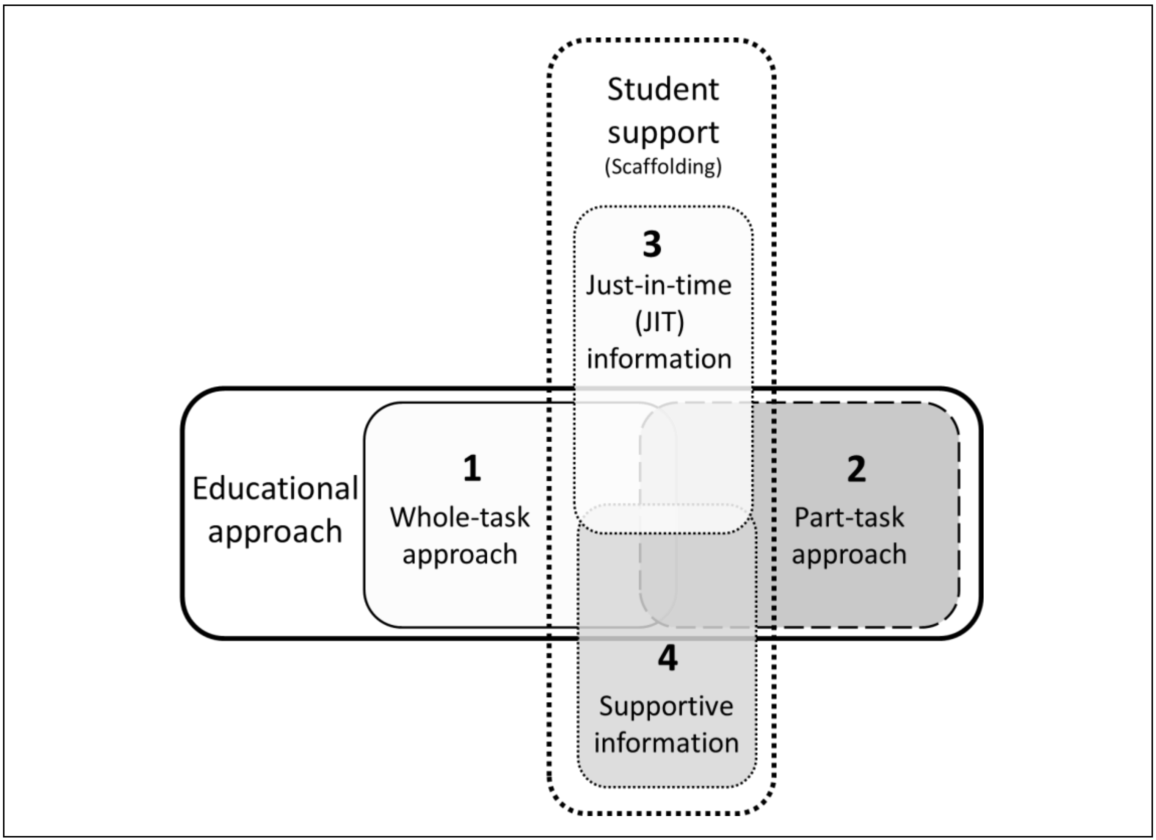

Figure 3.6 The fundamental components of the 4C/ID-model for complex learning[31]

The whole-task approach will be described first.

3.3.7.1 The Whole-task Approach

The first fundamental component of the 4C/ID-model (Figure 3.6, page 57), the whole-task approach, addresses a problem or a task in its entirety (Figure 3.7, below). In the context of CPC the task can be defined as a CPC patient encounter, which typically includes the elements of the CPC approach (Figure 1.4, page 6). A whole-task approach is more likely to ensure a better understanding of the broader context and is also more likely to foster improved integration as opposed to a fragmented part-task approach.[31]

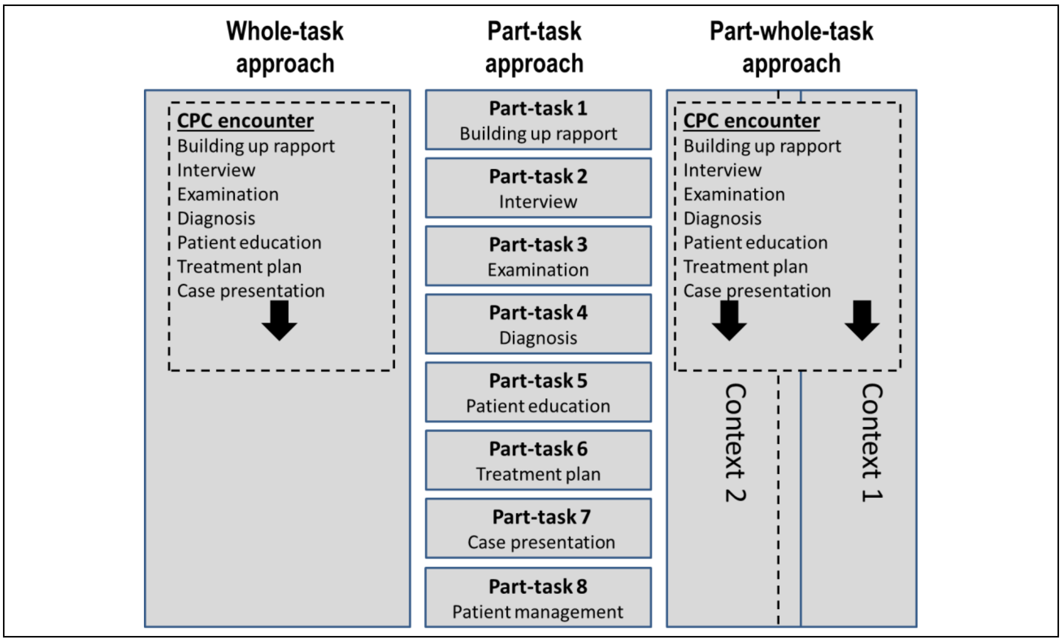

Figure 3.7 Diagrammatic illustration of whole-task, part-task and part-whole-task approaches[31]

In Dentistry a clinical encounter with a patient, which includes various aspects, such as building up rapport with the patient during the interview, a dental examination, making a diagnosis, patient education, treatment planning, the treatment plan presentation to the patient, and management of the patient (Figure 1.4, page 6) could be defined as a whole task. The disadvantage of the whole-task approach is that a situation might arise where learners, while still being novices (such as junior students), experience cognitive overload due to the magnitude and complexity of the task.[31] As previously mentioned in Chapter 1 (page 10), cognitive overload refers to a state where the working memory cannot handle the amount of knowledge the learner is bombarded with at one time, which leads to a breakdown in learning processes.[31]

Tasks in the whole-task context are defined as relevant developmental exercises designed firstly to construct new knowledge based on the non-recurrent (novel) attributes of the learning, and secondly to partly assist in the automation of the recurring aspects.[31] Tasks may be designed in the form of case studies or real-life problems.[31]

Whole tasks can be categorised into *task classes* (Figure 3.8, below), which can be defined as a hierarchical construct, whereby tasks are placed on a continuum from novice to expert based on their level of complexity.[31] Each task class may contain one or more tasks. The tasks within each task class should ideally contain a large variety of attributes but have to be on a similar level of difficulty.[31] An example of a lower order task class might be a simple case study during preclinical teaching and learning, whereas higher order task classes might constitute patient encounters in a clinic setting.

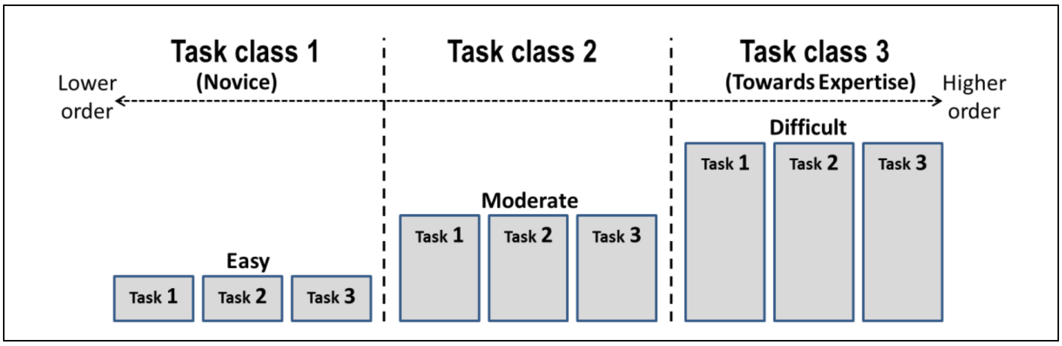

Figure 3.8 The hierarchical construct of the task-class concept[31]

3.3.7.2 The Part-task Approach

The second fundamental component of the 4C/ID-model (Figure 3.6, page 57), namely the part-task approach, can be defined as a process where the whole-task design is broken down into smaller parts (Figure 3.7, page 58) to ensure that the learners master the subject matter through repetitive exercises. Part-task teaching and learning should focus on specific tasks, especially where the desired outcome could be achieved by simply following the steps or the rules.[31] It can be argued that most of the clinical dental procedures fall in this category. In the CPC approach (Figure 1.4, page 6), this teaching and learning can typically be equated with practising each of the steps, namely, building up rapport during the interview with the patient, the dental examination, diagnoses, patient education, treatment planning, the treatment plan presentation to the patient, and patient management, in isolation (Figure 3.7, page 58).

Part-task exercises are specifically designed to automate and to strengthen isolated recurring aspects of the learning in order to achieve high levels of automation. Overtraining is sometimes required to ensure that a specific skill becomes fully automatic.[31] This recommendation of the 4C/ID-model relates to the School's use of minimum quotas for clinical teaching and learning.[27] Repetitive teaching and learning should initially focus on accuracy, followed by accuracy and speed, and subsequently accuracy and speed subjected to time pressures.[31]

Although the method might be useful to teach students relatively simple tasks, the part-task approach is not ideal in a situation where highly complicated situations are encountered.

The best time to introduce a part-task is after the introduction of the task in its entirety to ensure that the context of learning is understood. The best method to utilise part-task exercises is by means of distributed practice, in other words, spreading learning opportunities over long periods of time (intermixed teaching and learning). Such an approach allows learners to relate the specific recurrent skill to the whole-task context over time. Long, concentrated periods of part-task teaching and learning (massed practice) yield less effective results.[31]

A part-task approach might lead to a situation at the end of the course where it is merely hoped that the learner will be able to lump all the smaller parts together to achieve integration. Using a part-task approach, the risk is high that the learners might not understand the broader context of the learning, hence the learning processes might be impeded.[31]

Unlike other instructional design models, the 4C/ID-model is flexible by making provision for the use of a combination of whole-task and part-task approaches to facilitate learning in a broader context. In the case of highly complex scenarios, a part-whole-task approach[31] (Figure 3.7, page 58) can be used to break up the required learning into two or more smaller parts. Whole-task principles are however maintained in the process.[31]

3.3.7.3 JIT Information

The third fundamental component of the 4C/ID-model (Figure 3.6, page 57), namely JIT information, can be defined as procedural (step-by-step) information that is required to complete the recurring aspects of a task. It can also be defined as providing specific information exactly at the time when the information will be used.[31]

Initially, learner support (scaffolding) may be provided within each of the task classes, but the support should be decreased gradually as proficiency increases (Figure 3.9, page 62). This approach is called “scaffolding” (See also Figure 3.6, page 57).[31] Primarily, two types of support can be provided, namely process-orientated support and product-orientated support. The current section is devoted to process-orientated support provided on a JIT basis, while product-orientated support will be described in the next section under the heading "Supportive Information" (paragraph 3.3.7.4).

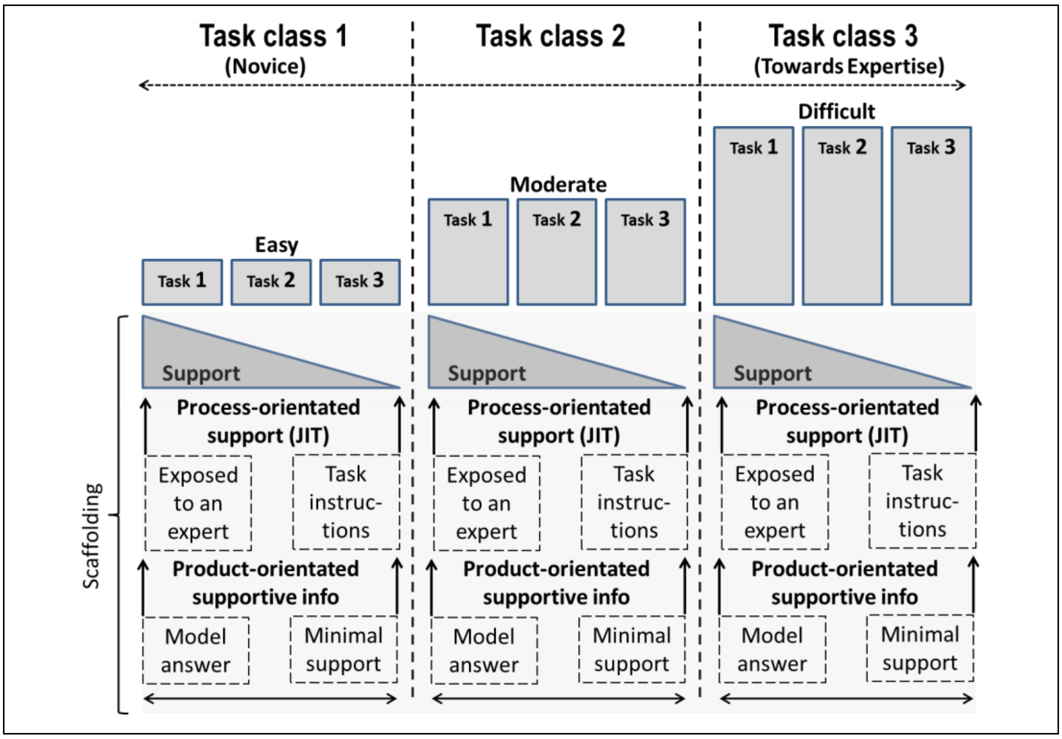

Figure 3.9 Scaffolding – process-orientated and product-orientated support[31]

Process-orientated support (Figure 3.9, above) can be placed on a continuum.[31] At the one extreme, process-orientated support might be provided by exposing the learner to an expert in the process of solving a case or a problem (also referred to as role modelling). This type of support is generally not feasible on a constant basis in resource-constrained environments. At the other extreme, minimal performance support structures can be provided in the form of process guidelines (task instructions) in the assignment. These guidelines might be accompanied by performance constraints, for example, learners might be instructed not to proceed to the next step until the preceding step is completed. An example in the context of clinical reasoning might be that the diagnosis should precede the treatment plan. Performance support structures and performance constraints should ideally be designed according to systematic approaches to problem-solving, based on cognitive task analysis as performed by experts.[31] It was however established in paragraph 3.3.1 (page 37) that generalisable approaches to problem-solving in the context of teaching and learning of clinical reasoning in a classroom setting do not exist.

Students may be exposed to experts, or be given task instructions, either using whole-task (paragraph 3.3.7.1, page 58) or part-task approaches[31] (paragraph 3.3.7.2, page 60). The repetitive nature of process-orientated support – provided as JIT information – allows for it to be faded after a while as students become acquainted with the sequential order of the steps of the task.[31]

Having elaborated upon the first scaffolding method described in the 4C/ID-model, namely JIT information, the next section explores the second scaffolding concept, namely "supportive information".[31]

3.3.7.4 Supportive Information

The fourth fundamental component of the 4C/ID-model (Figure 3.6, page 57) is supportive information.

Supportive information is a form of product-orientated support (Figure 3.9, page 62), proposed by the 4C/ID-model. Product-orientated support can be defined as the provision of content-related information to the student that will help to attain the "product" of the teaching and learning.[31] The "product" referred to in the context of this study is diagnosis and treatment planning.

High-level product-orientated support can be provided to the learners by way of a case study with a model answer (Figure 3.9, page 62).[31] This method will help learners to conceptualise how the area of study is organised. When using high-level product-orientated support it might be desirable to incorporate some "wow factor" or controversy into the case study in order to ensure that learner interest is maintained and that deep processing is attained.[31]

At the other end of the continuum the learners have to solve the case study themselves with no or minimal support (Figure 3.9, page 62), and this by default requires deep processing and the induction of mental modelling. However, if the novice receives no support, this last method might result in situations of cognitive overload (also refer to page 10) and the subsequent breakdown of the learning process.[31]

Similar to process-orientated support (Figure 3.9, page 62), product-orientated support can be diminished within a task class as proficiency increases following the establishment of new knowledge structures.

On the basis of the deliberations above, supportive information can be defined as the bridge between existing knowledge (Figure 3.10, below) and new knowledge required for the task at hand.[31]

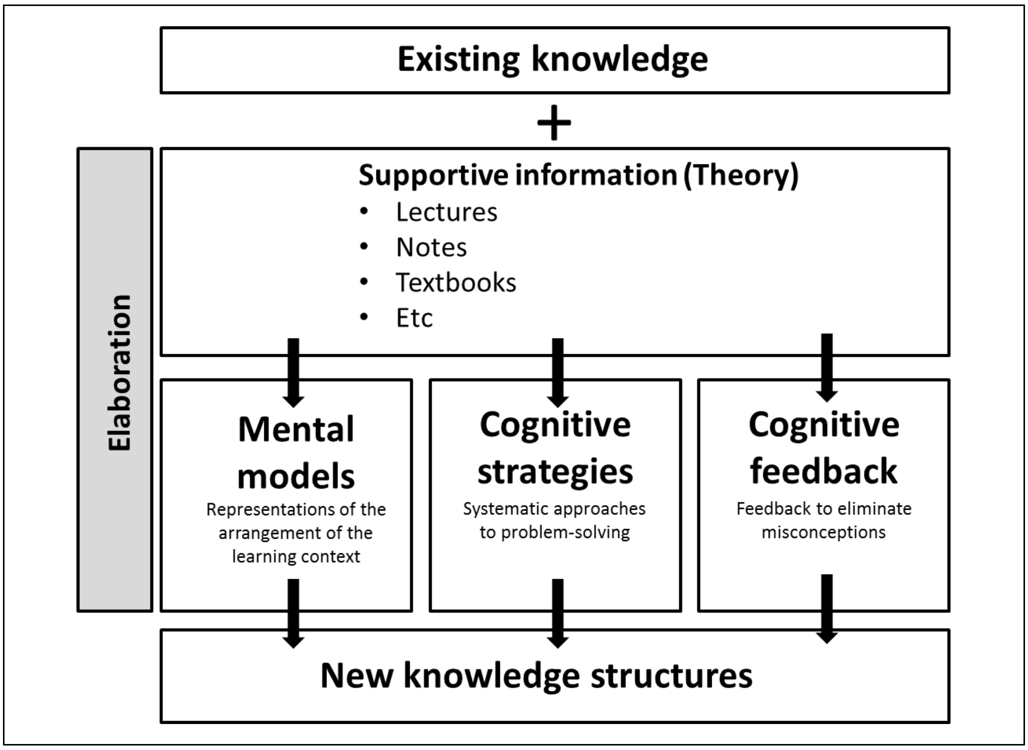

Figure 3.10 Supportive information – the bridge between existing and new knowledge[31]

Supportive information may be provided to the student in the form of textbooks, lectures, notes and/or other forms of information (Figure 3.10, page 64) related to the task at hand.[31]

Supportive information can be divided into three categories, namely, support related to the formation of mental models, support in order to develop cognitive strategies, and cognitive feedback (Figure 3.10, page 64). [31] New knowledge is constructed by providing support – in the above-mentioned three categories – in combination with the elaboration of previously encountered knowledge (Figure 3.10, page 64).[31]

The following sections will address the three categories of supportive information systematically. Mental models will be addressed first, while cognitive strategies and cognitive feedback will only be dealt with much later, towards the end of this section.

Mental models are representations of the arrangement of the learning context and may comprise both abstract and general knowledge. Such models may include concrete cases that represent this information.[31] Mental models are divided into three interrelated subcategories (Figure 3.11, below), namely, conceptual models, structural models and causal models that enable qualitative reasoning within a specific learning context.[31]

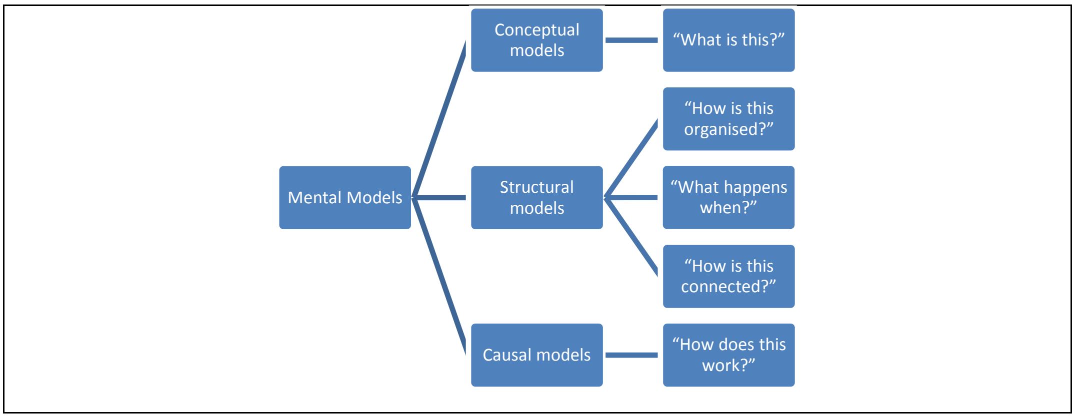

Figure 3.11 Mental models[31]

Conceptual models (Figure 3.11, page 65) answer the question: "What is this?". It is a representation of how objects or concepts are classified.[31]

Structural models (Figure 3.11, page 65) answer the questions: "How is this organised?"; "What happens when?"; and "How is this connected?". Structural models contain illustrations of how concepts relate to each other, which might be useful to understand or predict behaviour and to identify the required elements of a design.[31]

Causal models (Figure 3.11, page 65) answer the question: "How does this work?". Causal models represent how concepts influence each other, which might help with understanding processes, explaining occurrences, and predicting what will happen in the future.[31] In the context of clinical reasoning these abstract models may relate to understanding the aetiology and pathogenesis of diseases, making diagnoses, determining prognosis and risk of future disease, planning treatment and sequencing treatment plans (Figure 3.12, below).

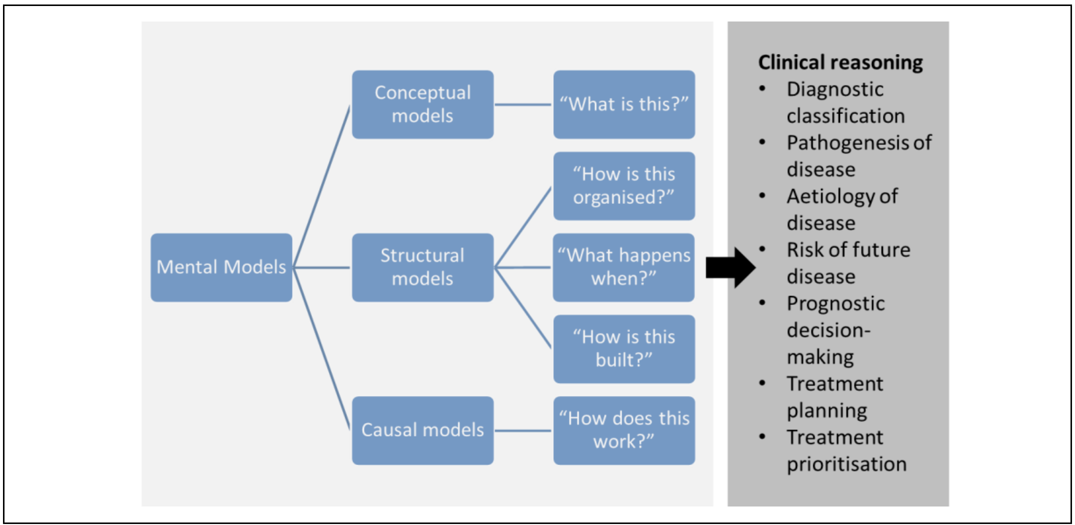

Figure 3.12 Association between mental models and clinical reasoning[31]

Different instructional designs are appropriate to embed conceptual, structural and causal models in the mind of the student.[31] The 4C/ID-model specifically differentiates between didactic approaches and real-life simulation (Figure 3.13, page 67). Didactic approaches will be addressed first, and real-life simulation will be examined later in this section.

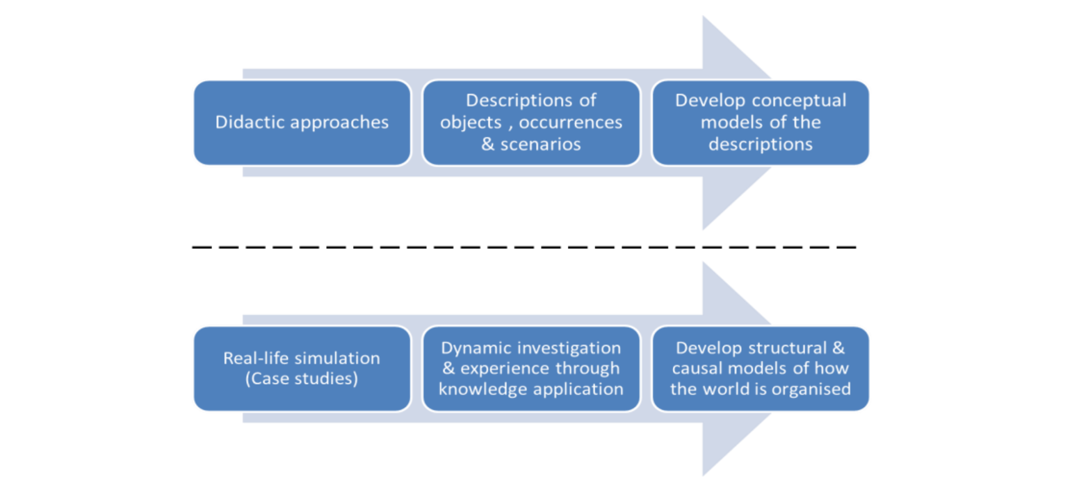

Figure 3.13 Distinction between didactic approaches and real-life simulations[31]

Didactic approaches, such as descriptions of objects, occurrences or scenarios, result in the formation of conceptual models of these descriptions (Figure 3.13, above).[31] A didactic approach to teaching and learning is considered to be a deductive instructional design (Figure 3.14, page 68). Deductive teaching and learning strategies are used when the theory is thoroughly addressed before engaging in an authentic task (for instance, a case study) at a later stage.[31] Didactic approaches are synonymous with a teacher-centred approach, “information gathering” and the likelihood of passive learning (Figure 3.2, page 45).[25,39] Examples of didactic teaching and learning approaches in the context of the current study are the teaching and learning strategies, lower down in the continuum for “problem-based” learning, as defined by Harden and Davis (Figure 3.3, page 49).[74] This can be related to the lecture-based teaching and learning in CPC observed by the researcher in 2007 and 2008. Deductive teaching and learning strategies are only indicated if time is limited and a deep understanding of the content is not absolutely necessary.[31]

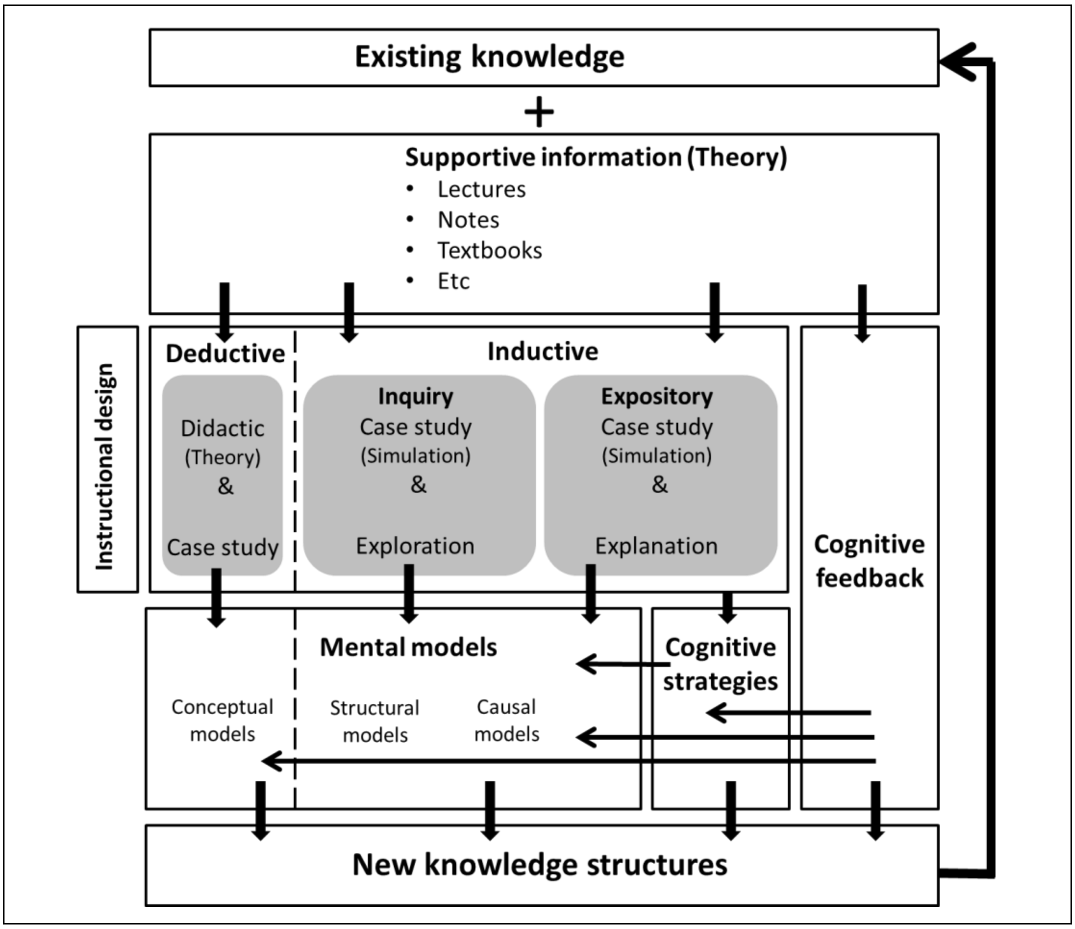

Figure 3.14 Deductive and inductive instructional designs[31]

Didactic approaches are not optimal to embed structural and causal models (Figure 3.11, page 65) in the mind of the student.[31] Teaching and learning based on real-life simulations (Figure 3.13, page 67 and Figure 3.14, above) – for example, by means of case studies – are, however, likely to result in the establishment of structural and causal models in the learner's mind.[31] The use of simulations, such as case studies, primarily assists the learner to form mental models of how different concepts relate to each other through a process of dynamic investigation, and secondary to this, it provides experience through the application of knowledge.[31] An instructional design that depends on simulation practices where the learners explore a problem by means of a student-centred approach[25,39] (Figure 3.2, page 45) – for example, the teaching and learning strategies higher up in the "problem-based" continuum proposed by Harden and Davis (Figure 3.3, page 49)[74] – relates to inductive teaching and learning strategies (Figure 3.14, page 68). These strategies might result in deep learning, but might be much more time-consuming than deductive strategies.[31] According to the 4C/ID-model there are two inductive teaching and learning approaches, namely inquiry and expository methods (Figure 3.14, page 68).[31]

Inquiry methods (Figure 3.14, page 68) are especially suited to establish knowledge relationships required for the formation of structural and causal models in the mind of the student. Inquiry methods require students to discover the elements of learning themselves, and in this way they add new knowledge onto existing knowledge structures and create new knowledge structures. By asking the students to answer a question, the inquiry-based learning process becomes a method of guided discovery. Ultimately, it is the guiding question that helps the learners to establish the organised links between the knowledge elements.[31]

Knowledge connections can also be established through expository methods (Figure 3.14, page 68), whereby the links are unambiguously explained to the students after exploration.[31]

Of the two inductive methods namely, inquiry-based and expository methods of conveying supportive information (Figure 3.14, page 68), inquiry-based learning is likely to be more appropriate than expository methods to establish new knowledge structures, but will also be the most time-consuming. Compared to expository methods, inquiry methods will be more prone to cognitive overload (also refer to page 10) without adequate scaffolding.[31,36] The 4C/ID-model generally recommends that the inductive-expository strategy be employed to facilitate learning with students who have limited prior knowledge.[31] This strategy is considered to be practical and time-efficient because it starts with a concrete recognisable case study, after which the relationships between the various aspects of the case study are explained in detail to facilitate the formation of mental models.[31]

The construction of the first category of support, namely, the provision of supportive information, in order to develop mental models, has been addressed up to this point in this section. The second category of support, namely, the provision of supportive information with the aim of developing cognitive strategies (initially referred to on page 65) is addressed next.

Cognitive strategies (Figures 3.10, page 64 and 3.14, page 68) can be defined as systematic approaches to problem-solving.[31] These approaches refer to a sequence of processes used to solve a problem. An example of a supportive information method in this instance might be the provision of a flowchart explaining the steps to solve a problem. Cognitive strategies are highly abstract, hence the 4C/ID-model only suggests an inductive-expository approach.[31] It was mentioned earlier in the chapter that the use of clinical reasoning strategies vary considerably, even amongst experts. Therefore, no validated clinical reasoning process exists.[86] The only cognitive strategies that are validated are active (hypothetical-deductive[95]) and passive (pattern recognition[94]) reasoning strategies applied by clinicians for diagnostic purposes. There are no known teaching methods to generically develop these strategies in the medical or dental education in a classroom setting. Support in this regard, in the context of this study, will therefore be merely incidental and by default be based on the experience and knowledge of the teacher.

The feedback provided during the task, or after the completion of a task, is the third and final category of supportive information (initially referred to on page 65).[31] This type of feedback is termed cognitive feedback (Figures 3.10, page 64 and 3.14, page 68) in the 4C/ID-model[31]. The purpose of cognitive feedback is to eliminate misconceptions with regards to the development of mental models and cognitive strategies. [31] Properly designed feedback processes have the potential to motivate learners to reflect on their knowledge and performance. [31] This, in turn, will allow for the development of mental models and cognitive strategies in order for new knowledge to be constructed.[31]

The sections above explained how supportive information[31] contributes to the development of knowledge structures in the 4C/ID-model for complex learning.[31]

The 4C/ID-model for complex learning has not been applied in a dental teaching and learning environment before. The fact that the 4C/ID-model makes provision for a developmental approach and is suited for case-based teaching and learning makes the model suitable for application in the CPC unit. The model appears to be particularly suitable for the development of integrated clinical reasoning skills, using case-based teaching and learning and a problem-solving approach. However, faculty will always have to consider the resources that are available for these processes.

Conclusion: This literature review confirms the view that the instructional design for CPC should make provision for the systematic development of reasoning skills in an authentic context, complemented by adequate feedback and learner support. On the basis of the deliberations above, the proposal to use the 4C/ID-model (paragraph 2.3, page 24) as conceptual model for CPC has been corroborated.

The identification of a model to manage the complexity of clinical decision-making in an authentic or simulated environment concludes the review relating to teaching practices. The following section will concentrate on assessment.

3.3.8 The Need for Valid Assessment

The educational processes and assessment followed in CPC showed a lack of constructive alignment with the course outcomes and the exit-level outcomes of the undergraduate dental curriculum (Figure 2.1, page 24). Furthermore, it was shown that knowledge-based assessment was used in CPC to assess clinical reasoning skills. Formative feedback was also lacking in the learning process. A need therefore existed to design and implement valid assessment practices

(Figure 2.1, page 24) as part of the educational intervention that will contribute to learning.

Assessment stands at the centre of effective learning.[5] It has been argued by some[5] that assessment drives and encourages learning.[5] From the perspective of the teacher, assessment provides management information regarding the effectiveness of the educational processes.[5] From a societal point of view, assessment is very important to ensure that graduates are competent to render health care services to the public.[5,155] Society's high expectations require defendable assessment practices to be applied at training institutions.

3.3.8.1 Principles for "Good" Assessment

According to Norcini *et al*[5] there are seven principles for good assessment, namely, validity, reproducibility, equivalence, feasibility, acceptability, educational effect and catalytic effect:

- <u>Validity</u>: The ability of a test to measure what it intends to measure is termed validity. The assessment is done in a way to ensure coherence or inclusion of the various aspects of the skill being tested.[5]
- <u>Reproducibility</u>: Reproducibility, often referred to as reliability[40], can be defined as the ability of a test to consistently render the same results when administered under the same circumstances on different occasions.[5,40] This might be affected by the judgements of the examiners, the cases employed, the test conditions, and the anxiety levels of the students.[40]
- <u>Equivalence</u>: Equivalence is the ability of a test to yield an equal outcome between different cycles of assessment or across institutional boundaries.[5]
- <u>Feasibility</u>: Practicalities such as time and resources determine what is feasible, or not, in terms of assessment.[5]
- <u>Acceptability</u>: Stakeholders should be in agreement about the process and must regard the results as credible.[5]

- Educational effect: Ideally, the methods of assessment should inspire the learners to adopt an approach that is beneficial to learning.[5]
- Catalytic effect: Assessment results and feedback should support the educational process by driving learning forward.[5]

To ensure quality in the educational process, the above-mentioned principles should be strived for in both formative and summative assessment practices.

3.3.8.2 The Need for Formative Assessment

Formative assessment is designed to provide the learner with feedback during teaching and learning processes, hopefully stimulating the learner to elaborate on existing knowledge.[5] Formative assessment is synonymous with cognitive feedback as described in the 4C/ID-model[31] (Figure 3.14, page 68). Due to its proximity to the learning process,[31] formative assessment is very likely to have a strong educational and catalytic effect to drive learning forward.[5]

Formative assessment might, however, be weak in terms of reliability. This lower reliability can be ascribed to the variability of the situation, such as different assessors and different situations in the clinical context. However, formative assessment can be designed to address the individual learner's needs as well as the needs of an entire group. Formative assessment should therefore be built into teaching and learning processes to facilitate growth in student knowledge and competence. Formative assessment can be used in combination with summative assessment but should ideally complement summative assessment practices.[5]

3.3.8.3 The Need for Summative Assessment

Summative assessment is done for quality assurance purposes. The student's competence is graded to determine the amount of knowledge, skills and values learned. Summative assessment often determines progression to the next level of teaching and learning or graduation. Validity, reproducibility, equivalence, feasibility and acceptability are therefore of critical importance in any test design with a summative purpose.

Although summative assessment might have an educational effect, it is doubtful whether it contributes much in terms of a catalytic effect to drive further learning forward. Assessors should always be wary that summative assessment does not cause an inappropriate educational effect. For example, if students are aware that clinical competence will be measured by means of knowledge-level questions, then the educational effect might be rote learning and the memorisation of unrelated facts, which do not result in clinical competence. Therefore, a need exists to perform summative assessments at the most appropriate, yet feasible, level, and to strive for validity and reproducibility.[5]

3.3.8.4 The Assessment of Clinical Reasoning

In the absence of a universal assessment method to test clinical reasoning, validity can be said to imply that a range of assessments need to be employed to assess this skill.[40] Miller[41] proposed a framework to assess clinical competence (Figure 3.15, below).

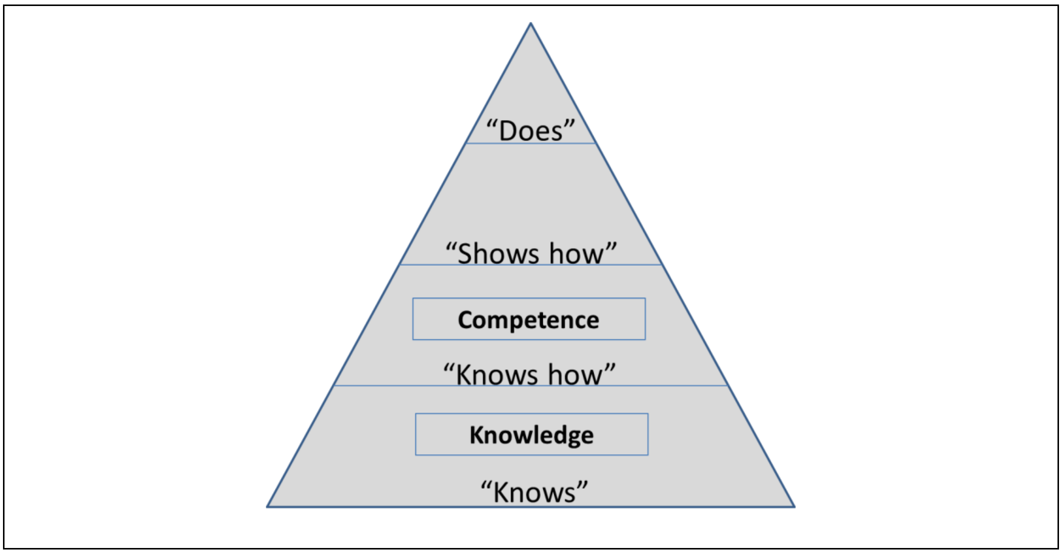

Figure 3.15 Miller's framework to assess clinical competence[41]

The first level of Miller's framework (Figure 3.15, page 74) is "knowledge". As knowledge is recognised to be very important,[41] it is depicted in the broadest part of the triangle. Knowledge levels have been shown to partially correlate with clinical reasoning ability,[2] but it has been argued that knowledge on its own is not enough to make diagnostic and treatment-planning decisions.[41] This indicates a need for the assessment of the application of knowledge, and this leads to a discussion of the second level of Miller's framework.

On the second level (Figure 3.15, page 74), the learner "knows how" to acquire, analyse and interpret information from various sources, and to apply the information to make effective clinical decisions. Adequate ability on this level of the framework is labelled by Miller[41] as "competence". By moving from knowledge testing to the testing of the application of knowledge, the assessment of clinical reasoning immediately becomes more valid because the assessment automatically becomes a test in "authentic" simulated context. In other words the assessment more or less reflects the decision-making that is required from a clinician in real life. High validity, accompanied by the relatively high levels of reliability[40] that can be achieved on this level, makes this level of assessment attractive to assess clinical reasoning outcomes in a resource-constraint environment. This level allows for a wide coverage of content by using written formats such as context-rich multiple-choice questions (MCQs), including single answer MCQs, extended matching questions[64] and essays. These three formats have been shown to be the most reliable methods amongst a wide choice of assessment methods[40] in both the first and second levels of Miller's framework.[41] Achieving "competence" in this context does not necessarily guarantee performance in a simulation or real-life environment. Assessment on this level, however, remains the most feasible and valid way, available to the teacher, of measuring competence in the domain of clinical reasoning.[2,40]

The third level of Miller's framework[41] (Figure 3.15, page 74) is the "shows how" level. On this level, assessment simulates the activity as close as possible to the authentic task, for example, through using standardised patients and objective, structured clinical examinations. Using real patients for assessment purposes brings additional variability to the table. Reliability issues start to creep in at this stage as it becomes difficult to ensure wide enough coverage, especially in a domain such as clinical reasoning. Increasing coverage utilising these methods will decrease feasibility due to resource constraints.[156] These issues do not preclude the use of assessment on a "shows how" level. In fact this level of assessment might be valuable in terms of formative feedback in a real-life setting.

There are some that suggest that assessment can be done on the final level of Miller's framework (Figure 3.15, page 74), namely the "does" level.[40] In this instance, "does" refers to performing the task independently in a real-life context. Any assessment that takes place at this stage will be reduced to the "shows how" level of Miller's framework (Figure 3.15, page 74).

Another practical method of assessing clinical reasoning is the "script concordance test".[157] The "script concordance test" is a highly sophisticated assessment tool which is based on script theory[93,157,158] that has been found to be useful for the measurement of clinical reasoning in ambiguous situations in different disciplines,[159-162] even for the preclinical assessment of medical students.[163] This method has been used frequently in medical education[162,164-166] but not specifically in a general dentistry context.

The "script concordance test", which has been evaluated extensively over a ten-year period,[162,164-166] uses case scenarios that contain elements of ambiguity. This method of assessment, therefore, fits in on the "knows how" level of Miller's framework.[41] Learners are asked to indicate their inclination towards accepting, ignoring or rejecting the hypothesis pertaining to diagnosis, the requirement for additional diagnostic testing and the selection of appropriate treatments. The learners' reasoning is subsequently compared with the reasoning of qualified professionals (usually from an academic environment) taking into account the varying clinical opinions that qualified professionals from varying backgrounds might have. The drawback of this method of assessment is that the process of developing good questions for the "script concordance test" is very complex, requiring the inputs of multiple "expert" clinicians.[167,168]

On the basis of the assessment above, the formulation of MCQs appear to be more feasible and practical compared to "script concordance test" questions in the relatively resource-constraint environment of the School of Dentistry, University of Pretoria.

Conclusion: The above deliberations confirm the need for a combination of formative assessment and summative assessment that is aligned with educational processes. Formative assessment should be used to guide the clinical reasoning process, whereas summative assessment should be employed to measure students' ability. Case study exercises and MCQs remain good options to develop and measure "competence"[40] on a "knows how" level.[41]

The current study is concerned with the development or progression of clinical reasoning over time. Therefore, the following section explores the progress test concept.[63]

3.3.8.5 A Need for Progress Testing

Progress testing is a concept that was introduced in the medical curriculum at the Maastricht University late in the twentieth century.[63] This form of testing is now used worldwide.[67] Progress testing involves the repeated assessment of students over time using the same or similar tests to measure progress.[63]

Progress testing is usually conducted independently of the clinical disciplines and attempts to cover the full range of content at exit level.[66] These standardised tests can even be used to compare the knowledge levels at different training institutions.[63]

A spiral curriculum design (referred to in paragraph 3.3.7, page 56) would be appropriate for the implementation of a progress test to measure the development of clinical reasoning skills over time because the course objectives remain the same for all the years of study.[148,149] It is proposed that progress testing provides a powerful source of information regarding the learners themselves and that it drives learning forward through the retention of knowledge elements over time.[67]

Progress testing is a new concept in dental education. However, student progression has been demonstrated by Bennett *et al*[66] using a progress test in a dental setting. The test consisted of MCQs, of which some were based on vignettes (shortened case studies[169]). The formulation of enough good quality questions remains a challenge in the dental environment primarily due to personnel and time constraints.[66]

Bennett *et al*[66] suggests that progress testing has the potential to become a valuable assessment tool in dental education.

Conclusion: The above-mentioned study lends support to the decision to use a progress test to measure progress in terms of the application of clinical reasoning skills.

In the context of the current study, which intends to examine progression in clinical reasoning, the principle of equivalence[5] should be examined as part of summative assessment practices to provide valuable information regarding student progression over time and to compare the performance of different cohorts with one another.

3.4 Conclusion to the Chapter

This chapter was written in the form of literature review. Consideration was given to global and local environments, as well as to relevant codified knowledge contained in the literature.

The following reinforcements in the form of needs were identified to support the proposed intervention (Figure 2.1, page 24) design of the current study:

There is a need for –

- the improvement of clinical reasoning teaching and learning through the repeated application of knowledge in order to develop students' knowledge structures;
- the use of an outcomes-based approach, always considering the limitations of the approach;
- the constructive alignment of educational processes and assessment in CPC with the exit-level outcomes in the undergraduate dental curriculum;
- student-centred learning using active learning processes, such as problem-solving strategies, through an integrated case-based instructional design;
- the management of cognitive load and complexity in CPC, especially in the development of clinical reasoning skills of preclinical third-year students in preparation for clinical teaching and learning through models such as the 4C/ID-model for complex learning;
- valid formative assessment to guide the development of clinical reasoning skills;
- valid summative assessment, with the aim of measuring the level of "competence" on a "knows how" level[41] through the use of context-rich MCQs;
- the development of a progress test to measure the development of clinical reasoning skills over time; and
- consideration of available resources in the selection and design of educational processes and assessment.

The above-mentioned needs should be taken into account during the final design and implementation of the educational intervention.

3.5 Summary of the Chapter

Support for the proposed intervention was obtained through the literature review in Chapter 3.

Chapter 4 continues with an assessment that focuses on the needs of the targeted learners and their potential influence on the outcome of the educational process. Chapter 4 will be the final part of the needs assessment (refer to Figures 1.6 and 1.7 on pages 17 and 18, respectively).

CHAPTER 4: POTENTIAL INFLUENCE OF LEARNER BEHAVIOUR AND ACADEMIC ABILITY ON EDUCATIONAL OUTCOMES – TARGETED NEEDS ASSESSMENT

4.1 Introduction

Chapter 4 follows the general needs assessment that was conducted in Chapter 3 by means of a literature review.

