Assessment of Competence in Dentistry:
The Expectations, Perceptions, and Predictions

A thesis submitted to the University of Manchester for the degree of
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Reza Vahid Roudsari

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Abstract

Introduction
Competence has been a term subject to many interpretations over the years. This discrepancy in agreement is not due to the clash of minds but mostly the fruit of differences in expectations and legal requirements of local healthcare systems. As a result, the assessment of competence has been subject to dynamic changes with abundance of literature published to address its properties from different angles. This research project is designed to explore a number of unknowns: firstly, we aim to explore what it is meant by competence and compare it to how it is defined by the regulators. Once this is established, such expectations are to be compared to the expectations of the Educational Supervisors (ESs): the trainers who are in charge of training the newly qualified dentists. The next goal of this project is to shed light on how students perceive competence and explore the assessment methods that reflect such competencies best. Once known, these assessment methods will be explored in the national level to understand how they are implemented. The project also aims to explore if such assessment methods could be improved and finally, to examine if new assessment methods can be introduced to the field of medical and dental education with significant benefits and advantages.

Methodology
A mixed-method approach was chosen, consisted of qualitative, quantitative and descriptive statistics.

Results
Profile of a competent newly qualified dentist as described by the regulatory bodies, ESs and students was discussed. The most reflective assessment methods to illustrate students' competencies were identified and their use at national level explored. We looked at the benchmarking of the OSCEs and where the line of competence is drawn, and finally, we developed a new mathematical model that can predict competence after observing a number of clinical encounters.

Conclusion
Several conclusions and recommendations were drawn and discussed at their relevant chapter.
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Dedication

This thesis is dedicated to my beautiful wife: Ghazaleh for all her perseverance during the preparation of this work. She has been my rock and the ear to my non-stop rants!

And also dedicated to my little boy: Soren for all the evenings and weekends that I missed playing Lego with him!
Acknowledgement

I would like to thank Dr Lucie Byrne-Davis for her continuous guidance and support throughout the run and write up of this project. I started this work knowing nothing about assessment and without her constant constructive feedback this work would have been nothing but a dream!

I also would like to thank Prof Nick Grey for the numerous opportunities that he created so that the conduct of this project could continue and its results could be implemented into our assessment strategy.

And finally I would like to thank Prof Julian Satterthwaite for developing and suggesting the initial idea of this project and his continuous support during my training.
About the author

The author is a clinical lecturer and consultant in Restorative Dentistry. The author graduated with the degree of DDS in 2003 and after two years of vocational training joined the University of Manchester and completed his MSc in Fixed and Removable Prosthodontics in 2006. He gained a PGDip in Oral and Maxillofacial Surgery from the same University in 2007 before starting work as a Maxillofacial Senior House Office in Cardiff and Rotherham.

He joined the University of Manchester in 2009 as a Clinical Teaching Fellow and Specialist Registrar in Restorative Dentistry. He was appointed the Assessment Lead for the School of Dentistry in 2013, responsible for the quality assurance and conduct of the assessments of the BDS and BSc OHS programmes.
Chapter 1
1 The art and science of competence in dental education

1.1 Introduction

The ultimate aim of education is for students to learn. For this reason, teaching is described as activities that stimulate, facilitate and guide this learning process (Oliver et al., 2008). Educators name this “planned learning experience” a curriculum (Kern and Thomas, 1998). An optimal curriculum should produce graduates skilled in life-long, self-directed, reflective learning (Kersten, 1997). Literature recommends several properties for a curriculum to produce such graduates (Chambers, 2002; Kember, 2008; Kersten, 1997; Nicholls, 2002; Oliver et al., 2008): (1) Prior knowledge is key to learning; therefore, the curriculum should consider this when mapping learning activities. (2) Students show more eagerness to learn if teaching is provided in context; in other words the students will remain interested in learning if the material is meaningful and relevant to them. (3) Students need to practice to learn; therefore, favourable learning conditions and time should be allocated to this. And (4) optimal time should be allocated to self-study.