Chapter 4 is a targeted needs assessment, also in the form of a literature review, focussed on the needs of the targeted learners (Figure 1.7, page 18), as well as the potential influences of learners' behaviour and academic ability on the educational outcomes in the curriculum. The targeted needs assessment represents Step 2 in Kern's "six-step approach to curriculum development"[60] (Figure 1.6, page 17).

Targeted learners are defined as students who are subjected to the educational process.[60] The targeted learners in this study are the third-, fourth- and fifth-year dental students (2009-2011) studying at the School of Dentistry, University of Pretoria.

The academic requirements (which include the students' academic experience) of the curriculum were specified as part of the internal context in Chapter 1 and will therefore not be repeated in detail. Chapter 4 will rather focus on the learners' characteristics and factors associated with academic performance, such as self-regulated learning and academic ability in the context of the University of Pretoria. This will be supported by theoretical descriptions of the aspects covered.

General learner characteristics in a South African context will be explored first.

4.2 General Learner Characteristics

The general characteristics of the targeted learners are explored in this section in terms of "ethnoracial" characteristics and gender differences that may have an association with variable academic performance.

4.2.1 "Ethnoracial" characteristics of the student population

South Africa is a developing country that displays considerable "ethnoracial" variances.[53,78] As transformation and redress from its political past continues, these variances are increasingly reflected in the classrooms at tertiary institutions.[53] The broad demographic composition of the learners involved in the current study is displayed in Appendix A (page 243) as part of the research results. The reader is encouraged to have a look at these results at this stage to understand the context.

A brief overview regarding the country's political past and the impact of the Apartheid system on the educational system was provided in Chapter 1 (paragraph 1.2.3, page 13). In this section it was noted that it is important to investigate "ethnoracial" issues for the purpose of understanding and solving social dilemmas in the educational setting. It was also noted in Chapter 1 that some students originating from previously disadvantaged racial groups may still today be disadvantaged in terms of the primary and secondary schooling they received to prepare them for university despite considerable redress that already took place in the country.

Conclusion: Therefore a statistical association between academic performance and the students' race[***] may be expected.

It is, however, pertinent to note that it is not the student's race that determines success at university level but rather the student's self-regulation ability and academic skills. The concept of self-regulation was mentioned in Chapter 1

[***] Race labels in this instance are merely referred to in order to gain an understanding of "ethnoracial" and social dilemmas that may affect the outcome of the educational process.

(paragraph 1.2.3, page 13) as part of the identification of the problem, and will be dealt with in detail, later in this chapter.

Self-regulation ability is the most probable reason for gender differences[46,47] in the student population, which is elaborated upon in the next section.

4.2.2 Potential gender differences in the student population

The demographic profile of dental students has also been changing in terms of gender distributions.[170] In recent decades, the number of females selected for undergraduate dental programmes (BChD and BDS) has increased gradually and has started to exceed the number of males.[170,171] Generally, diligence amongst students is recognised as a factor that facilitates achievement, and diligence is often associated with female learners.[46,47] When proper sampling is employed, female performance appears to be only marginally better compared with their male counterparts.[47] Overall, first-year performance at the University of Pretoria shows contrary findings with male students faring marginally better than their female counterparts.[48]

Conclusion: A need therefore exists to examine the association between the students' gender and academic performance.

Having addressed the general learner characteristics in terms of "ethnoracial" characteristics and gender differences, the next section explores potential factors that might influence academic performance in terms of the acquisition of clinical reasoning skills.

4.3 Factors Associated with Academic Performance

Theoretical descriptions of self-regulated learning[44] and self-handicapping behaviour[45] are backed up by evidence of self-regulation at the University of Pretoria[48,70,172] as discussed in the sections below. This is followed by an analysis of the predictors of academic performance and academic skills at the University of Pretoria, while taking prior knowledge in the BMSs into consideration.

Self-regulated learning is explored first.

4.3.1 Self-regulated Learning

Since variable academic performance can be predicted (refer to the section above) in the School of Dentistry, University of Pretoria, it is worthwhile to explore psychological models that relate to academic performance.

There is a substantial body of scientific literature pertaining to academic performance. An important concept that has arisen over the last few decades is the theory of self-regulation of learning[44] in the academic environment. Self-regulated learning can be defined as a proactive way of acquiring knowledge, skills and competence.[44] Those who engage in self-regulated learning set goals for themselves, display strategic thinking, and monitor their own academic performance and effectiveness. This is in stark contrast to students who merely react to what the environment enforces on them.[44]

Based on a substantial body of literature, Zimmerman[44] adapted a model of self-regulated learning (Figure 4 .1, below) from a publication titled “The Nature of Problem Solving”.[173] There is indeed growing empirical evidence to support the validity of the components of the model as well as of the interactions of the components.

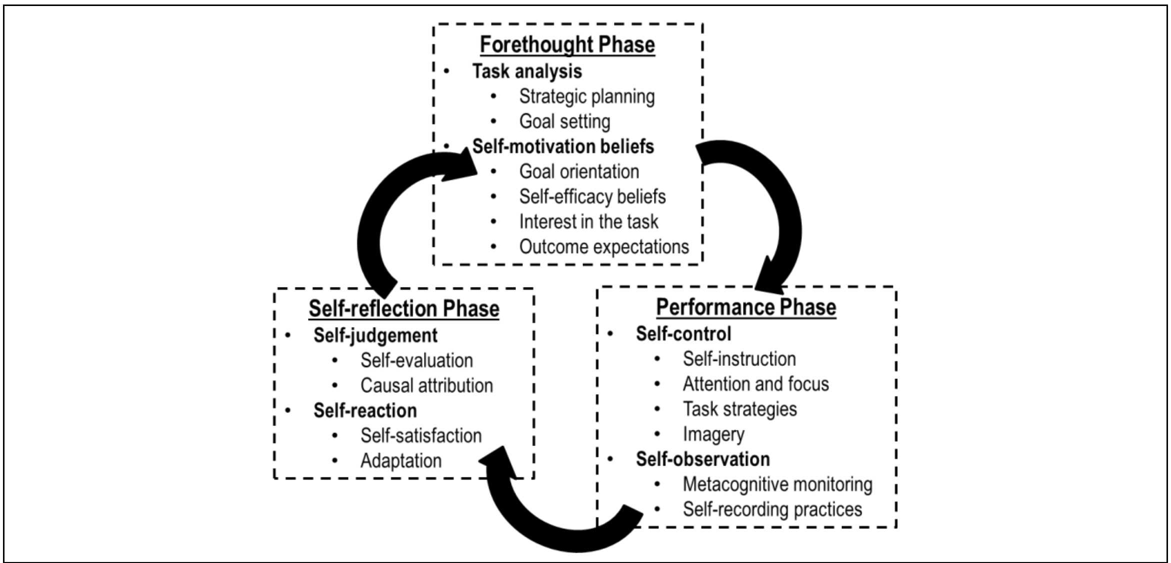

Figure 4.1 The cyclic model of self-regulated learning[44]

Figure 4 .1 (page 84) demonstrates that the cyclic model has three phases. The forethought phase precedes the performance phase, which is followed by a self-reflection phase. Self-reflection is often followed by a new forethought stage for further or enhanced learning.[44]

The following section contains a more detailed description of each of the phases. The first phase is the forethought phase.

4.3.1.1 Forethought Phase

The forethought phase is controlled by task analysis and self-motivation beliefs. Task analysis can be described as a process of strategic planning and the setting of goals. Self-motivation beliefs include those of goal orientation with self-efficacy beliefs – belief in your own abilities – and an interest in the task at hand, with distinct outcome expectations, for example, expectations of the achievement of “excellent” assessment results.[44]

The second phase is the performance phase.

4.3.1.2 Performance Phase

Self-control and self-observation are the key processes in the subsequent performance phase. Self-control is a process of self-instruction, displaying attention and focus. The adoption of task strategies and imagery are typical processes employed by self-regulated learners during the performance phase. Self-monitoring is related to self-control and entails metacognitive monitoring and self-recording practices.[44]

The third phase is the self-reflection phase.

4.3.1.3 Self-reflection Phase

The self-reflection phase consists of self-judgement and self-reaction. Self-judgement includes processes of self-evaluation and causal attribution.[44]

Causal attribution can be defined as the reasons (provided by the learner) for the cause of a specific event.[44] The learner might perceive the cause to be from an internal origin (due to his or her personal behaviour) or from an external source. Self-judgement is followed by self-reaction based on the individual's perception of self-satisfaction. A lack of self-satisfaction might, for example, affectively stimulate a renewed forethought phase to continue the learning. Adaptations to behaviour might also be made as a result of the self-evaluation.[44]

The sections above addressed the three phases of Zimmerman's cyclic model of self-regulated learning,[44] namely, the forethought, performance and self-reflection phases. The following section continues with a concept opposed to the concept of self-regulated learning, namely, self-handicapping behaviour.

4.3.2 Self-handicapping Behaviour

In contrast to self-regulated learning, which was described in the section above, there is learning that might be impeded by a student's personal behaviour.[45] Self-handicapping can be viewed as directly opposite to self-regulation. Some students employ self-handicapping strategies to protect and enhance their self-esteem.[45]

Those who employ self-handicapping strategies typically postpone their learning to the last minute and might subsequently blame the circumstances and the external environment rather than their lack of ability or lack of motivation and diligence.[45] Those who are guilty of self-handicapping behaviour tend to project their lack of performance or failures away from themselves in an attempt to protect their own ability and self-worth.[174,175]

Self-handicapping has a negative correlation with a goal-setting approach in the academic environment.[176] The issues mentioned indicate a need for feedback and reflection in the teaching process.[177]

Having explored the psychological aspects of self-regulated learning, evidence of self-regulation in the Faculty of Health Sciences at the University of Pretoria will be investigated in the next section.

4.3.3 Evidence of Self-regulation at the University of Pretoria

Lemmens[48,70,172] studied the association between psychological factors and first-year academic performance at the University of Pretoria.[†††]

He found that students with a goal-avoidance orientation had a higher risk of failure. Lemmens[48] also found that Afrikaans and English students (predominantly white) who had a goal-orientated approach were more likely to be academically successful compared to those who did not have a goal-orientated approach. The same findings applied to learning efficacy scores, which are related to academic skills, and an internal locus of control. Locus of control relates to the theory of causal attribution (refer to the self-reflection phase in Figure 4.1, page 84), which was mentioned under paragraph 4.3.1.3.[44]

Similar differences could not be shown for the African students who generally displayed lower goal-orientation and self-efficacy scores compared with their Caucasian counterparts.[48] University of Pretoria data, quoted by Lemmens, indicated that African students were likely to proceed to the second year of study, but they were academically at risk in the subsequent study years (up to fifth-year level).[48]

The 2012 student readiness survey[152] carried out in the Faculty of Health Sciences at the University of Pretoria indicates that 53%, 56%, and 63% of the first-year students reported low to medium scores, respectively for planning, self-efficacy and locus of control. These relatively low scores indicated a lack of preparedness, in general, for challenging university studies.

[†††] A copy of the Student Academic Readiness Report is available on request from the author.

Table 4.1, below, quotes results from the above-mentioned Student Academic Readiness Report pertaining to the various aspects of goal orientation.[70] These results[70] show a large variety of psychological factors that might influence the performance of individual learners.

Table 4.1 Goal orientation of first-year students in the Faculty of Health Sciences, 2012[70]

Goal-orientation aspect	Description[172]	Low %	Medium %	High %
Goal achievement	Belief in your own ability to achieve goals	8	55	37
Future vision	Level of optimism about the future, related to your own goals	5	30	65
Hope agency	Abilities to visualise ways to achieve your goals	8	49	43
Hope pathway	Abilities to direct yourself towards your goals	10	63	27
Optimism	Expectation that good things will happen to you	15	47	37
Self-motivation	The level of responsibility and action taken	10	60	26
Hopefulness	Positivity about the future	17	42	41
Agency	Abilities to formulate and pursue personal objectives	9	43	48

Although the said results might not apply to individual learners in general, or even to specific courses, they provide a valuable indication to faculty of the characteristics of the student population at the University of Pretoria.

Conclusion: Although the teacher has an obligation to address the above-mentioned factors, some of these factors are likely to be beyond the direct control of the teacher, especially in a large class context. A need therefore exists to adjust for a lack of self-efficacy amongst large groups of students when evaluating the effect size of an educational intervention. A need, however, exists to take these factors into consideration when evaluating academic performance.

The section above concludes the appraisal regarding psychological and behavioural aspects that might influence learning and academic performance. The following section explores the potential predictors of academic performance.

4.3.4 Predictors of Academic Performance

It was mentioned above, under the heading "General Learner Characteristics", (paragraph 4.2, page 82) that a student's race and gender might be associated academic performance in a South African context. It was determined above that these associations stem from the students self-regulation ability and that the statistical associations that is to be expected between a student's race and gender and academic performance are reflections of the socio-economic environment and personal traits of the learners themselves.

The above-mentioned socio-economic and behavioural reasons that are indicators of variable academic performance, give rise to the question whether there are perhaps more objective predictors of future academic performance. This is especially relevant, as it has become fairly standard practice in tertiary institutions in South Africa for entry-level requirements for health-related courses to be lowered for previously disadvantaged groups to gain access to medically related programmes.[52,53]

The "composite admissions score" at the University of Pretoria is the best predictor of first-year academic performance at the University. Low scores are predictive of academic risk.[48] Conversely, the composite score and Grade 12 school performance correlated poorly with academic performance in the undergraduate dental programme.[178]

Conclusion: A need therefore exists to take previous academic performance, such as exit-level school results, into consideration when evaluating the effect of the intervention.

The section above explored potential predictors of academic performance. The following section continues with an appraisal of academic skills at the University of Pretoria.

4.3.5 Academic Skills at the University of Pretoria

Academic performance is also partly related to an individual's ability to process information.[45,179] It has been shown that inadequate academic language proficiency amongst students from diverse backgrounds impacts on the ability to read, understand and synthesise complex arguments.[180] Such a situation is particularly relevant to students in a South African context.[53]

Negative reading behaviour could, however, not be correlated positively with a risk of poor academic performance when first-year results at the University of Pretoria were used. It must be noted that reading behaviour does not constitute reading ability.[48]

A lack of academic skills at the University of Pretoria, such as those mentioned in Table 4.2[70] below, might severely hamper the teaching of complex skills. This indicates a pertinent need for adequate student support during teaching and learning, and formative feedback to guide the learning process.

Table 4.2 Academic skills – Expressed needs for support in the Faculty of Health Sciences, 2012[70]

Academic skill	Expressed need for support
Reading skills	40%
Writing skills	37%
Study skills	77%
Time management skills	75%
Test-taking skills	65%
Mathematical skills	63%
Computer skills	68%
Presentation skills	71%

During 2012, first-year students in the Faculty of Health Sciences expressed a need for support for a variety of academic skills[70] (Table 4.2, page 90). Alarmingly, four out of ten students requested support in terms of reading and writing skills, while nearly eight out of ten students indicated that they had problems with study and time management skills. Between six and seven out of ten students expressed a need for support in terms of test-taking, mathematical and computer skills, while seven out of ten students had a problem with their presentation skills.[70] Again these results indicate a lack of preparedness for most students for university studies.

Considering the high likelihood of the existence of a lack of academic skills, as well as a lack of a high degree of goal orientation, the use of the proposed student-centred approaches (Chapter 1 to 3) might, therefore, impede the learning process. In the context of this history, a need exists to provide additional support for students who are academically at risk and to take account of their abilities in the learning process without lowering the standards. Such a process in the local context has been documented at least once.[52] Based on the findings of this study[52] it appears as if there is some evidence that problem-based learning might be to the benefit of students who are academically at risk.[52]

Conclusion: The above considerations indicate a need for proper scaffolding to be given during learning processes (as proposed in the 4C/ID-model) and formative feedback to be given during teaching and learning processes, accompanied by a summative assessment design that would promote appropriate learning.

In the context of a dental curriculum, deficiencies in some of these skills might influence learning in the BMS context and in the subsequent clinical teaching and learning.

4.3.6 Prior Knowledge: Basic Medical Sciences

The School of Dentistry, University of Pretoria has relatively high throughput rates as reflected in the data of a 2007 study.[178] The study indicates that Oral Biology in the third study year appears to have been the most challenging subject to pass in recent years.

Oral Biology – which includes the anatomy and physiology of the oral cavity, and other relevant structures of the head and neck region – can be considered to be a BMS. Oral Biology forms an important building block (prior knowledge) for the clinical sciences in the dental curriculum. The subject is generally content-based and the assessment is conducted mostly on lower cognitive levels. The exact reasons why certain students struggle with this particular subject remain speculative but might be related to a lack of goal orientation and academic skills, as mentioned in the sections above.

Furthermore, the importance of relevance in adult learning is well documented,[38] and the role that relevance plays here should be considered. A recent study indicated that second-year dental students questioned the relevance of a joint medical curriculum[181] in the first two years of study (Figure 1.1, page 2). Oral Biology is fundamentally dependent on prior knowledge of Anatomy and Physiology gained in the first two years of study. The students' questioning of the relevance of the teaching and learning in the first two years might suggest that some students lack knowledge in these subjects. These inadequacies might impact negatively on the development of clinical reasoning skills, seeing that it was previously indicated that clinical reasoning skills might be dependent on BMS knowledge.[49]

Conclusion: The likely importance of BMS knowledge as a requirement for clinical reasoning[49] indicates a need for Oral Biology to be included as a potential contributing factor to be considered in the development of clinical reasoning skills in dental students. Poor performance in Oral Biology might be a predictor of poor ability in clinical reasoning. This should be taken into account during the curriculum evaluation.

4.4 Conclusion to the Chapter

This chapter demonstrated that learning is dependent on self-regulation and information processing abilities.

The assessment determined that there might be large numbers of enrolled students who might not be able to exercise self-regulated learning and who do not have optimal academic skills, such as reading, study time management and taking of tests.

All of the above-mentioned factors might indeed be contributing factors to the relatively poor performance of students, for example, in Oral Biology.

Based on the deliberations in this chapter, the following needs, which are related to the learners themselves, were identified:

- Because variable performance in clinical reasoning is to be expected, proper scaffolding and feedback are required in the learning processes.
- Feedback and reflection will be essential in the learning process, not only in terms of clinical reasoning itself, but also in terms of the students' self-regulation ability. The question of self-regulation ability might, however, be beyond the scope of this project.
- The possibility of a statistical association between academic performance and factors such as race, gender and prior knowledge, for example, the students' Oral Biology results should be taken in to account during the study design and the interpretation of the results.
- The performance of self-handicapping and underperforming students might result in a negative reflection of the positive effect size of an educational intervention. Therefore, it is suggested that these negative factors be taken into consideration when evaluating a curriculum.

The needs identified in this chapter will be used in combination with the needs identified in Chapters 1 to 3 to inform the curriculum design and educational processes, as well as the curriculum evaluation later on in the thesis.

4.5 Summary of the Chapter

Chapter 4 described the targeted learners (Figure 1.7, page 18) and identified factors that might have an influence on the outcome of the educational process.

Chapter 5 will address the goals and objectives of the curriculum of the "new" CPC unit.

CHAPTER 5: COMPREHENSIVE PATIENT CARE – GOALS AND OBJECTIVES

5.1 Introduction

The researcher formulated the goals and objectives for the “new” CPC unit during 2008 in accordance with Step 3 of Kern’s model[60] for curriculum development (Figure 1.6, page 17). The aim of these goals and objectives was to lay a platform to functionalise the proposed educational intervention (Figure 2.1, page 24) in the CPC unit.

The reader should note that Chapter 5 (Figure 1.7, page 18) is only concerned with the formulation of objectives.[60] Therefore, detailed descriptions of the instructional design of the teaching, learning and assessment of the proposed educational intervention will not be provided in this chapter. Detailed descriptions of the instructional design for the “new” curriculum for CPC will only be described in Chapter 6 as part of the design and implementation of the educational intervention as advocated in Kern’s model for curriculum development.[60]

Kern’s model[60] requires that the following three types of curriculum objectives be defined to guide the educational processes:

- The purpose of the course (course objectives)
- Outcomes (learner objectives)
- Process objectives[60]

5.2 Comprehensive Patient Care Unit Purpose Statement (Course Objectives)

Course objectives are statements about the product the course intends to deliver.[60] Although it is not always possible to measure the effects of a curriculum on real-life patient care, it is highly desirable that the intent of a course be specified. These course objectives usually influence the content of the curriculum as well as the educational methods.[60]

The conception and structure of the M: CPM (Figure 1.3, page 5) in 2007 was described in Chapter 1 as part of the background information on the institution. The reader is referred back to Chapter 1 to gain insight into the origin and broader aims of the M: CPM.

The M: CPM (Figure 1.3, page 5) comprises three units, namely, CPC, Risk Management and Dental Practice Management.[182] Risk Management includes Ethics and Jurisprudence, Infection Control and Occupational Health and Safety. Dental Practice Management includes, amongst others, Patient Care Management, Strategic Management, Marketing Management, Financial Management and Personnel Management.

The M: CPM aims to teach students how to manage their patients and practices to ensure a viable dental practice with minimum risk.[182] The M: CPM and all aspects of the dental curriculum are interrelated. It draws on business and behavioural and clinical research, and attempts to integrate knowledge in the dental curriculum.[182]

The current study is concerned with CPC only. The problem identification in Chapter 1 provided a historical overview of the undergraduate dental curriculum being followed in the School of Dentistry, University of Pretoria.[6,7,10,15] This overview included the position of CPC within the context of the broader curriculum.[8,9] It goes without saying that the central principles of the M: CPM[12,15,16] guide the educational processes in CPC strategically.

The formulation of the purpose (course objective) of the “new” CPC unit, specified below, was based on these guidelines.

Unit: Comprehensive Patient Care – Purpose Statement
To foster integrated patient care through the development of relational communication, integrated clinical reasoning and patient administration skills

The course objective subsequently guides the development of the course outcomes (learner objectives).[60]

5.3 Course Outcomes (Learner Objectives)

Learner objectives are the specific objectives that learners have to master to pass the course.[60] In the context of the University of Pretoria, the learner objectives are typically formulated and expressed on three levels in the form of course outcomes and assessment criteria.[183]

- Firstly, the School defines the exit-level outcomes[183] of the overarching curriculum based on a (continuous) assessment of the environment.[60] Exit-level outcomes[21] are high-level, broad descriptions of knowledge, skills, attitudes, behaviour and competencies that a graduate should possess[60] when qualifying as a dentist.
- Secondly, the responsible academic department formulates the mid-level course outcomes in alignment with the exit-level outcomes.[183] Outcomes on this level are still broad statements of competence, but are more detailed descriptions compared to exit-level outcomes.[183]
- Thirdly, the mid-level course outcomes are broken down into assessment criteria, which can be defined as lower-level learner objectives.[60] These assessment criteria are detailed statements of the knowledge, skills and attitudes that should be mastered for assessment purposes.[183]

The following section contains a description of the exit-level outcomes of the undergraduate dental curriculum of the School of Dentistry, University of Pretoria, as well as the newly formulated mid-level course outcomes and the lower-level assessment criteria for the CPC unit.

5.3.1 Exit-level Outcomes of the Undergraduate Dental Curriculum

The exit-level outcomes[21] (Table 5.1, page 98) of the undergraduate dental curriculum are based on faculty consensus and include three main outcomes, namely, competencies in clinical management, dental practice management and community health management.[21]

Table 5.1: Exit-level outcomes of the undergraduate dental curriculum (School of Dentistry, University of Pretoria)[21]

Clinical management competencies

- Assessment and diagnostic skills
- Treatment planning
- Treatment plan presentation and acceptance
- Establishment and maintenance of a healthy oral environment

Dental practice management competencies

- Business management
- Patient care management
- Technology management
- Marketing management
- Ethics and jurisprudence
- Professionalism
- Occupational ethics
- Risk management

Community oral health management competencies

The M: CPM relates to both the clinical and practice management exit-level outcomes of the undergraduate dental curriculum presented in Table 5.1 above. In turn, the "new" CPC unit of the M: CPM relates to clinical management competencies involving the development of diagnostic and treatment planning skills, as well as patient care, ethical behaviour, professionalism and risk management.

On the basis of national quality assurance requirements,[184] information appraisal and critical thinking skills[21] (Table 5.2, page 99) are propagated in all the modules of the undergraduate curriculum, including the M: CPM. The above-mentioned skills are critical to CPC since competence in clinical reasoning require the learner to process and use information effectively.[21]

So-called "value-added" skills[21] (Table 5.3, page 99) are also propagated, based on national quality assurance requirements,[184] in conjunction with the main exit-level outcomes and the "information appraisal and critical thinking" competencies.[21] The mentioned "value-added" outcomes are behavioural outcomes that facilitate professionalism.[21] These skills relate strongly to the M: CPM and the CPC unit, and are hence contained in the M: CPM study guide.[11,182,185]

Table 5.2: Information appraisal and critical thinking competencies of the undergraduate dental curriculum (School of Dentistry, University of Pretoria)[21]

Conduct critical thinking and self-directed learning and have a commitment to life-long learning.
Identify primary written and electronic sources, and be able to use them to acquire information.
Acquire, analyse, process and communicate information in a scientific, critical and effective manner and attempt to solve relevant problems.
Locate, read, interpret and critically evaluate the published dental and related literature and apply such information when evaluating new materials and procedures.
Evaluate the evidence published in refereed professional journals for sound experimental design and statistical analysis.
Evaluate the validity of claims related to products and techniques.
Perform self-evaluation and peer review.

Table 5.3 "Value-added" outcomes of the undergraduate curriculum (School of Dentistry, University of Pretoria)[21]

Identifying and solving problems by using critical and creative thinking, and displaying responsible decision-making
Working effectively with others as a member of a team
Organising and managing oneself and one's activities responsibly and effectively
Collecting, analysing, organising and critically evaluating information
Communicating effectively using visual and language skills in the modes of oral or written persuasion
Using science and technology responsibly, effectively and critically, and showing responsibility towards the environment and health of others
Contributing to the full personal development of each learner and the social and economic development of society at large by making it the underlying intention of any programme of learning to make an individual aware of the importance of: • Reflecting on and exploring a variety of strategies to learn more effectively; • Being culturally sensitive across a range of social contexts;
Developing entrepreneurial opportunities

The exit-level outcomes[21] (Table 5.1, page 98) guide the mid-level course outcomes, which will be described in the following section.

5.3.2 Mid-level Course Outcomes: Comprehensive Patient Care

In his capacity as module chairperson, the researcher formulated new mid-level course outcomes (Table 5.4, below) for the CPC unit during 2008. Other faculty members of the DoDMS gave inputs during this process. These outcomes were implemented in 2009.[182]

Table 5.4: CPC mid-level course outcomes[182]

Specific outcome 1:	Demonstrate professionalism during clinical or practical sessions.
Specific outcome 2:	Arrange the chair-side environment to ensure customer/patient satisfaction.
Specific outcome 3:	Build up rapport with patients and/or their guardians through effective communication.
Specific outcome 4:	Determine the patient's main complaint and establish the patient's expectations.
Specific outcome 5:	Source and interpret the patient's dental history correctly.
Specific outcome 6:	Source and interpret the patient's medical history in order to prevent potential medical emergencies and/or to minimise the risk of litigation.
Specific outcome 7:	Exercise proper infection control before, during and after the examination and/or treatment of the patient.
Specific outcome 8:	Implement measures to ensure occupational health and safety during clinical/preclinical teaching and learning.
Specific outcome 9:	Conduct a specific examination in order to solve the patient's immediate problem(s), document the clinical findings on the dental record according to protocol, and inform the patient about additional treatment needs.
Specific outcome 10:	Conduct a comprehensive extra- and intra-oral examination in order to determine the patient's needs and document clinical findings on a dental record according to protocol.
Specific outcome 11:	Formulate and document a set of diagnoses based on the history and the clinical findings (signs and symptoms) identified during extra- and intra-oral examinations.
Specific outcome 12:	Source and document information regarding the patient's self-care and behavioural practices that might influence the patient's oral health status.
Specific outcome 13:	Explain the diagnoses, aetiologies and pathogenesis of diseases and conditions, and propose alternative self-care practices to the patient in a coherent way.
Specific outcome 14:	Formulate and document a prioritised, integrated comprehensive dental treatment plan based on the patient's bio-psychosocial status.
Specific outcome 15:	Present appropriate treatment options and their cost to the patient in such a way that would increase the likelihood of case acceptance and informed consent.
Specific outcome 16:	Document the treatment procedures performed and the diagnostic codes on the dental record according to protocol.
Specific outcome 17:	Refer the patient in a clear and coherent manner to another department/practitioner.

Using an outcomes-based approach, the researcher formulated the new mid-level outcomes, based on a typical CPC encounter as specified in the CPC approach (Figure 1.4, page 6). During this process the researcher ensured constructive alignment between the exit-level skills[21] such as assessment (clinical examination), diagnostic and treatment planning skills, as well as patient care, and the newly formulated mid-level outcomes. The “value-added” outcomes (Table 5.3, page 99), which include communication skills, were also considered when the mid-level course outcomes were formulated. The format and syntax of the newly formulated mid-level outcomes (Table 5.4, page 100) were based on University of Pretoria standards.[183]

By adopting the 4C/ID-model (Figure 2.1, page 24), which conforms to spiral curriculum properties (paragraph 3.3.7, page 56 and 57),[148-152] and the concept of progress testing (paragraph 3.3.8.5, page 77),[63] the researcher made no distinction between the mid-level outcomes for third, fourth and fifth year students.

In order to guide the students in terms of their assessment requirements, the mid-level course outcomes were used to guide the formulation of learner objectives,[60] also referred to as assessment criteria in this thesis.

5.3.3 Assessment Criteria for Comprehensive Patient Care

University guidelines for the compilation of study guides[183] require that detailed assessment criteria be developed for each of the mid-level course outcomes.[183] Well formulated assessment criteria are critical for quality assurance purposes.[5] These criteria serve as standards that can be used to assess the students as well as the quality of the assessment processes. The assessment criteria are, therefore, detailed lower-level learner objectives.[60]

The researcher developed the assessment criteria, which are displayed in Appendix B, page 244, for the CPC unit in 2008.

Learner objectives, such as outcomes and assessment criteria, can only be implemented if process objectives are defined.[60]

5.4 Process Objectives

Process objectives are broad specifications of the educational methods required to ensure an appropriate instructional design, aimed at achieving the course outcomes.[60]

On the basis of recommendations in Kern's model for curriculum development,[60] the availability of institutional resources had to be considered during the formulation process objectives to ensure that the implementation of the proposed educational intervention (Figure 2.1, page 24) remained feasible.

5.4.1 Institutional Resource Considerations

Feasible process objectives are dependent on resources such as the availability of scheduled time, venues and staff.[60,69]

5.4.1.1 The Availability of Scheduled Time and Venues

The time available for teaching and learning in the "new" M: CPM in the "Pretoria curriculum" was limited to specific weekly time slots when the students were not engaged in teaching and learning with the other academic disciplines Figure 5.1 (page 103).

At the end of 2008, the researcher identified approximately 35 ninety-minute sessions on Wednesdays (mid-day) for lecturing and/or group work for the third-year cohort (Figure 5.1, page 103) throughout the year for 2009. Five of these sessions had to be allocated to Risk Management (Figure 1.3, page 5). The remaining 30 sessions were available for CPC. The entire third-year cohort could be accommodated during each of these sessions. A dedicated lecture room for the third-year cohort was available for this purpose.

The researcher identified two two-hour sessions on Tuesday and Thursday afternoons (Figure 5.1, page 103) that could be used for communication teaching and learning, throughout the year, based on the existing programme of 2007 and 2008. The allocation of two two-hour sessions per week for communication skills teaching and learning, allowed for 12 hours (six two-hour sessions) of contact time per student throughout the year when the students were taught in groups of eight. The existing CPM simulation room was used for teaching and learning in communication skills during 2007 and 2008. The simulation room was again available for use in 2009.

	Monday	Tuesday	Wednesday	Thursday	Friday
7:15-9:15			Clinical teaching and learning (BChD IV)	Clinical teaching and learning (BChD IV)	Clinical teaching and learning (BChD IV)
9:30-11:30			Clinical teaching and learning (BChD IV)	Clinical teaching and learning (BChD IV)	Clinical teaching and learning (BChD IV)
11:45-13:15			CPC lectures and group work: Patient administration and clinical reasoning (BChD III)		
14:00-16:00	Clinical teaching and learning (BChD IV)	Communica-tion skills (BChD III) Clinical teaching and learning (BChD IV)	Clinical teaching and learning (BChD IV)	Communica-tion skills (BChD III) Clinical teaching and learning (BChD IV)	Preclinical examination skills (BChD III)

Figure 5.1 Available weekly time slots for the "new" CPC unit (BChD III and IV) identified by the researcher for 2009

A further 21 two-hour sessions were identified in an Odontology clinic that could be used for teaching and learning in preclinical examination skills on Friday afternoons (Figure 5.1, page 103). Dividing the third-year class into three equal groups allowed for seven two-hour sessions of teaching and learning per student throughout 2009.

Approximately 27 hours of clinical time were available to each fourth-year student for clinical teaching and learning in CPC, under the supervision of faculty members of the DoDMS. Fifth-year students, however, had to conduct their clinical teaching and learning in CPC in other departments, such as Odontology, under the supervision of various full-time and part-time faculty members.

It should be noted that some of the venues changed during the course of the project due to the addition of a dedicated lecture room for the third-year cohort as well as a clinical training unit for the DoDMS. These changes will be elaborated upon in Chapter 6 when the implementation of the “new” curriculum for CPC is described.

5.4.1.2 The Availability of Faculty Members to Teach CPC

The DoDMS had four full-time faculty members allocated to the M: CPM during the time when this research project was implemented and executed (2009-2011). This meant that responsibilities, involving the three separate study years, for CPC, Risk Management and Dental Practice Management had to be shared.

One of the four full-time staff members (the researcher himself) could be allocated for CPC lecturing and group work for the duration of the third study year, whereas the workload had to be shared in terms of teaching and learning in communication- and preclinical examination skills.

The researcher and one other fulltime member from DoDMS historically participated in the clinical teaching and learning in CPC in the fourth year of study in the Odontology clinics. The objective was therefore that this arrangement would continue. Changes in this regard occurred in 2011, which will be highlighted in Chapter 6 when the implementation of the project is discussed.

Having identified the resources that were at the disposal of the DoDMS to implement the "new" curriculum for CPC, the process objectives could be specified.

5.4.2 Specification of Process Objectives Based on Institutional Resource Considerations

The researcher formulated the process objectives during 2008 with aim of implementing the educational intervention during 2009.

It was mentioned earlier in the chapter that the CPC course outcomes and assessment criteria were derived from exit-level outcomes[21] relating to assessment (dental examination), diagnostic and treatment planning skills. The application of these skills in an authentic context by default required that the students be acquainted with communication- and record-keeping skills in the context of CPC (Figure 1.4, page 6). On the basis of this assessment the researcher proposed that the educational process be divided into four key themes, namely the development of:

- Patient administration skills
- Communication skills
- Clinical examination skills
- Clinical reasoning skills

In dealing with these complex skills, the 4C/ID-model[31] (paragraph 3.3.7, page 56-71) for complex learning was identified as model to guide the instructional design of the proposed educational intervention (Figure 2.1, page 24). This model was specifically selected to ensure that the development of the students be supported during the transfer from the preclinical to the clinical teaching and learning environment. The use of this model indicated that the above-mentioned clinical skills had to be practised in the third year of study through role-play or simulation that is as close as possible to a real context.

Third Year of Study – Preclinical Objectives

- *Patient administration skills*: The first objective that was set was that each student had to be able to satisfactorily complete the standardised patient records based on a complex case study. [‡‡‡] This had to be achieved within approximately one month of the commencement of the study year (Figure 5.2, page 107). The justification for placing this objective first was based on the requirement of the partial mastery of record-keeping to be able to simulate clinical interviews, examinations and clinical reasoning in context.
- *Communication skills*: The original relational communication skills teaching and learning[15,16] comprised building up rapport with the patient, educating the patient and presenting the treatment plan case, all of which were practised as a single simulation exercise. Having 12 hours of teaching and learning time available per student, and groups of eight students each (refer to the resource considerations in paragraph 5.4.1, page 102), allowed for the communication teaching and learning to be conducted in three more or less equal parts. The communication teaching and learning was subsequently divided into three logical parts, namely, building up rapport with the patient, patient education, and treatment plan presentation (Figure 1.4, page 6). The objective was that each student had to role-play each theme twice throughout the year (Figure 5.2, page 107), once as a practice run with feedback, and once as a video-recorded assessment. Working in groups of eight students each, students also had to attend at least twenty communication role-play exercises of fellow students throughout the year. The objective of the communication teaching and learning was to provide the student with a mental model[31] (paragraph 3.3.7.4, page 65-69) of what

[‡‡‡] As mentioned in the introduction of this chapter, details regarding the specific design of the educational methods will only be dealt with in Chapter 6. The current Chapter only deals with the objectives of the proposed educational intervention and the feasibility thereof.

relational communication skills entail, in preparation for the clinical study years. The aim was not to create expert communicators.

Outcome	Patient Administration Skills (Dedicated lecture room)	Communication Skills (CPM simulation room)	Clinical Examination Skills (Odontology clinic)	Clinical Reasoning Skills (Dedicated lecture room)
January	Holiday			
	Teaching and assessment of patient administration skills		Basic examination skills	
February		Building up rapport with a patient	Interview/Intra- and extra-oral examinations	Case study 1
March			Periodontal probing	Start task 2
April	Holiday			
		Patient education	CPC examination up to hard-tissue examination	Case study 2
May			Full CPC encounter	Case study 3
June				Start task 4
	Holiday			
July		Treatment plan presentation to the patient		Case study 4
August			Patient education and prevention	Case study 5
September			Full CPC encounter including prevention	Progress test
October				

Figure 5.2 Time line of the curriculum processes – BChD III

- *Clinical examination skills*: Considering the availability of scheduled time in the Odontology clinic (paragraph 5.4.1, page 102), it was proposed that each student participate in seven preclinical teaching and learning sessions throughout the year (Figure 5.2, page 107). Each session simulated a part of a typical patient encounter, by examining a peer. The aim of these exercises were to expose the student to comprehensive dental examinations in a simulated environment and to establish the link between patient administration, communication, clinical examination and clinical reasoning skills in an "authentic context" before clinical teaching and learning commenced in the fourth year of study.
- *Clinical reasoning skills*: Considering the availability of scheduled time during the course of the year (paragraph 5.4.1, page 102) and the potential assessment load, the objective was set that each student had to complete five portfolio case studies (either in groups or individually) that simulate the clinical reasoning process in a typical CPC encounter (Figure 5.2, page 107). The aim of this teaching and learning was to formatively assess the cognitive aspects of clinical reasoning and to provide constructive feedback to drive the learning forward. Similar to communication teaching and learning, the aim was to provide the student with a mental model[31] (paragraph 3.3.7.4, page 65-69) of the processes of clinical reasoning and to start developing an integrated knowledge base through the application of knowledge. At the end of the preclinical study year the student had to complete a clinical reasoning progress test. The main objective of this test was to assess the student's ability in clinical reasoning before engaging in clinical teaching and learning during the fourth year of study.

Fourth Year of Study – Objectives of the First Year of Clinical Teaching and Learning

- *Clinical teaching and learning*: The objective was set that each fourth year student had to complete a minimum of seven comprehensive clinical examinations on real-life patients under the supervision of DoDMS faculty members. After each examination, the student had to make a complete set of diagnosis and implement a dental treatment plan.

- *Clinical reasoning skills*: A further objective was set that each student had to complete two portfolio case studies of a patient treated during clinical teaching and learning and had to explain their clinical reasoning for their diagnoses and planned treatment. The two case studies had to be submitted by the end of the first and second semesters respectively. The aim was to develop the student's clinical reasoning skills further in a real-life context in order to prepare the student for a more independent approach in the fifth study year. At the end of the first clinical study year (BChD IV), each student had to complete a clinical reasoning progress test. The main objective of this test was to assess the outcome and development of the students' clinical reasoning ability after the first year of clinical teaching and learning.

Fifth Year of Study – Objectives of the Second Clinical Training Year

- *Clinical teaching and learning*: For the fifth year of study it was proposed that each student had to complete three comprehensive clinical examinations on real-life patients who specifically require fixed prosthodontic work, make a complete set of diagnosis and implement a dental treatment plan. These examinations had to take place in the Odontology clinics under the supervision of Odontology faculty members who taught fixed prosthodontics.
- *Clinical reasoning skills*: Each student had to complete one portfolio case study of a patient treated during clinical teaching and learning and had to explain their clinical reasoning for their diagnoses and planned treatment. The case study had to be submitted by the end of the first semester. At the end of the fifth clinical study year, each student had to complete a clinical reasoning progress test. The main objective of this test was to assess the outcome and development of the students' clinical reasoning ability at the exit-level of the undergraduate dental curriculum.

The formulation and specification of the process objectives based on resource considerations are hereby concluded.

5.5 Conclusion to the Chapter

This chapter articulated the purpose (course objectives), course outcomes and assessment criteria (learner objectives) of the “new” CPC unit in order to functionalise the proposed educational intervention (Figure 2.1, page 24). The chapter also specified the process objectives considering the availability of scheduled time, venues and staff to teach CPC.

5.6 Summary of the Chapter

Chapter 5 addressed the goals and objectives of the “new” CPC unit curriculum.

Chapter 6 will subsequently describe the design of the educational strategies (Figure 1.7, page 18) that will be suitable to complement the identified goals and objectives of the curriculum of the “new” CPC unit.

CHAPTER 6: EDUCATIONAL STRATEGIES – DESIGN AND IMPLEMENTATION

6.1 Introduction

Chapter 5 explained the purpose (course objectives), course outcomes (learner objectives) and process objectives of the "new" curriculum for the CPC unit, which laid the foundation for the detailed design and implementation of the proposed educational intervention (Figure 2.1, page 24). Chapter 6 subsequently addresses the selection of educational strategies, namely, content selection and the detailed design of the educational methods,[60] and the implementation (Figure 1.7, page 18) thereof.[60] This section represents Step 4 in Kern's "six-step approach to curriculum development"[60] (Figure 1.6, page 17).

The design and choice of educational strategies require that the content of the course be determined first.

6.2 Determination of Content

Content that is aligned with the exit-level outcomes is determined by and embedded in the discipline-based clinical modules in the undergraduate dental curriculum, thereby ensuring a wide coverage of the required knowledge. The goal of the CPC unit is not to duplicate this content determined by and embedded in the other modules, but to apply and integrate knowledge learned in other modules in the context of an integrated CPC encounter. Comprehensive coverage of the content has indeed been propagated in CPC[11] for the clinical teaching and learning years, even before the conception of this project.

However, with the notion that the development of clinical reasoning skills should commence in the third year of study it was realised that not all diseases and conditions could be included for the purpose of preclinical teaching and learning. Furthermore, most diseases and conditions are only systematically addressed in the undergraduate dental curriculum during the fourth and fifth years of study in the Module: Maxillo-facial Pathology. A different sampling strategy was therefore required to decide what content should be included into the preclinical part of the CPC teaching and learning.

Kessner *et al*,[186] propounded the use of so-called “tracer conditions” for assessment purposes. The use of “tracer conditions” is a sampling strategy that focuses on diseases and conditions that are commonly found. The use of such a strategy will ensure that the assessment has a high degree of validity and authenticity because it will be based on that which a dentist is exposed to most of the time.[186,187] The WHO draws attention to the most important oral and dental diseases as evidenced by epidemiological studies. The occurrence of dental caries, which is often the cause of toothache, as well as of periodontal diseases and tooth loss, is widespread. Trauma to the teeth and tooth wear conditions, such as dental erosion, are also highly prevalent. The WHO also mentions oral cancer as a particular cause for concern.[188]

On the basis of the assessment above, and due to limited resources, such as time and staff (paragraph 5.4.1, page 102), it was decided that CPC should focus only on diseases and conditions encountered most frequently for teaching and learning in the third year of study. The content covered during preclinical teaching and learning in the CPC unit was therefore limited to the following conditions: dental caries, tooth wear conditions, gingivitis, periodontitis, pain (pulpal and frequently encountered periapical conditions), tooth loss and oral mucosal conditions. Emphasis was placed on the aetiology, pathogenesis, diagnoses, treatment planning, patient administration and health promotion with regard to all the aforementioned diseases and conditions.

Since it will be impossible to cover all oral mucosal lesions in detail during the third year of study, the focus had to fall on the screening for oral cancer to detect white (leukoplakias) and red (erythroplakias) lesions of the oral mucosa.[188] This was done for four reasons. Firstly, the screening for cancer is an integral part of the comprehensive oral examination. Secondly, although the prevalence of oral cancer is very low compared to dental caries, the condition might be life-threatening and therefore has to be considered extremely important. Thirdly, oral cancer and oral diseases, such as dental caries and periodontal diseases, share common risk factors, such as smoking.[188] Fourthly, in the South African context, oral cancer is particularly relevant due to the relatively high incidence of human immunodeficiency virus (HIV) infections,[189] which exacerbates the likelihood of high morbidity and mortality rates in the affected group due to immune suppression.[190] The implication for the student is that conditions that could typically be included in a differential diagnosis will also have to be studied. Since this content is only formally presented in the fourth study year in the Module: Maxillo-facial Pathology to students, inquiry methods had to be employed in the instructional design to ensure some degree of understanding of these concepts.

Apart from oral mucosal lesions, there are many other medical conditions that might influence a dental treatment plan. These diseases and conditions are included in the curriculum of the CPC unit although no formal didactic teaching and learning in them are given. This knowledge base is concurrently studied in the Module: Applied Medicine during the third study year. The Module: Orofacial Surgery also presents some of this content in a surgical context in the later study years. It goes without saying that this content is applied during clinical teaching and learning in all the clinical modules during the fourth and fifth years of study. Third-year students will, however, only be assessed on the diseases and conditions that are formally covered during the formative part of the CPC course.

Epidemiological evidence and relative risk ratings indicate that cardio-vascular disease and allergies pose the biggest threats in causing medical emergencies in dental practice.[191] Local anaesthetics are used many times a day for pain management in dental care. The use of local anaesthetics – some of which contain vasoconstrictors – requires knowledge about a wide range of cardio-vascular conditions. Dental injections are often associated with pain, and pain and stress might result in increased blood pressure levels.[192] This provides the opportunity for the creation of context-rich scenarios during which bio-psychosocial contexts can be integrated.

Although cases involving infective endocarditis and related conditions are rare, these are conditions that are potentially life-threatening if managed incorrectly during dental care.[193] The main focus of summative assessment in the CPC unit was therefore limited to the safe use of local anaesthetics, allergies and a history of infective endocarditis (and related conditions). It was assumed that the other diseases and conditions were adequately covered in the other modules mentioned above.

The above-mentioned selection of content was aimed at establishing a sample that is more or less representative of what a general dental practitioner is exposed to most of the time.

Based on the comprehensive patient care process (Figure 1.4, page 6), four key content themes were defined in Chapter 5 during the formulation of process objectives:

- Patient administration skills
- Communication skills
- Clinical examination skills
- Clinical reasoning skills

Although the aforementioned skills can be considered to be integrated, each of them constitutes a complex skill on its own.

The determination of content as part of the educational strategy selection, in the section above, is followed by the design of educational methods. The instructional design for each of the key content themes is proposed in the sections below.

6.3 Educational Methods – Instructional Design of the Proposed Intervention

This section describes the instructional design of the proposed intervention.

6.3.1 Introduction

Comprehensive patient care is a complex skill that seeks to integrate information across disciplines. This aim indicates a need for a model for complex learning. Chapter 3 provided a detailed overview of the theoretical basis of the 4C/ID-model (paragraph 3.3.7, page 56-71).[31] The 4C/ID-model provides detailed guidelines of how complex learning can be facilitated based on sound instructional design and education theory. The model appears to be suitable for the development of clinical reasoning skills using a case-based approach, and hence it was adopted as the basis to teach the four central themes (Figure 5.2, page 107) to be covered by CPC, namely, patient administration skills, communication skills, clinical examination and clinical reasoning skills. Three of the four key skills, namely, patient administration skills, communication skills and clinical examination skills can be classified as predominantly psychomotor skills, which require the use of body parts, and sensory perception.[60] The 4C/ID-model suggests that learning opportunities for psychomotor skills must be broken down into a part-task approach (paragraph 3.3.7.2, page 60) to enable practice and repetition, with the ultimate aim of automation.[31]

The fourth skill, namely clinical reasoning, is a complex cognitive domain skill[60] that would best be presented using a whole-task approach (paragraph 3.3.7.1, page 58).[31] As already mentioned in Chapter 3, a part-whole-task approach (paragraph 3.3.7.2, page 61) is recommended when the whole-task context becomes unmanageable for the student. A part-whole-task approach allows for breaking down a very complex task into smaller parts by removing some of the elements.[31]

The instructional design of the CPC unit was designed based on these principles of the 4C/ID-model for the preclinical study year.

6.3.2 Instructional Design – Preclinical Patient Administration Skills

Patient administration was identified as a skill that must be mastered early on in the course (paragraph 5.4.2, page 106) in order to facilitate authentic learning in the other three key areas. To make the learning more authentic, case studies (similar to the case study in Appendix C, page 253) were developed to be presented by means of a part-task[31] problem-assisted approach,[74] and providing JIT information, supportive information,[31] and assessment.

6.3.2.1 Part-task Approach

A part-task approach was adopted to teach patient administration skills due to time constraints and the psychomotor nature of the task. The task was broken up into three logical parts (Figure 6.1, page 117) to fit into three 90-minute lecture periods.

The first part of patient administration teaching and learning included interviewing a patient, taking down a patient's history, and doing extra- and intra-oral (oral mucosal elements) examinations. The second part consisted of recording the periodontal examination on the patient record. Students had to complete the hard-tissue odontogram in the third part.

6.3.2.2 JIT Information

The teaching and learning process had to be facilitated by providing each student with the patient administration forms that contained a chronological sequence of investigations that had to be completed. To enable this learning, the existing patient administration forms were standardised for use in disciplines such an Odontology, Periodontology and Fixed Prosthodontics. The original forms had to be simplified to support an authentic comprehensive patient care encounter, which usually took about 2½ hours in the case of an inexperienced student. The new set of standardised patient administration forms were presented to faculty for approval and were fully implemented in 2009 (Appendix D, page 258).

Outcomes/ skill	Patient administration skills	Communication skills	Clinical examination skills	Clinical reasoning skills
Professionalism	Develop professionalism through formative feedback.	Develop professionalism through formative feedback.	Develop professionalism through formative feedback.	Develop professionalism through formative feedback.
Building rapport	Develop patient administration skills by documenting relevant findings from case studies on standardised patient records.	**Part-task 1** Develop relational communication and interviewing skills through role play.	Develop communication, administration, examination and diagnostic skills. **Part-tasks 1 to 4** **Part-task 5** **Part-whole-task 6** **Part-whole-task 7**	Develop clinical reasoning and patient administration skills. **(Part-whole-task approach)** Includes task classes: **Task class 1** **Task class 2** **Task class 3** **Task class 4** **Task class 5**
Interview				
Examination	**Part-task 1** Complaints, expectations, medical and dental history, intra- and extra-oral examinations **Part-task 2** Gingival and periodontal charting **Part-task 3** Hard-tissue charting			
Diagnosis		**Part-task 2** Develop relational communication, interviewing and patient education skills through role play. Develop selective diagnostic skills using case studies.		
Patient education				
Treatment plan		**Part-task 3** Develop selective treatment planning skills using case studies. Develop treatment plan presentation skills.		
Treatment plan presentation				

Figure 6.1 Curriculum outlay for the preclinical study year

Since the third-year students are novices, it was envisaged that they would require a substantial amount of support in order to master the content.[31]

6.3.2.3 Supportive Information

Each of the three parts mentioned in the part-task approach above, was complemented by a formal lecture to provide the necessary theoretical knowledge required to complete the task. These deductive methods[31] (Figure 3.14, page 68) were followed because standard methods were used to complete patient administration forms, and there was a lack of time to follow a more original problem-based approach.[74] Students were provided with a workbook containing illustrations, instructions and notes to assist in the form-completion exercise. The students were instructed to work in groups of two or three to facilitate discussion and interaction. A model answer was not provided, but product-orientated support[31] (Figure 3.9, page 62) from an experienced dentist was available to complement the information contained in the workbook and the preceding lecture. Students were allowed to ask questions to which detailed answers were given. Feedback was provided after the completion of each part-task based on the questions that arose during the exercise.

6.3.2.4 Assessment

The above-mentioned three-part exercise (paragraph 6.3.2.1, page 116) was repeated in the form of an open-book assessment. Remedial exercises and support were provided to those who failed the patient administration assessment.

The section above addressed the first central theme, namely, patient administration skills. The next section continues with the second theme, namely, communication skills.

6.3.3 Instructional Design – Preclinical Communication Skills

Communication skills training was introduced into the M: CPM as part of an educational research project conducted during the period 2004 to 2006.[12,15,16] Since then the teaching and learning have evolved because of financial and educational reasons. A remunerated actor (standardised patient) was used to simulate a patient encounter during the above-mentioned research period. Finances, however, forced the DoDMS to resort to peers to simulate patients.

During the formulation of the process objectives in Chapter 5 it was determined that the objective on third-year level was not to create an expert communicator. The aim was rather to provide a student with a mental model[31] (paragraph 3.3.7.4, page 65-69) or framework in terms of relational communication skills and also to repeat the process as many times as possible with the aim of developing the student's confidence and some degree of automation.

Communication in the CPC context is an extremely difficult skill to master. Besides the psychomotor aspects of the activity,[60] it requires substantial cognitive ability.[60] Students needed to acquire knowledge by studying the content and had to be able to apply the knowledge through the coherent explanation of clinical aspects to the patients. Although the development of cognitive skills was officially addressed during teaching and learning of clinical reasoning skills, formative feedback had to be provided during the communication teaching and learning. According to the 4C/ID-model,[31] psychomotor skills, such as communication,[60] are suitable to be developed through a part-task approach (paragraph 3.3.7.2, page 60).

6.3.3.1 Part-task Approach

Based on the recommendations of the 4C/ID-model, the original role-play exercise (part-whole-task) was divided into a part-task approach (paragraph 3.3.7.2, page 60).[31] To optimise the use of time, the students were divided into groups of eight students each. They were required to participate together in six separate two-hour teaching and learning sessions (paragraph 5.4.2, page 106). Two randomly selected students had to role play the communication between a dentist and a patient to simulate a typical CPC encounter. Each student got the chance to role play both the "dentist"[16] and the "patient" during each training session. The student who had to simulate the patient was provided with a vignette (shortened case study[169]), which served as the script for the role-play exercise. Eight vignettes were designed per part-task (Appendix E, page 265) to create different bio-psychosocial contexts and personalities. Each of the vignettes had to be role played (approximately 15 minutes per case). An attempt was made to build in a bit of humour and controversy into some of the case studies to keep the role-play exercises interesting. A wide range of diagnoses and themes were included based on the course content selection. During a second occasion, the conversation was video recorded for assessment purposes in a soundproof simulation surgery.[16]

The simulated "dentist-patient" interaction took place in three parts:

- In part one (Figure 6.1, page 117), the student who role played the dentist had to simulate the *rapport building process*. The process included greeting the patient, introducing both parties, making small talk with the "patient" and selectively gathering information on the "patient's" psychosocial history.[16] This was followed by determining the main complaint, the history of the main complaint and the patient's expectations. The dental and medical histories were recorded, and the role-play exercise ended with a request for consent to examine the patient. The vignettes for the rapport-building communication role-play exercise are contained in Part-task 1 in Appendix E (page 265).
- The second part (Figure 6.1, page 117) involved the *education* of the patient. Students were informed that the rapport building part, which they previously practised, had to be omitted due to time constraints. The conversation started with establishing the main complaint and expectations of the "patient" and obtaining a brief history. After consent was obtained, the student who role played the "dentist" was allowed to read selective diagnostic information, which simulated the findings of the "clinical examination". The "dentist" then had to make a diagnosis, which was discussed in the group. The "dentist" was

allowed to put selective questions to the "patient" about the "patient's" oral health-related behaviour. The vignette provided to the "patient" contained information that could only be disclosed if the "dentist" asked a question related to it. The "dentist" subsequently had to simulate the education of the "patient" by focusing on the "patient's" needs. Diagnoses had to be explained using co-diagnostic techniques.[15,16] The aetiology, pathogenesis of the disease and suggested preventive measures had to be interactively discussed with the "patient" by using visual aids. The vignettes for the patient education communication role-play exercise are contained in Part-task 2 in Appendix E (page 269).

- The third part (Figure 6.1, page 117) involved the *treatment plan presentation*. The treatment options, based on the "patient's" needs, had to be recommended and discussed with the "patient" using a chair-side Microsoft PowerPoint presentation[§§§] to obtain the patient's consent for one of the treatment options. The vignettes for the treatment plan presentation role-play exercise are contained in Part-task 3 in Appendix E (page 280).

The three part-tasks were scheduled throughout the year, and followed one another sequentially.

The three part-tasks were supported as follows.

6.3.3.2 JIT Information

Recurring process information was provided from two sources. Firstly, the lecturer verbally guided the sequence of events on a JIT basis during the communication exercises. This was repeated for each of the eight vignettes during the practice exercise. Secondly, the students received a rubric for each part-task (Appendix E, pages 268, 279 and 282) that gave

[§§§] The use of chair-side computers is a modern trend in dentistry. The use of such technology to educate the patient is one of the fundamental concepts taught as part of the M: CPM. Since 2009 all the clinical teaching and learning areas in the School of Dentistry have been supplied with chair-side computers, which can be used for this purpose.

the sequence of events. The students used the rubrics to prepare for the communication exercise and assessment.

This support was taken away for the assessment role-play exercise.

The supportive information for the communication role-play exercises is described in the following section.

6.3.3.3 Supportive Information

In order to facilitate the teaching and learning in communication skills, supportive information was provided in the form of theoretical information (notes contained in a workbook[194]) based on previous research.[15,16]

The best way of presenting a part-task approach though, is to expose the learner to the task in its entirety before starting with the part-task teaching and learning.[31] Role-play exercises were didactically introduced through a short lecture explaining the outcomes, basic context and assessment methods. The context was also learned through teaching and learning in clinical reasoning and examination skills that took place concurrently. The clinical knowledge needed for the task and the information related to patient education practices had to be integrated with the supportive information that was used for patient administration, and with the clinical reasoning teaching and learning. This information was contained in the notes in the above-mentioned workbook.[15,16,194]

The students had to prepare for the communication role-play exercises using inductive-inquiry methods[31] (Figure 3.14, page 68). When they subsequently role played a situation, an experienced dentist who is acquainted with communication skills training provided product-orientated support[31] in the form of cognitive feedback (Figure 3.14, page 68) to ensure that the content of the conversation remained valid. When the students were unable to execute the task correctly, expository methods Figure 3.14, page 68) and demonstrations had to be employed to explain the relationships between concepts. Feedback was also provided after the role-play exercise through the replay of selective recordings. Students had access to their own recordings.

6.3.3.4 Assessment

Process-specific and communication skills criteria were included in a marking rubric for each task (Appendix E, pages 268, 279 and 282, respectively). Students were assessed on their level of competence per criterion.

The section above addressed the second central theme, namely, communication skills. The next section continues with the third theme, namely, examination skills.

6.3.4 Instructional Design – Clinical Examination Skills

Clinical examination skills are psychomotor skills requiring bodily movements and sensory perception.[60] Naturally there is a cognitive element required for this process. The aim of this teaching and learning was, however, to develop students' psychomotor skills in the context of a CPC encounter.

The communication and patient administration processes were again simulated during these sessions, and actual clinical observations and diagnoses were made. Initially, a part-task approach was employed and later on when the students could accomplish more work in a contact session, a part-whole-task approach[31] was employed to facilitate the teaching and learning (Figure 6.1, page 117).

6.3.4.1 Part-task Approach

As determined in Chapter 5 (paragraph 5.4.1, page 102), the class had to be divided into three more or less equal groups, and examination skills had to be taught through peer examination. The teaching and learning had to be spread throughout the year in seven two-hour contact sessions. The development of professionalism, ethical behaviour and ergonomics in a clinical context was also addressed during each of the simulated encounters.

The magnitude of the task required it to be broken up into substantially smaller bits. The aim was to obtain a fair bit of automation before clinical teaching and learning started in the fourth study year, which meant that the parts that have been practiced before, had to be repeated. The design of the examination teaching and learning was therefore based on the practicing of an element. This element was repeated on a subsequent occasion, but the next part was added onto the process until the task could be done more or less in its entirety, which was again repeated.

The teaching of examination skills took place in seven sessions:

- Since the novice students had never examined the oral cavity of a patient before, the first session had to be a simple exercise of preparing the chair-side environment and of washing hands, followed by an examination of the oral cavity using a dental mirror and making a drawing of the oral cavity. The aim of the exercise was to teach the students basic examination skills, namely, the use of a hand mirror and to develop some sensory awareness when working on a live person.
- Session two included the patient interview (as practised during communication teaching and learning) and extra- and intra-oral examinations (mucosal aspects only). The findings had to be documented according to the standards taught in the patient administration part of the teaching and learning.
- Session three was a repeat of session two, but the periodontal examination was added.
- Session four built on session three by adding the hard-tissue examination.
- Session five constituted the full examination
- Session six included patient education and preventive procedures
- Session seven was used for clinical assessments of the entire procedure.

The students were guided in the process as follows.

6.3.4.2 JIT Information

The recurring aspects of the teaching and learning, namely the process that were followed for each session, were explained in a 15-minute tutorial just before the clinical training session started. The process the students followed was monitored by faculty during the session and was corrected if deviated from. The patient administration forms served as a guide for the clinical observations they had to record.

The product-orientated support provided during the teaching of examination skills is set out in the section below.

6.3.4.3 Supportive Information

Supportive information for clinical skills was provided through clinical demonstrations and videos just before the students engaged in the activity. The knowledge and skills learned during the patient administration and communication teaching and learning also served as learner support. The workbook[194] containing the theoretical knowledge could be used during the clinical encounter. Three supervising faculty members were generally on duty to provide cognitive feedback[31] (Figure 3.14, page 68). Formative feedback was also provided during and after the session.

The assessment of the examination skills is described in the following section.

6.3.4.4 Assessment

The assessment was done by means of a rubric (Appendix F, page 283). The aim was not to ensure competence, but to provide the student with a mental model (paragraph 3.3.7.4, page 65-70) of what examination skills entails before they start with real-life clinical teaching and learning. The emphasis was therefore on formative feedback based on performance during the exercise.

The section above addressed the third central theme, namely, examination skills. The remaining section addresses clinical reasoning skills.

6.3.5 Instructional Design – Clinical Reasoning Skills

The fourth and final central theme is clinical reasoning, which is considered to be a cognitive skill.[60] It must be noted that the teaching and learning in clinical reasoning skills were not isolated exercises. The teaching and learning of clinical reasoning skills was often integrated with patient administration, communication and preclinical examination exercises.

The theory of clinical reasoning was addressed in Chapter 3. Based on the recommendations of the 4C/ID-model, a part-whole-task approach (paragraph 3.3.7.2, page 61) was adopted for this complex skill.[31]

6.3.5.1 Part-whole-task Approach

To provide a broad context, a task was be defined as a typical CPC encounter. Components of such an encounter include: building up rapport with the patient; determining the main complaint; obtaining the history of the main complaint and patient expectations; obtaining dental and medical histories; doing extra- and intra-oral examinations (excluding the teeth and gingiva); doing a periodontal examination; doing a hard-tissue examination; and obtaining information about the patient's oral health-related behaviour. These components were built into the instructional design for each of the tasks.

However, tasks differ in terms of their degree of difficulty. Obviously, the novice had to start with the easiest case and had to move on to more difficult cases later. The 4C/ID-model suggests that task classes (Figure 3.8, page 59) be used to order the sequence of tasks from least difficult to most difficult.[31]

It was mentioned in Chapter 3 that the presentation of dental diseases and conditions in the mouth is often complex and variable (Figure 3.5, page 55). This complexity is increased because of psychosocial considerations that might influence the treatment plan. This high degree of variability therefore makes the classification of complexity an impossible task. It was decided that each task class would focus predominantly on one disease or condition originating from the periodontal or hard-tissue structures. To maintain a wider context, the inclusion of other diseases or conditions was not to be precluded, but was limited so as not to dominate the clinical reasoning process. A second disease was added for the second task class, and so forth. Based on this decision, the task classes (Figure 6.1, page 117) were defined as follows (refer to Appendix G (page 284-295) for the task class case studies):

- Task class 1: Dental caries
- Task class 2: Dental caries and tooth wear conditions
- Task class 3: Dental caries, tooth wear conditions and periodontal diseases
- Task class 4: Dental caries, tooth wear conditions, periodontal diseases, pulpal and periapical conditions
- Task class 5: Dental caries, tooth wear conditions, periodontal diseases, pulpal and periapical conditions, and tooth loss

During the formulation of the process objectives (paragraph 5.4, page 102), it was calculated that there was only time for five case studies in the third year of study. This decision was based on the availability of contact time and assessment load. The 4C/ID-model[31] makes provision for multiple tasks in a task class. The model suggests that the learning should only advance to the next task class level when the learner has mastered the current task class. Due to the complexity of each of the cases, as well as time and staff restrictions, it was decided to only have one case study per task class as indicated above. Remedial attention was however offered to struggling students during the transition to the next task class.

Group work was used to ensure interaction. For the first two tasks, students were instructed to work in self-selected groups of two or three students each. Students were randomly divided into groups of eight students for the third and fifth tasks. The fourth task was an individual task. Time is allowed in the allocated contact time for the groups to work on their tasks.

6.3.5.2 JIT Information

A combination of high- and low-level process-orientated support[31] (Figure 3.9, page 62) was provided to the students to solve the ensuing cases studies. An experienced dentist was present during the contact periods when the students worked on the case studies and the students were also supplied with step-by-step instructions (Appendix H, page 296).

Besides being JIT information, these step-by-step instructions could be considered to be cognitive strategies (paragraph 3.3.7.4, page 70).[31] It was noted in Chapter 3 that no validated model exists for clinical reasoning teaching at the time of the study. The cognitive guide was designed based on the following two suppositions. Firstly, the third-year dental students are novices who cannot be expected to reason the way experts do. Secondly, these students needed considerable scaffolding to support their learning. Crespo *et al*[101] observed and listed the clinical reasoning activities of beginners, providers considered competent and experts in a dental context. The reasoning activities of the expert appeared to be variable and too unstructured to be used in the current teaching and learning context. The step-by-step instructions were therefore chronologically based on those of the "competent" provider.[101] This follows the traditional approach to clinical reasoning to a large extent, and conformed to recommendations in the 4C/ID-model.[31]

The JIT process-orientated information was supplemented by supportive information.

6.3.5.3 Supportive Information

The supportive information was provided in the form of notes that were contained in the CPC workbook.[194] The study material used for instruction in clinical reasoning corresponded with the literature sources prescribed by the other disciplines. Additional study material was, however, provided to support the application of knowledge. In some instances, a faculty member, who was involved in the applicable discipline, gave an introductory lecture to third-year students when the content has not been covered yet. These didactic strategies[31] (Figure 3.14, page 68) were designed for the establishment of conceptual mental models (paragraph 3.3.7.4, page 65-70), which pertain to the classification of diseases and conditions, that students might or might not have been exposed to. Specific attempts were made to schedule such lectures after the relevant content has been covered in Oral Biology and Periodontology courses.

A model answer was not provided and students had to solve the cases through exploration (inquiry methods[31]) (Figure 3.14, page 68). Students, however, may unofficially have had access to answers obtained from the preceding third-year cohorts. Students were allowed to ask questions, upon which expository methods[31] were employed to give feedback (Figure 3.14, page 68). If a student asked a question, the relationships pertaining to the concepts raised were explained in detail. During this process, cognitive feedback was provided in terms of related issues and identified misconceptions. Cryptic written feedback was provided for each assignment, which were followed up with a thorough discussion on request of the student. In addition, feedback was provided to the larger group based on mutual misconceptions.

Assessment of clinical reasoning skills will be described in the following section.

6.3.5.4 Assessment

A pertinent need for formative feedback was expressed during the needs assessment. The five tasks mentioned above – scheduled for the third year of study – require an explanation of the clinical reasoning process in essay format. This method enabled the provision of written and verbal formative feedback.

The case study assignments continued in the subsequent clinical training years. In the fourth study year, the students had to submit case study portfolios on two of their complex real-life patients, for which they had to use the same assignment instructions as the third-year students. The fifth-year students only had to complete one case study, complemented by colour pictures.

The marking rubric[10] is contained in Appendix I (page 299).

The case study assessment was complemented by a progress test[63,66,195] for all three cohorts. The progress test consisted of a complex case study and higher order MCQs that tested the application of knowledge. These questions focused on clinical reasoning outcomes and decisions. A detailed description of the design of the progress test is provided later in this chapter as part of the implementation.

The instructional design of the preclinical clinical reasoning teaching and learning is hereby concluded.

The sections above explained the design of the simulation exercises, using a case-based approach. The following section continues with clinical teaching and learning in CPC.

6.3.6 Instructional Design – Clinical teaching and learning

Clinical teaching and learning commenced early in the fourth study year. Only in the very beginning of clinical teaching and learning in the fourth study year, the entire comprehensive patient care encounter was handled as a part-task approach. This was only due to students' inexperience and practical time constraints. Clinical teaching and learning were facilitated as a whole-task approach[31] as soon as the students gained confidence to employ the skills efficiently. During this phase, students were provided with high-level process-orientated support[31] by an experienced clinical supervisor who focused on establishing CPC skills.

Assessment was done on a "shows how" basis through observation of a comprehensive case.[40,156,196] The assessment was criterion based and only one student was observed per session (Appendix F, page 283).

In the fifth year of study the process-orientated support fell away. The students were consequently supervised by a large contingent of full-time and part-time faculty members who focus on all the procedural aspects of dentistry in general. This meant that the students had to start exercising comprehensive patient care independently.

The section above described the instructional design for CPC. The next section describes the design of the progress test.

6.4 Progress Test Design

The main focus of the assessment was on the development of cognitive dimensions of clinical reasoning that targets the outcome of students' clinical decision-making. The selection of appropriate assessment tools was therefore based on these requirements.

The development of the MCQs is addressed first.

6.4.1 Multiple-choice Questions

In Chapter 3 (paragraph 3.3.8.4, page 74) it was established that context-rich MCQs[40], developed to test the application of knowledge, would provide the most feasible way to obtain a valid assessment of clinical reasoning outcomes.

The principles of complex learning[31] were applied to develop a complex case study in order to establish the context. The case study was constructed to cover the defined content as broadly as possible.

Using the case study as reference, a combination of 32 context-rich MCQs were constructed by the researcher to assess the clinical decision-making ability of the students. The decision to use 32 questions was based on the time it would take to complete the test. A 90-minute time slot was available for each of the study year groups.

The construction of MCQs is highly technical and requires the careful formulation of stems and distracters.[64]

6.4.1.1 Stems

Generic stems were developed based on the literature[64,197] and the University's guidelines,[198] as well as examples used by Coderre, *et al*.[199] Refer to Table 6.1, below, for examples of stem designs.

Table 6.1: MCQ stem design examples

Select the most likely diagnosis for the described lesion/condition.
Classify the extent of the disease or condition.
Classify the severity of the disease or condition.
Identify the most likely cause(s) of the described lesion/condition.
Select the most appropriate treatment for the described lesion/condition.
Select the most appropriate health promotional advice to prevent the further progression of the disease/condition.
Identify the most appropriate precaution(s) that should be taken to prevent a medical emergency.
Identify the most appropriate precaution(s) that should be taken to prevent litigation.

Adapted from Coderre, *et al*[199]

The grammar of the above-mentioned stems has been altered from the example used by Coderre, *et al*[199] to start with a specific verb so as to be in line with the University of Pretoria's guidelines in terms of the formulation of outcomes and assessment criteria.[183]

6.4.1.2 Distracters

Appropriate distracters (answer options) were also developed according to guidelines in the literature[64,197] and those of the University.[198]

A complex case study and a set of 40 questions were initially drafted. An example of a case study and one of the questions are given in Appendix J (page 302-304). The progress test is kept secret because it is currently (2013) still in use.

All the questions were subjected to a quality control and standard setting process.

6.4.2 Quality Control and Standard Setting

The standard setting and quality control form used during the process can be viewed in Appendix J (page 300). Standard setting refers to the determination of the cut-score,[197] and quality control relates to the formulation of appropriate test questions. During this study, these two processes were done in tandem and will therefore be addressed together in this section.

To ensure content validity, it is recommended that subject experts, who are familiar with the abilities of the target group, be involved with the quality control of questions and the standard setting process.[200] It is also advisable to involve the teaching staff of the particular discipline.[201] Guidelines from the University of Liverpool[202] indicate that attempts should be made to involve at least 10 faculty members (without discussion) or six members (with discussion) during the standard setting process.

Based on the above-mentioned guidelines, at least two subject specialists per question were identified from faculty, including general dentists or dental specialists. The subject specialists were asked to evaluate the newly drafted questions pertaining to their field of expertise. General dentists who have been involved in teaching and learning in the CPC environment were also asked to evaluate all the questions in the questionnaire. Initially it was endeavoured to get the input of at least five additional dentists. This was, however, reduced to four faculty members due to practical considerations. Ratings that were considered to be outliers were discussed with the individual assessor who had the choice to change the rating or not.

Case and Swanson[64] recommend that questions should be relevant in terms of content and that questions should not be overly difficult or easy. Participating faculty members rated the relevance and difficulty level of the questions on a visual analogue scale (Appendix J, page 305). The end points of the relevance scale were defined as “irrelevant” and “highly relevant”. The extremities of the difficulty scale were defined as “very easy” and “very difficult”. The appropriateness of the distracters was also evaluated on the scale between “inappropriate” and “very appropriate”. Irrelevant questions and distracters were revised or discarded. Questions that did not display the desired properties were discarded or altered and re-evaluated.

Standard setting is performed to distinguish competent students from those who are not yet competent. Over the years many methods of standard setting have been described in the literature.[203-206] The two main methods of standard setting use either relative standards, whereby the worst performing students are failed based on a statistical cut-off point, or absolute standards where a cut-off score is predetermined based on specific criteria. The latter method is generally the more acceptable one. To date, no perfect standard setting measure has been devised. All standard setting methods depend, in one way or another, on the subjective estimations of the judges. Of these methods, the frequently used Angoff method[197] (or modifications thereof) has been described as one of the most acceptable methodologies. The Angoff method[197] requires the judges to estimate the percentage of borderline candidates that would answer the question correctly. The average estimated percentages for all the questions determine the cut-score[204]. The interpretation of what constitutes a borderline candidate might, however, be problematic and variable.[197] These uncertainties indicate the need for external validation of the standard setting process.[201]

Beuk[203] proposed the use of a combination of relative standards and absolute standards. One of the measures used in this method requires the judges to predict the percentage of students that will pass the question.[203] This method therefore eliminates the interpretation of what constitutes a borderline candidate. A modified version of this method was employed for the current study. The participating academic staff indicated on a visual analogue scale their predictions of the percentage of students (at exit level) that they thought would answer each question correctly (Appendix J, page 305). The predictions of the academic staff obviously varied, since these predictions are mere estimations based on the staff's knowledge of the students they are teaching. The average of these estimates was used to derive the exit-level pass mark, using the lower value of the 90% confidence interval to compensate for the error and to set the cut-score. The upper limit was considered to be the benchmark for a distinction. The 90% confidence interval was chosen above the 95% confidence interval because substantial variability is expected amongst faculty predictions, and the 90% confidence interval would yield a more precise estimate compared with the 95% confidence interval. If more judges could have been afforded, the higher confidence level could have been considered. This method provides a broad interval within which most students' performances should fall. It must be noted that this standard was not implemented during the course of the study because of the unequal teaching methods used for the different cohorts. Furthermore, the proposed method used to determine the pass mark is new and untested. Instead, it was decided to subject this hypothetical cut-off score to an external validation by comparing it against the student's performance during the three-year period.

The sections above described the design of the progress test as well as the quality control and standard setting methods employed during the design process. The following section considers the use of an open-book assessment strategy.

6.4.3 Open-book Strategy

It has been proposed that closed-book test strategies should be complemented by open-book testing.[207] However, evidence exists that a closed-book strategy might be better to instil deep learning compared with an open-book strategy.[208] Open-book testing will, however, be acceptable if the core knowledge is covered using a closed-book approach,[207] and it might be a better predictor of ability when testing higher order skills.[209] Furthermore, if the authentic situation allows the use of references then an open-book approach might be appropriate since it evaluates the student's ability to read and interpret the references.[210] Since the core knowledge is already tested by the various disciplines in the undergraduate curriculum and the development of clinical reasoning is a problem-solving exercise requiring the application of knowledge, an open-book assessment strategy was selected. Due to practicalities a time limit of 90 minutes was applied.

The section above described the indications for open-book tests. The next section briefly elaborates on test security measures.

6.4.4 Test Security

Using progress test principles required that the case studies and questions be kept secret. Firstly, the test took place under strict examination conditions. Secondly, the test paper and case studies were handed in after the test under strict control. Students were also blinded of knowing that the progress tests for all the study years contain the same questions. An effort was made to have the three cohorts write the test at about the same time, although this was not possible in every instance. Using generic questions based on a highly complex case study that contains many detailed signs, symptoms and attributes, makes the transfer of knowledge between students unlikely.

The marking was done as follows.

6.4.5 Marking

The marking of the answer sheets was done manually by a faculty member of the DoDMS who were not involved with the research at all. The answers were controlled by a second faculty member of the DoDMS during the marking process.

The section above described the design of the progress test for CPC, which concludes the planning of the proposed educational intervention. The next part briefly elaborates on the implementation of the intervention.

6.5 Implementation

The “new” curriculum for the CPC unit – designed according to the principles of the proposed educational intervention (Figure 2.1, page 24) – was implemented in 2009.

The implementation process included institutional approval, and the issuing of a study guide and a workbook.

6.5.1 Institutional Approval

This novel educational design required negotiation and approval of the following aspects:

- The new standardised patient administration system
- The new study guide for the M: CPM, containing the newly formulated course outcomes (learner objectives), assessment criteria and assessment requirements for CPC
- The allocation of a dedicated 90-minute time slot per week for clinical reasoning teaching and learning in the form of lectures and group work
- The allocation of time (a two-hour session) for practical preclinical training and the procurement of a teaching venue

Faculty was consulted on the above, and approval to implement was given by the Education Innovation Committee of the School of Dentistry.

6.5.2 Study Guide

The newly designed mid-level outcomes for the CPC course (learner objectives) (Table 5.4, page 100) and the assessment criteria (lower level learner objectives) contained in Appendix B (page 244), were communicated to the third-, fourth- and fifth-year students by means of the M: CPM study guide.

The study guide was complemented by supportive information in the form of a workbook.

6.5.3 Workbook and Study Notes

Students were issued with workbooks and study notes[15,16,194] containing theoretical descriptions of the defined content and the case study exercises as defined in the discussion of the educational methods in paragraph 6.3.5.1, page 126.

6.5.4 Comprehensive Patient Care Teaching and Learning – 2009

The instructional design (case-based teaching and learning), described in paragraph 6.3 (page 115-131) was implemented as planned in 2009, and the focus was on the third-year students.

The newly designed case-based instructional design included content to which the 2009 fourth- and fifth-year cohorts had not been exposed. In order to address that disparity, additional didactic instruction was provided during the year to cover the content and to prepare the students for the clinical reasoning assessment by means of a progress test.

6.5.5 Progress Test Implementation

The above-mentioned third-, fourth- and fifth-year cohorts wrote the progress test for the first time at the end of the 2009 academic year.

The implementation of the proposed intervention, as well as the progress test, was explained above, and the next section outlines the differences between the "old" and the "new" CPC curriculum. This outline explains the context of the practical changes that occurred due to the curriculum development process.

The evaluation provided in the following section contains a comparison between the outcomes of the “old” and those of the “new” CPC unit curricula.

6.5.6 Differences between the “Old” and the “New” CPC Unit Curricula

It is pertinent to note that the most profound change in the curriculum was the introduction of case-based teaching and learning in the third study year, utilising models for complex learning. The introduction of a case-based instructional design as part of the course is novel since no such teaching and learning was provided before despite the existence of a problem-solving philosophy followed by CPC.

The second profound change was the introduction of preclinical teaching and learning in the form of clinical examination skills in a clinical setting. These exercises (as outlined in paragraph 6.3.4, page 123) entailed the examination of peers throughout the year in a part-task, part-whole context. In the past (before 2008), this was done through simulation practice on phantom heads, but the emphasis was on restorative procedural skills.

The third change involved the partitioning of the communication teaching and learning into smaller manageable parts. Coupled with this, a range of eight shorter vignettes were designed to replace the one long case study. These changes were made to allow repeated exposure and a wider coverage of content.

Although the patient administration system was completely changed in 2009 only, the senior students had been taught to use the new patient administration forms in a clinical setting during the second half of 2008. The only differences between the “old” and the “new” systems were the user-friendliness and the increased compactness of the formats. In essence, the patient administration remained the same.

The clinical teaching and learning processes in the fourth study year also remained the same in principle. Before 2011 the clinical teaching and learning was conducted in the Department of Odontology. At that stage the teaching and learning was provided by a large number of full-time and part-time staff from Odontology. Two dentists from the DoDMS participated meaningfully in clinical teaching and learning before 2009. The 2011 fourth-year group were the first fourth-year group that were taught at a different location after infrastructure changes at the School. All in all, the four original faculty members assigned to M: CPM as well the Head of Department of the DoDMS were assigned to supervise clinical teaching and learning in CPC.

Since 2009 the case study assignments of the fourth-year groups changed from a primary preventive approach to a comprehensive approach in that the integrated clinical reasoning pertaining to two real-life cases had to be explained in the form of an essay. A similar case study was also added to the curriculum for the final-year students. The portfolio of clinical records the students had to compile for assessment purposes prior to 2009 was done away with.

6.6 Conclusion to the Chapter

A case-based instructional design, in accordance with the principles of the 4C/ID-model was chosen as the core strategy for teaching and learning in CPC. These newly designed educational strategies were implemented for third-year students in 2009.

6.7 Summary of the Chapter

Chapter 6 outlined the detailed design of the proposed educational intervention (Figure 2.1, page 24). The chapter described the educational strategies, which included content selection and instructional design, selected for the CPC unit. The implementation of the proposed intervention was described in the last part of the chapter, which concluded Phase 1 (Figure 1.7, page 18) of the study.

Phase 2 of the study (Figure 1.7, page 18), namely the curriculum evaluation, will be described in Chapters 7, 8 and 9.

Chapter 7 continues with the methods of the evaluation (Figure 1.7, page 18).

Chapter 7

CHAPTER 7: CURRICULUM EVALUATION – METHODS

7.1 Introduction

The functionalisation of the “new” curriculum for the CPC unit – based on the educational principles of the proposed educational intervention (Figure 2.1, page 2.4) – was explained in Chapter 6, which concluded the curriculum development phase (Figure 1.7, page 18) of the study.

Chapter 7 commences with the curriculum evaluation phase (Figure 1.7, page 18), which represents Step 6 in Kern’s “six-step approach to curriculum development”.[60] The reader is referred back to paragraph 1.5.1 (page 16) for a discussion about Kern’s model and the guiding role it played in the methods of this study.

Chapter 7 is the first of three chapters that addresses the evaluation of the educational processes of the “new” CPC unit (Figure 1.7, page 18). This chapter specifically reports the research methods used to conduct the evaluation. The purpose of the evaluation was to test the hypotheses listed in paragraph 2.4 on page 27 in Chapter 2.

It was mentioned in Chapter 1 (paragraph 1.5.1, page 16) that the researcher adopted action research and evaluation research principles[57] to implement and evaluate the educational intervention. Applying these philosophies, mixed methods[58,59] – namely, a combination of quantitative and qualitative research methods – were employed for this evaluation.[58,59]

In the quantitative part of the evaluation the researcher compared the development of clinical reasoning skills of different cohorts of students who were exposed to different instructional designs in the CPC unit by means of a progress test (paragraph 6.4, page 131). Quantitative methods were also used to evaluate the progress test’s discrimination properties.[64] The advantage of quantitative methods, in the context of this study, was that effects and phenomenon could be expressed in mathematical terms.[58,59] The use of quantitative methods of evaluation allowed for “objective” judgements to be made about the effectiveness of the educational intervention,[58,59] within the boundaries of the study design.[56,57] The disadvantage of quantitative methods is that statistics do not explain the detailed reasons for certain observations, [56,57] which generally leads to speculation.[56,57] This can partially be overcome with the simultaneous use of qualitative methods of research. [56,57]

In the qualitative part of the evaluation the researcher attempted to gain insight from the students why some students progressed in their development of clinical reasoning skills, while others did not. This part of the research also looked at perceptions of the students regarding the new instructional design. Although qualitative results cannot necessarily be generalised beyond the context of the experiment itself, the information gained from this source may be valuable to give insight to some of statistical differences observed in the quantitative part of the evaluation.[58,59,211] The results obtained from qualitative research maybe particularly useful to highlight novel aspects that should be further investigated, for example, by means of quantitative methods.[58,59,211]

The quantitative methods of the evaluation are addressed in the first part of the chapter, and the methods of the qualitative component are addressed in the second part of the chapter. The third part of the chapter pays attention to the ethical considerations of the evaluation and administrative aspects, such as the funding of the research findings.

7.2 Quantitative Methods

The description of the design of the quantitative part of the evaluation includes a description of the subjects, the expected sample size, the study design, the instruments used for the analyses and the statistical analyses.

7.2.1 *Subjects*

All the third-, fourth- and fifth-year BChD student cohorts for the period 2009 to 2011 were targeted for this evaluation.

7.2.2 *Expected Sample Size*

It was estimated before the study that the sample size for each of the cohorts would range between 45 and 55 students, without taking attrition due to academic underperformance into account.

7.2.3 *Study Design, Measurement Instruments and Statistical Analysis*

A longitudinal cohort study[212] (Figure 7.1, below) was designed to measure the effectiveness of the cased-based instructional design as opposed to lecture-based instructional to develop the students' clinical reasoning over time. In order to compare the results of the two different instructional designs cohorts of students who were subjected to the cased-based teaching and learning were labelled as "intervention" groups and the cohorts who received lecture-based teaching and learning were labelled as "control" groups.

Year	Third study year	Fourth study year	Fifth study year
2009	Cohort A Intervention group – cased-based teaching and learning	Cohort B Control group – lecture-based teaching and learning	Cohort C Control group – lecture-based teaching and learning
2010	Cohort D Intervention group – cased-based teaching and learning	Cohort A Intervention group – cased-based teaching and learning	Cohort B Control group – lecture-based teaching and learning
2011	Cohort E Intervention group – cased-based teaching and learning	Cohort D Intervention group – cased-based teaching and learning	Cohort A Intervention group – cased-based teaching and learning

Figure 7.1 Design of the quantitative part of the evaluation

This quasi-experimental study design[213] was indicated because, the gold standard design, namely, a randomized design was not practical and feasible in the context of education research.[213] It would not be ethical in educational research to expose half of a student cohort to an innovative instructional design, while the other half of the cohort is exposed to a potentially inferior instructional design. A comparison of the outcomes of different cohorts, who received their teaching and learning by means of different instructional designs, therefore, remained the only feasible option left to the researcher. Although this design is not a hundred per cent ideal it would be more appropriate than an uncontrolled experiment or an observational study to evaluate the effectiveness of the intervention.[213] Due to the non-randomized nature of the adopted study design, any direct comparisons between the different cohorts had to be interpreted with caution[213] because the different cohorts may have differed in their composition and behaviour.[213] Therefore anticipated variances had to be controlled for during the statistical analysis.[213] The results of the experiment was dependent on whether the circumstances that might have influenced the outcome of the intervention remained the same during the course of the experiment.[213] Observed changes in this regard have been alluded to in paragraph 6.5.6 (page 139).

This design, and how it relates to the measurement instruments, namely, the progress test and the student feedback, is explained in detailed later in this paragraph.

7.2.3.1 Progress Test

This above-mentioned study design (Figure 7.1, page 143) was specifically selected to test the first research hypotheses listed in paragraph 2.4.1 (page 28). The newly developed progress test (paragraph 6.4, page 131) was used to measure the changes in clinical reasoning over time.

Cohorts A and D, who had received preclinical case-based teaching and learning, were used as the intervention groups. Cohorts B and C, who had received lecture-based teaching and learning before the implementation of the educational intervention, served as the control groups. Students who failed a study year were excluded from the main progress test analysis in the subsequent year because in many instances it would have meant that a student who was originally in a control group would have moved to an intervention group. It also did not make sense to keep repeating students in the main analysis because it would have meant that these students completed the same course more than once and would therefore have had at least double the exposure for a particular study year. The performance of consenting repeaters was rather reported separately for comparative reasons.

In order to evaluate the effect of the intervention at exit level (fifth study year), the progress test results of Cohort A (intervention group) was compared with the progress test results of Cohorts B and C (control groups) in the fifth study year. Similarly, for the fourth study year, the results of Cohorts A and D (intervention groups) were compared with the results of Cohort B (control group).

Progress was also measured for Cohorts A and D (intervention groups) and Cohort B (control group) by comparing their respective progress test results for each study year.

A variety of statistical methods were used for the progress test analyses and the level of significance for all the analyses was set at $P<0.05$.

A descriptive summary of the results of the progress test scores was complemented by mixed model statistics that measured changes in progress test scores over time.

For analytical purposes, the questions of the progress test were divided into two components, namely diagnostic and treatment components Refer to Appendix K, Table K.1 (page 307). The diagnostic component represents a composite score for all the questions where the students only had to make a diagnostic and not a treatment decision. The treatment component score is a combined score for complex questions involving a combination of diagnostic, prognostic and treatment planning decisions. The scores were therefore a reflection of what has been covered in the respective components of the test (Appendix K, Table K.1, page 307.

In Chapters 2 and 4 a need was identified to consider various confounding factors, such as demographic influences and prior knowledge, when evaluating academic performance.

Analyses of covariance and linear regression models were employed to measure the effect of the educational intervention by comparing the test results of the intervention and control cohorts. Age, race, gender and previous academic performance were controlled for in the models to test the first two research hypotheses listed under paragraph 2.4.2 (page 29).

It must be noted that the dichotomy as regards race between White and so-called "previously disadvantaged" racial groups in South Africa namely, Black, Coloured and Indian/Asian students was handled by separating the students into two groups. This distinction was made based on the deliberations in Chapters 1 and 4 that showed that a statistical association may exist between students from different "ethnoracial" origins in South Africa. The reasons[50-53,78] for the possibility of such associations have been addressed in Chapters 1 and 4 (pages 13 and 82, respectively).

Students' results in Oral Biology were chosen as an indicator of prior knowledge instead of their results in Grade 12 or in their first year of tertiary education, because initial evaluations of the last two groups of results showed that these were not uniform. For example, in many cases students did not have the same subjects at school; they qualified in different years and some received recognition for subjects completed at other universities. Oral Biology was identified in Chapter 4 as an important building block for clinical reasoning. Assessment in this subject is done randomly, and the assessment appears to be consistent. Oral Biology has seemed to be a challenging subject for struggling students over a number of years. Based on these arguments the research protocol for this project was amended and Oral Biology was included as a control variable for the evaluation. This amendment will be elaborated upon under the "ethical considerations" of the evaluation, later in this chapter.

Besides the above-mentioned analyses of the progress test results, the progress test itself was subjected to scrutiny by the researcher himself in terms of the way it discriminated between students as an assessment tool. These statistical analyses were done to test the second research hypothesis listed in paragraph 2.4.1 (page 28).

- The effectiveness of each of the distracters was measured in terms of the percentage distribution according to which they were selected.[64,198]
- The discrimination index[64] of each MCQ question was calculated by subtracting the ratio of correct answers obtained from the 25% worst performing students from the ratio of correct answers obtained from the top 25% performers.[64] The Chi^2-test, the Fisher's Exact test, Analysis of Variance (ANOVA) and the Bonferroni *post hoc* contrast analyses were used to make statistical comparisons for the above-mentioned analyses. It has been proposed by Case and Swanson[64] that a discrimination index of 0.3 and above indicates a high quality MCQ question.[64]
- The level of difficulty[64] of each MCQ question, based on the proportion of students who answered the question correctly,[64] was calculated. The same methods mentioned under the previous bullet were used for the statistical analyses.
- The level of difficulty[64] of each of the questions was subsequently compared with the predictions made by faculty members during the standard setting process using the Chi^2-test.

The above-mentioned qualitative analyses of the progress test results were complemented by student perceptions reported by means of student feedback questionnaires.

7.2.3.2 Student Feedback Questionnaires

In order to test the third and fourth hypotheses listed in paragraph 2.4.1 (page 28) anonymous student feedback from Cohorts A to E was sourced by means of a questionnaire.

Student feedback questionnaires (Appendix L, page 321) were custom designed based on the needs assessment conducted in Chapter 3. These questionnaires were not piloted beforehand. The questionnaires were developed to test students' perceptions regarding "relevance", "curriculum alignment", "the assessment's contribution to learning", "integration", and the ability of the CPC unit to reduce the knowledge gap between the third and the fourth study years. Standard items in the University of Pretoria's feedback systems, namely, competence of the lecturers and the quality of the course organisation, were added to the questionnaires. A section was also provided where students could write open-ended comments. Since each study year has a unique educational situation, different questionnaires were developed for the third, fourth and fifth years of study.

A visual analogue scale was chosen as measurement tool because it is considered to be an appropriate method of measuring information of a subjective nature[214] – such as student perceptions.[215] Visual analogue scales also allow for a wide range of statistical analyses through the use of continuous data.[216] The visual analogue scales were presented to the students by means of 127mm horisontal lines comfortably placed in the centre of standard A4 page in a portrait orientation (Appendix L, page 323). The length of the lines was based on the recommendation that a visual analogue scales ranging from 100mm to 150 mm would render valid and reliable results in subjective surveys.[217] The endpoints of each question were defined to be "maximally" positive and "minimally" negative,[218] (Appendix L, page 323) allowing for the measurement to be expressed on a continuous range that would avoid endpoint or label aversion, often experienced when categorical scales are employed.[218]

Student responses were manually measured by an administrative member of staff of the DoDMS by means of a standard ruler. The measured values were captured on Microsoft Excel and mathematically adjusted to provide a value on a scale of naught to 100.

The anonymous feedback results for the fifth-year control groups, Cohorts B and C, were grouped together for comparison with the fifth-year intervention group, Cohorts A. Similarly, the feedback results for the fourth-year intervention groups, Cohorts A and D, were grouped together for comparison with the fourth-year control group, Cohort B. The feedback results of the three third-year cohorts were kept separate for comparison with each other.

Two sample t-tests were used to assess the difference between the intervention and control groups in terms of the students' perceptions of the educational process.

Linear regression models were used to assess the correlation between student feedback regarding relevance, curriculum alignment, assessment's contribution to learning, integration, course organisation and lecturer competence.

The section on quantitative research methods is hereby concluded, and the section is followed by a description of the qualitative methods.

7.3 Qualitative Methods

During the study it was realised that certain students, subjected to the intervention, showed progressed in terms of their clinical reasoning decision-making, whereas others did not. Based on this observation, the research protocol was amended. This amendment will also be elaborated upon under the "ethical considerations" later in this chapter. The amendment included adding a qualitative study in the form of focus group discussions to identify the factors that might predict reasons for progression or non-progression.

The following section addresses the sample selection, study design, focus group procedures, the transcription and the analysis of the qualitative part of the evaluation.

The section commences with the sample selection.

7.3.1 Sample Selection

It was decided to target the 2011 fourth-year group due to the fact that they had clinically applied the knowledge they had gained in the preclinical study year. These students had completed the progress assessment more than once, and hence their progress could be tracked. The fifth-year group, who were in the final phase of their undergraduate course at that stage, were not interviewed due to time considerations.

7.3.2 Study Design

Two groups of eight students each from Cohort D, who were more or less representative in terms of race and gender, were purposively selected by the researcher for focus group discussions.[219] The two groups were differentiated based on their progression in terms of clinical reasoning (Figure M.1, Appendix M, page 331). Focus Group 1 consisted of students who appeared to have improved their progress test scores by 9% or more. Focus Group 2 consisted of students who have either achieved lower progress test scores or have improved their progress test scores by 6% or less. Of the eight invitees for Focus Group 1, four were white, three were Black, and one was of Indian descent. Five of these students of Focus Group 1 were female. Of the eight invitees for Focus Group 2, four were White, and four were Black. Five of these students were female.