Although all of these elements have significant importance in the creation and delivery of a success curriculum; however, the latter, in particular requires added attention. “Learning is an activity of the brain that principally acts to best effect during self-study” (Oliver et al., 2008) therefore it is crucially important to get the balance between the prescriptive elements of the curriculum and the time allocated to self-study right. Students demonstrate variable learning styles (Reed et al., 2014) and hence the goal is to produce a “constructive friction” (ten Cate, 2007), as illustrated in Table 1.1, to result in optimal learning.
<table>
<thead>
<tr>
<th>Student self-regulation</th>
<th>Educational guidance (prescriptive)</th>
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<td>High</td>
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<td>Medium</td>
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<td>Low</td>
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<td>High</td>
<td>Destructive Friction</td>
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<td>Constructive Friction</td>
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<td>Constructive Friction</td>
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<td>Destructive Friction</td>
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Table 1.1. Friction between the degree of self-regulated learning and educational guidance.

Reproduced from the presentation on Philosophy of Curricular Models, given by Prof O ten Cate at the 33rd ADEE conference, Dublin, Ireland in 2007.

Based on these fundamental elements several modern models of curriculum design have been developed: SPICES (Dent et al., 2017), PRISMS (Bligh et al., 2001), CELTIC (Oliver et al., 2008), and PPR (Biggs, 2011; Fish and Coles, 2005) being a few examples. Although these models have differences in their philosophy, however, they all share the same key principle: they are student-centred and outcome-based, further reinforcing the “self-regulation" element.

On this note, assessment becomes a crucial part of the teaching and learning process. Effective assessment drives learning (Epstein, 2007) and is a mean of highlighting to the student and the educator what areas of knowledge, skills, or attitudes are in need of attention and what areas are adequate to allow progression. For this reason, assessment should not be counted as an aftermath or a burden to the curriculum design; but instead an integral part of it, where delivery of certain learning outcomes are intended as part of the bigger picture.
1.2 Competency-based dental education

Although competency-based education (CBE) is not a new concept in medical or dental education (Spady, 1977; McGaghie, 1978; Gibbons, 1980), there has been great disparity between the scholars in defining what CBE means. Historically it was proposed that the “intended output of a competency-based programme is (to produce) a health professional who can practice medicine at a defined level of proficiency, in accord with local conditions, to meet local needs” (McGaghie, 1978).

Although it may sound simple on paper, medical and dental educators have their personal interpretation of this concept and therefore have defined and developed CBE programmes that are occasionally fundamentally different. Frank conducted a systematic review of the published literature to explore how scholars define CBE (Frank et al., 2010a). This resulted in identification of 176 records produced between 1973 and 2009, defining CBE in the context of four major themes and six sub-themes (Table 1.2). He concluded that the “CBE is an approach to preparing physicians for practice that is fundamentally oriented to graduate outcome abilities and organized around competencies derived from an analysis of societal and patient needs. It deemphasizes time-based training and promises greater accountability, flexibility, and learner-centredness”.

Those in favour of CBE firmly believe that it is the expertise, rather than the experience, that drives the competency-based practice and certification (Aggarwal and Darzi, 2006). This has resulted in a paradigm shift from the traditional experience-based models to programmes that require documentation and recording of proficiency (Debas et al., 2005). Curriculum design in the traditional models starts with the question “what do the learners need to know?”
and follows with “how shall we teach them what they need to know?”. In contrast
the design of a CBE curriculum starts with the question “what abilities are
needed of our graduates?” and follows by defining “competencies” that are
needed to be demonstrated to prove mastering of those abilities (Harden et al.,
1999).

Frank defines competency as “an observable ability of a health professional,
integrating multiple components such as knowledge, skills, values, and
attitudes. Since competencies are observable, they can be measured and
assessed to ensure their acquisition. Competencies can be assembled like
building blocks to facilitate progressive development” (Frank et al., 2010b). He is
also a great believer of the “progression of competence” and explains that “for
each aspect or domain of competence, {an} spectrum of ability from novice to
mastery {can be expected}. The goal of medical education is to facilitate the
development of a physician to the level of ability required for optimal practice in
each domain. At any given point in time, and in a given context, an individual
physician will reflect greater or lesser ability in each domain”.