7.3.3 Focus Group Procedures

The focus groups were facilitated by a dentist who was not directly involved with the intervention. This dentist just joined the university from another institution and had no involvement with the teaching and learning in CPC.

Answers to open-ended questions were voice recorded with a digital voice recorder.[219] To start the discussion, the following open-ended question was posed to the students in the discussion groups by the facilitating: "*In terms of your own learning, how did you experience the case studies that were used in the third year of study to train your diagnostic and treatment planning skills?".*

The focus group was conducted in a semi-structured way.[219] Semi-structured focus groups are conducted in order to keep to some form of order and to specifically to elicit responses from the students, they thought were important, albeit not exactly focussed on the original intention of the researcher.[219]

The students were allowed to respond randomly in a paticipative manner. Efforts were made not to lead the students in any way in the conversation. However, probes were made by the facilitator during the conversation to enquire about how the students "experienced" and "approached" the case-based teaching and learning, especially when the conversation became stagnated. When the conversation became stagnated the students were asked in a sequential order as they were seated around the table to respond to the facilitators questions. Students who were not naturally engaged in the conversation were specifically asked about their perceptions on the topic in the latter part of the focus group discussion. Ultimately, all students were afforded an opportunity to speak.

7.3.4 Transcription and Analysis

The voice data was transcribed[219] by one of the administrative members of staff of the School of Dentistry by typing the conversation into a text format.

The dentist who facilitated the focus groups controlled the transcription and made corrections. The thematic analysis[220] of the data was done by the same dentist. Thematic analyses[220] can be described as flexible methods that are designed to identify and to record thematic patterns within data sets such as narratives or conversations.[220] The purpose of a thematic analysis is to organise and describe a data set in "rich" detail.[220] Thematic analysis may be based on a preconceived or identified models related to the research.[220] Such structure is not a prerequisite in order to maintain flexibility in the analyses.[220]

Anticipated coding themes based on concepts such as "self-regulated learning"[44] and "self-handicapping"[45] behaviour described in paragraph 4.3 (pages 83-86) were as follows:

- 01: Accepted responsibility
- 02: Displayed diligence
- 03: Displayed ability to focus
- 04: Actively engaged with the task
- 05: Displayed comprehension
- 06: Was able to reason and elaborate
- 07: Had problems with time management
- 08: Displayed problems with language/reading skills
- 09: Had inadequate prior knowledge
- 10: Had adequate prior knowledge
- 11: Displayed self-handicapping behaviour
- 12: Displayed ability to perform self-evaluation

Provision was made for other themes to be added to the list, based on what the students felt was important regarding the topic.[220]

The researcher himself controlled the thematic analysis after the initial identification of themes by the facilitator of the focus groups. During this process, quotes from the discussion groups were reorganised by the researcher, through a process of merging themes with a similar context together into a single theme.[220] Such practice is highly recommended in thematic analyses to maintain focus in the research findings.[220]

The quotes identified were tabulated per theme for both the sample groups.

The qualitative research methods are hereby concluded. The following section addresses the ethical considerations of the study.

7.4 Ethical Considerations

The ethical considerations presented in this section particularly apply to the evaluation stage of the study as it involves an assessment of student progress and student perceptions as part of a research project.

Institutional permission, ethical clearance, informed consent, anonymity and a declaration about conflict of interest are therefore covered in this section.

7.4.1 Institutional Permission

The research protocol, including the two amendments mentioned above, was approved by the Research Committee of the School of Dentistry.

It should be noted that the titles of the two information leaflets contained in Appendix N (page 338) differ. The title contained in the leaflet of quantitative part of the study is the title of the main study and this thesis. The title contained in the leaflet of the qualitative part of the study was registered by the Research Committee of the School of Dentistry and the Research Ethics Committee of the Faculty of Health Sciences, University of Pretoria as an adjunctive study, which is subordinate to the main study. The reason for this was that this part of the study was completed as part of a Foundation for the Advancement of International Medical Education and Research fellowship the researcher completed as part of his scholarship in medical education.

The Dean/Manager of the School of Dentistry gave permission for both the studies (including the amendments) to be conducted at the School of Dentistry, University of Pretoria, and for the use of University data.

7.4.2 Ethical Clearance

Ethical clearance (Protocol 153/2009) was provided by the Research Ethics Committee of the Faculty of Health Sciences, University of Pretoria.

7.4.3 Informed Consent

Student data was only included in the qualitative and quantitative analyses, for which written informed consent (Appendix N, page 338) was obtained. Students' individual consent was obtained to use the data they had supplied for the University of Pretoria's records as regards their race, age, gender and previous academic performance (in Oral Biology).

The need for informed consent was waivered by the Research Ethics Committee for students who had already left the system. This only applied to Cohort C (the 2009 fifth-year cohort) who wrote their first progress test before final the ethical approval was received.

7.4.4 Anonymity

Anonymity was maintained in terms of the student feedback questionnaires (Appendix N).

7.4.5 Conflict of interest

No conflict of interest exists.

The explanation of the management of ethical considerations is followed by a description of the funding for the project.

7.5 Funding

The study forms part of the normal operation (teaching and assessment) of the DoDMS. The operational costs were therefore absorbed by the departmental budget. Approval for the funding of the research analyses and for reporting on the study in an appropriate forum was obtained from a DoDMS research fund.

7.6 Conclusion to the Chapter

The quantitative and qualitative methods that were used for the evaluation was described in this chapter. The subjects, study design, instruments and statistical methods used for the analyses were also mentioned.

7.7 Summary of the Chapter

Chapter 7 outlined the research methods used for the curriculum evaluation. Chapter 8 (Figure 1.7, page 18) subsequently describes the evaluation results.

CHAPTER 8: CURRICULUM EVALUATION – RESULTS

8.1 Introduction

Chapter 7 described the methods that were used for the evaluation of the curriculum of the “new” CPC unit.

Chapter 8 (Figure 1.7, page 18) is the second of three chapters that will address the evaluation, and represents Step 6 in Kern’s “six-step approach to curriculum development”[60] (Figure 1.6, page 17).

This chapter concentrates on the results of the evaluation and is divided into four parts. The first part is an analysis of the progress test score results. The second part includes the evaluation of the properties of the progress test itself. The quantitative student feedback results are reported in part three. Part four reports on the qualitative results obtained from the focus group discussions.

8.2 Progress Test Results

This section commences with a summary of the progress test results, which is followed by the diagnostic and treatment planning component scores of the various cohorts. The section continues with the progression increments regarding each cohort over time, and outlines the differences in progress test results between the different cohorts. The frequency distributions of the test scores are also reported. The section concludes with the correlates of the progress test scores.

8.2.1 Summary of Progress Test Scores

Table 8.1 (page 157) provides a broad overview of the progress test scores (2009 - 2011) per cohort. Refer to the design of the evaluation (paragraph 7.2.3, page 143) for an explanation of the labelling of the different cohorts.

Table 8.1 Progress test scores (2009 - 2011)

Cohort	Study year	Year	Intervention	n	X	SD
A	3	2009	Yes	39	63.70	12.45
A	4	2010	Yes	39	66.59	10.69
A	5	2011	Yes	36	75.69	6.93
B	4	2009	No	49	58.74	9.33
B	5	2010	No	48	63.67	11.14
C	5	2009	No	48	64.97	9.71
D	3	2010	Yes	54	62.27	14.52
D	4	2011	Yes	48	68.95	10.40
E	3	2011	Yes	49	61.54	11.57

Improved progress test scores are observed for cohorts who have written the test more than once. The statistical significance of these changes will be addressed later in this chapter. It is pertinent to note that the fifth-year cohort (Cohort A) (intervention group) of 2011 achieved the highest mean (X) score of 75.69%, as well as the most precise scoring of all the cohorts, with a standard deviation (SD) of 6.93. This cohort's results also became increasingly more precise over time and displayed a lower SD every subsequent year. The same finding applies to the other intervention group, Cohort D.

The converse, however, applies to control group Cohort B.

During the evaluation a distinction was made between the diagnostic and treatment planning components of the test. The diagnostic component evaluation results will be addressed first.

8.2.2 Diagnostic Component of the Progress Test Results

The diagnostic component scores of the progress test scores are displayed in Table 8.2, below. Similar to the overall test scores, the marks of the diagnostic component improved over time. Again, the 2011 fifth-year group (Cohort A) recorded the highest (83.64%) and most precise (SD = 7.96) score.

Table 8.2 Diagnostic component scores of the progress test (2009 - 2011)

Cohort	Study year	Year	Intervention	n	X	SD
A	3	2009	Yes	39	70.37	15.73
A	4	2010	Yes	39	73.79	12.99
A	5	2011	Yes	36	83.64	7.96
B	4	2009	No	49	67.35	12.45
B	5	2010	No	48	68.87	14.66
C	5	2009	No	48	71.75	11.34
D	3	2010	Yes	54	67.18	16.45
D	4	2011	Yes	48	73.38	12.71
E	3	2011	Yes	49	67.01	12.90

The summary of the diagnostic component results is followed by a discussion of the treatment component of the progress test in the next section.

8.2.3 Treatment Planning Component of the Progress Test Results

Table 8.3 (page 159) illustrates the treatment planning component scores of the progress test. In general, lower scores were observed for this component when compared with the diagnostic component (Table 8.2, above).

Table 8.3 Treatment component scores of the progress test (2009 - 2011)

Cohort	Study year	Year	Intervention	n	X	SD
A	3	2009	Yes	39	55.13	14.00
A	4	2010	Yes	39	57.33	12.53
A	5	2011	Yes	36	65.47	11.13
B	4	2009	No	49	47.67	9.82
B	5	2010	No	48	56.99	14.4
C	5	2009	No	48	56.25	13.87
D	3	2010	Yes	54	55.95	19.01
D	4	2011	Yes	48	63.24	13.66
E	3	2011	Yes	49	54.52	14.56

Consistent with the trends above, the scores (over time) of the treatment component of the test (Table 8.3, above) improved. Notably, the 2011 fifth-year group (Cohort A) also achieved the highest score (65.47%) for this component. Their results were again the most precise, yet variable (SD = 11.13).

The section above displayed the treatment component scores for the various cohorts, which concludes the summary of the progress test results. The next section addresses the changes in clinical reasoning scores over time.

8.2.4 Progress Test Score Increments

The following section describes the progress test score differences between the various cohorts.

The statistically corrected mean differences (X dif) between the different progress test scores for Cohorts A, B and D over time are contained in Table 8.4 below.

Table 8.4 Improvements in progress test scores for Cohorts A, B and D

	Year 3 to Year 4			Year 4 to Year 5			Year 3 to Year 5		
Cohort	**X dif**	**SE**	**P**	**X dif**	**SE**	**P**	**X dif**	**SE**	**P**
A	2.88	1.91	ns	8.73	1.47	<0.001	11.60	1.89	<0.001
B	-	-	-	5.04	1.49	0.001	-	-	-
D	5.30	1.14	<0.001	-	-	-	-	-	-

SE: standard error

Cohort A improved their average score by 11.60% (mixed-model statistics, $P<0.001$) from the third to the fifth study years (Table 8.4, above). This improvement took place in increments of 2.88% (mixed-model statistics, $P<0.001$) between the third and the fourth years of study, and 8.73% (mixed-model statistics, $P<0.001$) between the fourth and the fifth years of study.

Cohort B showed a 5.04% ($P=0.001$) improvement between the fourth and fifth years of study (Table 8.4, above) while Cohort D showed a 5.30% ($P<0.001$) improvement between year three and year four.

Following the above illustration of the progress test score differences between the different cohorts, the next section describes the differences between the different cohorts.

8.2.5 Progress Test Score Differences between Cohorts

An analysis of Variance and the Least Square Difference pairwise comparison showed small and insignificant, mean differences (X dif) between the three third-year cohorts' progress test scores (Table 8.5, page 161).

Table 8.5 Progress test mean score differences between cohorts

Cohort	2010 third year (D)	2011 third year (E)	2009 fourth year (B)	2010 fourth year (A)	2011 fourth -year (D)	2009 fifth year (C)	2010 fifth year (B)	2011fifth year (A)
2009 third year (A)	-1.43	-2.16	-4.97*	-	5.24*	1.27	-0.03	-
2010 third year (D)		-0.73	-3.53	4.32	-	2.71	1.40	13.43*
2011 third year (E)			-2.80	5.04*	7.40*	3.43	2.13	14.15*
2009 fourth year (B)				7.85*	10.21*	6.24*	-	16.95*
2010 fourth year (A)					2.36	-1.61	-2.92	-
2011 fourth year (D)						-3.97	-5.27*	6.75*
2009 fifth year (C)							-1.30	10.72*
2010 fifth year (B)								12.02*

*Analysis of Variance, Least Square Difference pairwise comparison, P<0.001

The 2009 fourth-year mean score of Cohort B (Table 8.5, above) was significantly lower (P<0.001) compared with the averages of the 2010 and 2011 fourth-year intervention cohorts, which were X dif = 7.85% and X dif = 10.21%, respectively. The scores of the latter two cohorts did not differ significantly.

Cohort B's 2009 fourth-year mean score was 4.97% lower (Table 8.5, above) than the 2009 third-year average of Cohort A (P<0.001). The 2010 fourth-year average of Cohort A was respectively 5.04% and 7.85% higher (P<0.001) than that of the 2011 third-year cohort (Cohort E) and the 2009 fourth-year cohort (Cohort B). In turn, the 2011 fourth-year mean score of Cohort D was significantly higher ($P<0.001$) namely X dif = 5.24% and X dif = 7.40% respectively, than the 2009 and 2011 third-year mean progress test scores.

Cohort A's fifth-year mean score was significantly higher ($P<0.001$) in comparison to that of all the other third- and fourth-year cohorts (Table 8.5, page 161), as well as to the mean scores of the 2009 and 2010 fifth-year control groups (X dif = 10.72% and X dif = 12.02% respectively). The scores of the fifth-year control groups (Cohorts B and C) did not differ significantly.

The 2010 fifth-year Cohort B average was 5.27% lower ($P<0.001$) than that of the 2011 fourth-year Cohort D (Table 8.5, page 161). The mean score of the 2009 fifth-year Cohort C exceeded the 2009 fourth-year Cohort B's mean score by a significant 6.24% ($P<0.001$).

The section above described the progress test score differences between the various cohorts. The following section contains graphic representations of the frequency distribution of the progress test scores.

8.2.6 Frequency Distribution of the Progress Test Scores

Figures 8.1 to 8.3 (pages 163-164) illustrate the frequency distribution of the progress test scores.

Figure 8.1 (page 163) displays the distribution of the combined data of the three third-year groups.

Figure 8.2 (page 163) is a representation of the frequency distribution of the pooled data for the fifth- and fourth-year control groups.

It is noticeable that the distribution of the fourth- and fifth-year control groups is similar, but more precise, than that of the third-year groups (Figure 8.1, page 163). The bulk of the observations are located to the left of the distribution peak in both graphs (Figures 8.1 and 8.2, page 163).

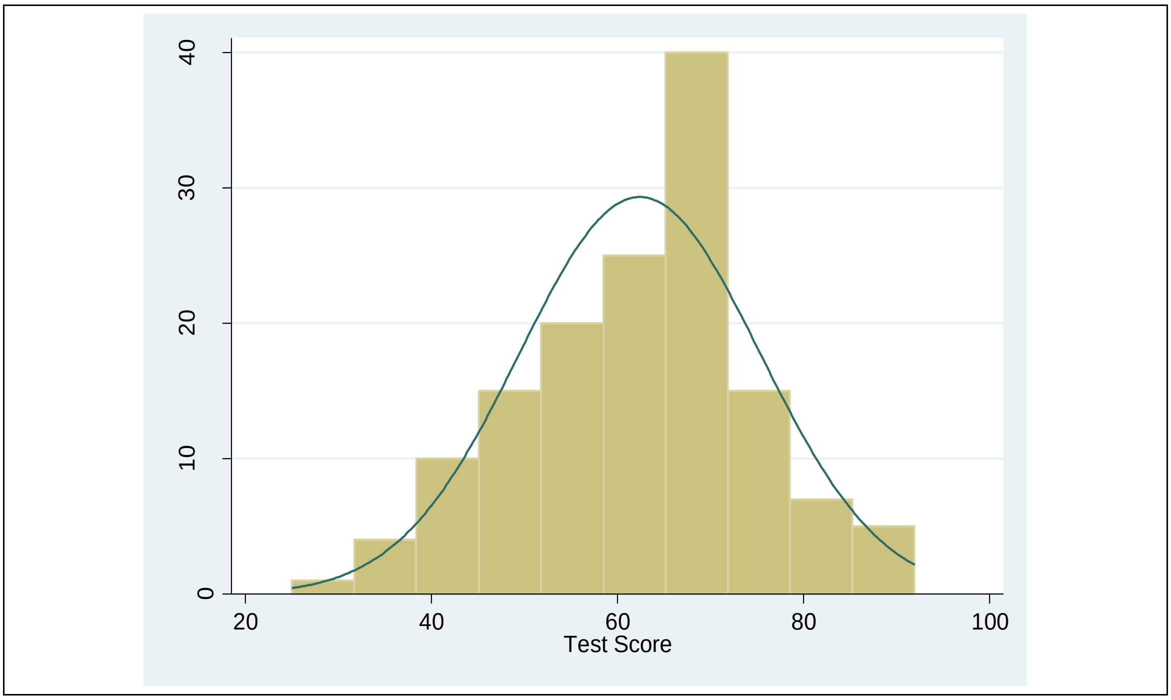

Figure 8.1 Distribution of the combined data of the three third-year groups

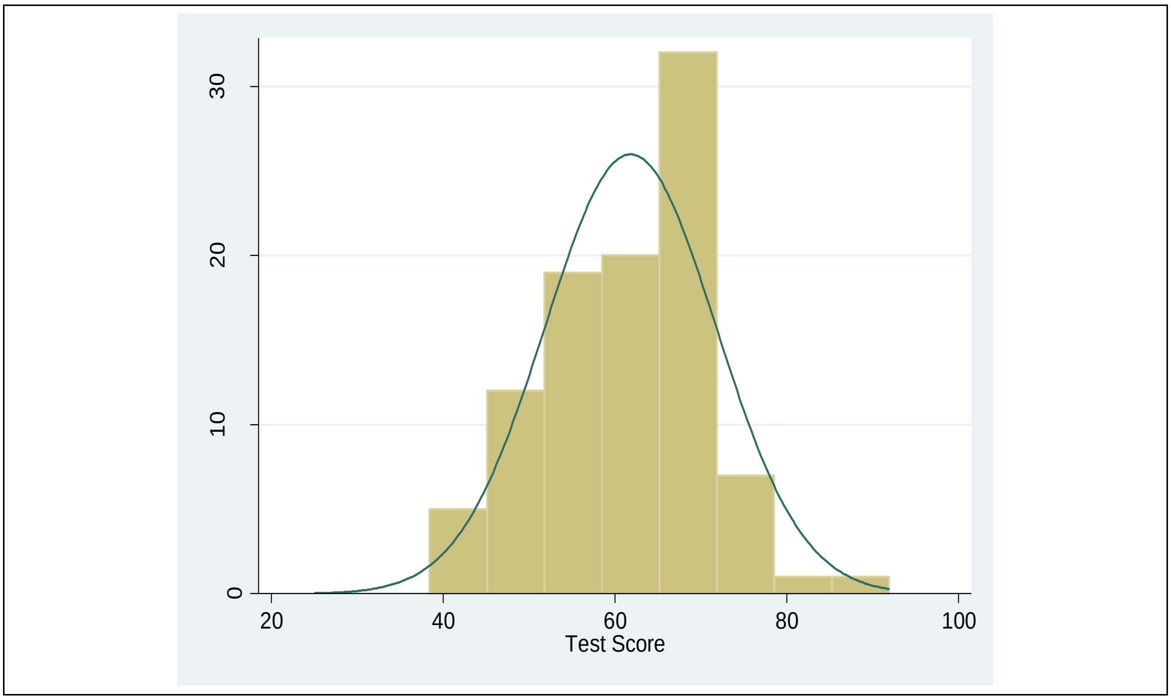

Figure 8.2 Distribution of the pooled data for the fourth- and fifth-year control groups

Figure 8.3 below is a representation of the combined data for the fourth- and fifth-year intervention groups.

In contrast to the third-year (Figure 8.1, page 163) and control group data (Figure 8.2, page 163), the bulk of the observations (Figure 8.3, below) lies to the right of the peak for the combined fourth- and fifth-year intervention groups.

The distribution peaks, however, appear to be very similar in all three graphs (Figures 8.1 and 8.2, page 163; Figure 8.3, below).

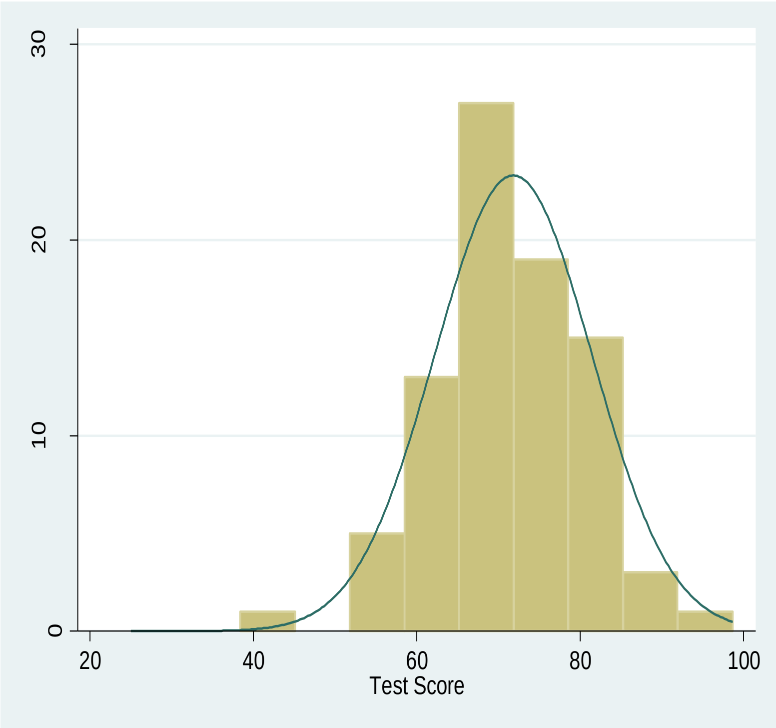

Figure 8.3 Distribution of the pooled data for the fourth- and fifth-year intervention groups

The graphic representations of the progress test results are followed by analyses of the correlates of the progress test scores.

8.2.7 Correlates of the Progress Test Results

The following section illustrates the bivariate and multivariate correlations between the progress test scores and covariables such as race, gender, exposure to the preclinical case-based training (the intervention), and the third-year Oral Biology marks.

Progress Test Scores by Race and Gender

Table 8.6 (page 166) shows a summary of the progress test results grouped according to race and gender. The test scores for most groups generally increased over time.

The mean scores for the Black, Coloured Indian/Asian male students of Cohort B were lower in the fifth year of study compared with the results of the fourth year of study (Table 8.6). It should be noted that the results of one student in this group who had failed the fourth year of study, were omitted for the subsequent fifth year of study.

It was noticeable that the scores of the white students were generally higher compared to the scores of the students from other “etnoracial” origins.

On face value, the scores of males and females appeared to be similar.

These associations between the test scores and the demographic variables were statistically tested using multivariate models. The multivariate analyses are displayed in the sections below in Tables 8.7 to 8.12 (from page 167, onward).

The correlations for the fourth and fifth years of study are reported separately for the purpose of this evaluation.

Table 8.6 Progress test results breakdown according to race and gender

				Black, Coloured and Indian/Asian students									White students								
				Female			Male			Total			Female			Male			Total		
Cohort	Study year	Year	Inter-vention	n	X	SD	n	X	SD	n	X	SD	n	X	SD	n	X	SD	n	X	SD
A	3	2009	Yes	6	58.33	12.29	3	54.17	7.86	9	56.94	10.69	21	65.63	13.76	9	65.97	9.04	30	65.73	12.38
A	4	2010	Yes	6	66.67	13.79	3	56.25	14.32	9	63.20	14.04	21	66.96	10.11	9	69.10	8.33	30	67.60	9.52
A	5	2011	Yes	4	77.34	10.94	2	79.69	2.21	6	78.12	8.62	21	74.55	6.03	9	76.74	7.98	30	75.21	6.61
B	4	2009	No	6	59.38	11.86	7	56.70	10.59	13	57.94	10.80	23	56.66	8.75	12	63.54	8.03	35	59.02	9.02
B	5	2010	No	7	63.84	11.81	6	49.48	14.31	13	57.21	14.51	22	65.77	9.32	12	66.67	8.14	34	66.09	8.81
C	5	2009	No	8	57.03	7.61	5	61.25	7.19	13	58.65	7.46	25	67.00	10.48	10	68.13	6.72	35	67.32	9.48
D	3	2010	Yes	16	62.11	11.74	8	52.73	10.75	24	58.98	12.06	19	67.60	17.00	8	62.11	14.60	27	65.97	16.25
D	4	2011	Yes	14	66.96	8.10	6	63.02	12.41	20	65.78	9.43	18	74.65	10.66	8	65.63	7.83	26	71.87	10.61
E	3	2011	Yes	15	55.83	9.29	4	47.66	18.47	19	54.11	11.65	17	66.91	7.50	12	66.67	10.00	29	66.81	8.45

Fourth Year of Study

Tables 8.7 and 8.8 (below), respectively, illustrate the multivariate correlates of the progress test scores and the diagnostic component scores for the fourth year of study. Exposure to the intervention and the Oral Biology marks in the third year of study correlated positively with both the progress test score and the diagnostic component score of the test. The demographic variables of gender and race showed no association with the test scores and were dropped from the regression model during a stepwise process. The adjusted R^2 for the two linear regression models were 27% and 19%, respectively.

Table 8.7 Multivariate correlation of the fourth year of study (progress test scores)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	8.62 (5.23-12.01)	1.71	<0.001
Gender (Male=1 / Female=0)	Dropped from the model		ns*
Race (White=1 / Other=0)	Dropped from the model		ns
Oral Biology	0.35 (0.21-0.48)	0.07	<0.001

Adjusted R^2: 27%
*ns: not significant

Table 8.8 Multivariate correlation of the fourth year of study progress test scores (diagnostic component)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	5.27 (1.09-9.45)	2.11	<0.05
Gender (Male=1 / Female=0)	Dropped from the model		ns*
Race (White=1 / Other=0)	Dropped from the model		ns
Oral Biology	0.44 (0.27-0.61)	0.09	<0.001

Adjusted R^2: 19%
*ns: not significant

The treatment component of the progress test correlated positively with exposure to the intervention and to the diagnostic component score (Table 8.9, below) in the fourth year of study. Again, gender and race showed no association with the test scores and were dropped from the model. The adjusted R^2 for the linear regression model was 27%.

Table 8.9 Multivariate correlation of the fourth year of study progress test scores (treatment component)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	11.54 (7.17-15.90)	2.21	<0.001
Gender (Male=1 / Female=0)	Dropped from the model		ns*
Race (White=1 / Other=0)	Dropped from the model		ns
Oral Biology	0.11 (-0.08-0.30)	0.10	0.26
Diagnostic component score	0.26 (0.09-0.44)	0.09	<0.01

Adjusted R^2: 27%
*ns: not significant

Fifth Year of Study

Factors such as exposure to the intervention, being a member of the white race, and the marks obtained in third-year Oral Biology, all correlated positively with the overall progress test scores (Table 8.10, below) in the fifth year of study. The adjusted R^2 was 31%.

Table 8.10 Multivariate correlation of the fifth year of study (progress test scores)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	10.21 (6.69-13.74)	5.73	<0.001
Gender (Male=1 / Female=0)	Dropped from the model		ns*
Race (White=1 / Other=0)	4.68 (0.77-8.59)	2.37	<0.05
Oral Biology	0.20 (0.06-0.34)	2.76	<0.001

Adjusted R^2: 31%
*ns: not significant

In the fifth year of study, correlations for the diagnostic component scores (Table 8.11, below) were the same as for the overall scores (Table 8.10, page 168). Race, however, lost its significance in the diagnostic component. The linear regression model recorded an adjusted R^2 of 27%.

Table 8.11 Multivariate correlation of the fifth study year progress test scores (diagnostic component)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	12.12 (7.67-16.56)	2.25	<0.001
Gender (Male=1 / Female=0)	Dropped from the model		ns*
Race (White=1 / Other=0)	4.08 (-0.84-9.01)	1.64	0.103
Oral Biology	0.27 (0.08-0.45)	2.88	<0.01

Adjusted R^2: 27%
*ns: not significant

Table 8.12 Multivariate correlation of the fifth study year progress test scores (treatment component)

Covariable	Coefficient	SE	P
Intervention (Yes=1 / No=0)	6.30 (0.63-11.97)	2.87	<0.05
Gender (Male=1 / Female=0)	4.32 (0.62-9.27)	2.50	0.086
Race (White=1 / Other=0)	4.99 (-0.73-10.71)	2.89	0.087
Oral Biology	0.12 (-0.10-0.34)	0.11	0.274
Diagnostic component score	0.13 (-0.08-0.33)	0.10	0.219

Adjusted R^2: 12%

Table 8.12 (above) shows that only exposure to the intervention correlated with the treatment component score in the fifth year of study. Noticeably, gender and race nearly achieved significance. Furthermore, unlike in the fourth study year, the diagnostic component did not correlate significantly with the treatment scores. The adjusted R^2 of 12% was the weakest of all the linear regression models.

The first part of the evaluation results is hereby concluded. It contained the actual results of the progress test for the period 2009 to 2011. The following section continues with the second part of the evaluation results, namely the progress test evaluation.

8.3 Progress Test Evaluation

The results of the progress test evaluation are illustrated by means of an MCQ distracter analysis that concentrates on percentage distribution, discrimination properties and level of difficulty.[64] The standard setting standards are also compared with the actual performance in each MCQ question.

The MCQ distracter evaluation results are contained in Appendix K (page 307). The context of individual questions will not be elaborated upon in this section. Detailed discussions will, however, follow in Chapter 9. Table K.1 in Appendix K (page 307) can be consulted for a content description of the stems of the individual questions.

The percentage distribution of the MCQ distracters is addressed first.

8.3.1 MCQ Distracter Analysis – Percentage Distribution

Table K.2 (Appendix K, page 309) contains the percentage distribution of the MCQ options – correct answers and chosen distracters – of the progress test. It must be noted that the data of all the cohorts was pooled for this analysis.

The correct answer is marked with an asterisk in Table K.2 (page 309). Predominantly, the correct answer was given to all the questions, except for Questions 22, 23 and 30 where most of the subjects chose one of the other incorrect distracters. Questions 23 and 22 appeared to be the two most difficult questions in the test, and Question 30 appeared to be the fourth most difficult. All three of these questions belong to the treatment component of the test.

Questions 17 and 10 appeared to be the easiest and second easiest questions, respectively, in the test.

Questions 14, 17 and 30 contained one distracter each that was not selected at all. Questions 3, 5, 10, 17, 18 and 21 contained at least one distracter that was chosen less than 1% of the time.

Following this report of the evaluation results of the percentage distribution of the progress test distracters, the discrimination properties of the MCQ questions are set out.

8.3.2 MCQ Analysis – Discrimination Properties

Table K.3 (Appendix K, page 310) displays the Discrimination Index (DI)[64] for the pooled data of the progress test, including the diagnostic and treatment components of the test. All the test questions showed significant discrimination between low and high scoring students, except for Questions 15 and 23. However, Question 15 was discriminatory (DI = 0.16, Chi^2-test: $P<0.05$) in terms of the diagnostic component of the test. Similarly, Question 23 significantly discriminated (DI = 0.18, Chi^2-test: $P<0.01$) between high and low performing students in the treatment component of the test.

A comparison of the DI of the progress test scores (pooled data) for each of the study years is contained in Table K.4 (Appendix K, page 311). More questions for the third study year showed significant discrimination as opposed to the questions for the fourth and fifth study years. Furthermore, fewer questions for the fifth study year discriminated significantly when compared with data of the fourth study year. Thirteen out of the 32 questions could discriminate significantly between high and low scoring students in all three of the study-year groups. Seven questions were discriminatory for two of the study years, while nine questions discriminated significantly in only one of the three study years. Questions 15, 22 and 23 did not display significant discrimination for any of the three study-year groups.

For at least one or more of the discriminatory analyses (Appendix K, Tables K.3 and K.4, page 310 and 311, respectively), a DI of 0.3 or more was achieved for 23 of the 32 questions.

The results of the MCQ discrimination properties are followed by an analysis of the differences in the level of difficulty of each of the questions.

8.3.3 MCQ Analysis – Level of Difficulty

This section illustrates the differences in the level of difficulty[64] of each of the questions for the third, fourth and fifth years of study. This is followed by a similar comparison for the different years of study for Cohorts B, A and D. Question 23 – apparently the most difficult question in the progress test – is analysed separately for the third, fourth and fifth years of study in terms of the level of difficulty. The section is concluded by an analysis of the questions that could not be associated with the intervention by means of a difficulty-level comparison.

The results for the third year of study are described first.

8.3.3.1 Third Year of Study

The ratios of correctly answered questions for the third-year cohorts are displayed in Table K.5 (Appendix K, page 312). Using the Chi^2-test, significant differences were recorded between Cohorts A and D for five questions (Questions 17, and 29-32). Nine significant differences (Questions 6, 7, 9, 10, 13, 16, 18, 29 and 32) were recorded between Cohorts A and E. A further four significant differences (Questions 1, 6, 20 and 28) were recorded between Cohorts D and E.

The results for the third year of study are followed by the results of the fourth year of study.

8.3.3.2 Fourth Year of Study

A comparison between the control and intervention groups in the fourth year of study regarding the ratio of correctly answered questions is displayed in Table K.6 (Appendix K, page 313). For nine of the questions (Questions 8, 9, 11, 16, 21, 25, 27, 30 and 31) a significantly higher ratio was observed for the intervention group when compared to the control group. Three of these questions (Questions 8, 9, 16) belonged to the diagnostic component of the test, and the other six questions (Questions 11, 21, 25, 27, 30, and 31) belonged to the treatment component.

No differences in difficulty level were observed for 22 of the remaining questions. Question 15, however, showed a significantly lower ratio for the intervention group in relation to the control group.

The observations about six (Questions 8, 16, 21, 27, 30 and 31) of the nine questions mentioned above, were reconfirmed by a comparison (Table K.7, Appendix K, page 314) between the three respective fourth-year cohorts (see the study design in Chapter 8). In all six of these cases, the ratios of the two intervention groups (Cohorts A and D) were significantly higher when compared with the results of the control group (Cohort B).

In three instances, (Questions 9, 11 and 20) the ratio of correctly answered questions was significantly higher for Cohort D (intervention group) than for Cohort B (control group). The ratio of correctly answers was also significantly higher for Question 25 for Cohort A (intervention group) compared to Cohort B (control group).

Three other significant observations were made as regards the lower ratio of correctly answered questions by one of the two intervention groups in comparison with that of the control group. Firstly, as far as Question 2 was concerned, Cohort D had a lower ratio than Cohorts B and A. Secondly, Cohort A (intervention group) had a lower ratio for Questions 15 and 18 when compared with Cohort B (control group).

The level of difficulty analysis for the fourth year of study is followed by that of the fifth year of study.

8.3.3.3 Fifth Year of Study

The same analyses as described above for the fourth-year groups were conducted for the fifth study year (Table K.8, Appendix K, page 315). The intervention group (Cohort A) achieved a significantly higher ratio than the control groups for twelve of the 32 questions (Questions 1, 4, 5, 6, 9, 11, 12, 13, 16, 19, 26, and 31).

These findings were reconfirmed for Questions 4, 6, 16 and 31 when the cohorts were compared separately (Table K.9, Appendix K, page 316). Cohort A (intervention group) also showed a significantly higher ratio of correct answers for six other questions (Questions 1, 11, 12, 13, 26 and 27), in comparison to Cohort C (control group). Comparing Cohort A (intervention group) to Cohort B (control group), Cohort A achieved a significantly higher ratio of correctly answered questions for four questions (Questions 5, 7, 9, 19).

A further five significant differences were observed between the two control groups (Table K.9, Appendix K, page 316).

The section above concludes the comparison of the questions that discriminated between different cohorts in different study years in terms of level of difficulty. The following section illustrates a similar comparison between cohorts over time.

The results of control group Cohort B are illustrated first.

8.3.3.4 Cohort B (2009 - 2010)

Table K.10 (Appendix K, page 317) contains a comparison of the ratio of correctly answered questions for Cohort B for 2009 (fourth year of study) and 2010 (fifth year of study). The ratios for six of the questions (Questions 8, 21, 25, 26, 30 and 31) improved significantly from 2009 to

2010. Conversely, the ratio for Question 22 dropped significantly from 0.39 to 0.13 (Chi^2-test, $P<0.05$). Statistically speaking, the ratios for the rest of the questions that were answered correctly remained the same.

The results of control group Cohort B are followed by the results of intervention group Cohort A.

8.3.3.5 Cohort A (2009 - 2011)

Table K.11 (Appendix K, page 318) shows the results for Cohort A from 2009 (third year of study) to 2011 (fifth year of study) as regards correctly answered questions. Significant increases (ANOVA, $P<0.05$) were shown for Questions 4 and 15 between the third year of study and the fourth year of study. Significant increases (ANOVA, $P<0.05$) were also shown for Questions 4, 12, 27 and 31 between the third year of study and the fifth year of study.

The ratio for Question 7 was the only one that improved between the fourth and the fifth years of study. The fourth-year ratio (0.51) for Question 15 was significantly lower (ANOVA, $P<0.01$) compared with the third-year ratio (0.81). Again, the ratios for the rest of the questions that were answered correctly remained similar.

Using the Chi^2-test, statistically significant differences could be shown for Cohort A from the third-year of study to the fifth year of study for nine questions – Questions 2, 4, 6, 9, 12, 26, 27, 29 and 31.

The results of Cohort A are followed by the results of another intervention group, namely Cohort D.

8.3.3.6 Cohort D (2009 - 2010)

The results for Cohort D for 2009 (third year of study) and 2010 (fourth year of study) are contained in Table K.12 (Appendix K, page 319). Six of the questions (Questions 4, 11, 21, 26, 27 and 29) showed significant improvement in terms of the ratio of correctly answered questions from

2009 to 2010. However, the ratio for Question 30 decreased significantly (Chi^2-test, P<0.05) from 0.65 to 0.44 during the same period. The ratios of correct answers for the remaining questions did not differ significantly.

The results of Cohort D given above conclude the analysis of the differences in the level of difficulty of questions for the cohorts over time. The following section displays the results for Question 23.

8.3.3.7 Question 23

On further inspection it was determined that 20%, 28% and 38% of the third-, fourth- and fifth-year students respectively, selected the correct treatment for Question 23. The difference between the results of the third- and the fifth-year group was significant (Bonferroni, P<0.05).

8.3.3.8 Questions not associated with the Intervention

Of the 32 questions, 11 did not have any association with the intervention in terms of differences in the level of difficulty.

Two of these questions – Questions 10 and 17 – were rather easy, and produced a ratio of correctly answered questions above 90% (Appendix K, Table K.2, page 309). A further four of these questions – Questions 3, 14, 28 and 29 – had a ratio of correctly answered questions ranging from 80% to 90%.

Another three questions – Questions 20, 22, and 23 – had a ratio of correctly answered questions below 33%.

Two questions of intermediate difficulty – Questions 24 and 32 – had no association with the intervention. Although not statistically significant, Question 24's scores showed an increase over time for Cohort A, and the scores were higher for the fifth-year groups compared to both the third- and fourth- year groups.

The MCQ analyses in terms of level of difficulty are hereby concluded. A comparison between the standard setting standards for each of the questions and actual performances is illustrated in the next section.

8.3.4 Standard Setting Estimations versus Actual Performance

The judges' estimations and predictions of students' performance in terms of the individual questions of the progress test during the standard setting process are compared with students' actual exit-level performance in Table K.13 (Appendix K, page 320). In general, high variability was observed in terms of their predictions. Statistical differences between the judges' predictions and actual performance were only shown for three of the 18 questions (Questions 1, 4, 19) in the diagnostic component of the test. The judges underestimated the students' ability to answer Question 4, and expected better performance in the other two questions (Questions 1 and 19).

In contrast to the diagnostic component, the predictions and actual performance differed significantly in nine of the 14 questions in the treatment component. Generally, the students performed below expectation, except in Questions 26 and 29. The judges underestimated the knowledge of the final-year students that enabled them to answer these two questions.

The hypothetical cut-score was set at 59.5 for the fifth-year students using the average of the lower 90% confidence interval value of the judges' predictions (Table K.13, Appendix K, page 320).

Table 8.13 (page 178) illustrates the hypothetical pass rates for the control group and the intervention groups. The results showed significant statistical differences (Fisher's Exact test, P<0.001). No student in the intervention group "failed" the test, however 33% of students in the non-intervention groups "failed".

Seven students who had consented to take part in the study, had to repeat their fourth year of study, but they still wrote the progress test in their fifth year. Their results were not included in the main analyses above. However, their fifth-year marks are displayed in Table 8.14 (below).

Table 8.13 Hypothetical progress test pass rates for fifth-year students

	Intervention (n=36)	No Intervention (n=96)
"Pass"	100%	67%
"Fail"	0%	33%

Fisher's Exact test: P<0.001

Table 8.14 Progress test scores of fifth-year students who repeated their fourth year

	Progress Test Score %	Year
Student 1	50.00	2011
Student 2	50.00	2011
Student 3	56.25	2010
Student 4	59.38	2011
Student 5	65.63	2011
Student 6	68.75	2011
Student 7	84.38	2010

Two of the students had written the progress test once before, and five of them had written it twice before. Four of the seven students who were repeaters achieved a score that was lower than the hypothetical cut-score of 59.5% (Table 8.14, above). All four students who scored below the cut-score subsequently failed their fifth year. Two of the remaining three students who scored higher than the cut-score passed their fifth year, while the third student failed owing to unforeseen circumstances.

The progress test evaluation results are hereby completed. The third part of the evaluation results, namely the qualitative student feedback, is described in the following sections.

8.4 Quantitative Student Feedback

This section commences with the results of the qualitative student feedback for the third-, fourth- and fifth years of study. The section concludes with multivariate correlations of perceived relevance.

The student feedback for the third year of study is addressed first.

8.4.1 Student Feedback – Third Year of Study

The feedback results – based on a scale of zero to a hundred* – of the third-year students are displayed in Table 8.15 (below). The differences between the groups were not statistically significant.

The ratings for all the educational aspects, except for vertical integration, were relatively high. Vertical integration received the lowest ratings.

Table 8.15 Student feedback on the educational processes – third year of study

Student feedback	2009 (n=43)		2010 (n=55)		2011 (n=56)	
	X (95% CI)	SD	X (95% CI)	SD	X (95% CI)	SD
Course relevance	88 (84-92)	14	93 (91-95)	8	91 (89-94)	9
Training aligned with required outcome	87 (82-91)	14	87 (82-92)	18	91 (89-94)	9
Assessment's contribution to learning	84 (80-89)	14	84 (79-89)	19	88 (85-91)	12
Course organisation	86 (81-91)	16	88 (84-91)	12	91 (88-94)	10
Lecturer competence	89 (85-93)	14	90 (87--93)	13	90 (87-92)	11
Horizontal integration	78 (71-85)	24	79 (73-85)	21	83 (78-87)	18
Vertical integration	64 (57-72)	25	65 (58-73)	27	71 (64-78)	25
Diagnostic ability	70 (65-75)	16	75 (71-80)	16	76 (72-81)	15
Treatment planning ability	75 (70-79)	14	75 (70-79)	16	72 (67-77)	18

CI: Confidence Interval

* For interpretation reasons, refer to the course feedback questionnaire for the third year of study (Appendix L, page 323) for the a description of the endpoints of the visual analogue scales for each of the variables tested

The student feedback results for the third year of study are followed by the feedback from the fourth-year students.

8.4.2 Student Feedback – Fourth Year of Study

Table 8.16 (below) and Figure 8.4 (page 181) display the feedback results – on a scale of zero to a hundred[†] – for students in their fourth year of study.

Table 8.16 Student feedback on the educational processes – fourth year of study

Student feedback	No intervention (2009)			Intervention (2010 / 2011)			T-test
	n	X (95% CI)	SD	n	X (95% CI)	SD	P
Course relevance	51	67 (61-72)	19	99	83 (81-86)	15	<0.001
Training aligned with outcomes	51	55 (48-62)	24	98	82 (79-86)	17	<0.001
Assessment's contribution to learning	51	61 (54-67)	23	98	78 (75-82)	17	<0.001
Course organisation	51	76 (71-81)	18	99	81 (77-84)	18	ns
Lecturer competence	51	74 (67-81)	25	99	84 (80-87)	17	<0.05
Horizontal integration	51	64 (57-70)	22	99	75 (71-79)	19	<0.01
Vertical integration	51	63 (56-70)	25	99	66 (61-71)	23	ns*
Gap between 3rd and 4th study years	51	52 (43-61)	33	99	40 (33-46)	31	<0.05
Struggle with tooth numbering in 4th year	51	34 (25-43)	33	98	22 (16-27)	27	<0.05
Diagnostic ability	51	81 (77-84)	13	99	79 (76-83)	16	ns
Treatment planning ability	51	81 (76-85)	16	99	82 (79-85)	15	ns

CI: Confidence Interval / *ns: not significant

The students who had been exposed to the educational intervention rated the course relevance, course alignment with the outcomes, assessment's contribution to learning, competence of lecturers and horizontal integration

[†] For interpretation reasons, refer to the course feedback questionnaire for the fourth year of study (Appendix L, page 325) for the a description of the endpoints of the visual analogue scales for each of the variables tested

significantly higher than those who had received lecture-based training (Table 8.16, page 180 and Figure 8.4, below). The intervention groups perceived the gap between the third and fourth study years to be significantly smaller and struggled significantly less with tooth numbering in the fourth year compared with the control group. No differences were observed in regard to course organisation, vertical integration and self-rated diagnostic and treatment planning ability.

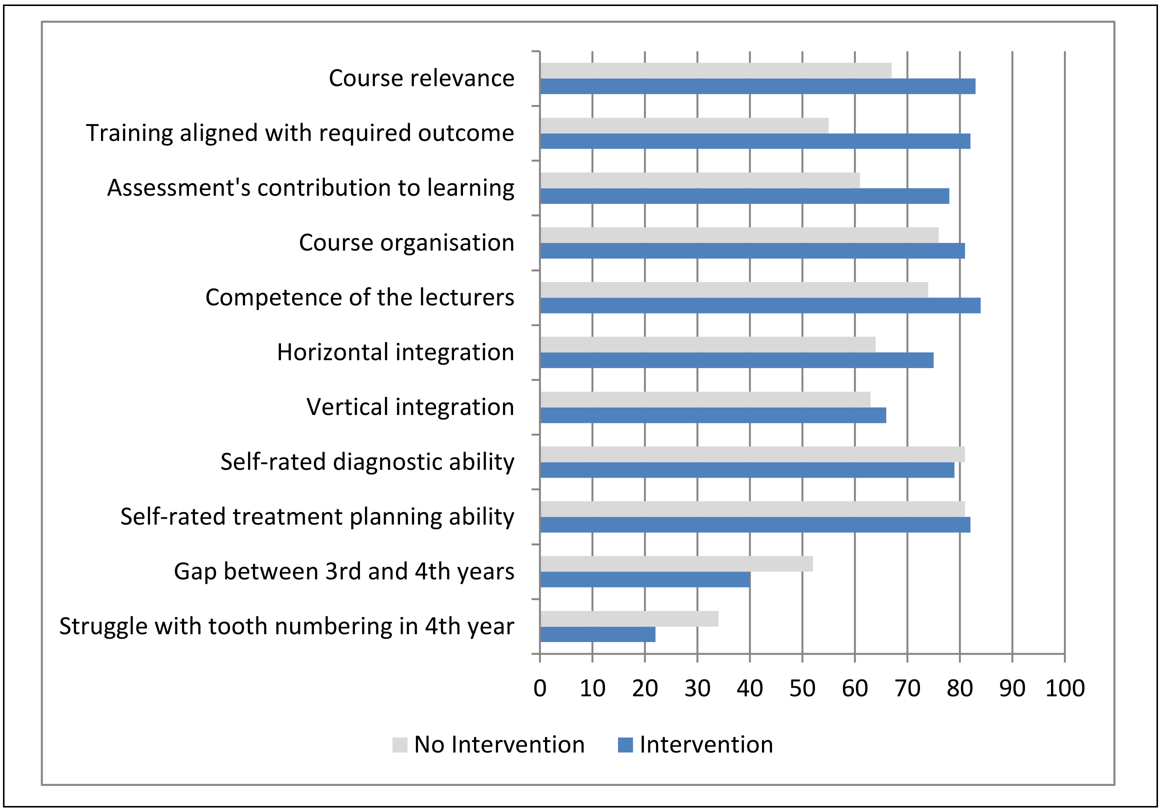

Figure 8.4 Student feedback on the educational processes – fourth year of study

The feedback results of students in their fourth year of study are subsequently followed by the feedback from the fifth-year groups.

8.4.3 Student Feedback – Fifth Year of Study

The fifth-year feedback – on a scale of zero to a hundred‡ – is displayed in Table 8.17 (below) and Figure 8.5 (page 183). The intervention group rated all the educational aspects significantly higher than the control group did.

Table 8.17 Student feedback on the educational processes – fifth year of study

Student feedback	No intervention (2009 / 2010)			Intervention (2011)			T-test
	n	X (95% CI)	SD	n	X (95% CI)	SD	P
Course relevance	95	64 (60-67)	18	43	87 (83-91)	13	<0.001
Training aligned with required outcomes	95	59 (54-63)	22	43	82 (78-87)	14	<0.001
Assessment's contribution to learning	95	51 (47-56)	22	43	78 (72-83)	18	<0.001
Course organisation	95	62 (58-67)	21	43	85 (80-89)	15	<0.001
Lecturer competence	94	70 (66-75)	21	43	86 (82-90)	14	<0.001
Horizontal integration	95	59 (54-63)	23	43	75 (69-82)	21	<0.001
Vertical integration	95	58 (53-62)	22	43	72 (66-77)	19	<0.001
Knowledge and skills gap between 3rd and 4th years	95	61 (55-67)	30	43	41 (31-51)	32	<0.001
Diagnostic ability	95	80 (78-83)	13	43	84 (80-88)	13	ns*
Treatment planning ability	95	78 (75-81)	16	43	86 (82-89)	11	<0.01

CI: Confidence Interval / *ns: not significant

Similar to students in the fourth year of study, the intervention group perceived the knowledge and skills gap between the third and fourth years of study to be smaller compared with the control group.

The intervention group rated their own treatment planning ability higher than the control group did. However, no statistical difference in the two groups' self-rated diagnostic abilities was found.

‡ For interpretation reasons, refer to the course feedback questionnaire for the fifth year of study (Appendix L, page 328) for the a description of the endpoints of the visual analogue scales for each of the variables tested

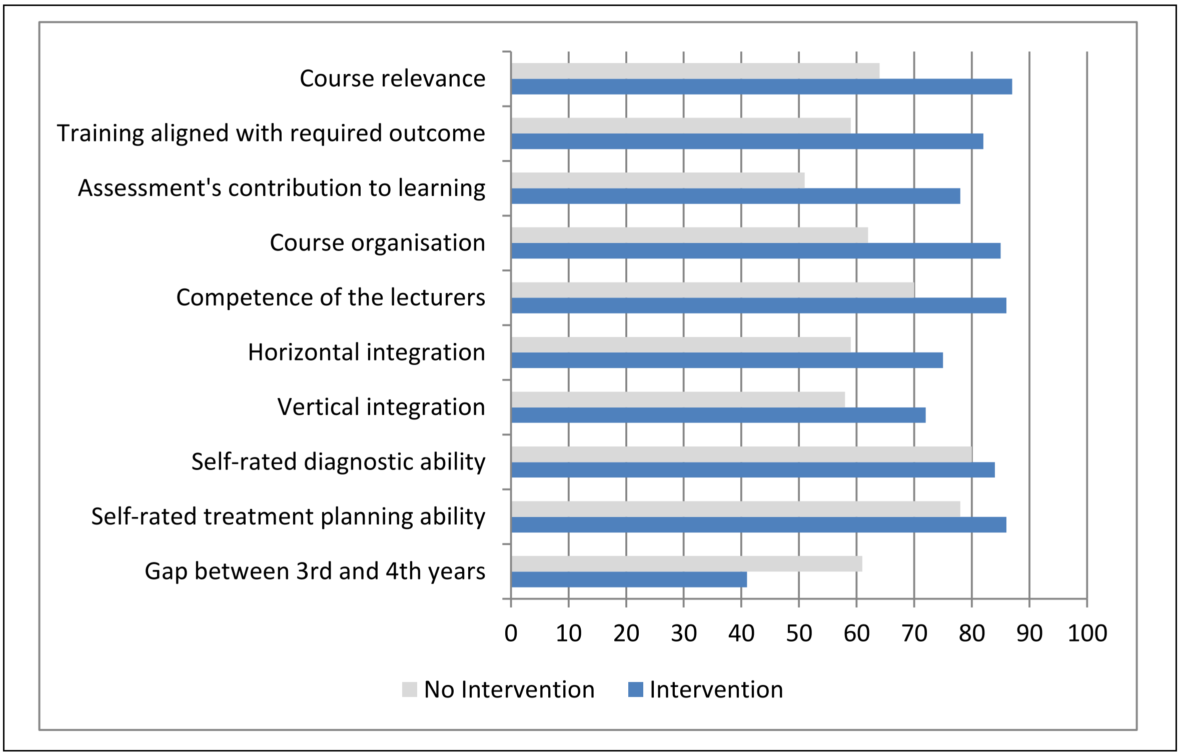

Figure 8.5 Student feedback on the educational processes – fifth year of study

8.4.4 Perceived Relevance – Multivariate Correlations

Table 8.18 (below) shows the multivariate correlation of perceived relevance with the perception of curricular alignment, assesssment's contribution to learning, course organisation and lecturers' competence for the third-year cohorts (combined).

Table 8.18 Multivariate correlation of perceived relevance with the other educational aspects – combined feedback results of the third-year cohorts

Educational aspects	Coefficient	SE	P
Training aligned with outcomes	0.16 (0.04-0.29)	0.06	0.01
Assessment's contribution to learning	0.21 (0.09-0.32)	0.06	<0.001
Course organisation	Dropped from the regression model		ns*
Competence of the lecturers	0.23 (0.09-0.36)	0.07	0.001

Adjusted R^2: 47%
*ns: not significant

Student feedback regarding the course alignment, assessment's contribution to learning and the competence of the lecturers correlated positively with perceived relevance. These findings were statistically significant. Only the perception of the quality of the course organisation did not correlate with perceived relevance. The adjusted R^2-value for this regression model was 47%.

The multivariate correlation of perceived relevance with the educational aspects (including exposure to the intervention), which contains the combined feedback of the fourth-year cohorts, is displayed in Table 8.19, below. All the aspects correlated positively with perceived relevance. Again, the findings were statistically significant. The adjusted R^2 for this model equalled 51%.

Table 8.19 Multivariate correlation of perceived relevance with the other educational aspects – combined feedback results of the fourth-year cohorts

Educational aspects	Coefficient	SE	P
Exposed to the intervention=1 Not exposed to the intervention=0	5.78 (0.46-11.11)	2.70	<0.05
Training aligned with outcomes	0.22 (0.09-0.36)	0.07	<0.01
Assessment's contribution to learning	0.15 (0.05-0.29)	0.07	<0.05
Course organisation	0.20 (0.05-0.35)	0.08	0.01
Competence of the lecturers	0.13 (0.01-0.26)	0.07	<0.05

Adjusted R^2: 51%
*ns: not significant

Similar correlations (Table 8.20, page 185) were shown for the combined fifth-year feedback results (adjusted R^2: 58%). However, unlike in the fourth-year analysis, perceptions of lecturer competence did not correlate significantly with perceived relevance.

Table 8.20 Multivariate correlation of perceived relevance with the other educational aspects – combined feedback results of the fifth-year cohorts

Educational aspects	Coefficient	SE	P
Exposed to the intervention=1 Not exposed to the intervention=0	6.68 (0.84-12.53)	2.95	<0.001
Training aligned with outcomes	0.28 (0.13-0.43)	0.07	<0.001
Assessment's contribution to learning	0.14 (0.00-0.28)	0.07	<0.05
Course organisation	0.28 (0.15-0.41)	0.07	<0.001
Competence of the lecturers	Dropped from the regression model		ns*

Adjusted R^2: 58%

The above model concludes the quantitative student feedback results. The following section contains the fourth and final part of the evaluation results, namely, the qualitative student feedback results.

8.5 Qualitative Student Feedback

The results of the qualitative analysis for the two focus groups are reported separately. Focus Group 1 is a sample of students who showed 9% or more progression in terms of clinical reasoning decision-making in the progress test (Figure M.1, Appendix M, page 331), whereas the sample of students in Focus Group 2 progressed minimally or not at all.

8.5.1 Focus Group 1 – Progression Group

The results of the first focus group (progression group) are displayed in Table M.1 in (Appendix M, page 332) according to the identified themes. It must be noted that the discussion generally did not cover the themes that were proposed in the protocol. Therefore, new themes were generated based on students' comments. The results are displayed in the form of extracts quoted from the students' verbal responses.

Students frequently stated that the course provided a useful structure and a framework for the clinical training in the fourth study year (Theme 1). Remarks were made that the teaching and learning were relevant and that it integrated content and addressed issues of complexity to some degree, but that initial exposure to clinical training was still overwhelming for some of the students. Some students suggested that the educational approaches used in CPC[*] had to be considered for the other discipline-based subjects. Peer training was criticised as being unrelated to real situations. The students, however, felt that the peer examinations were useful and helped to reduce the knowlegde gap between the third and the fourth study years. The study notes were complimented but the students felt that the first case study was overwhelming and that proper support was lacking. They suggested the use of pictures in the case studies. They also requested more information about hospital administration systems before they started their clinical teaching and learning. Standardisation among lecturers received negative criticism.

The remarks made by the students were always constructive and focused on improving the educational processes of CPC.

8.5.2 Focus Group 2 – Non-progression Group

The results of Focus Group 2 (non-progression group) are displayed in Table M.2 (Appendix M, page 334).

It must be noted that the second focus group's discussions had to be postponed because the majority of the students either arrived late or indicated that they could not find the venue.

Again, substantial comments were made about the usefulness of the case studies. Focus Group 2 expressed much more dissatisfaction with the use of case studies in the training than Focus Group 1.

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[*]It should be noted that the students often referred to CPC as ”CPM”, which is an abbreviation for the overarching Module: Comprehensive Patient Management (Figure 1.3, page 5).

One of the students who did not find the case study assignments always useful, admitted that he might not have done the assignments as thorougly as he should have. Another student who did not appreciate the case studies admitted to a lack of mathematical ability, which influenced her ability to unravel the cases.

Students in this group were more self-centred in their responses and projected their failures and difficulties onto others. One student attributed the failure of managing a “difficult” case to lack of teaching and learning. Another student felt that he did not know what to do because of unclear instructions. However, clearly formulated written instructions had been given to the students.

Students in this group were not aware of the feedback given for each case. Some of these students were also not aware of the introductory lecture that was given on pathological lesions in the third year of study.

Issues raised about relevance, integration, complexity, simulation teaching and learning (role play) and standardisation between lecturers were more or less the same as those raised by the first focus group.

8.6 Conclusion to the Chapter

This chapter displayed the results of the progress test over the period 2009 to 2011. The chapter also included the results of an evaluation of the progress test as an assessment tool, as well as quantitative and qualitative student feedback.

8.7 Summary of the Chapter

Chapter 8 illustrated the curriculum evaluation results.

Chapter 9 will continue with a detailed discussion of the evaluation results (Figure 1.7, page 18).

CHAPTER 9: CURRICULUM EVALUATION – DISCUSSION AND CONCLUSION

9.1 Introduction

The results of the evaluation were presented in Chapter 8.

Chapter 9 (Figure 1.7, page 18) is the third and final chapter that will address the evaluation, and it represents the final part of Step 6 of Kern's "six-step approach to curriculum development"[60] (Figure 1.6, page 17).

Chapter 9 discusses the results of the evaluation in detail. The purpose of this chapter is to draw conclusions regarding the hypotheses made in Chapter 2, paragraph 2.4, page 27.

9.2 Discussion

The following section is an elaboration on the evaluation results of the action research study.

9.2.1 Introduction

This action research study evaluates the implementation of a new educational intervention in the CPC unit of the undergraduate dental curriculum at the University of Pretoria. The intervention aims to develop the cognitive aspects of students' clinical reasoning abilities by exposing dental students to integrated preclinical case-based teaching and learning. The assessment was conducted by means of a newly developed progress test, which measured students' ability to make diagnostic and treatment planning clinical reasoning decisions based on a complex case study that covered a broad selection of specified content. The evaluation compared the clinical decision-making of cohorts who had received *lecture-based* CPC teaching and learning before the implementation of the intervention, with the clinical decision-making of students who had been exposed to preclinical *case-based* teaching and learning. A new variant of the original progress test was used as the measurement tool for the comparisons. These comparisons were complemented by student feedback about the educational processes that had been followed.

The discussion commences with the progress test results. The student feedback will be discussed later in the chapter.

9.2.2 Progress Test Results

Progress testing in dental education is in its infancy. Bennett *et al*[66] recently showed progression in knowledge amongst dental students over time using a progress test. This finding could also be demonstrated in the current study (Table 8.4, page 160) when the progression of the groups was followed over time.

9.2.2.1 Effectiveness of the Intervention to Develop Clinical Reasoning Skills

The main focus of this evaluation was the differences between intervention and control groups in terms of their clinical reasoning decision-making ability in a progress test. The current study showed that the students who had been exposed to the educational intervention – namely, preclinical case-based teaching and learning – consistently performed better (Tables 8.1 to 8.3, and 8.5, pages 157-161) in the newly developed progress test compared to the performance of the control groups who had received lecture-based CPC teaching and learning. This association between exposure to the intervention and subsequent performance persisted, even when controlling for confounding factors, such as gender, race and prior academic performance in Oral Biology (Tables 8.7 to 8.12, pages 167-169). It also appeared that the decision-making of the intervention groups was more accurate than that of the control groups. These findings are unique. It is the first time in dental education history that the results of a progress test are reported in the literature where the performance of intervention and control groups, sampled from the same University, is compared.

Further findings that the precision and accuracy of the clinical decision-making of the intervention groups increased over time suggested that the student's decision-making had become more proficient with increased exposure to clinical dentistry. Moreover, these findings were confirmed by the decreasing discrimination ability of the progress test from the third to the fifth study year. These findings correlated with empirical evidence regarding the clinical reasoning ability of novices in comparison to more experienced clinicians.[90,101-104] These studies suggest that novices do not possess integrated knowledge structures to make coherent and complex decisions, while more experienced clinicians do. Novices also may not possess enough forceful features[90] to retrieve knowledge from their relatively unstructured knowledge bases. Therefore, when challenging preclinical students with complex clinical decision-making using MCQ options, it is likely that their answers will be quite variable and somewhat inaccurate. As clinical decision-making proficiency increases through appropriate experience, such as clinical teaching and learning, knowledge structures become more elaborate and perhaps refined, increasing the likelihood of more accurate and precise decisions.[59-62,105] This is evidenced by the intervention groups' results obtained in this study. These findings suggest that the intervention might have contributed to the development of knowledge structures in the context of a CPC encounter.

In contrast to the observations above, the SD for the control group Cohort B increased over time. Notably, their initial fourth-year mean score was fairly inaccurate, yet it was seemingly precise when compared with the other cohorts' results. Logically, an inaccurate group score that is relatively highly precise can only be obtained if the whole group answers the same questions incorrectly. Indeed, this group performed very poorly in at least three questions (Questions 20, 30 and 31).

Respectively, only 8%, 14% and 6% of the Cohort B students answered the above-mentioned questions correctly. Unlike the results for Question 20, the results of Questions 30 and 31 differed significantly from the other fourth-year cohorts (Table K.7, page 314). Although the results of other questions might have played a role, these findings suggest that misconceptions in the group with regard to the content of Questions 30 and 31 contributed most to the lower overall progress test scores (which show relatively high precision). Descriptions of these two questions are as follows:

- Question 30 relates to the safe selection of local anaesthetics for a patient with high blood pressure; and
- Question 31 requires the student to make a decision to administer antibiotic prophylaxis for a patient with a cardiac condition, based on guidelines[193] recommended by the Module: Orofacial Surgery.

In the qualitative feedback, the fourth-year students complained about a lack of standardisation in the undergraduate curriculum and that it caused confusion. For instance, it was mentioned that there were distinct differences in the interpretation of blood pressure readings in the different modules. The student who raised the issue referred specifically to the modules Orofacial Surgery and Odontology. Most of the fourth- and fifth-year clinical teaching and learning is presented in the Module: Odontology. Faculty members teaching Orofacial Surgery present the management of medical conditions (from a surgical perspective) to the students and apply the concepts during clinical teaching and learning. The Module: Odontology focuses on restorative treatment. Needless to say, not being subject experts in the field of the management of medical emergencies, Odontology faculty members are much more conservative in their interpretation of medical conditions. This could have influenced their selection of local anaesthetic agents and might have resulted in the discrepancies. Although it is not specifically observed in the evaluation results of this project, a lack of standardisation among the modules could also have been the reason for Cohort B's misconceptions about the need for administering antibiotic prophylaxis. Retrospectively, it appears that both these examples might have been instances of case specificity[90] – originating from the discipline-based environment – that influenced the fourth-year test results negatively.

When observing Cohort A's fifth-year results for Question 31 (Table K.7, page 314) an association with the intervention was noted, suggesting that the students' knowledge and decision-making were influenced by the novel teaching and learning. The same can, however, not be said about the selection of local anaesthetics (Question 30) for patients with histories of high blood pressure, and this leaves room for improvement in the educational processes.

In the fifth year of study, control group Cohort B (Table K.10, page 317) improved their scores significantly for Questions 30 and 31. Notably, their overall progress test results were more variable and displayed a higher SD than in their fifth year of study. Whether these observations can be attributed to their participation in the progress test at the end of the fourth study year or perhaps to their clinical teaching and learning in the fifth study year is unknown. However, it appears as if Cohort B students started to consider more options when they wrote the fifth-year test. Considering various alternatives, instead of simply assuming you already know the correct answer, demonstrates flexibility in the reasoning process. Developing flexibility in the reasoning process is important because it facilitates forward and backward hypothesis-driven reasoning[94,100] and pattern recognition in synergy[94] to make clinical decisions, which reduce the likelihood of misconceptions – such as those mentioned in the previous paragraphs. The similarity between the overall progress test results of the fifth-year Cohort B group and the results of the third- and fourth-year intervention groups suggests novice-like knowledge structures with similar levels of flexibility in decision-making in these groups. It therefore appears as if the intervention might have the ability to develop flexibility in the reasoning process, even at the preclinical stage. These suggestions should be confirmed through further research.

The sections above contained an elaboration on the evaluation results in terms of the effectiveness of the intervention to improve the cognitive aspects of clinical reasoning at the exit level of the undergraduate dental curriculum using the progress test as an assessment tool.

The following part explores the association between student-dependent factors and the progress test results. The analyses include correlations between the progress test scores and demographic factors, such as race and gender.

9.2.2.2 Demography and the Progress Test Scores

The evaluation results showed that the white students generally achieved higher progress test scores than the students from other "ethnoracial" origins. When controlling for confounding factors, it was found that race manifested as a correlate of the progress test score of the fifth-year cohorts only. Again it must be reiterated that the observed associations between race and progress test scores have nothing to do with "race" itself. These associations rather relate to the concepts of self-regulation[44] and self-handicapping[45] behaviour. These associations stem from the socio-economic disparities that originated from the abolished Apartheid political system that discriminated against people from Black, Coloured and Indian/Asian origins (refer to Chapter 1, page 13 for a detailed explanation).[50-53] The correlations found are in line with conclusions from other research done at the University of Pretoria that showed that, compared to white students, black students' approach to their studies was less efficacious and goal orientated,[48] and that they were more likely to be academically at risk in the senior study years.[48] Contrary to the current study's findings, a University of Cape Town[221] study in Medicine revealed that early intervention through an academic intervention programme may have helped “academically at-risk” students to overcome their problems and to perform well at the exit-level of the curriculum. This contradiction may be due to the fact that the current study did not focus on “academically at risk” students, *per se*.

Contrary to suggestions in the literature,[46,47] the influence of gender remained insignificant.

The subsequent section elaborates on the correlation between the Oral Biology results and the progress test scores.

9.2.2.3 Oral Biology and Progress Test Scores

Woods *et al*[49,108,222] mentioned the link between BMS knowledge and clinical reasoning ability. This study supports the notion of a consistent correlation between third-year Oral Biology marks and progress test scores, as well as diagnostic component scores. The results of the current study suggest that knowledge of Oral Biology might be an important building block for making correct diagnostic decisions in dentistry. Considering an alternative explanation for the above-mentioned association, Veenman and Beishuizen[223] suggest that students’ intellectual ability and metacognition might be important factors to consider when subjecting students to complex texts with time constraints. Those with higher intellectual ability and metacognitive strategies will typically fare better than those with lower intellectual ability and metacognition. These observations are particularly relevant to both the progress test and the Oral Biology course. The progress test uses a complex, written case study, and the Oral Biology course requires the study of a contemporary, internationally-used class textbook.[224] In addition to this, the curriculum is already somewhat crowded,[9] requiring good time-management and self-regulation skills to cope. Nevertheless, it is highly likely that those who performed better in the Oral Biology assessment probably possessed more knowledge of the subject. A good knowledge base in Oral Biology will probably increase the ability to distinguish between “normal” and “abnormal”, which will most probably assist with diagnostic reasoning skills.

As proposed by Woods *et al*,[108] the preclinical intervention attempts to address students’ understanding of the pathogenesis of the diseases covered. This requires that aspects of Oral Biology be touched on during the instruction. For example, it would be difficult to teach the pathogenesis of dental caries if the students do not understand the microscopic anatomy of dental enamel and dentine. Trying to establish links between concepts related to Oral Biology and diagnostic reasoning can be described as an attempt to establish vertical integration[10,68] in the undergraduate curriculum. Students’ perceptions, as indicated in their feedback, about the CPC unit’s ability to integrate knowledge from previous study years, are the only other empirical evidence that the integration of knowledge on a vertical plane was successful or not, and their perceptions differed significantly. Fifth-year students who had been exposed to the intervention rated the occurrence of vertical integration significantly higher compared to the control groups (Table 8.17, page 182). Compared to the other educational aspects, vertical integration received the lowest rating from students in all the study years (Tables 8.15 - 8.17, pages 179 - 182), even in the third year where vertical integration was purposefully attempted. Bronkhorst and Postma,[181] however, showed that second-year dental students found many aspects of BMS teaching and learning in the joint medical curriculum irrelevant. It is therefore plausible to say that the third-year students are still grappling with relevance and integration by the end of their third year of study, and that they only start to realise the value of integration when they have more insight in the final year. The lower ratings for vertical integration, in relative terms, imply that further improvement may be required in this regard. This conclusion is based on a remark made at the end of paragraph 3.2.1 (page 35) where it was mentioned that it is a contemporary requirement that students should possess a sound knowledge in BMS, which they must be able to apply during their diagnostic reasoning processes.[187]

Oral Biology marks could, however, not be associated with the treatment planning decisions in the progress test. The treatment planning decisions in the progress test required the selection of treatment options after having made a diagnosis. Students in the intervention groups were taught to first make a diagnosis[93] and to propose treatment based on their diagnostic decisions. It was therefore not surprising to find that the diagnostic component score of the fourth-year cohorts in the progress test correlated with the treatment planning decision-making in the test. However, the same was not found in the case of the fifth-year cohorts, probably due to the sampling bias. Two of the three fifth-year cohorts had not been exposed to the intervention. The progress test diagnostic component scores of these two fifth-year groups were relatively low and similar to those of the third- and fourth-year groups, which might have influenced the expected correlation between the progress test scores and the Oral Biology marks negatively.

The section above elaborated upon the correlation between the third-year Oral Biology marks and the progress test results. The following section examines the performance of the progress test as a measurement tool.

9.2.2.4 Progress Test Validity

Another unique aspect of this research is the design of the progress test that was developed for this study, and which was based on a complex case study. The use of a complex case study is based on recommendations of the 4C/ID-model[31] that whole-task principles should be used to facilitate the development of cognitive skills in novices. This is unlike the more conventional progress test described by Bennett *et al*,[66] which comprises a combination of knowledge-based and clinical questions based on vignettes (shortened case studies). The use of vignettes will result in a part-task approach during assessment, which is likely to result in a loss of the big picture,[31] and was therefore not considered for this project. The use of a complex case study in the newly designed progress test therefore originated from the need to establish relevance in the educational processes of the CPC unit and to prepare the third-year students for that which they will be faced with in the fourth study year. This was achieved through the constructive alignment of the CPC unit outcomes (learner objectives)[182] with the teaching, learning and assessment, and the adoption of a part-whole-task approach (Figure 3.7, page 58)[31] in the educational processes of the unit to teach the cognitive aspects of clinical reasoning.

The use of a complex case study for assessment purposes brought significant differences to the fore in terms of clinical reasoning complexity as experienced by a dental student. The diagnostic component scores of the progress test differed distinctly from the treatment component scores. The evaluation results indicated that the students achieved substantially higher scores in the diagnostic component (Table 8.2, page 158 and Table 8.3, page 159) than in the treatment component. The results suggest that the treatment component of the progress test – which requires the student to make diagnostic, prognostic and treatment decisions to answer a single question – is inherently much more complex than the diagnostic component, which requires a student to make a diagnosis only. The results, in particular of the third and fourth years of study (Table K.6, page 313), indicate that the intervention might have played a role to develop treatment planning skills. These findings relate to Figures 3.8 to 3.14 (pages 59 - 68).[31] It appears as if the case study exercises, combined with the inductive-inquiry methods used in the intervention, to some degree established structural and causal mental models[31] (Figure 3.11, page 65) in the minds of the learners. The content covered in the treatment component required decisions about the prognosis and treatment of at least four different teeth, for instance, extractions, basic restorations and rehabilitation (root canal treatments and crowns), tooth replacement strategies, management of a white oral mucosal lesion, management of tooth-wear lesions, treatment prioritisation, selection of an appropriate full-mouth fluoride treatment regimen, selection of an appropriate local anaesthetic, management of high blood pressure, establishment of the need for antibiotic prophylaxis, and the administering of antibiotics. These decisions are usually complicated by several bio-psychosocial considerations. It must also be taken into consideration that using an open-book strategy[207] (with time constraints) allowed the students to consult their references. It is much easier to look up a diagnostic classification than taking a treatment decision. Furthermore, by limiting the diagnostic content to the tracer conditions[186] listed in Chapter 6 (page 112), the students might have been greatly assisted with mastering the diagnostic aspects of these commonly found conditions. However, the selection treatment options might have been more variable. It is therefore not surprising that the diagnostic component yielded substantially higher and less variable results compared to the treatment component.

A comparison of the results of the judges' feedback in the quality control and standard setting processes with the students' performance in the diagnostic component of the test, indicated that the students had performed as expected (Table K.13, page 320). The judges who took part in the study are all actively involved in student teaching and learning, are acquainted with the above-mentioned diseases and conditions, and are generally aware of students' abilities, therefore they might have had an advantage in predicting student performances in the diagnostic component. However, this was not the case in the treatment component: firstly, the judges could not predict student performance in the treatment component on a consistent basis and, secondly, the students generally performed below the judges' expectations. This could indicate that the students were not adequately prepared for the intricacies of the specific problems they were expected to deal with in the test.

The deliberations above suggest that the intervention was largely successful in adequately developing the students' diagnostic ability – related to the selected tracer conditions[186] – over time and to a level that generally conforms to faculty standards and expectations. The treatment decisions they were faced with, however, appear to have been substantially more complex so that the students were unable to live up to faculty's expectations. This requires teaching and learning issues, including the intervention, to be carefully scrutinised. Clearly the preclinical case-based teaching and learning only succeeded partially in developing the prognostic and treatment planning decisions the students had to make in the progress test. Although the students in the intervention groups fared better than the control groups, these findings indicate that there is substantial room for improvement in terms of developing students' abilities to make the more complex decisions they are faced with. These issues appear to have influenced the reliability of the treatment component of the test negatively. Since problem-solving is closely linked to knowledge and experience[88], students will have to be exposed to a much wider range of prognostic and treatment planning decisions to develop their skills.

There were few controversial findings in the diagnostic component of the test, which indicates good construct validity. For coherence purposes[5], students were required to diagnose the full range of tracer conditions[186]. Question 15 produced the worst performance in terms of discrimination ability in the diagnostic component of the test. The question involved the identification of the primary cause of leaking dental restorations. It was found that the fourth-year control groups gave more correct answers than the intervention groups, which suggests that the intervention group suffered from misconceptions. It must, however, be noted that the ratio of correctly answered questions was relatively high for both the groups.

The evaluation results specifically question the construct validity of Questions 22, 23 and 30 in the treatment component. These questions were very difficult and at first glance it could be argued that these questions did not display adequate discriminatory properties. The judges rated the relevance of these questions particularly high in the quality control process and had higher expectations of the students' ability to answer them correctly. The content of the questions was as follows:

- The most difficult question, Question 23, required the students to assess the prognosis of a periodontically and endodontically compromised molar tooth. The tooth presented with loss of tooth structure due to occlusal tooth wear, a pulpitis lesion and a furcation lesion. The students had to select an appropriate treatment planning decision to manage the problem. Nearly half of the students opted for restoration with a gold crown only, failing to take periodontal and endodontic factors into account when making the prognosis. It was noted in Chapter 7 that 20%, 28% and 38% ($P<0.05$) of the third-, fourth- and fifth-year students, respectively, selected the correct treatment for Question 23. These results show an expected increase in competence from the preclinical year to the fifth year of study. This increase, however, showed no association with the educational intervention. It can, therefore, be argued that some development of the decision-making processes did take place in the discipline-based environment of the School. However, these findings show that most students did not possess the knowledge structures to answer a complicated question like Question 23, and that they need to be exposed to similar problems more. In this instance it appears as if Question 23 possesses a valid construct. The failure of the question to discriminate extensively can rather be attributed to the educational process that was lacking, than to an inherent flaw in the question itself.

- Question 22 was the second most difficult question. The question required students to select an appropriate prosthesis to replace missing teeth. Although Question 22 could discriminate between high and low scoring students, the question did not display a significant association with the intervention. The fifth-year scores for this question were lower compared to those of preceding years, but only significantly so in the case of Cohort B students whose scores for this question were much lower in the final year than in the fourth year. This considerable drop in the scores of Cohort B students between their fourth and fifth years of study appears to have given rise to the differences between the scores of the two control groups at exit level. The exact reason for this occurrence is unknown but might be attributed to misconception and case specificity[90]. The MCQ distracters that were chosen most often by Cohort B related to more expensive fixed prosthodontic and implant options, which may be due to the fact that students received teaching and learning in fixed prosthodontics in the fifth study year. No correlation could, however, be found between the selection of these distracters and any of the groups. Although prosthodontic treatment was covered in task class five, it appears as if the preclinical intervention failed to adequately develop the students' decision-making in this regard. Question 22 required integrated decision-making and consideration of the bio-psychosocial aspects of the case. These evaluation results suggest that the students need to be exposed to a larger variety of scenarios where tooth replacement is required. This can only be accomplished by using shorter case studies, such as vignettes during the teaching and learning process.
- Question 30 – which was the fourth most difficult question – was the third question that failed to discriminate between groups as expected. A description of the question and deliberations about the fourth- and fifth-year performances in this question were provided in the previous section. It is quite likely that the suggested lack of standardisation in

the discipline-based undergraduate dental curriculum influenced the discrimination properties of the question. In general, the third-year students fared the best in Question 30, and the fifth-year students fared the worst. It must be noted that the third-year students were taught according to the standards followed by the Module: Orofacial Surgery. Lecturers teaching this module served as judges to evaluate the specific question in the quality control process. Since third-year students do not actively use local anaesthetics, their knowledge was derived from the paper cases they had been exposed to. In other words, the high third-year scores can be deemed as an instance of case specificity.[90] It appears as if students only become confused during the clinical training years due to a lack of standardisation (Table M.1, page 332) in the discipline-based undergraduate dental curriculum. Issues like these seriously affect the reliability of the test.

The evaluation of the progress test indicates that, with a few exceptions, all of the questions in the progress test could distinguish reliably between students who performed poorly and those who performed well. The majority of question had a DI of 0.3, or above, which is an indication of high quality MCQs.[64] The test generally showed logical discriminatory properties in terms of study year and could discriminate between the control groups and the intervention groups. Two-thirds of the questions in the progress test were associated with the intervention in some or other way. Six of the easiest questions – included for coherence purposes – and three of the most difficult questions showed no association with the intervention. These findings are to be expected, because easy questions are more likely to be mastered very early on, whereas very difficult questions might not be mastered at all. Questions 24 and 32, both of intermediate difficulty level, could also not be associated with the intervention. Question 24, however, displayed logical, but insignificant ($P<0.1$), trends in relation to the intervention. Question 32 is the only question where it is not clear why no association could be found. The question displayed rather erratic answering patterns as far as the various cohorts and study years were concerned. Question 32 was, however, the last question in the time-constrained test, which might have affected the question's reliability. This hypothesis is supported by observations that Question 32 discriminated significantly in all three of the study years between high and low scoring students. Since the question required the reading of a complex text-based case study, it is likely that the better students finished the test in time, whereas the average students could not finish the test[223]. Consequently, the results of the answers given to the test's last questions may have been unreliable.

As regards the way the students answered the questions, the results of the study showed several significant differences between the three third-year cohorts, and between the intervention groups in the fourth study year. Although it was endeavoured to maintain consistency in the presentation of preclinical case-based teaching and learning as far as possible, small adjustments were made in presenting the content. Furthermore, the content that was discussed was often determined by the students themselves, hence the variability of it. Minor influences from the clinical disciplines can also not be excluded. In addition, in some instances the intervention groups scored lower than the control groups in both the fourth and the fifth study years. Case specificity,[90] combined with misconception, could explain these discrepancies.

However, the test is by no means a measure of clinical reasoning ability as a whole, but it serves as a good reflection of students' diagnostic abilities as far as selected tracer conditions[186] are concerned, in particular if sourced from paper-based case studies. Based on the deliberations in the previous section, it appears as if deficiencies in the teaching and learning process and a lack of standardisation in the curriculum, instead of inefficiencies related to the progress test itself, resulted in the unexpected differences amongst cohorts. Given the variability of the sample and the variable nature of clinical reasoning, the results of this study suggest that the progress test succeeded reasonably well in illustrating differences amongst groups.

The findings pertaining to the treatment component suggest that the treatment planning component of the test should be expanded in alignment with the additional teaching and learning that is needed in this domain. In order to cover a lot more ground, teaching and learning will have to be augmented by a part-task approach using shorter vignettes before proceeding to part-whole-task approach.[31] Furthermore, doubling the assessment time to be in line with the additional teaching and learning will certainly increase the reliability of the assessment. For such an expansion to be possible and successful, additional resources in terms of workforce and time might be required.

The paragraphs above analysed the discrimination abilities of MCQ questions from various perspectives to establish the construct validity of the test. The following section continues with a discussion of the association between the standard setting specifications and the progress test results.

9.2.2.5 Standard Setting Specifications versus the Progress Test Results

For the purpose of the current study, a combination of actual and relative methods was used to derive a hypothetical cut-score of 59.5% for the progress test at exit level.

It is suggested in the literature that standard setting approaches be measured against actual performance data[223] to test the validity of the process. When plotting the results of the fifth-year control and intervention groups against the cut-score, it became evident that all the students who had been exposed to the intervention passed the test. One third of those who did not participate in the intervention would have failed if the cut-score had been implemented.

The comparison of the hypothetical cut-score and the 2011 progress test scores of proven borderline students (Table 8.14, page 178) indicated that the suggested cut-score for the test was fairly accurate. The results showed that only borderline students who had failed both their fourth and fifth study years achieved scores below the 59.5% mark. Although these borderline students originated from the control groups, all of them had received extra tutoring in the subject, and had written the test more than once.

Despite these positive signs, the level at which the cut-score is set should be confirmed through further research.

The only concern related to the cut-score is that the students did not achieve adequate scores in the treatment component of the test. Many students made up their marks in the diagnostic component. The judges rated the questions in the treatment component as very relevant, which suggests that a cut-score should perhaps be considered for both the diagnostic and treatment components of the test. Since the judges generally expected better performance in the treatment component, it is highly likely that a large number of students would have failed that part of the test, again indicating a need for additional teaching and learning in treatment planning skills.

The section above concludes the discussion pertaining to different aspects related to the progress test. The discussion continues with the next major section, namely, the student feedback.

9.2.3 Student Feedback

Although some of the aspects of the student feedback can be related to the discussions earlier in the chapter, the student feedback will be addressed as a separate entity here. The quantitative and qualitative feedbacks are deliberated upon under separate headings.

9.2.3.1 Discussion – Quantitative Student Feedback

It was noted in Chapter 2 that relevance is a key principle in adult learning,[38] and that learning is more likely to occur when students can visualise the way in which the content they are learning will benefit them in future (paragraph 3.3.4, page 45). A pertinent attempt was therefore made to develop clinical reasoning by employing case studies and models for complex learning[31,148,149] that simulate typical CPC encounters in the teaching and learning processes. The learning processes of the intervention included active learning opportunities,[25,39] accompanied by constructive formative feedback and summative assessment[5] based on the application of knowledge.[40,41] The student feedback (2009 – 2011) served as an additional gauge of the effectiveness of these strategies (Figures 8.4 and 8.5 on pages 181 and 183, respectively). The findings that the fourth- and fifth-year intervention groups consistently rated relevance, teaching and learning's alignment with the outcomes, assessment's contribution to learning, course organisation and lecturer competence higher compared to those who had received lecture-based CPC teaching and learning, indicated an improvement in the CPC educational processes since 2009. The findings that the last four aspects correlated with relevance in the multivariate model provide empirical support for the educational strategies adopted by the new CPC unit. These findings also provide empirical evidence of the value of the constructive alignment of a curriculum.

Besides indicating a need for constructive alignment, the problem statement (paragraph 2.2, page 23) expressed a need to improve integration in the discipline-based dental curriculum. The student feedback provided some evidence that the students who had been exposed to the intervention thought that horizontal and vertical integration occurred in the curriculum. Conversely, the integration ratings of the control groups were substantially lower, especially at the end of the fifth study year. This implies that the "observed" integration can most probably be attributed to the educational intervention in CPC. These findings are supported by findings from the progress test evaluation. The integrated treatment decisions of the intervention group were more accurate than the control group's decisions. Furthermore, performance in Oral Biology and BMS could also be associated with the progress test scores, suggesting that vertical integration does occur in the educational process of the School. Although many indications of integration were observed in the qualitative part of the study, the students suggested that increased attempts had to be made to integrate other subjects, specifically Orthodontics and Prosthetics.

A further main objective of the action research study was to expose students to the clinical context earlier to reduce the cognitive load during clinical teaching and learning in the beginning of the fourth year of study.

The qualitative feedback indeed confirmed that students felt that the transition to clinical teaching and learning was difficult. A similar situation[35] was previously reported in the case of medical students. Combined with the progress test results, fourth- and fifth-year qualitative and quantitative feedback suggests success in this regard. Not only did the intervention groups feel that the preclinical case-based teaching and learning reduced the knowledge and skills gap between the third and fourth years of study, but, in contrast to the control groups, they also reported that they struggled less with psychomotor[60] tasks, such as tooth numbering, after participating in the intervention. The qualitative research indicated throughout that the case studies provided a foundation and structure to the fourth-year clinical teaching and learning. Taken together, these findings suggest that the educational design of the "new" CPC unit was an improvement on the pre-2009 version.

During the annual student feedback, the students were asked to rate their self-perceived diagnostic and treatment planning abilities. No differences in self-rated diagnostic ability could be shown between the intervention and control groups for both the fourth and fifth years of study. Since the intervention group achieved substantially better results in the progress test compared with the control groups, it appears that the intervention group were more critical of their own diagnostic abilities than the control groups. Self-evaluation is part of the self-reflection phase of Zimmerman's model of self-regulated learning.[44] The intervention might therefore have contributed to the student's self-reflective capabilities[44] in terms of diagnosing dental diseases and conditions. However, this hypothesis should be examined through further research. Conversely, the fifth-year intervention group rated their treatment planning ability significantly higher than the control group did, and the progress test results can be said to corroborate this finding. However, the relatively high ratings the students in both the intervention and control groups gave themselves for treatment planning ability are a cause for concern, given their relatively poor performance in this domain. These perceptions tend to indicate poor self-reflection ability[44] with regard to treatment planning skills, and it seems as if the fifth-year students do not really know what the skills entail. Again, this hypothesis should be tested through further research. The inflated results pertaining to self-rated treatment planning skills indicate that this part of the educational intervention should be improved also.

The student feedback questionnaires also contained questions regarding the competence of the staff and the course organisation. The literature indicates that staff attitude and competence are important factors that influence the quality of teaching and learning.[225] In the current study, the students perceptions of "competence of the lecturers" and the "course organisation" displayed a positive association with the educational intervention and less favourable perceptions were observed for the students who received lecture-based CPC teaching and learning. The influence of staff competence and attitudes on teaching and learning should however be explored more extensively in future, especially in the context of the broader discipline-based teaching and learning environment. Since this educational intervention can only be deemed to be an adjunctive course in the discipline-based environment, with some degree of inter-disciplinary cooperation and integration, more research regarding staff competence, and attitudes towards a fully integrative approach would be essential.

The deliberation pertaining to the quantitative feedback is followed by a discussion of the qualitative student feedback results.

9.2.3.2 Discussion – Qualitative Student Feedback

The qualitative student feedback obtained from one of the intervention groups at the end of their fourth year of study showed that the sample of students whose test scores had improved by 9% and more, from the third to the fourth study years, continuously made constructive suggestions to improve the educational intervention. They suggested improved integration, standardisation and supportive information (such as the use of clinical pictures) and the provision of more knowledge about the administration of the hospital. These responses can be interpreted as that the students have a goal-orientated approach to providing improved care to their patients.

Although the students who progressed to a lesser extent were also constructive and positive in their remarks, there were signs of self-handicapping behaviour. Not only did they arrive late for the focus group sessions, but some also indicated that they had not been able to find the venue, which had been clearly communicated to them. It must be noted that this was not the case with the progression group. The non-progression group also mentioned that they had not received feedback and lecturing on certain topics they struggled with. These accusations were made despite the fact that feedback and supportive lectures on some of the topics they mentioned had been given. One student admitted that he might not have done the case study assignments as he should have. Another student admitted a lack of data processing ability to adequately solve the case study problems. Other students attributed their lack of performance to a lack of sufficient teaching and learning. Putting the blame for their own failures on external factors relate to the self-reflection phase of Zimmerman's model of self-regulated learning[44] and self-handicapping behaviour.[45] It was mentioned in Chapter 4 that some of these psychological behaviour patterns are generally beyond the control of the lecturer and therefore the measured effect of the progress test might be an underestimation of what it really might be.

The deliberations above conclude the discussion of the student feedback results as well as of the broader discussion section. The dissertation will now be concluded.

9.3 Conclusion

The section above provided a detailed discussion of the progress test results and the student feedback that were used to evaluate the newly implemented educational intervention in the CPC unit's undergraduate dental curriculum at the University of Pretoria.

Based on the deductions made in the discussion, the following section draws conclusions regarding the effectiveness of the integrated preclinical case-based teaching and learning to improve clinical reasoning skills at exit level in the discipline-based undergraduate dental curriculum of the University of Pretoria.

9.3.1 The Effectiveness of the Proposed Educational Intervention and the Validity of the Progress Test

The objective of the educational intervention was to develop clinical reasoning skills through integrated preclinical case-based training in a discipline-based teaching and learning environment.

9.3.1.1 The Effectiveness of the Educational Intervention – Progress Test Results

In order to test the effectiveness of the case-based teaching and learning, the following null hypothesis was formulated and tested (refer to paragraph 2.4, page 27): *"Adjunctive integrated preclinical case-based dental teaching and learning will not improve the clinical reasoning decision-making of dental students at exit level compared to the clinical reasoning decision-making of dental students who predominantly received lecture-based CPC and clinical reasoning teaching and learning in a discipline-based environment."*

In this instance the null hypothesis is rejected with caution.

The evaluation provided empirical evidence that preclinical case-based teaching and learning, as opposed to lecture-based CPC teaching and learning, in the undergraduate dental curriculum might have played a role in improving the development of clinical reasoning skills at exit level.

Clinical reasoning skills, in this context, should, however, not be interpreted as generic reasoning or problem-solving skills but rather as knowledge-dependent skills. The development of diagnostic skills was deliberately limited to those diseases and conditions most often encountered in practice to enable the comparison, starting from the third year of study. Interpretations of effectiveness should therefore be limited to these tracer conditions[186] employed in the intervention.

The evaluation of the development of prognostic and treatment planning skills revealed several inefficiencies pertaining to the more complex decisions students had to make. The students' performance in this domain appeared to be below expectations compared to that in the diagnostic component where the students performed reasonably well. Although the intervention group rated their treatment planning ability superior to that of the intervention groups, both the intervention and control groups overestimated their treatment planning ability at exit level. These findings indicate a need for the expansion of the educational intervention to include a wider range of treatment planning decisions.

A further limitation on how conclusions can be made in this part of the study is the limitation posed by the study design. The results of only one cohort could be followed from the third to the fifth year of study. Therefore, the results of the main intervention group were a cross-sectional snapshot of success. Although some of the trends could be substantiated through the multivariate analysis and through the progress test results of another cohort, long-term research is required to substantiate the findings irrefutably.

The above-mentioned inferences are, however, dependent on the validity of the progress test, which is addressed in the next section.

9.3.1.2 The Validity of the Progress Test Results

The evaluation of the progress test as a measurement tool was an integral part of the evaluation process. The following null hypothesis was drafted to test the validity of the progress test (refer to paragraph 2.4, page 27): *"A progress test as an assessment tool will not be valid."*

The hypothesis is rejected with caution.

The progress test seemed to be able to measure changes over time, and all the questions of the test seemed to be able to discriminate between high and low scoring students in some or other way. The majority of the progress test questions could discriminate either between study years or between the intervention and control groups. These observations show that the progress test was sensitive enough to measure what it was designed for, and this suggests a high degree of construct validity.

The analysis of the questions that appeared problematic showed that issues of reliability arose due to deficiencies in the intervention rather than to problems with the questions themselves.

It appears as if the diagnostic component of the test performed reasonably well. The assessment of the prognostic and treatment planning decision-making should, however, be expanded extensively to increase the reliability of the test.

The qualitative research suggested that the introduction of clinical pictures and images might improve the learning processes further. The introduction of pictures and images might also improve the authenticity of the progress test case study, which is currently described in a complex written text.

The findings regarding the standard setting and quality control process provide external support for the construct validity of the test. The cut-score was set during the standard-setting process using a novel method. Based on the external validation process it appeared as if the cut-score might be an acceptable measure of evaluating student performance. All the students in the final-year intervention group "passed" the standardised test, whereas a substantial number of students in the control groups, as well as most of the students who were usually borderline cases, "failed" the test. Moreover, the judges were able to predict the diagnostic ability of the students accurately. Their predictions of the students' ability to make treatment planning decisions were, however, less accurate.

Therefore, it appears as if the progress test as an assessment tool might have been valid in the context it was used for. In its current form, the progress test on its own will not be valid for a high-stakes examination at the exit level of the undergraduate dental curriculum. If the test is planned to be used for this purpose, the intervention and the test should be expanded to include a wider range of clinical decisions, particularly in the treatment planning domain.

9.3.1.3 Student Perceptions about the Educational Intervention – Student Feedback

Positive indications that the intervention succeeded in developing clinical reasoning skills are indirectly supported by the positive student feedback regarding constructive alignment and relevance.

The intervention was implemented through the constructive alignment of the outcomes with educational processes and assessment, and it was endeavoured to improve the integration in the undergraduate dental curriculum through the use of models for complex learning and “realistic” case studies.

In order to determine the value of the intervention through a process of constructive alignment – from the students’ perspective – the following hypothesis was articulated and tested (refer to paragraph 2.4, page 27): *“Students who received integrated case-based dental teaching and learning will not rate educational elements, such as relevance, constructive alignment, the contribution of assessment to learning, integration, lecturer competence and course organisation, as superior compared to students who received lecture-based CPC teaching and learning.”*

The above-mentioned null hypothesis is rejected.