Since progression of competence is an expected phenomenon, the next stage in
the development of CBE would be to define developmental pathways for
competencies and to set timeframes by when they are expected to be observed
in a learner. Such timeframes are known as “milestones” (Carraccio et al.,
2008). Once the milestones are set, educational activates and instructional
methods are designed and assessment tools are be put in place to measure
progress of the learners against them (Frank et al., 2010b).

Theoretically such curricula should result in proficient graduates with the ability
to serve their patient population’s needs, however, there are several challenges
facing the educators to ensure such programmes work; “It is easier to move a cemetery than to change a curriculum” (Kalkwarf et al., 2005). CBE requires ample infrastructure and significant faculty buy-in. Unlike the traditional methods where the educators deliver didactic teaching and planned exercises within set timeframes, the staff involved in CBE are expected to deal with a large number of observations and subsequently need a great deal of calibration and training to ensure they are assessing the learners against correct criteria (Frank et al., 2010b).

Furthermore, there is always the peril of “reductionism” whereby the competencies are broken down into the smallest observable units, making the process of doing and observing the competencies an endless and frustrating task for both the learners and the educators (Frank et al., 2010b). More importantly by putting emphasis on the milestones, the learners may sacrifice quality for the sake of the paperwork exercise, resulting in a healthcare system that is based on hitting targets instead of prompting excellence (Talbot, 2004).

Despite all the hurdles and shortfalls, CBE is gaining popularity worldwide (Brightwell and Grant, 2013; Campbell et al., 2010; Carraccio et al., 2008; Gotterer et al., 2009; Harden et al., 1999; Iobst et al., 2010; Jolly, 2012; Lowry et al., 2013; Morcke et al., 2013; Scicluna et al., 2012). This has resulted in the design and implementation of assessment methods that suit such programmes. There is a forward movement towards integration of competencies into the assessment strategy of CBE programmes (Epstein and Hundert, 2002; Harden, 2002; Smith et al., 2003).
<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-theme</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizing framework</td>
<td></td>
<td>All descriptions of competency-based education (CBE) as an approach to education explicitly oriented to graduate outcomes.</td>
</tr>
<tr>
<td>Defined outcomes and milestones</td>
<td></td>
<td>Refers to the identification of specific competencies that are aligned to the outcomes of a training program. These outcomes are derived from the abilities required of physicians for practice or to meet the standards of the profession. Competencies may also be described in terms of milestones or benchmarks that indicate progression of competence in one domain.</td>
</tr>
<tr>
<td>Curriculum of competencies</td>
<td></td>
<td>Includes all references that describe how curricula are organized around the identified competencies. The curriculum node includes references to learning strategies, teaching methods, and instructional design.</td>
</tr>
<tr>
<td>Demonstrable abilities</td>
<td></td>
<td>Includes all references that articulate the need for the components of competency-based education to be observable and comparable to objective criteria for all learners.</td>
</tr>
<tr>
<td>Assessment of competencies</td>
<td></td>
<td>Contains all citations that refer to the assessment of pre-defined standards or milestones that indicate progress toward the defined outcomes of a curriculum.</td>
</tr>
</tbody>
</table>
Assessment is criterion-referenced, in that learners are measured against set standards and not other learners. Assessment may also involve threshold standards that must be achieved before further progression of the learner through the curriculum.

<p>| Rationale | Includes all arguments as to the rationale for employing competency-based education as an approach to medical education. This may include how patient needs are a driver to use CBE, how physicians are better prepared for practice or the next stage of training, how it is better for learners, or how it can increase educational efficiency. |
| Learner-centred | Includes all discussion of the use of CBE to ensure curricula are aligned with the learning needs of diverse medical learners. It includes all references to organizing teaching and learning around facilitating the progression of trainee competence toward the defined outcome abilities for a program. This involves active engagement of learners in managing their learning, in regular self-assessment, and in ongoing frequent assessment of progress. This thread includes discussion of learner awareness of transparent goals, curriculum design, and assessment methods. It also includes mention of the self-directed continuing professional development of physicians in practice, and flexibility of curriculum processes to meet learners' needs. |</p>
<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Societal needs</td>
<td>Includes all discussions of the need for CBE to ensure that graduates have the essential abilities to effectively serve patients and populations once in practice. It also encompasses references to CBE as a mechanism to align curriculum goals with patient needs and optimal health care delivery.</td>
</tr>
<tr>
<td>Contrast with time</td>
<td>Includes all discussions that contrast time- or process-based medical education designs with CBE. All references to the pace of learning being tied to the acquisition of competence by a learner are incorporated. In this thread, training time is seen as a resource for instruction and not the organizing framework for medical education and credentialing.</td>
</tr>
<tr>
<td>Implementing CBE</td>
<td>Includes all discussions of CBE implementation designs, components, and ingredients.</td>
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Table 1.2. Definition of CBE in the context of themes.

Essentially, this movement follows insights from modern educational theory, which postulates that learning is facilitated when tasks are integrated (Van Merriënboer, 1997). “Instructional programmes that are restricted to the stacking of components or sub-skills of competencies are less effective in delivering competent professionals than methods in which different task components are presented and practised in an integrated fashion, which creates conditions that are conducive to transfer. This “whole-task” approach is reflected in the current competency movement. A competency is the ability to handle a complex professional task by integrating the relevant cognitive, psychomotor and affective skills. In educational practice we now see curricula being built around such competencies or outcomes” (van der Vleuten and Schuwirth, 2005b).

Inspired by the concept of CBE, competency-based dental education (CBDE) has been a concept incorporated into the curricula of a number of dental schools across the world. Those who are in favour of CBDE argue that “the success of dental curricula should be judged in terms of its impact on students, expressed as competency outcomes” (Yip and Smales, 2000) in contrast to traditional programmes that predominantly measure their outcomes based on success in written or end-of-year examinations. Since the introduction of the evidence-based practice (Guyatt et al., 1992) and its implementation into dental programmes, the dental schools are aiming to produce dentists who are prepared for the practice needs of the future (Chambers, 1993) and the CBDE programmes argue that they are capable of producing such clinicians (Yip and Smales, 2000).

This is theoretically due to the fact that they are capable of producing dentists who are competent; and by definition a competent dentist is a clinician who is
capable of functioning independently in realistic practice setting (Chambers and Gerrow, 1994). For a dental student to be considered competent it is expected that they combine fundamental knowledge and professional attitudes to perform in a reliable manner in real clinical situation; therefore, emphasis is given to the assessment of performance and the demonstration of skill, particularly in a longitudinal manner (Yip and Smales, 2000).

1.3 Definitions of professional competence

The past two decades have witnessed several definitions of competence and professional competency. This is partly due to the complex cultural and operational changes to our healthcare systems and partly due to changes in our understanding of how CBE programmes function. Competence, in its most crude form, can be defined as the ability to use professional knowledge and skills to solve the problems that arise in practice (Kane, 1992). LaDuca et al used the terminology “professional encounters” or “encounters” to describe a context, a client, and a reason for professional intervention (LaDuca et al., 1984). Professional encounters vary in terms of the problems to be addressed, the client characteristics (for example age, gender, behaviour), and the context and environment they take place. When defining domains of practice, variable emphasis can be given to possible encounters based on their importance, frequency or both. For a student to be professionally competent in a domain, they need to be able to handle the encounters in that given domain (Kane, 1992).

In a more complex context, however, professional competence can be defined as “the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the
benefit of the individual and community being served" (Epstein and Hundert, 2002). In this context, competence requires cognitive and technical functions to acquire base knowledge and master core skills; it requires an integrative function to link skills with knowledge and manage uncertainties; it needs a moral function to make the clinician act with professional attitudes; it requires a relationship function to make one act as part of the team and communicate effectively with colleagues and patients; and finally it depends on the habits of mind; including attentiveness, critical curiosity and willingness to acknowledge and correct errors (Table 1.3).