Student feedback clearly indicated the success of the renewal of the educational approach in CPC since 2009. The advantages of the constructive alignment of a curriculum coupled with authentic learning processes are reconfirmed.

The evaluation results also indicate that integration might have been improved to some degree. Integration can be improved further by an increased inclusion of more disciplines such as Orthodontics and Prosthetics. The issue of vertical integration in the curriculum might also need more attention.

The research further sought to uncover potential correlates of relevance through the student feedback analyses. Based on the reasons provided in Chapter 2, the establishment of relevance in the CPC unit was a key consideration in the design of the case-based intervention. Using fourth- and fifth-year students' feedback as reference, the following null hypothesis was devised to determine the factors that would predict relevance in the curriculum (refer to paragraph 2.4, page 27: *"Higher ratings of course relevance feedback will not correlate positively with positive perceptions of educational processes."*

This null hypothesis is rejected.

The results clearly indicate that when the students perceived the teaching and learning to be aligned with the outcomes (learner objectives), and assessment contributed to their learning, their perception of relevance increased. These results could be positively correlated with exposure to the preclinical case-based teaching and learning in the CPC unit since 2009.

The next aspect that was evaluated was the effect of earlier exposure to the clinical context.

9.3.1.4 Reducing the Knowledge and Skills Gap between Preclinical and Clinical Teaching and Learning

One of the needs expressed as part of the research problem was to give the students earlier exposure to the clinical context. A specific need was to address the knowledge and skills gap between preclinical and clinical teaching and learning.

The progress test results and student feedback were used to test the following null hypothesis (refer to paragraph 2.4, page 27): "*Adjunctive integrated case-based dental teaching and learning in the preclinical year will not reduce the students' perceptions regarding the knowledge and skills gap between the preclinical year and the first year of clinical teaching and learning."*

This null hypothesis is rejected on the basis of the quantitative and qualitative feedback as well as the progress test results.

The results of the quantitative student feedback showed that those who had been exposed to integrated case-based teaching and learning felt that the gap between the third and fourth study years had been reduced by the intervention. For example, they reported that they struggled less with psychomotor activities, such as tooth numbering, in the fourth study year compared to those who had not been exposed to the intervention. The qualitative research showed wide consensus that the case-based teaching and learning in the third year provided a good foundation for the clinical teaching and learning in the fourth study year. The progress test's results confirmed the students' perceptions. These results showed that in the third year, the clinical reasoning performance of students who had received case-based teaching and learning was more or less equal to the performance of fourth-year students who had received discipline-based teaching and learning. Furthermore, a marked difference was observed as regards many of the questions in the treatment component in the fourth year of study between the intervention and control groups, which suggests that the intervention groups might have benefited, especially from the treatment planning exercises in the third year of study. These deductions are confirmed by some of the students' comments during the fourth-year focus group discussions.

9.3.1.5 Conclusion

The overall evaluation results suggest that the preclinical case-based teaching and learning may have had a positive educational effect on the clinical decision-making of the students at exit level, considering the limitations of the study design and the content covered. The establishment of relevance and constructive alignment in the educational processes appears to be the key to this success. The evaluation results of the current study support the view that students should be exposed to the clinical context earlier and that clinical reasoning exercises should commence in the preclinical year. Such an approach is likely to ensure a smoother transition to clinical teaching and learning.

The treatment component of the intervention should, however, be expanded to incorporate a wider range of content. Such a strategy will, however, be dependent on resources such as time, money and staff.

The results of the progress test appear to be valid although there is room for improvement.

The sections above drew inferences regarding the effect of the intervention on clinical reasoning outcomes and earlier exposure to the clinical context.

The following section is the final part of the concluding remarks, which involves associations between student-dependent factors and educational outcomes.

9.3.2 The Association between Student-dependent Factors and Educational Outcomes

It was mentioned in Chapter 2 that faculty might not have any control over learner influences on educational outcomes. The following section draws inferences about demographic correlates of the intervention, previous academic performance, and evidence regarding self-regulated learning amongst the students.

The demographic correlates of the intervention are addressed first.

9.3.2.1 Demographic Correlates of the Intervention

The needs assessment suggested that demographic factors concerning the learners might influence the development of clinical reasoning skills of dental students in the South African context. Based on this assumption the following hypothesis was formulated and tested (refer to paragraph 2.4, page 27): *"Students' gender and race will not be associated with the outcome of the development of clinical reasoning skills."*

The hypothesis is partially accepted and partially rejected.

The study showed that a student's race correlated with clinical reasoning outcomes in the final year of study. White students performed significantly better than the other students from different "ethno-racial" origins, which was expected in the South African socioeconomic context (Refer to Chapter 1, page 13 for a detailed explanation). However, the students' gender displayed no association with clinical reasoning outcomes.

The following part draws inferences about previous academic performance.

9.3.2.2 Previous Academic Performance

The targeted needs assessment suggested that previous academic performance might influence the development of clinical reasoning skills of dental students in the University of Pretoria context. Based on this assumption the following hypothesis was formulated and tested (refer to paragraph 2.4, page 27): *"Prior academic performance, in the form of possessing BMS knowledge, will not be associated the outcome of the development of clinical reasoning skills."*

The hypothesis is rejected with caution.

As mentioned earlier, previous academic performance in third-year Oral Biology – which constitutes the degree of BMS knowledge that the student possesses – correlated positively with clinical reasoning outcomes.

These findings provide support for the notion that knowledge in the BMSs is necessary for the development of clinical reasoning skills. Oral Biology should therefore be considered an important basis for the clinical teaching and learning that will commence at a later stage. The correlations found between the Oral Biology marks and the progress test scores may, however, also be attributed to the students' self-regulation ability of the students during the learning process. The possibility for an intervention aimed at specifically supporting "academically at risk students" as an addition to the current methods should be explored.

The next section draws inferences about evidence of self-regulated learning and self-handicapping behaviour obtained from the qualitative analyses.

9.3.2.3 Evidence of Self-regulated Learning and Self-handicapping Behaviour

During the study it was observed that some students progressed as far as their clinical reasoning ability was concerned, whereas others did not. The following null hypothesis was formulated and tested: *"Students who progressed in terms of clinical reasoning will not display self-regulating behaviour, and students who did not progress will not display self-handicapping behaviour."*

The research could not demonstrate irrefutably that those who progressed in clinical reasoning outcomes displayed self-regulated behaviour. However, this group appeared to be focused on the broader mission of CPC because they gave substantial, constructive criticism to improve the educational processes further, and this can be associated with a goal-orientated approach.

Conversely, those in the non-progression group displayed self-handicapping behaviour such as poor time management and a lack of awareness of learning opportunities. In some instances, students in this group attributed their failures to a lack of teaching and learning. A lack of data-processing ability was also reported in this group.

Although this group also provided constructive criticism, the null hypothesis is rejected with caution.

Evidence from the qualitative part of the study suggests that students who progressed displayed a goal-orientation approach to a certain extent during the focus group discussions, and the group who did not progress displayed self-handicapping behaviour.

9.3.2.4 Conclusion

Race, previous academic performance in third-year Oral Biology, and psychological behaviour related to student learning appear demonstrated statistical associations with the educational intervention's development of students' clinical reasoning skills. These findings all relate to the students self-regulation ability and academic skills. These findings imply that increased support should be provided to struggling students. The findings also imply that formative assessment and feedback are required to develop the learning behaviour of all students.

9.4 The Way Forward

Following the evaluation of the educational processes employed in the new CPC unit, it can be concluded that the adjunctive preclinical case-based teaching and learning resulted in a positive educational effect in terms of the development of clinical reasoning skills at exit level. The establishment of relevance in the CPC curriculum and the constructive alignment of teaching, learning and assessment contributed most to the positive outcomes. These findings should be confirmed through further research.

Despite these positive results, the treatment planning component of the intervention as well as the progress test needs to be expanded to obtain a more reliable reflection of the students' treatment planning skills.

Learner support in the form of an intervention with the aim of improving students' self-regulation through formative feedback should be considered in the early years of study.

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APPENDIX A: DEMOGRAPHIC COMPOSITION OF STUDENTS

Table A.1 Demographic composition of consenting students

Study year	Year	Black, Coloured and Indian/Asian students			White students		
		Female n	Male n	Total n	Female n	Male n	Total n
3	2009	6	3	9	21	9	30
3	2010	16	8	24	19	8	27
3	2011	15	4	19	17	12	29
4	2009	6	7	13	23	12	35
4	2010	6	3	9	21	9	30
4	2011	14	6	20	18	8	26
5	2009	8	5	13	25	10	35
5	2010	7	6	13	22	12	34
5	2011	4	2	6	21	9	30

APPENDIX B: UNIT: ASSESSMENT CRITERIA: COMPREHENSIVE PATIENT CARE

Specific outcome 1		**Demonstrate an image of professionalism during preclinical/clinical/practical training sessions.**
	Students –	
1.1	arrive on time for preclinical/clinical/practical training sessions.	
1.2	attend training sessions regularly, and ask permission not to attend if they have good reasons.	
1.3	adhere to hair and dress guidelines for these sessions.	
1.4	adhere to infection control guidelines for these sessions.	
1.5	treat lecturers and support personnel with respect.	
1.6	treat patients with respect, compassion and empathy.	
1.7	display integrity and honesty during these sessions.	
1.8	administer local anaesthetic with empathy.	
Specific outcome 2		**Arrange the chair-side environment to ensure the satisfaction of patients.**
	Students –	
2.1	disinfect the chair-side environment, and put infection control barriers in place according to protocol.	
2.2	arrange the chair-side environment so that the patient can sit in the dental chair unobstructed.	
2.3	arrange the chair-side environment to be organised and to comply with ergonomic standards.	

Specific outcome 3	**Build rapport with patients and/or their guardians through effective communication.**	
	Students –	
3.1	greet patients politely on arrival, and introduce themselves when meeting patients for the first training sessions or role-play exercises.	
3.2	assume body postures that are conducive to good communication when conversing with patients.	
3.3	make sure that their non-verbal communication conveys confidence, sincerity and empathy, and that they avoid distracting habits.	
3.4	display good verbal communication skills, and keep patients' levels of understanding in mind during training sessions or role-play exercises.	
3.5	establish rapport with patients by making coherent small talk about, for instance, the patients' work, family and home.	
3.6	obtain the psychosocial history of patients (for instance finances, transport and fears) through careful observation and questioning.	
Specific outcome 4	**Determine patients' main complaints and establish their expectations.**	
	Students –	
4.1	determine main complaints, and record them accurately.	
4.2	ascertain the history of the main complaints.	
4.3	establish patients' expectations actively through selective questioning, and document these accurately.	
Specific outcome 5	**Ascertain and interpret patients' dental histories correctly.**	
	Students –	
5.1	note down patients' previous visits to a dentist and the types of treatment received.	
5.2	record adverse reactions to dental or medical treatments accurately.	

5.3	study patients' dental records thoroughly before commencing treatment.
Specific outcome 6	**Ascertain and interpret patients' medical histories to prevent potential medical emergencies and/or to minimise the risk of litigation.**
	Students –
7.1	follow hand-washing and general infection control procedures according to protocol before, during and after the examination and/or treatment of patients.
7.2	leave instruments that were dropped on the floor until after the end of a session.
7.3	disinfect X-ray films and sensors appropriately before and after treatment.
7.4	protect digital x-ray sensors with plastic bags during use.
Specific outcome 8	**Implement measures to ensure occupational health and safety during preclinical/clinical /practical training.**
	Students –
8.1	make sure their body postures comply with ergonomic standards when treating patients.
8.2	wear their gloves and masks correctly during dental treatment.
8.3	wear protective glasses during dental examination and treatment.
8.4	cap a needle by either using a needle incinerator or the one-handed needle-capping technique.
8.5	dispose of amalgam appropriately.
8.6	dispose of medical waste in appropriate containers.

8.7	adhere to radiation control guidelines when taking radiographs.	
Specific outcome 9		**Conduct specific examinations to solve patients' immediate problems, document clinical findings on dental records according to protocol, and inform patients about additional treatment needed.**
	Students –	
9.1	document clinical findings pertaining to specific examinations accurately on the relevant examination forms.	
9.2	screen oral and facial regions thoroughly for additional pathological conditions, note down these conditions, and inform patients about additional treatment needed.	
9.3	perform and/or request appropriate diagnostic tests, such as radiographs or pulpal tests, to assist in making diagnoses.	
9.4	identify and address patients' immediate problems.	
Specific outcome 10		**Conduct comprehensive extra- and intra-oral examinations to determine patients' needs, and document clinical findings on dental records according to protocol.**
	Students –	
10.1	document clinical findings pertaining to comprehensive examinations accurately on examination forms.	
10.2	perform and/or request appropriate diagnostic tests, such as radiographs or pulpal tests, to assist in making diagnoses.	

10.3	use extra-oral and intra-oral digital photography as an additional measure to record clinical findings.	
Specific outcome 11		**Formulate and document diagnoses based on histories and clinical findings (signs and symptoms) identified during extra- and intra-oral examinations.**
	Students –	
11.1	diagnose and document extra-oral or intra-oral conditions (excluding teeth and gingiva) correctly, or make differential diagnoses in the absence of definite diagnoses.	
11.2	diagnose dental caries correctly and document the degree of severity.	
11.3	diagnose tooth wear (abrasion, attrition and erosion) correctly and document the degree of severity.	
11.4	diagnose and document pulpal and periapical conditions correctly.	
11.5	diagnose and document periodontal diseases correctly, and classify periodontitis correctly according to the Van der Velden classification system.	
11.6	diagnose and document tooth loss correctly.	
11.7	diagnose and document malocclusion and/or occlusal disturbances correctly.	
11.8	diagnose and document tooth development disturbances/conditions (such as enamel hypoplasia) correctly.	

Specific outcome 12		**Ascertain and document information regarding patients' self-care and behavioural practices that might influence patients' oral health status.**
	Students –	
12.1	record the plaque index accurately according to protocol.	
12.2	ascertain and record patients' self-care and dietary behaviour accurately according to protocol using a selective-question technique.	
12.3	observe and record patients' motivational levels according to Maslow's theories and/or a 10-point Likert scale.	
12.4	assess patients' compliance with health-promotion recommendations during subsequent visits.	
Specific outcome 13		**Explain the diagnoses, aetiology and pathogenesis of diseases and conditions, and propose alternative self-care practices to patients in a coherent way.**
	Students –	
13.1	employ co-diagnosis (using intra-oral cameras, hand mirrors and visual aids) to involve patients in diagnoses.	
13.2	identify the aetiology of all diagnoses and problems, and formulate a consequential hypothesis for a situation should a problem/diagnosis be left untreated.	
13.3	explain the aetiology and pathogenesis of applicable disease processes and conditions to patients in layman's terms.	
13.4	use visual aids appropriately to explain disease processes and recommended self-care practices to patients.	
13.5	recommend and demonstrate alternative self-care practices to patients that are relevant to their oral health and psychosocial status.	

13.6	give patients an opportunity to demonstrate comprehension by physically illustrating oral hygiene techniques using appropriate aids.	
Specific outcome 14	**Formulate and document prioritised, integrated, comprehensive dental treatment plans based on patients' bio-psychosocial status.**	
	Students –	
14.1	formulate and document "ideal" comprehensive treatment plans, while taking patients' complete bio-psychosocial status into account.	
14.2	formulate and document alternative treatment options where appropriate.	
14.3	prioritise treatment plans according to patients' needs, demands and expectations, while taking the logical sequencing of dental procedures into account.	
Specific outcome 15	**Present appropriate treatment options and their costs to patients in a way that would increase the likelihood of obtaining their case acceptance and informed consent.**	
	Students –	
15.1	discuss treatment options with patients and elaborate upon the advantages, disadvantages, indications and contra-indications of each option so as to obtain patients' informed consent.	
15.2	discuss treatment options in a language patients can understand.	
15.3	explain treatment options to patients using visual aids.	
15.4	discuss cost estimates of different treatment options with patients so as to obtain their informed consent.	

15.5	obtain patients' written or verbal informed consent (depending on the situation) before procedures start.	
Specific outcome 16		**Document treatment procedures and diagnostic codes on dental records according to protocol.**
	Students –	
16.1	document a clear, concise description of each procedure performed.	
16.2	define dental procedure codes correctly.	
16.3	identify dental procedure codes used in the National Health Reference Price List (NHRPL) correctly.	
16.4	enter completed procedures on dental records according to the requirements of the South African Dental Association and the NHRPL.	
16.5	define and explain the coding system of the International Statistical Classification of Diseases and Related Health Problems (ICD) correctly.	
16.6	identify ICD-10 codes in the code list correctly.	
16.7	enter ICD-10 codes on dental records according to protocol.	
16.8	document radiological findings for each radiograph entered on patients' records.	
16.9	enter detailed instructions and warnings given to and discussed with patients on their records.	
16.10	see to it that dental records comply with the standards of the Health Professions Council of South Africa (HPCSA), and that alterations/corrections are made on dental records according to applicable guidelines.	

Specific outcome 17		**Refer patients in a clear and coherent manner to another department/practitioner.**
	Students –	
17.1	refer patients if students' competencies in relation to self-awareness of personal skills is lacking.	
17.2	refer patients who require additional attention or a second opinion in writing, and state the key clinical findings and/or considerations on these referrals, as well as what is requested.	

APPENDIX C: PATIENT ADMINISTRATION: CASE STUDY AND RUBRIC

Question

Read the case study carefully. Supply the missing information on the form (which serves as the answer sheet), use the correct terminology and follow the right conventions. Do not complete the treatment plan section on the form.

Case study

<u>Rapport building conversation and interview</u>

Demographic details: A patient (your own name; file number: FIL009; age: 55) arrives for a full oral examination and further treatment at the restorative ward on the 4th level on 10 March 2010.

Main complaint and dental history: The patient complains that he has a “sore tooth in the front of the mouth ...” that is painful when he bites down. The pain is dull and it does not persist, but he wants this pain relieved. The space between the teeth in the front of his mouth also bothers him because “it does not look nice”. The patient is scared of dentists and, therefore, he does not visit a dentist regularly. He visited a dentist three years ago to have a painful, loose tooth extracted. He did not have any adverse reactions to the treatment or the injections.

Medical history: The patient suffers from diabetes (which he controls by following a diet), had a heart valve replacement two years ago, is allergic to Amoxil, and smokes 10 cigarettes a day.

<u>Extra- and intra-oral examination</u>

Extra-oral examination: angular cheilitis (small red lesions) at the left (L) and right (R) corners of the mouth.

The patient does not wear dentures.

Intra-oral examination: linea alba on the occlusal plane of the buccal mucosa (L and R), and leukoplakia (8 mm in diameter) on the floor of the mouth.

The patient complains of a dry mouth and occasional bad breath.

<u>Absent teeth and spacing</u>: The four third molars are clinically absent; tooth 35 is absent and the tooth space is completely closed; tooth 14 is absent, leaving a 5 mm space between tooth 13 and tooth 15. Tooth 12 and tooth 22 are also absent. Tooth 12 is replaced by an implant-supported porcelain veneer crown, and tooth 22 with a porcelain veneer pontic. There is a 1 mm diastema between tooth 31 and tooth 32. Radiographically it can be seen that tooth 18 and tooth 38 are impacted.

<u>Periodontal examination</u>

Gingiva: Bluish pink, enlarged, rolled and spongy mandibular anterior; otherwise coral pink, of normal size, flattened and firm.

Calculus: Lingual and interproximal mandibular anterior calculus is present.

Recession: Tooth 13 (B) – 2 mm; tooth 33 – 2 mm (lingual); tooth 37 – 3 mm on all sides.

Periodontal probing depth: 3 mm probing depth throughout the mouth except at tooth 17 (DB) – 6 mm; tooth 16 (MP) – 6 mm; tooth 15 (P) – 7 mm; tooth 24 (MB) – 6 mm; tooth 26 (B) – 8 mm; tooth 27 (DP) – 6 mm; tooth 34 (B) – 4 mm; tooth 37 (L) – 5 mm.

Furcation lesions: Tooth 37 presents with a Class III furcation lesion lingually, tooth 24 with a Class I furcation lesion mesially, and tooth 26 with a Class II furcation lesion buccally.

Mobility: Teeth 17, 26 and 37 present with Class I mobility.

Radiographic examination: Generalised horizontal bone loss posterior; furcation lesion at tooth 37; calculus interproximally.

Bleeding on probing: Only mandibular anterior (mesial of tooth 33 to tooth 43)

Diagnosis: Periodontitis

Hard-tissue examination

Existing restorations: The clinical examination reveals the following: Tooth 17 (MOP) amalgam; tooth 16 (DOB) amalgam; tooth 15 occlusal composite; tooth 13 (DP) composite; tooth 11 (MBIP) composite; teeth 21 and 23 are porcelain veneer bridge retainers; tooth 24 (MOD) composite; tooth 26 (P) Class I composite in palatal fissure; tooth 27 (B) Class V composite; tooth 37 (OLB) composite; tooth 36 is a gold crown

Radiographic findings: Tooth 21 presents with a completed root canal treatment and a post. A 3 mm diameter radiotranslucent area is visible at the root apex.

Dental caries

Clinical findings: Tooth 46 presents with occlusal caries and a separate lesion in the buccal fissure; tooth 11 presents with caries in the pit adjacent to the cingulum on the palatal side; tooth 11 Class III presents with caries distal; tooth 47 Class V presents with caries buccally.

Radiographic findings: Secondary caries (M) adjacent to the overhanging restoration of tooth 17; Caries (M) underneath the overhanging restoration of tooth 17 and under the contact point of tooth 16.

Pulp status: Tooth 16 responds with pain to an ethylchloride ("cold") test. Tooth 37 does not respond to heat, cold or an electric pulp test (non-vital). Tooth 21 is percussion sensitive.

Tooth wear: Tooth 37 (B) presents with abrasion; teeth 13 and 11 (P) presents with incipient erosion; all anterior teeth (excluding bridge retainers) present with mild attrition; tooth 41 has an uncomplicated tooth crown fracture of the mesial part of the incisal edge.

Other findings of note: Enamel hypoplasia is visible buccally on teeth 32 to 42; tooth 17 presents with ditching of the amalgam; tooth 27 (B) has discoloured margins gingivally of the composite restoration.

Diagnosis: Pit and fissure caries; interproximal caries; smooth-surface caries; secondary caries; mild attrition; moderate abrasion; incipient erosion; uncomplicated tooth crown fracture; enamel hypoplasia; periapical periodontitis.

Aetiology: Smokes; suffers from diabetes; brushes only once daily; follows a cariogenic diet; drinks a lot of cola, which causes erosion; uses an ineffective brushing technique; had an unsuccessful root canal treatment.

Marking rubric

Student's name:______________________ Student number: ______________________ Date: ____________________	Not competent <70% correct/ Not completed	Becoming competent >70% correct	Competent 100% correct
Main complaint / Dental history complete / Medical history complete			
Extra- / Intra-oral examination complete			
Gingiva complete			
Periodontal chart (correct and complete)			
Absent teeth			
Calculus			
Furcation lesions			
Mobility			
Recession			
Periodontal probing depth			
Bleeding upon probing			
Radiographic and other findings			
Diagnosis (periodontal / periapical only)			
Odontogram (correct and complete)			
Absent teeth / impactions			
Spacing / rotations and transpositions			
Existing restorations: dimensions and position			
Existing restorations: correct surfaces			
Existing restorations: annotations			
Implants			
Bridges			
Endodontic lesions / periapical lesions / posts			
Caries			
Fractures			
Tooth wear			
Pulp status			
Diagnoses			
Overall neatness/impression			
Total			**/160**

APPENDIX D: PATIENT ADMINISTRATION FORMS

A set contains the following forms:

1. Medical history form
2. Oral examination form
3. Caries risk assessment form
4. Plaque index form
5. Health promotion form

Medical History Form

Place sticker here

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Medical Questionnaire

File No: ______________

Initials and surname: ________________________ Age: ________ Male ☐ / Female ☐

Mark with an X.

Is your health currently: Good .... / Fair .... / Poor ....

Do you currently suffer from or have you previously suffered from or received treatment for any of the following conditions?

Yes	No	Do not know	DISEASE / CONDITION / OPERATION / MEDICATION (Please encircle the relevant condition.)
			Heart conditions / heart operations / pacemaker
			High blood pressure
			Heart valve problems or replacement / rheumatic fever
			Blood vessel conditions / stroke / shunts / blood clots / thrombosis
			Prolonged bleeding following injury
			Blood sugar problems / diabetes
			Allergies (penicillin / dental injections / iodine / latex / other)
			Jaundice / hepatitis
			Lung and breathing problems (asthma / coughing up blood / tuberculosis / other)
			Joint replacement (knee / hip / other) / arthritis
			Seizures, fits and faints / epilepsy
			Sudden weight loss (more than 5 kg) / diarrhoea
			Swollen glands (in neck, groin or armpits)
			Cancer therapy (chemotherapy / radiation / surgery) Please specify:
			Do you smoke? If yes, how many per day? ______________
			HIV
			Sinus problems / mouth ulcers / fever blisters
			Anaesthetic complications
			Other diseases / conditions Please specify:
			Do you wear a MedicAlert bracelet?
			Females only
			Are you pregnant?
			Do you use contraceptives / hormonal injections / other types of contraceptives Please specify:

Are you using or did you use one of the following medications? (Please circle.):

Stimulants | Sleeping pills / Sedatives | Anti-depressants | Antibiotics | Cortisone | Blood thinners (Disprin, Grandpa, Compral, Warfarin)

Name the pills / medicine / injections / homeopathic or other substances you are currently using:

____

State your current or recent serious / important medical treatment: ________________

____

I hereby certify that the above-mentioned information is correct and that I intend to inform hospital staff members whenever my health status changes during treatment. I understand that incorrect information might influence my health during dental treatment.

____
Signature: Patient / Parent / Guardian

Name of student	*Signature of lecturer*	*Name of lecturer*	*Date*

Revision of medical status: Did your medical status change recently? Yes .... / No ....

____
Signature: Patient / Parent / Guardian

Name of student	*Signature of lecturer*	*Name of lecturer*	*Date*

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Oral Examination Form – Page 1

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Procedure code 8101 / 8102

Oral & Facial Examination Form

File No: ____________

Title: ________ Initials: ________ Surname: ______________________________ Age: ____________

Main dental complaint(s): Complaint(s), history of complaint(s), patient expectations ______________________

Dental history: Frequency of dental visits, previous dental treatment and outcome, previous radiographs, adverse effects to dental treatment ____________

Medical history: Important aspects and possible influence on dental treatment plan ______________________

Extra-oral examination: Eyes, face asymmetry, lips, skin, lymphnodes, hands, TMJ and masticatory muscles (including trigger points & myalgia)

Existing dentures: ____

Denture status: ***General condition***: Poor / Good; ***Bite***: Acceptable / Unacceptable; ***Fit***: Acceptable / Unacceptable

Intra-oral examination: Muscles (incl trigger points & myalgia), palate, pharynx, vestibulum, buccal mucosa, retromolar area, tongue, floor of the mouth, saliva

Gingiva: Colour, size, shape, consistency, surface texture, exudate ______________________

Periodontal chart

Tooth number	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Calculus																
Elective Pulp Testing																
Furcation lesions																
Mobility																
Recession																
Bleeding ○ Bu MAXILLARY Li																
Li MANDIBULAR Bleeding ○ Bu																
Recession																
Mobility																
Furcation lesions																
Elective Pulp Testing																
Calculus																
Tooth number	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

Radiographic & other findings: ______________________________________

Diagnosis: ______________________________________

Bleeding Index: [ ]

Oral Examination Form – Page 2

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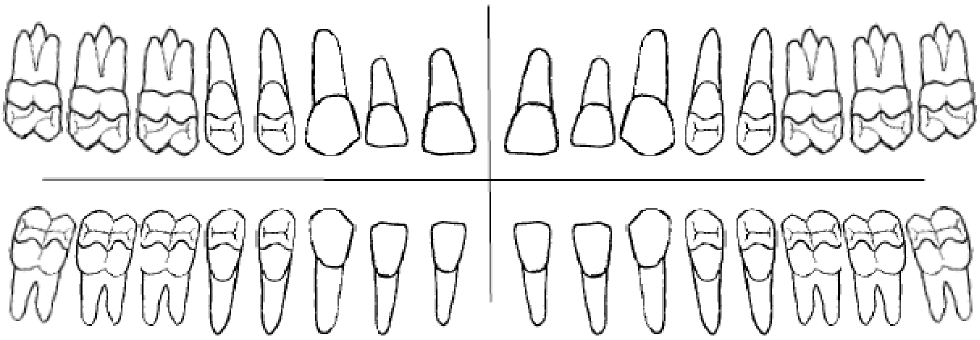
	18	17	16	55 15	54 14	53 13	52 12	51 11	61 21	62 22	63 23	64 24	65 25	26	27	28
Tooth wear																
Pulp status																

Odontogram



	48	47	46	45 85	44 84	43 83	42 82	41 81	31 71	32 72	33 73	34 74	35 75	36	37	38
Pulp status																
Tooth wear																

Diagnosis & other problems: ______________________________

____

____

Caries risk: H / M / L

Etiological / predisposing / risk factors to address: ______________________________

____

Comprehensive Treatment Plan & Informed Consent

Pri	Completed ✓	Pri	Completed ✓
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		☐
	☐		Cost of Treatment Plan:

Student name | *Lecturer signature* | *Lecturer name* | *Date*

The treatment plan was discussed with me and I accept the treatment: **Y / N**

I understand that this proposal is just an estimate and that the treatment and costs may change during treatment **Y / N**

Signature: Patient/Parent/Guardian | *Date*

Caries Risk Assessment Form

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File No:	Patient's name:	Age:	Caries risk:

CARIES RISK ASSESSMENT (Adapted from *ADA, 2006, JADA, (137), p1151-9.*

✓	YOUNGER THAN SIX YEARS	✓	SIX YEARS AND OLDER
	HIGH CARIES RISK		HIGH CARIES RISK
	• Any incipient/cavitated primary/secondary carious lesions during last three years		• Three or more incipient/cavitated primary/secondary carious lesions during last three years
	• Presence of multiple factors that might increase caries risk *(Indicate risk factors in table below.)*		• Presence of multiple factors that might increase caries risk *(Indicate risk factors in table below.)*
	• Suboptimal fluoride exposure *(fluoride in drinking water or using other fluoride products; toothpaste use; brushing only once daily)*		• Suboptimal fluoride exposure *(fluoride in drinking water or using other fluoride products; toothpaste use; brushing only once daily)*
	• Xerostomia *(medication, radiation, disease-induced)*		• Xerostomia *(medication, radiation, disease-induced)*
	MODERATE CARIES RISK		MODERATE CARIES RISK
	• No incipient/cavitated primary/secondary carious lesions during last three years		• One or two incipient/cavitated primary/secondary carious lesions during last three years
	• At least one factor that might increase caries risk *(Indicate risk factors in table below.)*		• No incipient/cavitated primary/secondary carious lesions during last three years, but presence of at least one factor that might increase caries risk *(Indicate risk factors in table below.)*
	LOW CARIES RISK		LOW CARIES RISK
	• No incipient/cavitated primary/secondary carious lesions during last three years		• No incipient/cavitated primary/secondary carious lesions during last three years
	• No factors that might increase caries risk		• No factors that might increase caries risk

RISK FACTOR	✓	RISK FACTOR	✓
Cariogenic diet		Inability or unavailability of means to take proper self-care	
Poor oral hygiene		Developmental/acquired enamel defects	
Overhangs/open margins		Prolonged nursing (bottle/breast)	
Many multiple surface restorations		Poor family dental health	
Exposed root surface		Drug/alcohol abuse	
Orthodontic treatment		High titres of cariogenic bacteria	
Physical/mental disability		Genetic abnormality of teeth	
Irregular dental care		Eating disorders	
Other (Specify.):			

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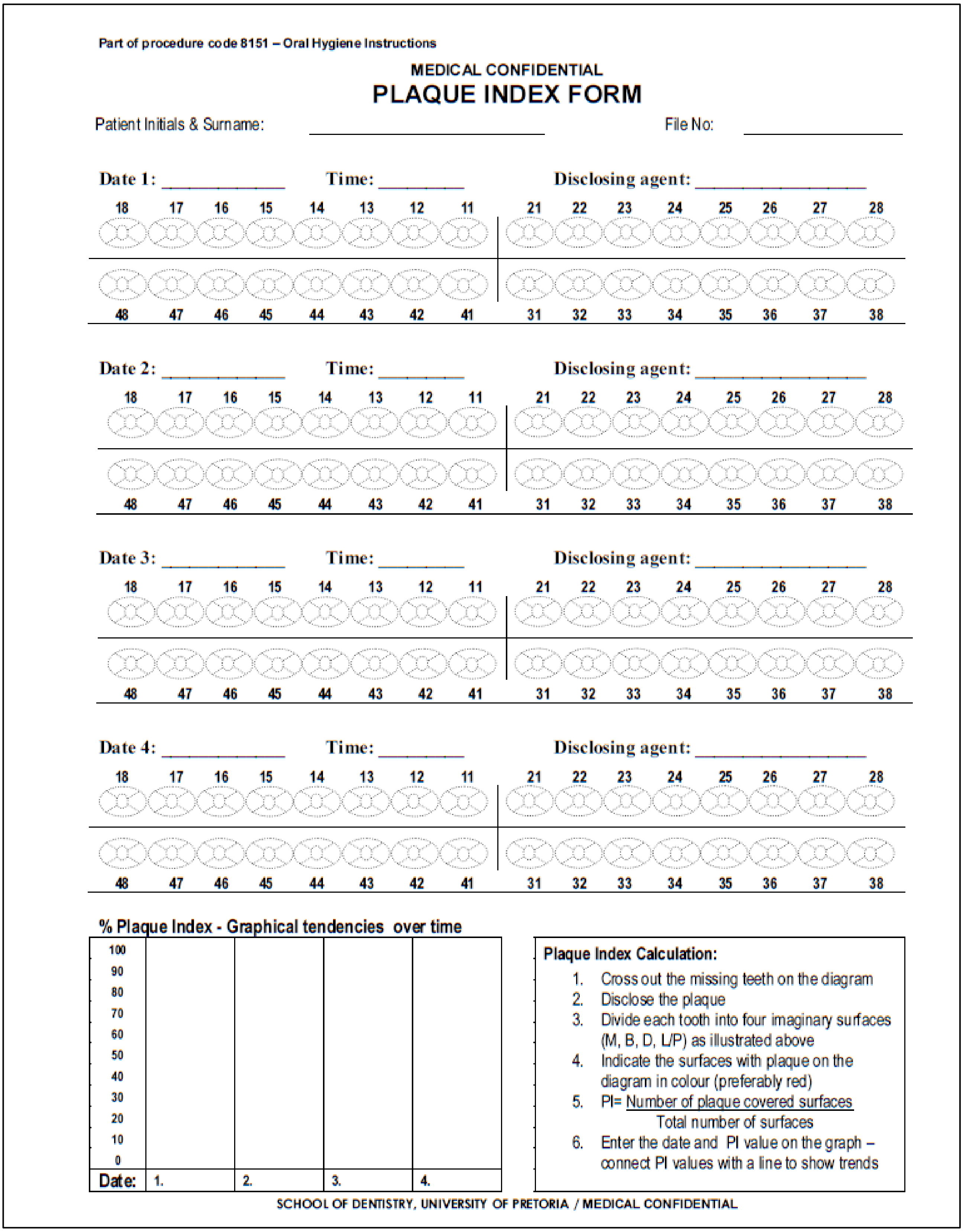
Plaque Index Form



Part of procedure code 8151 – Oral Hygiene Instructions

MEDICAL CONFIDENTIAL

PLAQUE INDEX FORM

Patient Initials & Surname: ______________________ File No: ______________

Date 1: ____________ **Time:** ________ **Disclosing agent:** ________________

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

Date 2: ____________ **Time:** ________ **Disclosing agent:** ________________

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

Date 3: ____________ **Time:** ________ **Disclosing agent:** ________________

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

Date 4: ____________ **Time:** ________ **Disclosing agent:** ________________

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

% Plaque Index - Graphical tendencies over time

100				
90				
80				
70				
60				
50				
40				
30				
20				
10				
0				
Date:	1.	2.	3.	4.

Plaque Index Calculation:

1. Cross out the missing teeth on the diagram
2. Disclose the plaque
3. Divide each tooth into four imaginary surfaces (M, B, D, L/P) as illustrated above
4. Indicate the surfaces with plaque on the diagram in colour (preferably red)
5. PI= $\frac{\text{Number of plaque covered surfaces}}{\text{Total number of surfaces}}$
6. Enter the date and PI value on the graph – connect PI values with a line to show trends

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Health Promotion Form

Replace this page with the Health promotion form

Procedure code 8151

MEDICAL CONFIDENTIAL

Health Promotion: Oral Hygiene Instructions

Complete this after the plaque index on the reverse side has been computed and the *areas of the most plaque* have been shown to the patient

Make use of co-diagnosis and illustrate techniques to the patient using visual aids – Patient must physically illustrate comprehension of the instructions received	File No:	Surname & Init:		Caries Risk:
	Date 1:	PI:	Date 2:	PI:
	Type/ Method		Type/ Method	
	Patient report	**Recommendation to patient**	**Patient report**	**Recommendation to patient**
How often do you brush?				
When do you brush?				
Toothbrush type & age				
Brushing method				
How often do you floss?				
Type of floss				
Flossing method				
Toothpaste type				
Amount of toothpaste				
Mouth rinse – brand & frequency				
Other oral hygiene aids				
Unsafe/unhealthy habits				
Diet				

Remember patients cannot concentrate longer than about 15 minutes	Patient motivation as perceived by the student			Patient's compliance to instructions		
	Low	Moderate	Strong	Low	Moderate	Good

Student name & surname   *Lecturer signature*   *Lecturer initials & surname*   *Date*

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APPENDIX E: COMMUNICATION ROLE-PLAY EXERCISES

Part-task 1: Rapport building and history taking

This task focuses on the relational communication skills that a dentist must demonstrate to gain the trust of a patient at a first meeting.

Each student role-plays a dentist, and a fellow student role-plays a patient.

Preparation: Students must read the relational communication skills section in the Comprehensive Patient Management workbook.

During this practice session the “dentist” must do the following:

- Fetch a patient (portrayed by a fellow student), whom you have not met before, from the waiting room.
- Ask the patient to take a seat.
- Engage in small talk to establish rapport with the patient.
- Ask about the patient’s main complaint, the history of the complaint and the patient’s expectations.
- Enquire about the patient’s dental history.
- Conduct a medical history interview.

During the next session the “dentist” must do the following:

- Role-play the situation as part of your BChD III assessment.
- Take note that the session will be videotaped for feedback purposes.
- Make sure that the role-play exercise and the assessment do not take longer than 15 minutes.
- Base the role-play exercise on one of the eight case studies below.

Refer to the marking rubric to see how you will be assessed.

Case Studies: Rapport building and history taking

Case study 1	**Case study 2**	**Case study 3**	**Case study 4**
Personal information 22 years old; born on a farm in the Free State where parents farmed; waiter at a popular restaurant; works in the evenings until late; appears sleepy – usually sleeps a lot in daytime; likes to play golf; third-year law student; brother also a law student (first year); lives in a flat in Hatfield; owns a car Main complaint Broken front tooth that looks ugly (patient hides mouth behind hand); tooth broke when he bumped his head against the edge of a swimming pool the day before; tooth is quite sensitive to cold; patient wants tooth fixed immediately Dental history Last visited a dentist a year before to have teeth cleaned; visits a dentist annually; some teeth have been filled; no adverse reactions; on his father's medical aid fund Medical history Heart problems – born with a leaking heart valve	Personal information Thirty-year-old mechanic at a wheel and tyre business; lives with his parents in Mayville; only child; no girlfriend; does not own a car, but busy building own car in backyard; reads car magazines; in a hurry to get back to work because his boss is a terror Main complaint Wants a check-up – on his mother's orders who says his breath has been smelling badly for six months; wants his teeth cleaned – they have black marks which look ugly Dental history Last visited a dentist when he was a little boy; very scared of a dentist; last dentist hurt him when extracting a tooth Medical history Smokes 20 cigarettes a day; suffers from allergies (grass and dust) and sinusitis; uses over-the-counter antihistamine medication	Personal information 58-year-old salesman at a shop for general building supplies; specialises in paint; lives in Wonderboom; married, with two children – the oldest, a boy, works in London as a travel operator, and his daughter studies drama at UP; Blue Bulls supporter; owns a car but prefers to travel by bus, because petrol is so expensive Main complaint Broken tooth (upper right jaw); not painful or sensitive to temperature but has sharp edges that hurt the inside of his cheek and this is uncomfortable; wants the edges smoothed or the broken tooth fixed; does not want expensive treatment like a root canal – rather extraction Dental history Visits a dentist only when he must; very scared of a dentist; had a root canal treatment done five years ago and it was very painful – dentist was very unsympathetic; passed out because he was so scared; hates a dentist Medical history Had a stroke two years ago; takes aspirin (half a tablet) every day, medication to control blood cholesterol levels and a beta blocker to control high blood pressure; had his blood pressure tested six months ago	Personal information 48 years old; does deliveries for a big banking institution; lives in Silverton; married; two children at school; his son is the oldest and in Grade 8 at Silverton High School; his daughter is in Grade 7 at Silverton primary School; both children are good athletes – take part in 100 m sprint and obtained Gauteng North colours; likes running himself; uses the work's delivery van to get around Main complaint Wants a new denture because the old one fits loosely and sometimes falls out when he speaks; must have a denture to replace front teeth; appearance very important to patient; wants a thinner plate – the current one is too thick and impairs his speech; current denture is three years old Dental history Current denture is three years old; visited a dentist twice over the last two months to repair the denture; it was adjusted and now fits too loosely; gets nauseous when impression material is put in his mouth Medical history Suffers from diabetes; uses insulin to control blood sugar levels and is on a special diet; he usually eats breakfast; carries a kit to test his blood sugar levels

Case study 5	**Case study 6**	**Case study 7**	**Case study 8**
Personal information Fifty-year-old female; owns an IT business that sells computers; very busy – has limited free time; lives in Waterkloof Ridge; divorced; has one child who is a third-year dentistry student and wants to become an orthodontist; loves to go for a manicure and massage at a local massage parlour Main complaint Front teeth are slightly yellow and she wants them whitened; appearance is extremely important because she works with customers; some teeth at back of mouth became slightly sensitive to cold three months ago Dental history Visits an oral hygienist every six months for cleaning of teeth and oral hygiene instructions; has strong teeth and no fillings Medical history Had rheumatic fever a long time ago and has a heart murmur	Personal information 23 years old; housewife; studied BCom but has not looked for work because got married recently and is pregnant with first child (a boy); looking forward to the birth of her child; has started to paint the baby's room blue; lives in Centurion with her husband who is a plumber Main complaint Gums have been bleeding when brushing since a week ago; scared it might affect the unborn baby and wants the problem solved; also wants her teeth cleaned Dental history Last visited a dentist when she was in Grade 12; the dentist removed her wisdom teeth and did one or two fillings; the injection caused her to start itching Medical history She thinks she might be allergic to dental injections; smokes two cigarettes a day	Personal information 52 years old; housewife and married for 20 years; complains about not sleeping because husband snores; lives in Lenasia; has three boys aged 13, 14 and 16; all at Pretoria Boys High School; the children excel in cricket Main complaint Suspects she has cavities and wants to make sure; wants fixed whatever is wrong; wants a new lower denture because finds chewing difficult; current denture is very old Dental history Last visited a dentist eight years ago who made her a denture with a metal frame; cannot remember anything else Medical history Tends to bleed easily; had a hip replacement six months ago which has affected her mobility; uses a prescribed blood thinner on a daily basis to prevent blood clotting	Personal information Thirty-five-year-old female; executive at a marketing company; married to a lawyer and lives in Midrand; has triplets (three-year-old boys) and they are a handful; does not want any more children; struggling to cope as it is; no free time Main complaint Had an emergency root canal done two weeks ago and now the area is swollen; wants the root canal to be completed and fixed; scared because the emergency procedure was very painful; wants a natural-looking tooth; aesthetics is very important Dental history Visits a dentist often and has had many crowns placed and root canals done; very used to dental injections and familiar with oral hygiene requirements Medical history Allergic to penicillin and erythromycin; regurarly uses contraceptives

Rubric: Rapport Building and History Taking

Assessment rubric **Name of student (role-playing the dentist):** ______________________________ **Name of assessor:** ______________________________ **Date:** ____________	Not competent	Becoming competent	Competent
Relational communication skills			
The "dentist" –			
• greets a patient politely and introduces himself or herself at a first meeting;			
• assumes a posture conducive to good communication when conversing with the patient;			
• establishes rapport with the patient through coherent small talk about the patient's work, family, home and so forth; and			
• obtains the psychosocial history (including finances, transport and fears) of the patient through careful observation and questioning.			
Main complaints			
The "dentist" –			
• establishes and records the patient's main complaints accurately;			
• obtains the history of the main complaints; and			
• determines the patient's expectations through selective questioning.			
Dental history			
The "dentist" –			
• notes down the patient's previous dental visits and types of treatment received; and			
• enquires about adverse reactions to previous dental or medical treatments.			
Medical history			
The "dentist" records the patient's medical history accurately.			
General			
The "dentist" displays –			
• confidence;			
• sincerity and empathy;			
• no distracting habits;			
• good verbal communication skills (coherent, fluent, meaningful);			
• knowledge of special verbal communication techniques such as summarising and echoing;			
• ability to speak on a level that allows the patient to understand;			
• preparedness for the assignment (evidence of self-study); and			
• efficiency in completing the assessment within 15 minutes or less without appearing to be rushed.			
Comments:			

Part-task 2: Education of Patient

Each student is required to perform a patient-education role-play exercise.

The student role-plays the dentist, and fellow students role-play the patients

Preparation: Students must do self-study on relational communication skills, diagnosis (from pictures and/or x-rays), aetiology, predisposing/risk factors, pathogenesis and health promotional (educational) advice related to –

- dental caries;
- tooth wear (attrition, abrasion and erosion);
- periodontal disease (gingivitis, periodontitis);
- pulpal and periapical conditions;
- Comprehensive Patient Management [Wrote out CPM. Check.]notes and presentations regarding diagnosis;
- standardised treatment protocol for caries risk assessment and oral hygiene instruction;
- the publication of EM Wilkins, 1999. Clinical Practice of the Dental Hygienist, 8th ed, p 356-390 on rolling-stroke and circular brushing techniques (the Phones technique) and flossing (the c-method);
- the video clips of the techniques; and
- communication notes.

The exercise involves –

- skipping the rapport-building process outlined in the previous task;
- establishing the main complaint and its history, and the patient's expectations (in other words, the reasons for the patient's complaint about the problem);
- gathering information on the patient's dental history; and
- asking the patient's permission to examine him or her.

At this stage, you may consult the back page of the instruction document to study the patient's oral health status. Take one minute to look at signs, symptoms and clinical findings.

Continue the exercise by –

- asking the patient further questions regarding relevant behavioural and self-care aspects related to your diagnosis;
- informing the patient about your diagnosis and/or differential diagnosis;
- telling the patient the cause of the disease and/or condition;
- explaining the pathogenesis of the disease and/or condition to the patient and the consequences if this process is not halted; and
- providing the patient with health promotional advice to change his or her habits or improve self-care.

If the patient asks about treatment, the "dentist" may briefly discuss broad treatment options and inform the patient that a comprehensive treatment plan will be compiled to be discussed with him or her at the next appointment.

Refer to the rubric below to see how you will be assessed.

Case Studies: Education of Patient

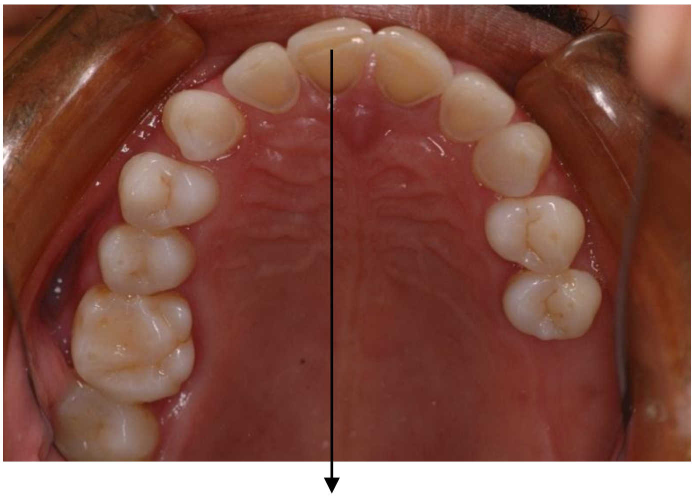
Case study 1

Information to a student who role-plays a patient

For the past month your front and back teeth have been sensitive when you drink cold water or eat ice cream. It has become so bad that you can no longer manage the discomfort and it is starting to affect your work and your social life. When you visited a dentist three years ago your teeth seemed to be in good shape, because he only cleaned them.