In this context, professional competence is developmental, impermanent and context-dependent (Epstein and Hundert, 2002) and therefore difficult to assess. To add to the complexity of the equation, we need to remind ourselves of the principal of evidence-based practice (Guyatt et al., 1992), where an important answerable question is generated, new knowledge to answer the question is interpreted and finally an informed conclusion is applied to the clinical practice. Polanyi argues that competence is achieved by tacit and not explicit knowledge (Polanyi, 1974). Tacit knowledge is the knowledge that we know it but it is hard to explain; for example use of rules of thumb and pattern recognition. When applying evidence-based decisions into practice, many heuristics at novice level are replaced with shortcuts at the expert level, making the model even more complex to assess (Benner, 1984; Hodges et al., 1999).

Therefore, professional competence is much more than demonstration of isolated competences (Eraut, 1994): “when we see the whole, we see its parts differently than in isolation” (Polanyi, 1969). For example, a student who is a good communicator, can take medical, social and dental history, has the knowledge of side effects of the medications in the oral cavity and knows how to
extract a single-rooted tooth, may miss the details needed to make the diagnose of a medicine-related osteonecrosis of the jaw (MRONJ) and manage the patient incorrectly.

<table>
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<th>Cognitive</th>
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<tbody>
<tr>
<td>Core knowledge</td>
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<tr>
<td>Basic communication skills</td>
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<td>Information management</td>
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<tr>
<td>Applying knowledge to real-world situations</td>
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<tr>
<td>Using tacit knowledge and personal experience</td>
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<tr>
<td>Abstract problem-solving</td>
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<tr>
<td>Self-directed acquisition of new knowledge</td>
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<tr>
<td>Recognizing gaps in knowledge</td>
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<tr>
<td>Generating questions</td>
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<tr>
<td>Using resources (e.g., published evidence, colleagues)</td>
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<tr>
<td>Learning from experience</td>
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<tr>
<td>Technical</td>
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<tr>
<td>Physical examination skills</td>
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<tr>
<td>Surgical/procedural skills</td>
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<tr>
<td>Integrative</td>
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<tr>
<td>Incorporating scientific, clinical, and humanistic judgment</td>
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<tr>
<td>Using clinical reasoning strategies appropriately (hypothetico-deductive, pattern-recognition, elaborated knowledge)</td>
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<tr>
<td>Linking basic and clinical knowledge across disciplines</td>
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<tr>
<td>Managing uncertainty</td>
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<td>Context</td>
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<td>Clinical setting</td>
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<td>Use of time</td>
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<tr>
<td>Relationship</td>
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<tr>
<td>Communication skills</td>
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<tr>
<td>Handling conflict</td>
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<tr>
<td>Teamwork</td>
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<tr>
<td>Teaching others (e.g., patients, students, and colleagues)</td>
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<tr>
<td>Affective/Moral</td>
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<tr>
<td>Tolerance of ambiguity and anxiety</td>
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<tr>
<td>Emotional intelligence</td>
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<tr>
<td>Respect for patients</td>
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<tr>
<td>Responsiveness to patients and society</td>
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<tr>
<td>Caring</td>
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<tr>
<td>Habits of Mind</td>
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<tr>
<td>Observations of one's own thinking, emotions, and techniques</td>
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<tr>
<td>Attentiveness</td>
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<tr>
<td>Critical curiosity</td>
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<tr>
<td>Recognition of and response to cognitive and emotional biases</td>
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<tr>
<td>Willingness to acknowledge and correct errors</td>
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</tbody>
</table>

Table 1.3. Dimensions of professional competence.

1.4 Regulatory bodies and the professional competence

Since professional competence is context-dependent, it is useful to look at the regulatory bodies in charge of regulating and certification of medical and dental clinicians. It can be hypothesised that due to environmental, cultural and statutory differences between such bodies, there would be variation in how professional competences are interpreted. For this reason, a search of the resources within the public domain was conducted to compare the professional competencies expected of the newly qualified doctors or dentists in four countries from three continents: the United Kingdom (UK), Canada, the United States (US), and Australia.

1.4.1 The UK

In the UK, the General dental Council (GDC) and the General Medical Council (GMC) are the two regulatory bodies in charge of regulating dentists and medical doctors respectively. Although both of these bodies regulate clinical professionals and one may assume profound similarities; however, the two organizations operate independently with unique goals and different priorities. The aim of this section is to explore the similarities and differences between the two based on the information provided by them onto the public sector.

1.4.1.1 The General Dental Council (GDC)

In the UK, the GDC is the regulatory body responsible for the regulation of the academic dental institutions and the qualified registrants. The GDC regulates the dental nurses, orthodontic therapists, dental hygienists, dental therapists, dental technicians, clinical dental technicians and dentists (GDC, 2017).
Mutual recognition of qualifications and free movement of dentists across the EU are guaranteed by the relevant sections of EU Directive 2005/36/EC (European Parliament, 2005). In 1999, 29 ministers of Education of the European countries signed the Bologna Declaration, starting the process of aiming to converge and harmonise the higher educational systems across the European countries. One of the objectives continues to be ‘to tune’ curricula in terms of structures, programmes and actual teaching to make them more comparable (Cowpe et al., 2010). The outcome was the production of two documents: the Profile and Competences for the European Dentist (Plasschaert et al., 2005) which was followed by and replaced by Profile and Competences for the Graduating European Dentist (Cowpe et al., 2010).

The above documents in conjunction with the Curriculum Structure, Content, Learning and Assessment in European Undergraduate Dental Education (Manogue et al., 2011), all published as part of the Association for the Dental Education in Europe (ADEE) task force, formed the backbone of the GDC’s First Five Year document (GDC, 2008). This document provided a list of domains of competence, major competencies and intended learning outcome with three levels of expected achievements for the graduating dentists: be competent at, have knowledge of, and be familiar with. This document, however was superseded by Preparing for Practice (GDC, 2011b) with amended domains of expected competencies.

In a separate document, Scope of Practice (GDC, 2013a), the GDC sets the scene for an array of skills and competences that are expected to be possessed in each category of dental professions and advises its registrants that “{they} should only carry out a task or type of treatment or make decisions about a patient’s care if {they} are sure that {they} have the necessary skills and are
appropriately trained, competent and indemnified. If a task, type of treatment or
decision is outside {their} scope of practice or {they} do not feel that {they} are
trained and competent to do it {they} must refer the patient to an appropriately
trained colleague.”

The management of the medical emergencies, however, was the one item of
competency that was required to be mastered by all the registrants. The GDC
believes that “a patient could collapse on any premises at any time, whether
they have received treatment or not. It is therefore essential that all registrants
are trained in dealing with medical emergencies, including resuscitation, and
possess up to date evidence of capability”.

The dentists were expected to provide the patients with all the treatments and
services that could be provided by all the other dental professions as long as
they were trained to do so and felt competent. In addition, the dentists were
expected to be able to make a diagnosis and formulate a treatment plan,
proceed with root canal treatment, perform oral surgery, provide fixed
orthodontics, prepare and fit fixed prostheses and take and interpret dental
radiographs. With evidence of additional training, however, the dentists are able
to provide dental implants and proceed with injectable facial cosmetics.

In addition to all of the clinical competencies expected of a dentist, the GDC lists
a range of expectations of the profession in their document Standards for the
Dental Team, also known as the GDC Standards (GDC, 2013b). The GDC
Standards consists of nine principles, each targeting an area of professionalism,
attitude or professional responsibilities, with putting patient’s interest first being
on top of their list of priorities (Figure 1.1).
The GDC also provides its registrants with a number of additional guidance documents ranging from advertising and using social media to child protection and vulnerable adults and duty of candour\(^1\). With such a broad range of expectations from dentists, the GDC has provided the dental schools and training providers with two further documents: the Standards for the Education (GDC, 2015) and Preparing for Practice (GDC, 2011b). The former sets the scene in the form of three main standards focusing on protecting patients, quality assessment of the training programme and student assessment while the latter introduces a number of intended learning outcomes (ILOs) that the dental schools or the training providers need to demonstrate successful achievement of before their graduates are allowed onto the register.