Disclose the following information only at the dentist's request: You drink orange juice for breakfast every morning. During the day you sometimes drink at least half a litre of cola, and a tot of brandy and cola with a touch of lemon juice as a night cap. You brush your teeth just before bedtime and in the morning directly after breakfast.

Information to a student who role-plays a dentist



Areas of sensitivity

Clinical findings/observations

- The plaque index is 10%, and brushing and flossing are up to standard.
- Palatal of the incisors and the canines, the appearance is smooth and shiny.

Case study 2

Instructions to a student who role-plays a patient

Your front teeth look ugly, and this makes you shy (you cover your mouth with your hand). You do not want to go out with friends anymore because you think they gossip about your teeth behind your back. The appearance of the teeth started changing about a year ago, but you put off going to a dentist because of fear since a dentist hurt you badly when removing a tooth three years ago. You hate dentists.

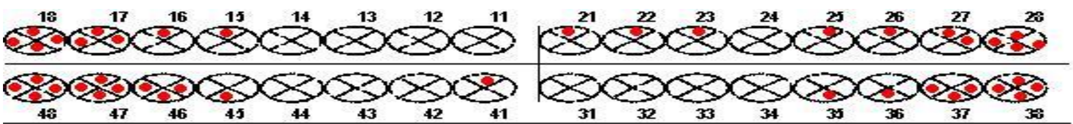
Disclose the following information only at the dentist's request: You always suck on mints to relieve the feeling of a dry mouth caused by your habit of smoking 20 cigarettes a day. You use a well-known brand of toothbrush with a large head and soft bristles, and a quality fluoride toothpaste. If the dentist asks about your brushing and flossing routine, you do not say you brush only once a day because you are embarrassed about it. You say you brush and floss three times a day.

Information to a student who role-plays a dentist

Clinical findings/observations

- The lesions observed here are also present on the cervical margins of all the molars.

- The patient's gingiva are red and swollen (edematous), and bleed when probed.
- The patient uses a combination of the rolling-stroke and circular brushing techniques, and the c-method of flossing. He is acquainted with the techniques and has no problems carrying them out.



Case study 3

Instructions to a student who role-plays a patient

A dentist cleaned your teeth nine months ago and the tool he used damaged the enamel of two of your front teeth. This tool sprayed a lot of water. Because the necks of these teeth are now sensitive to cold, you want to sue that dentist. Ask the dentist if he or she cleans and sterilises the instruments before use. You visit a dentist every year for a check-up, and for the past few years nothing has been found wrong.

You must disclose the following information only at the request of the dentist: You brush with a fierce scrubbing motion for at least five minutes two or three times a day, and you use a lot of toothpaste. Your toothbrush has a small head and hard bristles for better cleaning.

You brush vigorously when the dentist asks you to demonstrate your brushing technique.

Disagree with the dentist's recommendation that you use a softer brush. You are paranoid about hygiene.

Information to a student who role-plays a dentist

Clinical findings/observations

- The plaque index is 6%.
- No pathology is involved except for the v-shaped lesion gingivally on teeth 23 and 24, as illustrated in the picture below.

Case study 4

Instructions to a student who role-plays a patient

Your teeth are growing in length and you do not know why. However, their appearance does not bother you. On the other hand, you cannot handle the bad taste in your mouth. You cannot remember when last you visited a dentist. You only go when you need to.

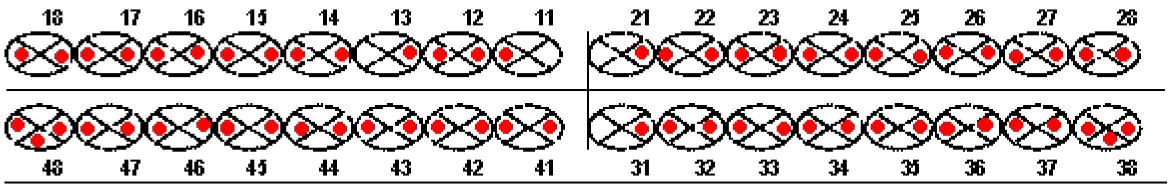
Disclose the following information only when the dentist requests you to do so: You generally brush twice daily – before bedtime and after breakfast. You floss only when something is stuck between your teeth, and then only at the specific spot. You use a circular brushing technique.

You find it hard to demonstrate flossing when the dentist asks you to do so.

Information to a student who role-plays a dentist

Clinical findings/observations

- The intra-oral examination reveals a thick, yellow coating on the posterior two-thirds of the tongue.
- Periodontal examination findings:
  - 6 mm periodontal pockets surround all molar teeth.
  - Class I furcation lesions are found on teeth numbers 17, 16, 27, 26, 36 and 46.
  - 1 to 2 mm gingival recession is present on all teeth.
  - All interdental papillae bleed when probed.
- The plaque index is 50%.



Case study 5

Instructions to a student who role-plays a patient Your upper left teeth ache at times (not currently). You have had difficulty sleeping since a week ago. You are scared of a dentist and only go when necessary. Disclose the following information only at the request of the dentist: You brush (in small circular motions) once daily when you wake up and do not floss at all. Your toothbrush has a small head with short bristles, and you use a well-known brand of toothpaste that contains an antibacterial ingredient.

Information to a student who role-plays a dentist

Clinical findings/observations

- The plaque index is 20%, found mostly posterior interproximally.

Case study 6

Instructions to a student who role-plays a patient
You are visiting this dentist for a thorough check-up. You had eight fillings done less than a year ago at another dentist. In preparation for an orthodontic treatment, you were asked to have your teeth checked before this treatment could start.
Disclose the following information only at the request of the dentist: You drink seven cups of coffee, each with three teaspoons of sugar, a day. You brush your teeth twice daily (before bedtime and after breakfast), and floss once daily.

Information to a student who role-plays a dentist

Clinical findings/observations

- The plaque index is 34%.
- The patient knows how to brush and floss.

Case study 7

Instructions to a student who role-plays a patient

You have been receiving orthodontic treatment for the past six months and the orthodontist asked you to have a thorough check-up at a dentist. You are not aware of any problems.

Disclose the following information only at the request of the dentist: You brush twice daily (after breakfast and before bedtime), and although you floss once a week with conventional floss, you are not comfortable with the technique.

Information to a student who role-plays a dentist

Clinical findings/observations

- The patient has orthodontic attachments fixed with arch wires.
- The plaque index is 34%.
- The plaque is found interproximally.
- The patient knows how to brush and can demonstrate a proper technique.

Case study 8

Instructions to a student who role-plays a patient

You are a pensioner. You have made an appointment with the dentist on the recommendation of your wife who is complaining that you have bad breath. You wear a full set of ten-year-old dentures which fits loosely and is stained. You worry about its appearance, and you are struggling to chew.

Disclose the following information only at the request of the dentist: You do not take the dentures out at night and you never clean them. You smoke a pipe three times a day.

Information to a student who role-plays a dentist

Clinical findings/observations

- The palate underneath the denture has a red appearance.
- The fitting surface of the maxillary denture is full of *materia alba*.
- The fitting surface between the teeth and the flanges has dark stains.
- It will take three weeks to a month to manufacture a new set of dentures.

Rubric: Education of Patient

Assessment rubric **Name of student (the "dentist"):** ______________________________ **Name of assessor:** ______________________________ **Date:** ______________	Not competent	Becoming competent	Competent
Main complaint			
The "dentist" establishes a patient's main complaints, the history of the main complaints and the patient's expectations accurately.			
Dental history			
The "dentist" obtains adequate information on the patient's dental history.			
Diagnosis			
The "dentist" –			
• diagnoses extra- or intra-oral conditions (including teeth and gingiva) correctly or makes differential diagnoses in the absence of a definite diagnosis; and			
• uses co-diagnosis techniques (intra-oral cameras, hand mirrors and visual aids) to involve the patient in making a diagnosis.			
Establishment and explanation of aetiology and pathogenesis of the disease			
The "dentist" –			
• establishes and records the patient's self-care and dietary behaviour accurately according to protocol using a selective-questioning technique;			
• explains the aetiology and pathogenesis of applicable disease processes and conditions;			
• recommends and demonstrates alternative self-care practices relevant to the patient's oral health and psychosocial status; and			
• gives the patient an opportunity to demonstrate comprehension of oral hygiene instructions provided.			
General			
The "dentist" displays –			
• confidence;			
• sincerity and empathy;			
• no distracting habits;			
• good verbal communication skills (coherent, fluent, meaningful)			
• appropriate use of visual aids to explain disease processes and recommend self-care practices to the patient;			
• ability to speak on a level that allows the patient to understand;			
• preparedness for the assignment (evidence of self-study); and			
• efficiency in completing the assessment within 15 minutes or less without appearing to be rushed.			
Comments:			

Part-task 3: Treatment Plan Presentation

Each student is required to role-play a dentist who presents a proposed treatment plan to a patient by means of a PowerPoint presentation in a chair-side environment. The exercise must be based on the case scenario assigned to each.

Preparation: Study the notes on relational communication skills.

The “dentist” must –

- discuss the advantages, disadvantages, indications and contra-indications of each option in a language the patient can understand; and
- discuss costs with the patient to obtain his or her informed consent.

Refer to the rubric to see how you will be assessed.

Case studies: Treatment Plan Presentation

Case scenario 1: A wealthy businessman who smokes and whose oral hygiene status is not up to standard, presents with an absent anterior tooth. His single-tooth removable plastic denture breaks often, and he requests something more durable. He pays cash, and money is not an object. Discuss the following options with the patient: chrome cobalt removable denture; a bridge; a single-tooth implant.

Case scenario 2: A businessman, whose oral hygiene status is very good, presents with an absent anterior tooth, but the adjacent teeth are sound. His single-tooth removable plastic denture has poor retention and often falls out when he speaks. He requests something fixed, but the cost may be a factor. Discuss the following options with the patient: a bridge; a single-tooth implant.

Case scenario 3: An attractive lady who is an accountant, who has no harmful habits and applies excellent oral hygiene self-care, presents with unaesthetic restorations of the maxillary incisors and canines. She comes from a middle-class family and her medical aid fund does not reimburse crown and bridge work. The following options must be discussed with the patient: porcelain veneers versus composite veneers.

Case scenario 4: A single, well-dressed young man (a salesman) with a neat appearance presents with a periapical abscess in a lower molar. Discuss the following options with the patient: root canal treatment versus tooth extraction.

Case scenario 5: A male aged 57 has a badly damaged tooth (number 17) that has little tooth structure left. The tooth is vital and he does not want to lose it. However, money is a factor. The following options must be discussed with the patient: root canal treatment versus indirect composite inlay.

Case scenario 6: A forty-year-old housewife presents with a small interproximal caries lesion mesial on tooth 14 and a large cavity distal on tooth 17 that extends beneath the gingiva. As appearance and health are important to her, she would like her amalgam fillings to be replaced with tooth-coloured restorations because she has read about amalgam toxicity on the internet. Discuss the following options with the patient: composite restorations versus amalgam restorations.

Case scenario 7: A thirty-year-old single lady with an attractive smile visits your dentist's rooms with the complaint that her teeth are yellow, but otherwise they are sound. You determine the shade of the anterior teeth to be predominantly A3. She is concerned about her appearance and is willing to pay cash to have her teeth bleached. The following options must be discussed with the patient: no treatment versus external bleaching done at home.

Case scenario 8: A lady aged 60 has a three-year-old, loose-fitting full upper denture that appears to be in excellent condition. The freeway space and the bite also appear to be good. She is following a diet and has lost a lot of weight, which could be the reason for the denture being loose. Discuss the following options with the patient: a new denture versus a relined denture.

Rubric: Treatment Plan Presentation

Assessment rubric **Name of student (the "dentist"):** ______________________________ **Name of assessor:** ___________________________ **Date:** ____________	Not competent	Becoming competent	Competent
Treatment plan presentation			
The "dentist" –			
• discusses treatment options with the patient and elaborates on the advantages, disadvantages, indications and contra-indications of each option;			
• uses appropriate visual aids to explain treatment options to the patient;			
• sets out cost estimates of different treatment options to the patient; and			
• guides the patient to select a treatment option and to get the patient's informed consent.			
General			
The "dentist" displays –			
• confidence;			
• no distracting habits;			
• good verbal communication skills (coherent, fluent, meaningful);			
• ability to speak on a level that allows the patient to understand;			
• preparedness for the assignment (evidence of self-study); and			
• efficiency in completing the assessment within 15 minutes or less without appearing to be rushed.			
Comments:			

APPENDIX F: CLINICAL TEST – MARKING RUBRIC

Assessment rubric **Name of student** ____________________________ **Name of assessor:** ___________________________ **Date:** ______________	Not competent	Becoming competent	Competent
The "dentist" –			
• arranges the chair-side environment in a way that allows the patient to be seated in the dental chair without obstruction;			
• organises the chair-side environment well;			
• assumes a body posture conducive to good communication when conversing with the patient to determine the patient's medical history;			
• completes the medical history form correctly and has the patient sign it;			
• washes hands according to protocol before examination commences;			
• adheres to infection control principles during the examination process;			
• maintains an ergonomic body posture during the examination process, and uses a mirror for indirect vision when required;			
• executes the extra- and intra-oral examinations correctly and enters the results on the form;			
• uses the correct periodontal probing technique;			
• completes the periodontal chart correctly;			
• completes the odontogram correctly with regard to existing restorations and dental caries;			
• completes the odontogram correctly with regard to tooth wear;			
• records the diagnosis and aetiology correctly on the form;			
• takes the necessary radiographs;			
• interprets the radiographs accurately;			
• takes the necessary precautions during radiographic procedures to protect the operator and the patient;			
• conducts and interprets the necessary pulpal tests correctly;			
• gives treatment plan formats (for instance, surfaces of proposed restorations and classes) and clear descriptions, and writes each treatment on a separate line;			
• formulates the correct treatment plan that will not harm the patient; (Harmful treatment plans will receive no marks.)			
• completes the patient file correctly and mounts and dates all x-rays;			
• leaves the workstation in a clean and an orderly condition in accordance with protocol, and disposes of waste and used instruments in an acceptable manner; and			
• records the plaque index and promotes oral health according to protocol.			
Difficulty level: Easy / Moderate / Difficult			

APPENDIX G: CLINICAL REASONING TASK CLASSES

Task Class 1 Case Study

During the rapport-building conversation you determine that your patient owns a flat and a car and prefers late-afternoon appointments that do not interfere with her work as an attorney. She is 26 years old, not married, well dressed, and appears to be concerned about her appearance. She has a new boyfriend. She does not belong to a medical aid fund, therefore cost is an important consideration.

Main complaint and dental history: She is concerned about her teeth and she asks for a full examination and a cleaning. She is scared of losing any teeth, but she last visited a dentist when she was 18 years old. The dentist cleaned her teeth and did one or two fillings.

Medical history: The patient had rheumatic fever and subsequently suffers from a heart valve lesion. She uses oral contraceptives, and smokes ten cigarettes a day.

Extra-oral examination: Nothing abnormal is found.

Intra-oral examination: The patient presents with a slight thickening of the buccal mucosa on the occlusal line bilaterally. The thickened area has a whitish appearance. She complains of a slightly dry mouth. Everything else appears to be normal.

Periodontal examination

Clinical findings: There is supra-gingival calculus mandibular anterior lingually and buccally at tooth 16 and tooth 26. The free gingiva is swollen and bleeds in the area of the calculus (K03.6) when probed.

Hard-tissue examination

Clinical findings: All teeth are present, including the third molars. Tooth 18 presents with a chalky white appearance surrounding the pit and fissure system. No cavity is visible. Tooth 17 presents with a chalky white appearance on the buccal surface along the gingival margin. Tooth 16 has a small cavity in the occlusal pit and fissure system, which extends over to the palatal surface. Tooth 26 has two separate small cavities in the pit and fissure system (occlusally in the central pit and in the buccal fissure). Tooth 27 has a yellow-brown cavity on the buccal surface adjacent to the free gingival margin. All the cavities identified thus far have softened walls. Internal grey discolouration is also observed palatally in the area below the contact point mesial of tooth 12 and distal of tooth 11.

Radiological findings: A small radiolucent area just into the dentine adjacent to the occlusal enamel, extending along the dentine-enamel junction (DEJ), is visible on tooth 16. A radiolucent area that extends up to the DEJ (not into dentine) is observed in the enamel below the mesial contact point of tooth 27. However, a radiolucent area is visible underneath the mesial contact point of tooth 28, which extends deep into the dentine but apparently not yet into the pulp. Tooth 15 presents with an MO amalgam with an overhang. A small radiolucent area is visible in the enamel and dentine under the overhanging restoration. Tooth 25 presents with an occlusal restoration that appears to be clinically acceptable.

Plaque index and report on patient’s behaviour related to self-care and oral health: The plaque index is 50% and most of the plaque is found posteriorly and interproximally. The patient brushes her teeth once a day when she wakes up and uses a toothbrush with a large head. She flosses only once in a while. She continuously sucks on mints to soothe her dry mouth during the day, and she drinks 500 mℓ ice tea every day. She also has four cups of coffee, with two teaspoons of sugar each, a day.

Task Class 2 Case Study

During the rapport-building conversation you determine that your patient is a sixty-year-old, married pensioner. He is dressed neatly, wears a tie and highly polished shoes. He owns a car, and, although he belongs to a medical aid, the benefits for general dentistry are limited. You notice that he wears a medical bracelet and that he is right-handed. He speaks in a nasal voice and you observe that his nose is blocked.

Main complaint and dental history: He complains that the necks of the teeth in his upper left jaw are sensitive to cold. The appearance of his teeth is not important to him at all. He complains that he has had bad breath for the past two weeks. He appears to be relaxed and indicates that he used to visit a dentist regularly. Some of his teeth have been filled, he was treated for periodontal disease about ten years back and he has been given oral hygiene instructions on several occasions.

Medical history: According to the patient's medical alert bracelet, he takes aspirin on a daily basis and suffers from stress-induced asthma. He has been using aspirin since he had a minor stroke three years ago, and he also takes medication for high blood pressure. Furthermore, he suffers from allergy-related sinusitis and a post-nasal drip. He stopped smoking three years ago.

Extra-oral examination: Small (2 mm in diameter), red, desquamating lesions at both corners of the mouth

Intra-oral examination: He has several small, dark red spots on both sides of the buccal mucosa more or less on the occlusal line. His tongue has large fissures and a thick, yellow coating on the posterior two thirds.

Periodontal examination

Clinical findings: Lingual and buccal supra-gingival calculus mandibular anterior is present at tooth 16 and tooth 26. The free gingiva is swollen and bleeds slightly when the calculus area (K03.6) is probed. There are no deep pockets but there is 2 mm to 3 mm gingival recession throughout the mouth.

Hard-tissue examination

Clinical findings: All teeth are present except for the third molars and tooth 37. The palatal surfaces of the maxillary incisors have a smooth, shiny appearance, and the yellow colour of the dentine shines through a thin enamel layer. Although the dentine is exposed on all the incisal edges of the maxillary and mandibular anterior teeth, these teeth are not sensitive. Teeth 23, 24, 25 and 26 all have v-shaped lesions in the dentine radicular of the cementoenamel junction (CEJ). The pulp of tooth 24 is visible through a thin layer of secondary dentine along the long axis of the tooth in the deepest part of the v-shaped lesion. You do a pulp test, and diagnose reversible pulpitis on teeth 23, 24 and 25. Tooth 26 has a normal pulp. (Note that reversible pulpitis can be treated by covering the dentine with a conventional restoration.) Tooth 26, however, presents with a slight orange-brown discolouration in the v-shaped dentine lesion. The following restorations are visible at the following teeth: 17 and 27 (MO) composites; 16 (MO) amalgam; 36 (OL) amalgam; and 46 (OL) amalgam. Dentine is exposed (1 mm to 2 mm in diameter) on the cusp tips of the first molars. There are enamel facets on all the other premolars and molars.

Radiological findings: Nothing abnormal is found on the panoramic radiograph (PAN) and the bitewing radiograph taken of the left-hand side. The right-hand side bitewing is shown below.

Plaque index and report on patient's behaviour related to self-care and oral health: The plaque index is 20%, with most of the plaque found posterior interproximally. The patient brushes his teeth twice daily using large circular movements, and he flosses his teeth once a day. He brushes for at least two minutes at a time and uses a lot of toothpaste. He has been enjoying half a tot of brandy and cola with a touch of lemon juice every evening for the past five years. He drinks seven cups of coffee per day, with at least two teaspoons of sugar each.

Task Class 3 Case Study

During the rapport-building conversation you determine that the patient travels by car and prefers late-afternoon appointments. He is 45 years old and works at a hotel where he is responsible for keeping guests happy in terms of entertainment and refreshments. He often works shifts. He belongs to a medical aid fund, but the dental benefits are limited.

Main complaint: He has been suffering from bad breath for the past six months and this is affecting his work. He thinks it might be related to his mouth-breathing when he sleeps. He complains of a sharp edge on one lower incisor tooth.

Dental history: The patient visited a dentist five years ago for a series of restorations and for a cleaning.

Medical history: The patient smokes 20 cigarettes a day and he is on a beta blocker for high blood pressure. He suffers from chronic sinusitis, is allergic to grass and dust and frequently uses an over-the-counter antihistamine medicine.

Extra-oral examination: He complains about headaches on the side of the head and below the ears. His masseter and temporalis muscles are in spasm and they hurt during palpation.

Intra-oral examination: The patient has a thick, yellow coating on the posterior third of the dorsal surface of the tongue. The tip of his tongue has a small (3 mm in diameter) white lesion. An organoleptic examination points to severe halitosis.

Periodontal examination: All teeth are present, except for the mandibular third molars. Clinically, the patient presents with a 5 mm periodontal probing depth at all six locations around all the molars. There are thick layers of supra-gingival calculus adjacent to the buccal surfaces of the maxillary molars and lingual to the mandibular anterior teeth. The palatal and lingual surfaces of his teeth are stained from smoking. When pieces of calculus are chipped off the buccal surfaces of tooth 16 and tooth 26, gingival recession of 2 mm is uncovered buccally at both teeth. A radiographic examination reveals horizontal bone loss at all molars. Also, the first and second molars show sub-gingival calculus mesially.

Hard-tissue examination: The following teeth have large amalgam restorations: 15 (OD); 16 (OD); 17 (MOD); 18 (MO); 25 (MOD); 26 (B); 26 (MOD); 27 (MOD); 28 (MOD); 45 (OD); 46 (MO); 47 (MOD); 34 (O); 35 (B); 36 (OD); 37 (MOD). The anterior teeth have facets on the incisal edges, and exposed dentine. These teeth are not sensitive and their appearance does not bother the patient. Tooth 41 has a fracture mesially that affects the incisal edge and the mesial, buccal and lingual surfaces. Also, the dentine is exposed, but not the pulp. The tooth is sensitive to cold. You diagnose reversible pulpitis, and hence the tooth can be restored conventionally. The maxillary incisors appear chalky white near the cervical margins buccally, but their appearance does not bother the patient. The bitewings show secondary caries under the overhanging restorations mesially on teeth 17, 18, 27, and 28. A radiolucent area is detected in the enamel (it does not penetrate the dentine) below the mesial contact point of tooth 16.

Plaque index and health promotion: The plaque index is 80%, with most of the plaque found interproximally and buccally at the molars. The patient brushes his teeth once daily using circular motions. However, he is unable to demonstrate a proper brushing technique on a model. He does not know the name of the toothpaste he is using. He drinks many cups of coffee, with three teaspoons sugar each, a day. He also drinks an alcoholic drink once a day and lives on junk food.

Task Class 4 Case Study

During the rapport-building conversation you determine that the patient is 38 years old, employed as a bookkeeper, travels by car and prefers early-morning appointments. She often visits a dentist for an examination and a cleaning session to prevent her losing any teeth and having to wear a denture. She belongs to a medical aid that has good benefits. She is neatly dressed, and appearance is important to her.

Main complaint: She experiences pain and swelling in the upper right jaw, and some of the teeth are sensitive to cold and heat. She wants the pain relieved and she wants her teeth saved.

Dental history: The patient no longer trusts the dentist whom she has visited for the past ten years, because he should have picked up the early signs of her current problem. She cannot remember when last that dentist took x-rays of her teeth. She informs you that she has had trouble with gum disease at the back teeth.

Medical history: The patient smokes 30 cigarettes a day, she is allergic to penicillin and uses an oral contraceptive. She has had a heart murmur since birth.

Extra-oral examination: Nothing abnormal is found.

Intra-oral examination: The patient presents with a thick, yellow coating on the posterior third of the dorsal surface of the tongue. The mandibular retromolar areas and hard palate have a white keratinised appearance. There is a large pyogenic swelling adjacent to the root apexes of tooth 14 and tooth 15. She complains of a dry mouth. You detect mild halitosis of which she is not aware.

Periodontal examination: All teeth are present, except for the mandibular third molars. Clinically, the patient presents with 6 mm pockets at all six locations around the third molars. Thick layers of supra-gingival calculus are present adjacent to the buccal surfaces of the maxillary molars and the lingual surfaces of the mandibular anterior teeth. Also, the palatal and lingual surfaces of the teeth are stained from smoking. The gingiva is soft and spongy and enlarged in relation to the calculus. A radiographic examination shows horizontal bone loss between tooth 18 and tooth 17, and between tooth 28 and tooth 27.

Hard-tissue examination: Teeth 16, 17, 26 and 27 have old occlusal amalgam restorations that are rough and plaque retentive. However, these restorations have near-perfect marginal seals. No other restorations are visible in the patient's mouth. Dentine is exposed on the cusp tips of teeth 36 and 46, but not on other posterior teeth. These two teeth show no other problems. Enamel facets are found on the incisal edges of the anterior teeth. The maxillary anterior teeth have a smooth, shiny, yellow appearance on the palatal side. A cavity with soft, brown walls is observed distally at tooth 14. The radiographic examination reveals distal caries at tooth 14 that extends into the pulp, with a large radiolucent area at the tip of the root apex. Tooth 15 presents with caries that extends from directly under the mesial contact point to close to the pulpal chamber. The root apex of tooth 15 appears normal. Tooth 16 also has a radiolucent area directly under the mesial contact point, and it spreads along the DEJ without penetrating the dentine any further. Pulp testing reveals the following: Teeth numbers 14 and 16 do not respond to percussion, but tooth 15 hurts on percussion and also responds to cold and heat. However, these tests do not cause severe pain, and the pain experienced does not last longer than 10 seconds. Tooth 16 responds to cold and heat tests, but no extended pain is experienced. Note that all the cavities are small enough to be restored conventionally, and crowns are not required.

Self-care practices: The plaque index is 35%, with most plaque found interproximally. The patient informs you that she sucks on mints to soothe her dry mouth, and that she drinks at least 340 mℓ diet cola a day. Although she displays good ability to floss, she informs you that she is lazy sometimes and generally flosses only twice a week.

Task Class 5 Case Study

During the rapport-building conversation you determine that the patient is 42 years old and employed as an executive at an IT company. She complains that she has limited free time due to the nature of her work. She refers to her previous dentist as an “idiot”.

Main complaint: She requires a stronger denture because the one front tooth on the denture keeps breaking off. Another complaint is that cold and hot foodstuffs cause a sharp pain in the upper back jaw (left- and right-hand sides) for about ten seconds. She wants this discomfort relieved. The appearance of the patient’s front teeth is important to her, and she is concerned because some have become black around the fillings. She also complains that her mouth is often quite dry.

Dental history: She last visited her previous dentist two months ago to repair her one-year-old upper plastic partial denture for the third time. Her teeth were extracted eight years ago.

Medical history: The patient smokes 20 cigarettes a day. She has tried to stop but has not succeeded. She suffers from chronic sinusitis, for which she uses antihistamines, and she also uses medication to control her high blood pressure of 130/90. She had rheumatic fever as a child, but has no heart murmur or heart valve lesions as a result of the illness. She is allergic to cephalosporin.

Extra-oral examination: Nothing abnormal is found.

Intra-oral examination: The patient has a thick, yellow coating on the posterior third of the dorsal surface of the tongue. The buccal mucosa presents with a white thickening along the occlusal line.

The following teeth are absent: 18, 12, 22, 28, 36 to 38, 46 to 48. The patient never had third molars.

Periodontal examination: Clinically, a 2 mm recession is observed buccally at teeth 26, 27, 44 and 45. The patient presents with 4 mm pockets at all six locations around teeth 26 and 27. A periodontal probing depth of 5 mm is found distally at tooth 15, as well as surrounding teeth 16 and 17. There are thick layers of supra-gingival calculus adjacent to the buccal surfaces of the maxillary molars and the lingual anterior of the mandibular anterior teeth, and the palatal and lingual surfaces of the teeth are stained from smoking. The gingiva is soft and spongy, enlarged in relation to the calculus and bleeds upon probing. A radiographic examination shows horizontal bone loss adjacent to and between the maxillary molars.

Hard-tissue examination: Existing restorations include a large BDP Class III restoration and a smaller MP Class III restoration on tooth 13. Furthermore, tooth 16 presents with a MOD amalgam. The following teeth present with B Class V composite restorations near the gingival margin: 15, 14, 13, 23, 24 and 25. Black marginal discolouration surrounds the Class V and Class III restorations. Most of these discoloured margins appear to be open during probing, especially close to the gingiva. Both the palatal cusps of tooth 16 are fractured but the pulp is not exposed. The open dentine palatally at tooth 16 is very sensitive to cold and heat, as is tooth 26. Tooth 14 has a small cavity with soft walls in a pit, mesial on the occlusal surface (too small to be detected on the bitewing). Tooth 27 presents with a dark brown cavity with soft walls distal on the occlusal surface. Tooth 27 is slightly sensitive to percussion but does not respond to cold and heat tests or an electrical pulp test. All incisors and canines have open dentine on the incisal edges. None of these lesions are sensitive to temperature stimuli. Teeth 44 and 45 have small concave lesions into the dentine below the CEJ in the gingival recession areas. Small radiolucent areas are identified under the distal contact point of tooth 26 and the mesial contact point of tooth 27. The lesion on tooth 26 extends into the DEJ, whereas the lesion mesial on tooth 27 extends 0,5 mm into the dentine. A large radiolucent area starting below the distal contact point of tooth 27 extends into the pulp. A small radiolucent area is observed at the disto-buccal root apex of tooth 27 (the *lamina dura* cannot be followed in this area). Tooth 13 has a completed root canal treatment which appears to be sound.

<ins>Self-care practices</ins>: The plaque index is 30%, with most of the plaque found interproximally. The patient informs you that she sucks on mints to soothe a dry mouth. She generally brushes her teeth in the morning using a vigorous scrubbing technique. As a rule, she does not floss, and sometimes she does not remove her dentures when brushing. She appears motivated while health promotion is being discussed.

APPENDIX H: CLINICAL REASONING EXERCISE INSTRUCTIONS

Step 1

Read the case study on the next page and complete the Oral and Facial Examination form and the Health Promotion: Oral Hygiene Instructions form using the format described. Do not complete the diagnosis and treatment plan sections at this stage.

Step 2

Write your clinical reasoning process down in essay format under the following headings:

Main complaint: Give an exact description of the patient's complaint and its history.

Patient's expectations: Explain the patient's expectations, and interpret the patient's motivation and psychosocial circumstances.

Interpretation of dental history: Interpret the patient's dental IQ, the patient's need to be educated, previous adverse reactions, and so forth.

Diagnosis and aetiology: Complete the table below.

Anatomical site	Signs and symptoms	Diagnosis (each diagnosis on a separate line)	Aetiology	Consequential hypothesis
Intra- and extra-oral examination Provide the exact anatomical location as described in the case study. Gingival and periodontal tissues Indicate general areas, such as mandibular anterior, where appropriate. Indication of specific spots is not required. Hard tissue Provide the tooth number and surface. Note carious lesions individually. List tooth-wear lesions that have the same diagnosis, separately or in groups.	As described in the case study	Interpret signs and symptoms. Read the notes that apply to the case study. Formulate your detailed diagnosis in accordance with the formats given in the notes. For the soft-tissue diagnosis, some research may be required. A differential diagnosis (potential diagnosis if definite diagnosis is impossible) may be provided. (Add the ICD-10 code in brackets.)	Explain the aetiology for each lesion in detail. Do not generalise, and do not copy the notes word for word, but indicate how the notes apply to the case.	Discuss the prognosis, in other words, what will happen in the short and the long term should the lesion be left untreated.

Step 3

Enter your detailed diagnosis on the Oral & Facial Examination form.

Design a treatment plan addressing all the problems identified during the diagnostic process. Complete the treatment plan part on the Oral & Facial Examination form. Add a short description of the planned procedure as well as the appropriate procedure code. Planned restorations must each be entered in a separate line.

The following format is compulsory for all restorations:

- 16 MOD Class I Amalgam (8434)
- 13 DP Class II Comp (8352)

Remember to include the preventive procedures required to eliminate the cause of the disease.

Prioritize the plan

Provide the specific recommendations on the Oral Hygiene Instruction form. Do not copy the answers directly from the notes. Apply it to the case <u>and address only the issues relevant to the case</u>.

Write a paragraph on the treatment plan modifications (based on the medical history) required to ensure safe treatment

Step 4

Write a short reflection answering the following questions:

What did you learn by completing this case study?

What is the relevance of the assignment?

APPENDIX I: CLINICAL CASE STUDY – MARKING RUBRIC

Rubric for assessment of case-study assignments[10]				
Name of student:		Name of assessor		Date:
Criteria	**Not yet adequate/not yet competent**	**Adequate/competent**	**Exemplary/ sophisticated**	Marks
Construct	Criteria			
Medical (M) and dental (D) history	Interpretation of M and D histories is incomplete and treatment can be harmful to patient. (2)	Interpretation of M and D histories is incomplete and treatment can be harmful to patient. (4)	Interpretation of M and D histories is complete/correct and treatment will not be harmful to patient. (7)	
Diagnosis	Diagnosis/differential diagnosis is incorrect and treatment can be harmful to patient. (4)	Differential diagnosis is correct and treatment will not be harmful to patient. (7)	Differential and final diagnoses are correct. (9)	
Treatment planning (TP)	TP is totally incomplete/incorrect and no alternative TP is given. (6)	Alternative TP is adequate, but a few elements are missing. (9)	TP is ideal, alternative TP is complete, and a reasoned choice of TP is given. (14)	
Total: 30				/30

APPENDIX J: STANDARD SETTING AND QUALITY CONTROL FORM

Information Leaflet

Dear Colleague,

A standardised assessment paper is being set for the Comprehensive Patient Care (CPC) section of the Comprehensive Patient Management (CPM) module of the BChD course. This assessment paper will form part of the CPM curriculum and will be used to assess the progress of third-, fourth- and fifth year students as far as clinical reasoning (diagnosis and treatment planning) is concerned.

A case-based approach will be used to integrate the diagnosis and treatment planning of different disciplines into CPC. Your expertise is required to evaluate the appropriateness and validity of the questions that have already been set to assess students' ability to exercise integrated clinical reasoning. Dr T.C. Postma, the module chairperson, will use the outcomes of the assessment papers in a research project that aims to measure the progress of individual students and to compare their progress with the performance of cohorts, hence the setting of rigorous standards.

Although your evaluation will not be anonymous, the researcher undertakes not to disclose any personal information, such as your name, that might compromise you. You will be referred to as a panel member in your field of expertise.

If you agree to assist CPM in this standard setting exercise, please sign below and complete the accompanying questionnaire by evaluating each question that falls in your field of expertise.

Consent Form

I ________________________________ agree to participate in the standard setting exercise.

My field of expertise is _________________________________.

Date: __________________

Evaluation Guidelines

- Please read the case study to be presented to students and the questions to be posed to them.
- Answer the questions put to you by evaluating each question separately.
- The first four questions require your evaluation on a visual analogue scale.

See the example below.

Example

Indicate your answer by drawing a cross in the appropriate place on the line.

The question is **highly relevant.**

The question is **irrelevant.**

Case Study

Read the following case study.

At the back of the examination paper there is an odontogram that you may use for rough work. Please hand in this sheet together with your answer script.

Rapport-building conversation: During the rapport-building conversation you determine that the patient is 42 years old and employed as an executive at an IT company. She complains that she has limited free time due to the nature of her work. She refers to her previous dentist as an “idiot”.

Main complaint: She requires a stronger denture because the one front tooth on the denture keeps breaking off. Another complaint is that cold and hot foodstuffs cause a sharp pain in the upper back jaw (left- and right-hand sides) for about ten seconds. She wants this discomfort relieved. The appearance of the patient’s front teeth is important to her, and she is concerned because some have become black around the fillings. She also complains that her mouth is often quite dry.

Dental history: She last visited her previous dentist two months ago to repair her one-year-old upper plastic partial denture for the third time. Her teeth were extracted eight years ago.

Medical history: The patient smokes 20 cigarettes a day. She has tried to stop but has not succeeded. She suffers from chronic sinusitis, for which she uses antihistamines, and she also uses medication to control her high blood pressure of 130/90. She had rheumatic fever as a child, but has no heart murmur or heart valve lesions as a result of the illness. She is allergic to cephalosporin.

Extra-oral examination: Nothing abnormal is found.

Intra-oral examination: The patient has a thick, yellow coating on the posterior third of the dorsal surface of the tongue. The buccal mucosa presents with a white thickening along the occlusal line.

The following teeth are absent: 18, 12, 22, 28, 36 to 38, 46 to 48. The patient never had third molars.

Periodontal examination: Clinically, a 2 mm recession is observed buccally at teeth 26, 27, 44 and 45. The patient presents with 4 mm pockets at all six locations around teeth 26 and 27. A periodontal probing depth of 5 mm is found distally at tooth 15, as well as surrounding teeth 16 and 17. There are thick layers of supra-gingival calculus adjacent to the buccal surfaces of the maxillary molars and the lingual anterior of the mandibular anterior teeth, and the palatal and lingual surfaces of the teeth are stained from smoking. The gingiva is soft and spongy, enlarged in relation to the calculus and bleeds upon probing. A radiographic examination shows horizontal bone loss adjacent to and between the maxillary molars.

Hard-tissue examination: Existing restorations include a large BDP Class III restoration and a smaller MP Class III restoration on tooth 13. Furthermore, tooth 16 presents with a MOD amalgam. The following teeth present with B Class V composite restorations near the gingival margin: 15, 14, 13, 23, 24 and 25. Black marginal discolouration surrounds the Class V and Class III restorations. Most of these discoloured margins appear to be open during probing, especially close to the gingiva. Both the palatal cusps of tooth 16 are fractured but the pulp is not exposed. The open dentine palatally at tooth 16 is very sensitive to cold and heat, as is tooth 26. Tooth 14 has a small cavity with soft walls in a pit, mesial on the occlusal surface (too small to be detected on the bitewing). Tooth 27 presents with a dark brown cavity with soft walls distal on the occlusal surface. Tooth 27 is slightly sensitive to percussion but does not respond to cold and heat tests or an electrical pulp test. All incisors and canines have open dentine on the incisal edges. None of these lesions are sensitive to temperature stimuli. Teeth 44 and 45 have small concave lesions into the dentine below the CEJ in the gingival recession areas. Small radiolucent areas are identified under the distal contact point of tooth 26 and the mesial contact point of tooth 27. The lesion on tooth 26 extends only into the DEJ, whereas the lesion mesial on tooth 27 extends 0,5 mm into the dentine. A large radiolucent area starting below the distal contact point of tooth 27 extends into the pulp. A small radiolucent area is observed at the disto-buccal root apex of tooth 27 (the *lamina dura* cannot be followed in this area). Tooth 13 has a completed root canal treatment which appears to be sound.

Self-care practices: The plaque index is 30%, with most of the plaque found interproximally. The patient informs you that she sucks on mints to soothe a dry mouth. She generally brushes her teeth in the morning using a vigorous scrubbing technique. As a rule, she does not floss, and sometimes she does not remove her dentures when brushing. She appears motivated while health promotion is being discussed.

Standard Setting and Quality Control Form

Carefully read the question posed to students before completing the evaluation form below.

Question posed to students

Diagnose the radiolucent lesion distal in the crown of tooth 26.

a. Severe interproximal caries
b. Active cavitated smooth-surface caries
c. Advanced interproximal caries
d. Moderate interproximal caries
e. None of the above

Evaluation of the question posed to students

1. Indicate the relevance of the question to the assessment of students' ability to diagnose dental caries, and indicate the severity of the disease.

The question is **irrelevant**. | The question is **highly relevant**.

2. Rate the degree of difficulty of the question.

Very **difficult** | Very **easy**

3. Indicate the percentage of final-year students who will be able to answer the question correctly.

0% will answer correctly. | **100%** will answer correctly.

4. If c. is the correct answer, indicate, in numerical sequence, the appropriateness of the remaining options used as distracters.

Question: Diagnose the radiolucent lesion distal in the crown of tooth 14.

Correct answer: c. Advanced interproximal caries

Distracters	Inappropriate	Very appropriate
a. Severe interproximal caries		
b. Active cavitated smooth-surface caries		
d. Moderate interproximal caries		
e. None of the above		

5. Propose additional distracter options for the question, or an alternative question.

APPENDIX K: PROGRESS TEST – MULTIPLE-CHOICE QUESTION DISTRACTER ANALYSES

Table K.1 Description of content of MCQ stems

Question	Content description	Test Component
1.	Diagnosis of an oral mucosal lesion	Diagnostic
2.	Diagnosis of a pulpal condition	Diagnostic
3.	Diagnosis of a pulpal condition	Diagnostic
4.	Diagnosis of a periapical condition	Diagnostic
5.	Diagnosis of a tooth-wear lesion (attrition)	Diagnostic
6.	Diagnosis of a tooth-wear lesion (attrition and erosion)	Diagnostic
7.	Diagnosis of a tooth-wear (abrasion) / caries lesion	Diagnostic
8.	Diagnosis of periodontitis	Diagnostic
9.	Diagnosis of interproximal dental caries	Diagnostic
10.	Diagnosis of a tooth fracture	Diagnostic
11.	Management of an oral mucosal lesion	Treatment
12.	Aetiology of tooth wear (attrition / opposing porcelain crown)	Diagnostic
13.	Aetiology of tooth wear (attrition and erosion)	Diagnostic
14.	Aetiology of tooth wear (abrasion)	Diagnostic
15.	Aetiology of dental caries	Diagnostic
16.	Aetiology of tooth wear (attrition)	Diagnostic
17.	Caries risk assessment	Diagnostic

Question	Content description	Test Component
18.	Aetiology of periodontitis	Diagnostic
19.	Identification of aetiology of pulpal condition	Diagnostic
20.	Selection of treatment option pertaining to attrition	Treatment
21.	Determination of prognosis of a compromised tooth and subsequent treatment selection	Treatment
22.	Selection of tooth-loss treatment based on patient's bio-psychosocial status	Treatment
23.	Determination of prognosis of a compromised tooth and subsequent treatment selection	Treatment
24.	Determination of prognosis of a compromised tooth and subsequent treatment selection	Treatment
25.	Determination of prognosis of a compromised tooth and subsequent treatment selection	Treatment
26.	Treatment prioritisation	Treatment
27.	Treatment prioritisation	Treatment
28.	Determination of prognosis of a compromised tooth and subsequent treatment selection	Treatment
29.	Selection of appropriate therapeutic treatment option	Treatment
30.	Safe administration of local anaesthetic	Treatment
31.	Decision to give prophylactic antibiotic (based on patient's medical history)	Treatment
32.	Decision to manage a patient with high blood pressure safely	Treatment

Table K.2 Analysis of MCQ distracters (pooled data for all cohorts)

Question	n	a %	b %	c %	d %	e %	f %
1	409	9.54	58.68*	29.58	2.20		
2	409	2.93	11.98	22.00	63.08*		
3	410	19.51	77.32*	2.93	0.24		
4	410	84.88*	8.05	5.85	1.22		
5	408	83.09*	10.54	0.98	5.39		
6	410	19.27	0.98	15.12	2.44	57.32*	4.88
7	409	2.44	20.29	15.16	6.60	55.50*	
8	410	17.32	8.78	66.10*	1.71	6.10	
9	410	19.51	26.59	1.95	3.17	48.78*	
10	410	0.49	2.93	91.22*	4.88	0.49	
11	410	5.12	11.22	7.80	2.68	73.17*	
12	408	7.60	10.54	14.95	1.23	65.69*	
13	408	7.35	8.58	9.31	71.81*	2.94	
14	410	87.07*	4.15	3.41	5.37	0.00	
15	410	2.93	1.95	1.22	69.27*	24.63	
16	410	20.49	70.98*	1.95	6.59		
17	410	0.24	3.66	96.10*	0.00		
18	410	0.73	1.71	0.24	19.51	77.80*	
19	410	18.05	55.12*	1.46	1.71	23.66	
20	408	31.86*	15.44	17.65	15.93	19.12	
21	410	68.29*	2.20	5.12	0.24	24.15	
22	410	26.34	34.88	30.73*	4.39	3.66	
23	409	4.65	13.69	48.17	4.89	28.61*	
24	410	1.71	61.46*	8.29	22.20	6.34	
25	410	6.59	1.22	2.44	66.34*	23.41	
26	409	11.00	7.33	10.51	71.15*		
27	410	15.12	72.20*	9.27	3.41		
28	409	2.20	4.40	82.15*	9.54	1.71	
29	410	4.63	4.39	1.22	82.44*	7.32	
30	410	8.29	46.83	5.61	39.27*	0.00	
31	410	49.02*	28.05	20.73	2.20		
32	410	1.22	1.46	8.29	35.61	53.41*	

* Indicates the correct answer

Table K.3 Properties of MCQ discrimination (pooled data for all cohorts)

Question	DI (test)	P	DI (Dx)	P	DI (Rx)	P
1	0.37	<0.001	0.33	<0.001		
2	0.34	<0.001	0.37	<0.001		
3	0.17	<0.01	0.23	<0.001		
4	0.28	<0.001	0.34	<0.001		
5	0.28	<0.001	0.35	<0.001		
6	0.53	<0.001	0.59	<0.001		
7	0.52	<0.001	0.63	<0.001		
8	0.35	<0.001	0.44	<0.001		
9	0.50	<0.001	0.48	<0.001		
10	0.21	<0.001	0.23	<0.001		
11	0.41	<0.001			0.42	<0.001
12	0.41	<0.001	0.54	<0.001		
13	0.39	<0.001	0.43	<0.001		
14	0.12	<0.05	0.15	<0.01		
15	0.13	ns*	0.16	<0.05		
16	0.39	<0.001	0.45	<0.001		
17	0.08	<0.01	0.10	<0.01		
18	0.17	<0.01	0.22	<0.001		
19	0.26	<0.001	0.37	<0.001		
20	0.18	<0.001			0.25	<0.001
21	0.39	<0.001			0.47	<0.001
22	0.17	<0.05			0.23	<0.001
23	0.09	ns			0.18	<0.01
24	0.31	<0.001			0.40	<0.001
25	0.17	<0.05			0.31	<0.001
26	0.37	<0.001			0.38	<0.001
27	0.40	<0.001			0.58	<0.001
28	0.23	<0.001			0.25	<0.001
29	0.26	<0.001			0.26	<0.001
30	0.23	<0.001			0.46	<0.001
31	0.56	<0.001			0.64	<0.001
32	0.28	<0.001			0.42	<0.001

Chi^2-test / Fisher's Exact test

*ns: not significant

Table K.4 Properties of MCQ discrimination per study year

Question	DI (year 3)	P	DI (year 4)	P	DI (year 5)	P
1	0.34	<0.01	0.45	<0.001	0.47	<0.001
2	0.51	<0.001	0.13	ns*	0.32	<0.001
3	0.22	<0.05	0.16	ns	0.18	ns
4	0.51	<0.001	0.08	ns	0.19	<0.05
5	0.46	<0.001	0.16	ns	0.17	ns
6	0.39	<0.001	0.45	<0.001	0.49	<0.001
7	0.63	<0.001	0.42	<0.001	0.46	<0.001
8	0.44	<0.001	0.47	<0.001	0.22	ns
9	0.47	<0.001	0.45	<0.001	0.47	<0.001
10	0.32	<0.001	0.13	ns	0.06	ns
11	0.50	<0.001	0.39	<0.001	0.42	<0.001
12	0.31	<0.01	0.42	<0.001	0.41	<0.001
13	0.33	<0.001	0.42	<0.001	0.33	<0.01
14	0.18	ns	0.18	<0.05	0.13	ns
15	0.05	ns	0.18	ns	0.22	ns
16	0.34	<0.01	0.34	<0.01	0.57	<0.001
17	0.13	<0.05	0.05	ns	0.06	ns
18	0.25	<0.05	0.03	ns	0.17	ns
19	0.30	<0.05	0.34	<0.01	0.19	ns
20	0.06	ns	0.21	<0.05	0.25	<0.01
21	0.42	<0.001	0.47	<0.001	0.33	<0.01
22	0.14	ns	0.16	ns	0.12	ns
23	-0.01	ns	0.08	ns	0.01	ns
24	0.30	<0.05	0.18	ns	0.18	ns
25	0.22	ns	0.29	<0.01	0.06	ns
26	0.26	<0.05	0.29	<0.01	0.30	<0.01
27	0.60	<0.001	0.29	<0.01	0.32	<0.01
28	0.29	<0.01	0.21	<0.05	0.18	ns
29	0.36	<0.01	0.11	ns	0.16	ns
30	0.45	<0.001	0.26	<0.05	0.14	ns
31	0.54	<0.001	0.50	<0.001	0.71	<0.001
32	0.31	<0.001	0.24	<0.001	0.44	<0.001

Chi^2-test / Fisher's Exact test
*ns: not significant

Table K.5 Ratio of correctly answered questions per third year cohort

Question	Third-year Cohort			Difference between Cohorts: Chi^2-test (P)		
	A (2009) (n=39)	D (2010) (n=54)	E (2011) (n=49)	A and D	A and E	D and E
1	0.59	0.52	0.78	ns*	ns	<0.01
2	0.62	0.50	0.51	ns	ns	ns
3	0.67	0.76	0.84	ns	ns	ns
4	0.72	0.69	0.78	ns	ns	ns
5	0.85	0.72	0.82	ns	ns	ns
6	0.62	0.65	0.37	ns	<0.05	<0.01
7	0.56	0.50	0.33	ns	<0.05	ns
8	0.62	0.59	0.65	ns	ns	ns
9	0.36	0.52	0.61	ns	<0.05	ns
10	0.95	0.87	0.76	ns	<0.05	ns
11	0.74	0.65	0.69	ns	ns	ns
12	0.64	0.59	0.57	ns	ns	ns
13	0.82	0.72	0.57	ns	<0.05	ns
14	0.82	0.80	0.90	ns	ns	ns
15	0.85	0.72	0.76	ns	ns	ns
16	0.87	0.72	0.67	ns	<0.03	ns
17	1.00	0.89	0.96	<0.05	ns	ns
18	0.59	0.78	0.84	ns	<0.01	ns
19	0.54	0.56	0.37	ns	ns	ns
20	0.18	0.26	0.08	ns	ns	<0.05
21	0.74	0.70	0.59	ns	ns	ns
22	0.36	0.26	0.37	ns	ns	ns
23	0.15	0.17	0.29	ns	ns	ns
24	0.56	0.57	0.57	ns	ns	ns
25	0.59	0.61	0.61	ns	ns	ns
26	0.74	0.56	0.55	ns	ns	ns
27	0.67	0.65	0.59	ns	ns	ns
28	0.87	0.78	0.92	ns	ns	<0.05
29	0.82	0.59	0.55	<0.05	<0.01	ns
30	0.38	0.65	0.55	<0.05	ns	ns
31	0.49	0.70	0.63	<0.05	ns	ns
32	0.41	0.69	0.63	<0.01	<0.05	ns

*ns: not significant

Table K.6 Ratio of correctly answered questions – comparison of fourth year intervention and control groups

Question	Control group (n=49)	Intervention groups (n=97)	Chi²-test P
1	0.55	0.60	ns*
2	0.65	0.52	ns
3	0.82	0.76	ns
4	0.90	0.94	ns
5	0.84	0.83	ns
6	0.53	0.67	ns
7	0.61	0.57	ns
8	0.37	0.80	<0.001
9	0.35	0.59	<0.01
10	0.88	0.93	ns
11	0.65	0.82	<0.05
12	0.59	0.64	ns
13	0.67	0.80	ns
14	0.86	0.90	ns
15	0.73	0.56	<0.05
16	0.45	0.78	<0.001
17	0.96	0.95	ns
18	0.86	0.75	ns
19	0.51	0.64	ns
20	0.08	0.21	ns
21	0.47	0.77	<0.001
22	0.39	0.31	ns
23	0.31	0.26	ns
24	0.59	0.57	ns
25	0.47	0.68	<0.05
26	0.65	0.78	ns
27	0.61	0.85	<0.01
28	0.82	0.80	ns
29	0.88	0.94	ns
30	0.14	0.39	<0.01
31	0.06	0.59	<0.001
32	0.55	0.51	ns

*ns: not significant

Table K.7 Ratio of correctly answered questions per fourth-year cohort

Question	Fourth-year Cohort			Difference between Cohorts: Chi^2-test (P)		
	B (n=49) Control	A (n=39) Intervention	D (n=48) Intervention	B and A	B and D	A and D
1	0.55	0.69	0.52	ns*	ns	ns
2	0.65	0.69	0.38	ns	<0.01	<0.01
3	0.82	0.74	0.77	ns	ns	ns
4	0.90	0.95	0.94	ns	ns	ns
5	0.84	0.85	0.81	ns	ns	ns
6	0.53	0.64	0.69	ns	ns	ns
7	0.61	0.46	0.67	ns	ns	ns
8	0.37	0.85	0.77	<0.001	<0.001	ns
9	0.35	0.54	0.63	ns	<0.01	ns
10	0.88	0.90	0.96	ns	ns	ns
11	0.65	0.77	0.85	ns	<0.05	ns
12	0.59	0.67	0.63	ns	ns	ns
13	0.67	0.85	0.77	ns	ns	ns
14	0.86	0.95	0.85	ns	ns	ns
15	0.73	0.51	0.60	<0.05	ns	ns
16	0.45	0.85	0.73	<0.001	<0.01	ns
17	0.96	0.95	0.96	ns	ns	ns
18	0.86	0.62	0.85	<0.01	ns	<0.05
19	0.51	0.59	0.69	ns	ns	ns
20	0.08	0.15	0.25	ns	<0.05	ns
21	0.47	0.59	0.92	<0.001	<0.001	ns
22	0.39	0.26	0.35	ns	ns	ns
23	0.31	0.21	0.31	ns	ns	ns
24	0.59	0.59	0.56	ns	ns	ns
25	0.47	0.72	0.65	<0.05	ns	ns
26	0.65	0.82	0.75	ns	ns	ns
27	0.61	0.85	0.85	<0.05	<0.01	ns
28	0.82	0.74	0.85	ns	ns	ns
29	0.88	0.95	0.94	ns	ns	ns
30	0.14	0.33	0.44	<0.05	<0.01	ns
31	0.06	0.62	0.56	<0.001	<0.001	ns
32	0.55	0.44	0.56	ns	ns	ns

*ns: not significant

Table K.8 Ratio of correctly answered questions – comparison of fifth year intervention and control groups

Question	Control group (n=49)	Intervention group (n=36)	Chi^2-test P
1	0.46	0.78	0.001
2	0.78	0.83	ns*
3	0.77	0.81	ns
4	0.86	1.00	<0.05
5	0.82	0.97	<0.05
6	0.46	0.83	0.001
7	0.57	0.75	ns
8	0.70	0.78	ns
9	0.40	0.61	<0.05
10	0.98	0.97	ns
11	0.70	0.89	<0.05
12	0.69	0.89	<0.05
13	0.64	0.83	<0.05
14	0.88	0.94	ns
15	0.68	0.69	ns
16	0.66	0.89	<0.01
17	0.98	1.00	ns
18	0.82	0.75	ns
19	0.52	0.72	<0.05
20	0.10	0.22	ns
21	0.70	0.75	ns
22	0.27	0.22	ns
23	0.40	0.33	ns
24	0.69	0.72	ns
25	0.81	0.72	ns
26	0.74	0.94	<0.01
27	0.73	0.89	ns
28	0.80	0.78	ns
29	0.91	0.97	ns
30	0.33	0.31	ns
31	0.31	0.81	<0.001
32	0.44	0.61	ns

*ns: not significant

Table K.9 Ratio of correctly answered questions in fifth study year

Question	Fifth-year Cohort C (n=48) Control	B (n=48) Control	A (n=36) Intervention	Difference between Cohorts: Chi²-test (P) C and B	C and A	B and A
1	0.31	0.60	0.78	<0.01	<0.001	ns*
2	0.79	0.77	0.83	ns*	ns	ns
3	0.81	0.73	0.81	ns	ns	ns
4	0.90	0.83	1.00	ns	<0.05	<0.05
5	0.90	0.75	0.97	ns	ns	<0.01
6	0.50	0.42	0.83	ns	<0.01	<0.001
7	0.69	0.46	0.75	<0.05	ns	<0.01
8	0.77	0.63	0.78	ns	ns	ns
9	0.42	0.38	0.61	ns	ns	<0.05
10	0.98	0.98	0.97	ns	ns	ns
11	0.60	0.79	0.89	<0.05	<0.01	ns
12	0.69	0.69	0.89	ns	<0.05	ns
13	0.60	0.67	0.83	ns	<0.05	ns
14	0.90	0.85	0.94	ns	ns	ns
15	0.63	0.73	0.69	ns	ns	ns
16	0.67	0.65	0.89	ns	<0.05	<0.05
17	1.00	0.96	1.00	ns	ns	ns
18	0.81	0.83	0.75	ns	ns	ns
19	0.56	0.48	0.72	ns	ns	<0.05
20	0.10	0.10	0.22	ns	ns	ns
21	0.71	0.69	0.75	ns	ns	ns
22	0.42	0.13	0.22	ns	ns	ns
23	0.42	0.38	0.33	ns	ns	ns
24	0.75	0.63	0.72	ns	ns	ns
25	0.83	0.79	0.72	ns	ns	ns
26	0.65	0.83	0.94	<0.05	<0.01	ns
27	0.69	0.77	0.89	ns	<0.05	ns
28	0.71	0.90	0.78	<0.05	ns	ns
29	0.94	0.88	0.97	ns	ns	ns
30	0.33	0.33	0.31	ns	ns	ns
31	0.31	0.31	0.81	ns	<0.001	<0.001
32	0.42	0.46	0.61	ns	ns	ns

*ns: not significant

Table K.10: Ratio of correctly answered questions for Cohort B (control group) – progression over time

Question	2009 Year 4 (n=49)	2010 Year 5 (n=48)	Chi^2-test P
1	0.55	0.60	ns*
2	0.65	0.77	ns
3	0.82	0.73	ns
4	0.90	0.83	ns
5	0.84	0.75	ns
6	0.53	0.42	ns
7	0.61	0.46	ns
8	0.37	0.63	<0.05
9	0.35	0.38	ns
10	0.88	0.98	ns
11	0.65	0.79	ns
12	0.59	0.69	ns
13	0.67	0.67	ns
14	0.86	0.85	ns
15	0.73	0.73	ns
16	0.45	0.65	ns
17	0.96	0.96	ns
18	0.86	0.83	ns
19	0.51	0.48	ns
20	0.08	0.10	ns
21	0.47	0.69	<0.05
22	0.39	0.13	<0.01
23	0.31	0.38	ns
24	0.59	0.63	ns
25	0.47	0.79	<0.001
26	0.65	0.83	<0.05
27	0.61	0.73	ns
28	0.82	0.80	ns
29	0.88	0.91	ns
30	0.14	0.33	<0.05
31	0.06	0.31	<0.001
32	0.55	0.44	ns

*ns: not significant

Table K.11 Ratio of correctly answered questions for Cohort A – progression over time

Question	2009 Year 3 (n=39)	2010 Year 4 (n=39)	2011 Year 5 (n=36)	ANOVA P	Bonferroni contrast analysis – Difference observed between:	Difference: Year 3 to Year 5 Chi²-test P
1	0.59	0.69	0.78	ns		ns*
2	0.62	0.69	0.83	ns		<0.05
3	0.67	0.74	0.81	ns		ns
4	0.72	0.95	1.00	p<0.001	Year 3 & 4, Year 3 & 5	<0.001
5	0.85	0.85	0.97	ns		ns
6	0.62	0.64	0.83	ns		<0.05
7	0.56	0.46	0.75	<0.05	Year 4 & 5	ns
8	0.62	0.85	0.78	ns		ns
9	0.36	0.54	0.61	ns		<0.05
10	0.95	0.90	0.97	ns		ns
11	0.74	0.77	0.89	ns		ns
12	0.64	0.67	0.89	<0.05	Year 3 & 5	<0.05
13	0.82	0.85	0.83	ns		ns
14	0.82	0.95	0.94	ns		ns
15	0.85	0.51	0.69	<0.01	Year 3 & 4	ns
16	0.87	0.85	0.89	ns		ns
17	1.00	0.95	1.00	ns		ns
18	0.59	0.62	0.75	ns		ns
19	0.54	0.59	0.72	ns		ns
20	0.18	0.15	0.22	ns		ns
21	0.74	0.59	0.75	ns		ns
22	0.36	0.26	0.22	ns		ns
23	0.15	0.21	0.33	ns		ns
24	0.56	0.59	0.72	ns		ns
25	0.59	0.72	0.72	ns		ns
26	0.74	0.82	0.94	ns		<0.05
27	0.67	0.85	0.89	<0.05	Year 3 & 5	<0.05
28	0.87	0.74	0.78	ns		ns
29	0.82	0.95	0.97	ns		<0.05
30	0.38	0.33	0.31	ns		
31	0.49	0.62	0.81	<0.05	Year 3 & 5	<0.01
32	0.41	0.44	0.61	ns		ns

*ns: not significant

Table K.12 Ratio of correctly answered questions for Cohort D – progression over time

Question	2009 Year 3 (n=54)	2010 Year 4 (n=48)	Chi^2-test P
1	0.52	0.52	ns*
2	0.50	0.38	ns
3	0.76	0.77	ns
4	0.69	0.94	<0.01
5	0.72	0.81	ns
6	0.65	0.69	ns
7	0.50	0.67	ns
8	0.59	0.77	ns
9	0.52	0.63	ns
10	0.87	0.96	ns
11	0.65	0.85	<0.05
12	0.59	0.63	ns
13	0.72	0.77	ns
14	0.80	0.85	ns
15	0.72	0.60	ns
16	0.72	0.73	ns
17	0.89	0.96	ns
18	0.78	0.85	ns
19	0.56	0.69	ns
20	0.26	0.25	ns
21	0.70	0.92	<0.01
22	0.26	0.35	ns
23	0.17	0.31	ns
24	0.57	0.56	ns
25	0.61	0.65	ns
26	0.56	0.75	<0.05
27	0.65	0.85	<0.05
28	0.78	0.85	ns
29	0.59	0.94	<0.001
30	0.65	0.44	<0.05
31	0.70	0.56	ns
32	0.69	0.56	ns

*ns: not significant

Table K.13 Comparison of standard-setting estimates and actual performance at exit level

Question	Estimates of judges			Predictions of judges: correct at exit level			Correctly answered at exit level n=132			Chi² Proportion test
		Relevance	Difficulty level		90% CI			90% CI		
	n	%	%	X	L	U	X	L	U	P
1	8	73	40	72	52	91	55	46	63	<0.05
2	6	80	15	88	83	92	80	73	87	ns*
3	6	67	16	85	77	92	78	71	85	ns
4	5	91	30	74	66	83	90	85	95	<0.01
5	6	73	24	78	66	90	86	80	92	ns
6	6	85	31	61	37	85	56	47	65	ns
7	6	92	24	67	50	84	62	54	71	ns
8	8	94	36	63	49	76	72	64	80	ns
9	5	80	42	51	30	72	45	37	54	ns
10	6	90	8	90	88	92	98	95	100	ns
11	5	91	20	86	73	100	75	68	82	ns
12	6	81	31	66	56	77	74	67	82	ns
13	6	78	30	68	52	85	69	61	77	ns
14	6	84	8	91	86	97	89	84	95	ns
15	6	93	28	64	36	92	68	60	76	ns
16	6	94	15	80	67	93	72	64	80	ns
17	6	95	6	94	87	101	98	96	100	ns
18	8	94	19	77	63	91	80	73	87	ns
19	6	91	13	87	79	95	58	49	66	<0.001
20	5	80	55	46	18	73	14	8	20	<0.001
21	6	87	14	88	82	95	71	63	79	<0.05
22	6	90	45	59	31	86	26	18	33	<0.001
23	6	92	33	56	39	74	38	29	46	<0.05
24	6	87	31	65	55	74	70	62	78	ns
25	6	90	16	77	70	84	79	72	86	ns
26	6	93	45	65	40	90	80	73	87	<0.05
27	6	88	22	81	66	97	77	70	85	ns
28	6	94	30	74	57	91	80	73	87	ns
29	6	85	22	80	69	91	92	88	97	<0.05
30	5	88	33	70	61	79	33	24	41	<0.001
31	8	88	24	64	54	73	45	36	53	<0.05
32	8	86	21	73	65	81	48	40	57	<0.001

X: mean; CI: confidence interval; L: lower; U: upper; *ns: not significant

APPENDIX L: COURSE FEEDBACK: COMPREHENSIVE PATIENT CARE

Dear student

In accordance with University policy, academic module committees are obliged to obtain feedback about the organisation, content, teaching/learning and assessment of modules every year.

Therefore, your participation in providing feedback by completing a questionnaire on the Comprehensive Patient Care module will be appreciated. Dr T.C. Postma will also be using the data obtained through these questionnaires in research that he is conducting. Questionnaires are completed anonymously and you are under no obligation to take part. You can refuse to participate or stop at any time without giving any reason. If you do not participate or you withdraw from participating, it will not be held against you in any way.

It is important that you understand what the proposed study involves and what is expected of you before you agree to participate. Therefore, please read the information leaflet before signing the informed consent form. You are welcome to ask for any clarification of the information or for more particulars.

<u>TITLE OF THE STUDY</u>

EVALUATING THE IMPACT OF ADJUNCTIVE INTEGRATED CASE-BASED DENTAL TRAINING ON CLINICAL REASONING IN A DISCIPLINE-BASED TRAINING ENVIRONMENT

<u>PURPOSE OF THE STUDY</u>

The purpose of the study is to determine whether additional clinical case-based training in Comprehensive Patient Care renders improved results in diagnosis and dental treatment planning skills when compared with the results of students trained in a traditional discipline-based environment. The study also examines the opinions of students about the integration of knowledge from different subjects.

Completion of the Questionnaire

Do not write your name on the questionnaire. The questionnaire is **anonymous**, and all information provided will be kept safe and confidential.

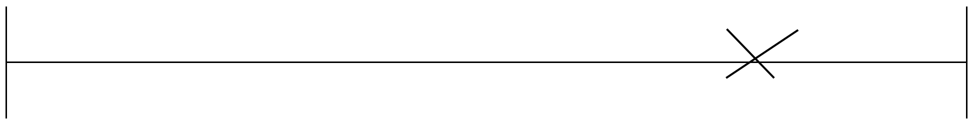
The questionnaire will take about 5 to 10 minutes to complete.

The questions are in the following format, and an example of a question is given below to assist you:

Read the question carefully and indicate your answer by drawing a cross in the appropriate place on the line.

Example

Do you think the course content is relevant to what a dentist does on a daily basis?



The course is **irrelevant.** The course is **highly relevant.**

Provision is made for recommendations at the end of the questionnaire.

Feedback Questionnaire: Third Study Year

1. Do you think the Comprehensive Patient Care course content is relevant to what a dentist does on a daily basis?

Not relevant at all — Highly relevant

2. Do you think the case-study exercises gave you a good basis to diagnose and plan treatment for a real patient in your fourth study year?

Not at all — Definitely

3. Did assessment opportunities contribute to your learning of course outcomes?

Not at all — Definitely

4. Does the way you are taught at the School help you integrate knowledge from different subjects studied in the **same** year?

Not at all — Definitely

5. Does the way you are taught at the School help you integrate knowledge from different subjects studied in **previous** years?

Not at all — Definitely

6. Rate your current ability to diagnose commonly found dental diseases/conditions.

Not competent at all — Competent

7. Rate your current ability to formulate a comprehensive dental treatment plan.

Not competent at all — Competent

8. Was the Comprehensive Patient Care course well organised?

Poorly organised — Very well organised

9. Were the lecturers competent to present the course material?

Not competent at all — Competent

Recommendations

Feedback Questionnaire: Fourth Study Year

1. Do you think the content of the Comprehensive Patient Care course is relevant to what a dentist does on a daily basis?

Not relevant at all — Highly relevant

2. Do you think the discipline-based training you received in your third year of study provided you with a good basis to diagnose and plan treatment comprehensively for a real patient?

Not at all — Definitely

3. Did assessment opportunities contribute to your learning of course outcomes?

Not at all — Definitely

4. Does the way you are taught at the School help you integrate knowledge from different subjects studied in the **same** year?

Not at all — Definitely

5. Does the way you are taught at the School help you integrate knowledge from different subjects studied in **previous** years?

Not at all — Definitely

6. Rate your current ability to diagnose commonly found dental diseases/conditions.

Not competent at all | Competent

7. Rate your current ability to formulate a comprehensive dental treatment plan.

Not competent at all | Competent

8. Was the gap between the third and fourth years of study **too big** in terms of examination, diagnosis and treatment planning?

Not at all | Definitely

9. At the **beginning of the fourth year**, did you still struggle with anatomical orientations (for instance quadrants, mesial and distal) when examining patients?

Not at all | Definitely

10. What is the **one** thing you struggled with most during your first two comprehensive patient examinations and treatment plans?

____

11. Was the Comprehensive Patient Care course well organised?

Poorly organised — Very well organised

12. Were the lecturers competent to present the course material?

Not competent at all — Competent

Recommendations

Feedback Questionnaire: Fifth Study Year

1. Do you think the Comprehensive Patient Care course content is relevant to what a dentist does on a daily basis?

Not relevant at all — Highly relevant

2. Do you think the discipline-based training you received in the third and fourth study years provided you with a good basis to diagnose and plan treatment comprehensively for a real patient?

Not at all — Definitely

3. Did assessment opportunities contribute to your learning of course outcomes?

Not at all — Definitely

4. Does the way you are taught at the School help you integrate knowledge from different subjects studied in the **same** year?

Not at all — Definitely

5. Does the way you are taught at the School help you integrate knowledge from different subjects studied in **previous** years?

Not at all — Definitely

6. Rate your current ability to diagnose commonly found dental diseases/conditions.

Not competent at all — Competent

7. Rate your current ability to formulate a comprehensive dental treatment plan.

Not competent at all — Competent

8. Was the gap between the **third and fourth** years of study **too big** in terms of examination, diagnosis and treatment planning?

Not at all — Definitely

9. Was the Comprehensive Patient Care course well organised?

Poorly organised — Very well organised

10. Were the lecturers competent to present the course material?

Not competent at all — Competent

Recommendations

APPENDIX M: QUALITATIVE ANALYSIS

Cohort D: Focus group selection

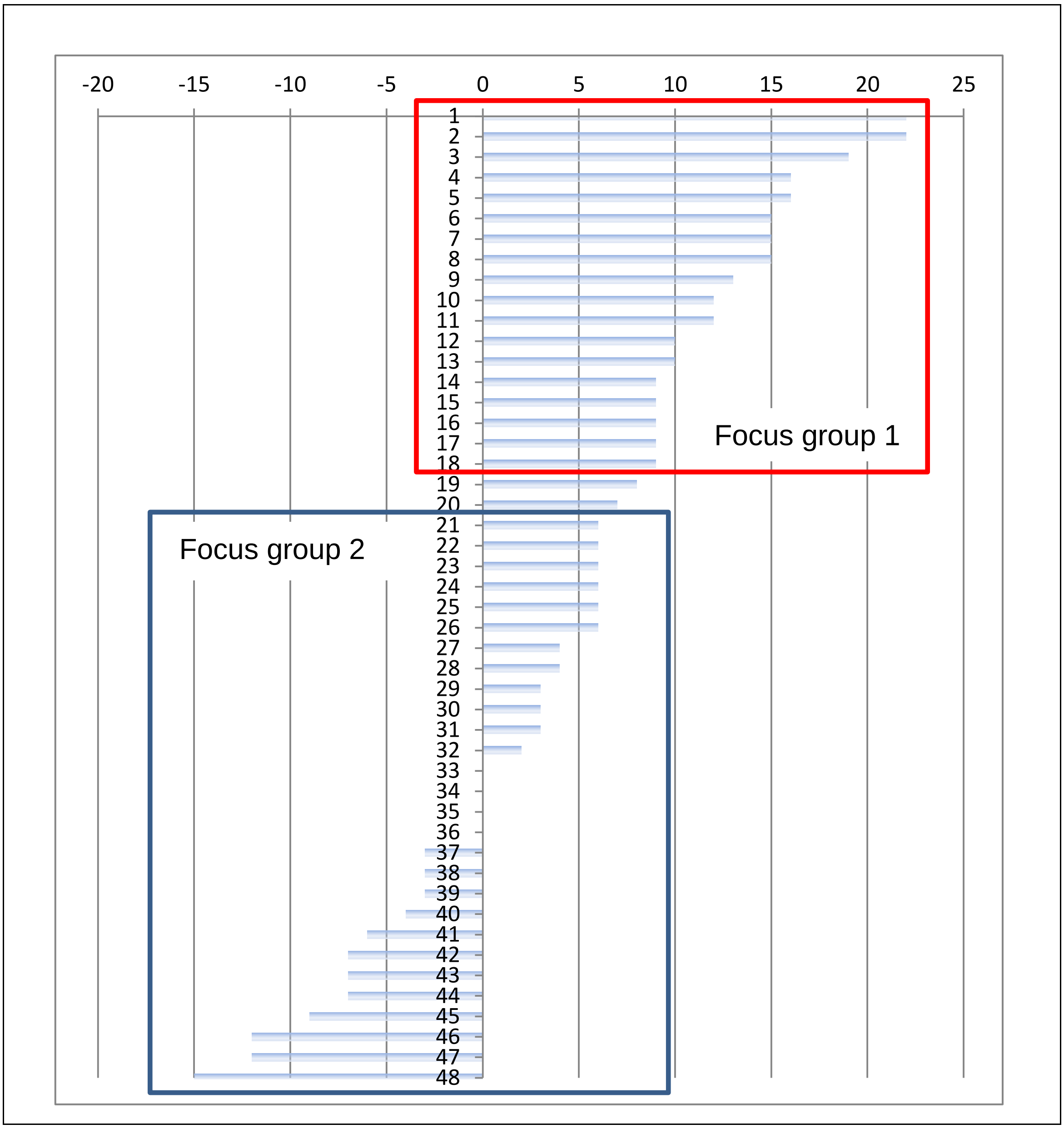


Figure M.1 Distribution of the individual progress test score differences between 2010 and 2011 for Cohort D (n=48)

Qualitative Results – Focus Group 1

Table M.1: Focus group 1: Student perceptions about preclinical training in the Comprehensive Patient Care unit

Theme 1: Framework for clinical training
"… at the end when you knew what to do, it helped a lot to get your thinking right because you knew, okay, this is the way I have to …"
"If I look at a person, or listen to him, this is how I am going to take it on; these are the steps that I'm going to follow."
"… and you also learn a lot of, like, diseases and names of things, and how to diagnose it … and do the treatment for it. So it helped a lot for me."
"When you got patients this year you knew how to formulate a treatment plan and how to work it out and how to do it."
"I mean we've started the year on the 4th floor … and we've started looking in the mouth and we knew exactly what to do."
"I mean CPM is more in the direction of, like, restorative in Odont. It helped us a lot in Odont …."
"We learned a lot more this year because we examined each other."
"Case studies are much better because we even got different cases … it helps your thinking to get a different case, and to make a treatment plan for that specific case."
"Okay, it did help a lot and I think it is a good thing that we have that. If we didn't have that we would have been totally lost with your first patient. I would have freaked out; I can't handle that."
"You feel that it has its place. Definitely, I think the CPM was probably the subject that I learned the most [from] in third year … because that is the only subject in third year that you're going to use in the following years; so I think that is probably the subject that helped me the most."
"We are going to use treatment planning for the rest of our lives with all our patients, and if we didn't learn it step by step with a good foundation then we never would have known how to do it. Yes, it really helped a lot. I think it gave us a good foundation."
"… like with OPB, everything has been step-by-step teaching to be able to approach the patient, to start talking to the patient – main complaint, health and medical history …."
"Yes, I think it helps a lot; it gives you an orientation on how to fill in a protocol. You know exactly what to achieve first."
"… it helps you to prioritise your treatment plan."
"It helps you, like, thinking on how to treat the patient, and you will actually have that much more confidence. The patient will also see that this person exactly knows what to do. So, CPM helps a lot ... I think it is actually the only subject [of] that sort."
Theme 2: Integration
"So, in this subject you learn a little bit of this, and a little bit of that, and then when we got to do the treatment plan everything comes together; you know where everything fits in, and how this affects that, and that affects that."
"… OPB is, like, the whole holistic thing …."
Theme 3: Complexity
"… and then [it] also teaches you a lot about treating complex cases."
"… and it really helped in diagnosing the problems and to see how severe problems are as well. You still

get severe problems even if you knew it all … so remember there are always surprises; so don't worry about that."
"... the very first patient that a fourth-year gets handed shouldn't be a complex, complex case so that you feel lost … you can't even find yourself, okay. So, maybe if there can be some decent screening, seeing that this is a patient … not like a patient that needs a partial denture, an endo, four extractions … has, like, perio on six of the teeth and don't even know the prognosis. The doctor doesn't even know what the prognosis of the tooth is going to be. If it is just a bit of an easier case, the first one, and then they can throw you into the deep end."
Theme 4: Relevance
"I also feel it was very, very relevant and the fact that it is such a practical subject. You go out, you do the sessions, you take the patient as a case and you do it. It is not just theory that you have to go and study. ... So, it is practical and it is hands-on and also the type of information that is really useful. It is things that you use every single day. It is the reason behind the theory."
Theme 5: Supportive information
"And the orange book, that helped a lot in the answering of the … we still use it. Keep that, it helps."
"It was just difficult for me. With the case studies there was no clinical picture so we couldn't see how severe it was or anything. That was difficult."
"But I think if they included pictures like in the beginning … it is nice to see stuff that you've seen before especially if you have to set up a treatment plan. So I think if they can include pictures in the third-year stuff, it will make stuff so much easier."
"We did the first one and then doctor … gave us corrections with the formats. ... Yes, the first one I did nothing right."
"So, if they give you, say, an example of what to do, say, on tooth 11 diagnosis, prognosis, those things, those things, next line … I mean, it will make stuff so much easier, it will make the marking for them easier and the students will be better off."
Theme 6: Peer training
"All of us are studying Dentistry, we brush our teeth, most of us had Ortho and everything, so you are not going to see anything funny ...."
"… but clinical seeing and doing, everything is different."
"Also doing it on your friend; they know what is going to happen … on a real patient, they are scared, their tongue is everywhere, so it is different than doing it on your friend."
"But I don't think they should scrap that doing on your friend. No, that is just part of helping the practice."
"It is only the phantom head and your friend ... it does make a difference. But you are also quite stressed, even though it is your friend … it helps a lot. Okay, these are the steps. Just to make the gap a bit smaller."
Theme 7: Educational approach of Comprehensive Patient Care versus other discipline-based subjects
"While in other subjects like Prosthetics and Ortho you get there and you look at a patient and you, like, okay, I've never seen this before, and you look at a form and you, like, okay, what is this, you don't know how to set up a treatment plan; but I mean for CPM ... helped us so much."
"I mean if we can actually get a subject like CPM for Ortho and for Prosthetics the performance will be so

much better."
"I think if they actually did what they did for CPM for other subjects …."
"… maybe they should include it … as it is a complete treatment and they should have sessions with the third-years in an Ortho set-up and show the Ortho forms, … , have an orientation in Prostho … how to treat a Prosthetics patient. Get one patient. Get everyone to have the mirror. Have a look how an edentulous mouth looks, because most of us haven't seen an edentulous patient ever."
"Obviously, CPM includes Prosthetics with the treatment plan as you still have to, like at the end, maybe the patient will have to get partial dentures but he doesn't get into details …, if they can include … and a detailed part of Prosthetics, then it will help a lot."
"… they must try to maybe broaden everything."
"Yes, everything that we do in our fourth year we have to practise in our third year."
Theme 8: Standardisation
"... and it is not negative towards them, it is just that some of the doctors, they tend to say, okay, you have to do an occlusal restoration on this tooth, and this tooth and this tooth, and you get into Odont when you are doing your treatment and the doctor said you are not going to do that, and that, and that tooth. We are just going to do a scale polish and give some fluoride."
"... some of the lecturers in CPM are not completely aware of what we are taught in Odont."
"I know that some of the students, when they did partial dentures, then they said you can still save the teeth and when they got to Prosthetics they told the patient, no, all the teeth have to be extracted, and then the patient already been to five, six, seven, eight restorative sessions and then Prosthetics tells them, no, sorry, extract the teeth. So it is not really very nice for the patient, or for the students. We cried."
"... so, if they can just have some correlation between them … because otherwise you get so confused …."
Theme 9: Hospital administration
"You came into fourth year and you don't have a clue of how the files work, where did the patient actually get the files and the payments. The patient asks me that all the time and I don't have an idea."

Qualitative Results – Focus Group 2

Table M.2: Focus group 2: Student perceptions about preclinical training in the Comprehensive Patient Care unit

Theme 1: Framework for clinical training
"For me, the assignments or the case studies did nothing really …."
"The practical work that we've done on the buddies … did a good job for me, but the assignments ...?"
"I think it sets the basis from where you can work. It's a lot different when you get a new patient rather than a friend … but it gives you a guideline from where you can work to, or what you can work from, or how to diagnose different caries and erosion and attrition … So it was a good baseline for us to work from."
"And, also, I feel that the case studies actually did help me, like, to prioritise my treatment … So, yes, for me it did play a role …."
"As well as different treating options, yes, so I think it helped."
"Further, the rest of the stuff was good – the clinical stuff and the case studies did me good." (Translated from Afrikaans into English)

"I was pretty, pretty nervous when I saw my first patient, only to find out that, luckily, I knew something."
"I think I'm hard-headed when it came to the case studies. I think they are great for other people … but for me? I had issues with the case studies and assignments. I prefer practical and theory."
"… for me, I feel it did really help a lot, like I don't think it should be changed on my side because I feel, like, okay, on some patients you won't be able to encounter everything, not all patients have the same problems …, so I feel the cases did add something that you didn't, maybe, know, or see first-hand. So, for me it really did help."
"I also think the third-year cases really helped in putting a base on how to handle a patient, and all that, so it does help. So it must continue."
"… the case studies we did, did not really prepare us for that test we wrote at the end. There were questions that I had never thought about in my life before. Unless I did not complete the case studies properly? Or did not understand them well enough?" (Translated from Afrikaans into English)
"I feel the same; that it sets a baseline for you where you work from."
Theme 2: Integration
"So, if you compiled the information from the book like that and took your patient as a whole, I think that it made it much, much easier."
"… because this is a subject that basically puts everything together, yes, that is cool." (Translated from Afrikaans into English)
"… and your perio, caries and endo and all those stuff … everything is in there, so if you go through it you won't be surprised in the following year like [in] the fourth year. So, once you get that a patient ... is full [of] pain … high blood pressure … everything together."
"… they gave us the basis of everything."
Theme 3: Complexity
"So, for me, case studies, I don't want to lie, even my maths are like, oh yeah, very low …."
"It is only with the third, fourth case studies it starts getting better, but the first one definitely not. If you go and look at your answers and look at someone else's answers they were totally different. There wasn't really a set way to answer anything. Yes, we were all confused about how to actually do the questions. So if there is a lecture before … we want this and this and this – whatever – then you will know better. Because everyone's case studies look different and I was always confused about how to answer them …."
"… when you get into fourth year and you see your first patient and you don't know where you have to be, you don't know what to do … and you are asking everybody and it [is] wasting a lot of time."
Theme 4: Relevance
"I think it is very relevant and I learned a lot from it." (Translated from Afrikaans into English)
Theme 5: Supportive information
"… because a lot of the things you rather want to observe clinically. It was therefore a bit difficult for me. Like, I know, one of the things they said, the patient's blood pressure was this and that, which will normally be considered to be high. But then you are supposed to ask more clinical questions to the patient, which you cannot really do in the test."

"Really, if you go through the handbook you would have seen that, actually, they gave us the basis of everything."
"Sometimes you don't know how to prepare for it, like they say you have to go home and get this ready and do a slide show for this … Sometimes it is a bit difficult to know what is expected of you to do … but otherwise it is okay."
"Okay, I just remember we always got these pathology questions in the case studies that we were not always prepared for. They would say there is a white lesion in the back of your gums. How would you diagnose it, how would you treat it? We had no idea about pathology when we were in our third year … I always found those questions very difficult. I understand that we also should go and study or look up things but if we just had a bit of information … yes, if we were just a bit more prepared for it."
"At that stage we don't do any pathology, so if they want to do it in the CPC or CPM or whatever [the] subject is ... just give a lecture on the basics … that you get in the mouth like ... how you would treat it. That will help in the case studies because I knew I always struggled with those ones."
Theme 6: Peer training/Role play
"... the practical work that we've done on the buddies … did a good job for me, but the assignments ...?"
"I prefer modelling – it stays in my head – and a little bit of theory [rather] than case studies. I know case studies is the incorporation of it, but if I will rather act in it, than trying to figure out what somebody else is thinking … but when we come to practical and doing everything, it is good for me."
"All that bothered me was that role play that we did – for example, they do not understand ... that we all have different personalities, and we have different ways of explaining things or how we communicate with the patient. It felt a lot as if we had to do things in specific ways …." (Translated from Afrikaans into English)
"… but now you know precisely what is going to happen because it is your classmate … rather employ a drama student, or somebody that prepared the case study … somebody you do not know …." (Translated from Afrikaans into English)
"... but I feel they might expose you a bit more to patients as to fellow students. So it is not a big train smash when you get into fourth year and you see your first patient and you don't know where you have to be, you don't know what to do … and you are asking everybody and it's wasting a lot of time. So, rather like in third year when you have, like, a session instead of working on your friend, get a patient and just do an examination and scaling and polishing, or something like that. Just to get used to the idea [of] seeing a patient."
Theme 7: Standardisation
"The thing is that they sometimes … the different departments differ … like for … blood pressure – high blood pressure, for example. For one department this is high blood pressure and for the other department this isn't too high to find a solution."
"There were a lot of times Dr X and Dr Y had different ways of what they want you to do. So then you are a bit confused. So then Dr Y will say, come and be prepared in this way and whatever and then we eventually had our session with Dr Y … and then he has his own opinion … Yes, he has his own opinion about everything. So, yes, I think just let the doctors be more on the same page."
Theme 8: Feedback
"I think the critique and the way they worked with us, it really helped us. I remember there was a case I had to do on Endo. I didn't know anything about Endo and counts and everything but they really hammered me … the way they did it... always stick in my mind – oh, okay – remember this, this is what they wanted and when you see a tooth like that you would know ... and the process sticks in my mind because of the critique. If they were lenient I would probably go with my own way of thinking … the way they criticise, it is very beneficial for us …."
"So, we didn't get feedback on any of the cases."
"Feedback. Yes, because we never got feedback on the case studies, and what was expected and what

the students never saw. Because everything in a case study is said for a reason, and then just to know all that reasons, then you will know what to look for in that final test."
Theme 9: Attribution
"But I feel it doesn't actually teach us how to deal with difficult patients; like, I have the worst patient, like, I don't know what to do because the patient was very angry because of the way he was treated and everything … so everything else was taken out on me ..., now, and I don't know how to control the situation and then Dr Y had to step in."
"Sometimes you don't know how to prepare for it, like they say you have to go home and get this ready and do a slide show for this … sometimes it is a bit difficult to know what is expected of you to do …."

Appendix N

APPENDIX N: PARTICIPANTS' INFORMATION LEAFLETS AND INFORMED CONSENT FORMS

QUANTITATIVE PART OF THE STUDY – PARTICIPANT'S INFORMATION LEAFLET AND INFORMED CONSENT FORM

Name of researcher: Dr T.C. Postma

Contact telephone number: 012 319 2553

Department of Dental Management Sciences

School of Dentistry

University of Pretoria

PO Box 1266

Pretoria 0001

<u>TITLE OF THE STUDY</u>

EVALUATING THE IMPACT OF ADJUNCTIVE INTEGRATED CASE-BASED DENTAL TRAINING ON CLINICAL REASONING IN A DISCIPLINE-BASED TRAINING ENVIRONMENT

Dear student

This leaflet gives you information to help you decide if you want to participate in the proposed study. Before you agree to participate, make sure you understand exactly what is involved. If you do not understand the information, or if you have any other questions, you are welcome to ask.

PURPOSE OF THE STUDY

The **purpose** of the study is **to determine whether additional clinical case-based training in Comprehensive Patient Care improves students' diagnosis and dental treatment planning skills, compared to the skills of students trained in a traditional discipline-based environment.**

PROCEDURES

The teaching and training methods of the Comprehensive Patient Care unit of the Module: Comprehensive Patient Management are being redesigned. To this end, a new clinical case-based approach to the teaching of diagnosis and treatment planning has been followed for the 2009 BChD III group. In contrast to them, the 2009 BChD IV and V groups have received mainly discipline-based clinical reasoning training in each of the different subjects, and these students have only learned to apply their knowledge from their fourth study year onwards when examining patients in the Odontology wards as part of the Comprehensive Patient Care course. The 2009 BChD III group will continue with clinical case-based training in their fourth study year.

From September 2009 until 2011, BChD III, IV and V students will write standardised multiple-choice-question tests on Comprehensive Patient Care. These tests have been set to achieve the outcomes in the study guide, and will test students' diagnostic and treatment planning skills. In essence, the tests are based on integrated case studies of patients who are frequently encountered in a general dental practice. Aspects such as patients' psychosocial status, medical and dental history, self-care behaviour and oral health status are incorporated into the case studies. All three BChD groups have been exposed to similar case study tests before and are acquainted with this method of testing. The tests are written at the Dental School on set dates. By the time you receive this document, you have perhaps written these tests already.

The average results of the different BChD groups will be compared at BChD V level. Your group's performance (except for the performance of the 2009 BChD

V group) will also be followed over time to establish if there has been any improvement in clinical reasoning competence. Your demographic particulars, including age, race and gender, as well as your average marks in Grade 12 and BChD I, will be used as control information in the study because these aspects might have a significant influence on the results. Your **anonymous** course feedback will also be used in the analysis to measure your perceptions about knowledge integration and the course presentation.

POTENTIAL BENEFITS

If it is proved that adjunctive case-based teaching results in better clinical reasoning, as opposed to teaching that is purely discipline based, case-based training might be instituted at the School based on empirical evidence that it adds value. Other universities with a discipline-based approach to training might then also consider using case-based training to improve student learning.

RISKS

First, the proposed study contains the risk of disproving the theory that the newly adopted adjunctive integrated case-based teaching intervention improves clinical reasoning skills of dental students. **Nevertheless, please note that the Comprehensive Patient Care training of the BChD III group will, at the least, be of the same standard as that of other BChD groups that have qualified over the past three years.**

Second, there is the risk that you may fail the test. **Special remedial attention will, however, be given to students of all study years who have failed these tests, after which they will have the option of writing additional assessments. This arrangement applies to students whether they participated in the study or not.**

CONFIDENTIALITY

The researcher undertakes not to identify you, the participant, in any analysis or publication at any time. A unique number (not your student number) will be assigned to your records to ensure that these are not accessible to a third party. Only lecturing staff will have access to your test mark for educational purposes. Your test mark will form part of your year mark and will be captured on the University's system. The researcher will be the only one to have access to your demographic detail and your Grade 12 and BChD I average marks, and this information will be stored electronically and will be protected by a password. Your course feedback will be anonymous.

PARTICIPANT'S RIGHTS

This study is voluntary and you are under no obligation to participate. You can refuse to participate or you can stop at any time without giving any reason. If you do not participate or if you withdraw from participating during the study, it will not be held against you in any way. You will still be required to write the test, but your mark will not be used in the analyses of the proposed study.

ETHICAL APPROVAL

Application will be made to the Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria to obtain written approval for the study to be undertaken.

INFORMED CONSENT FORM

By signing this document I confirm that I fully understand the information provided in the information leaflet about the proposed study, its risks and benefits, and my rights to participate in the study or not.

I give consent that my Comprehensive Patient Care **test mark** may be used in the proposed study.	Y / N
I give consent that my **demographic details** (age, race, gender) entered on the University's information system may be used in the proposed study.	Y / N
I give consent that the **average marks** I obtained in **Grade 12 and BChD I** may be used in the analysis.	Y / N
I give consent that the **average mark** I obtained in **Oral Biology III** may be used in the analysis.	Y / N

Name and surname of participant: ______________________________ (Please print)

Signature of participant: ________________________ Date: ________________

Name and surname of researcher: ______________________________ (Please print)

Signature of researcher: ______________________ Date: ________________

Name and surname of witness: ______________________________ (Please print)

Signature of witness: ______________________ Date: ________________

QUALITATIVE PART OF THE STUDY – PARTICIPANT'S INFORMATION LEAFLET AND INFORMED CONSENT FORM

Name of researcher: Dr T.C. Postma
Contact telephone number: 012 319 2553
Department of Dental Management Sciences
School of Dentistry
University of Pretoria
PO Box 1266
Pretoria 0001

TITLE OF THE STUDY

EVALUATING THE IMPACT OF ADJUNCTIVE INTEGRATED CASE-BASED DENTAL TRAINING ON CLINICAL REASONING IN A DISCIPLINE-BASED TRAINING ENVIRONMENT: "REASONS FOR PROGRESSION AND NON-PROGRESSION"

Dear student

This leaflet gives you information to help you decide if you want to participate in the proposed study. Before you agree to participate, make sure you understand exactly what is involved. If you do not understand the information, or if you have any other questions, you are welcome to ask.

PURPOSE OF THE STUDY

The purpose of the study is to identify student factors related to learning that might play a role in changes in students' clinical reasoning abilities over time.

PROCEDURES

Two groups of eight students each are interviewed by a third party who is not involved with the School or the curriculum. Questions are asked to get students' opinions about factors that both ensure and inhibit improvement in clinical reasoning skills over time.

Video and audio recordings of the interviews are made. Participants remain anonymous but are given numbers for reference purposes in the transcriptions of the audio recordings.

POTENTIAL BENEFITS

If the reasons for non-improvement in clinical reasoning skills over time can be identified, BChD III and IV Comprehensive Patient Care training can be adjusted to benefit all students.

RISKS

The study poses no known risks.

CONFIDENTIALITY

The researcher undertakes not to identify you, the participant, in any analysis or publication at any time. A unique number (not your student number) will be assigned to your records to ensure that these are not accessible to a third party. Only lecturing staff will have access to your test mark for educational purposes. Your test mark will form part of your year mark and will be captured on the University's system. The researcher will be the only one to have access to your demographic details and your Grade 12 and BChD I average marks, and this information will be stored electronically and will be protected by a password. Your course feedback will be anonymous.

PARTICIPANT'S RIGHTS

This study is voluntary and you are under no obligation to participate. You can refuse to participate or you can stop at any time without giving any reason. If you do not participate or if you withdraw from participating at any time, it will not be held against you in any way. Please note that you will still be required to write the test, but that your mark will not be used in the analyses of the proposed study.

ETHICAL APPROVAL

Application will be made to the Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria to obtain written approval for the study to be undertaken.

INFORMED CONSENT FORM

By signing this document I confirm that I fully understand the information provided in the information leaflet about the proposed study, its risks and benefits, and my rights to participate or not.

Name and surname of participant: ______________________________ (Please print)

Signature of participant: ________________________ Date: ________________

Name and surname of researcher: ______________________________ (Please print)

Signature of researcher: ______________________ Date: ________________

Name and surname of witness: ______________________________ (Please print)

Signature of witness: ______________________ Date: ________________