Figure 1.1. The nine principles of the GDC Standards for the Dental Team.

\(^1\) Duty of candour: being open and honest with patients when something goes wrong.
The Preparation for Practice document (PfP) sets the scene to illustrate what a newly qualified dentist looks like. The PfP puts patient’s safety on top of its priorities for education and introduces the term the “safe beginner”. The GDC explains that such a safe beginner is “a rounded professional who, in addition to being a competent clinician, will have the range of professional skills required to begin working as part of a dental team and be well prepared for independent practice. They will be able to assess their own capabilities and limitations, act within these boundaries and will know when to request support and advice.”

To produce such safe beginners, the dental schools are required to demonstrate that their students have successfully achieved a total of 150 ILOs, divided into four major domains of clinical, communication, professionalism, and management and leadership (Table 1.4). The PfP leaves the design of the dental curriculum to the discretion of the dental schools and according to their individual circumstances. It, however, insists that the dental schools should introduce robust assessment strategies to demonstrate that their graduates are assessed against all of the GDC ILOs, as opposed to ILOs just being delivered during the undergraduate programme.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Sub-domain</th>
<th>Sub-category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>Individual patient care</td>
<td>Foundations of practice</td>
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<tr>
<td></td>
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<td>Comprehensive patient assessment</td>
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<td>Diagnosis</td>
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<td>Treatment planning</td>
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<td>Patient management</td>
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<td></td>
<td>Patient and public safety</td>
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<tr>
<td></td>
<td></td>
<td>Treatment of acute oral conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health promotion and disease prevention</td>
</tr>
</tbody>
</table>
Management and treatment of periodontal disease
Hard and soft tissue disease
Management of the developing and developed dentition
Restoration and replacement of teeth
Population-based health and care

| Communication | Patients, their representatives and the public |
|              | Team and the wider healthcare environment |
|              | Generic communication skills |

| Professionalism | Patients and the public |
|                | Ethical and legal |
|                | Teamwork |
|                | Development of self and others |

| Management and Leadership | Managing self |
|                          | Managing and working with others |
|                          | Managing the clinical and working environment |

Table 1.4. The GDC PIP ILOs.

1.4.1.2 The General Medical Council (GMC)

The role of the GMC is to set the educational standards for all UK doctors through undergraduate and postgraduate education and training (GMC, 2017);
this includes standards for the admission to the medical schools, standards for teaching and assessing the medical students, skills and behaviours that the medical students must have learned to complete the programme and ultimately the decision as to whether the medical schools are allowed to issue a medical degree.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Sub-domain</th>
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</thead>
<tbody>
<tr>
<td>The doctor as a scholar and a scientist</td>
<td>Biomedical scientific principles</td>
</tr>
<tr>
<td></td>
<td>Psychological principles</td>
</tr>
<tr>
<td></td>
<td>Social science principles</td>
</tr>
<tr>
<td></td>
<td>Medical practice the principles</td>
</tr>
<tr>
<td></td>
<td>Medical research</td>
</tr>
<tr>
<td>The doctor as a practitioner</td>
<td>Consultation with a patient</td>
</tr>
<tr>
<td></td>
<td>Diagnose and manage clinical presentations</td>
</tr>
<tr>
<td></td>
<td>Communicate effectively with patients and colleagues</td>
</tr>
<tr>
<td></td>
<td>Immediate care in medical emergencies</td>
</tr>
<tr>
<td></td>
<td>Prescribe drugs safely, effectively and economically</td>
</tr>
<tr>
<td></td>
<td>Carry out practical procedures safely and effectively</td>
</tr>
<tr>
<td></td>
<td>Information governance</td>
</tr>
<tr>
<td>The doctor as a professional</td>
<td>Behave according to ethical and legal principles</td>
</tr>
<tr>
<td></td>
<td>Reflect, learn and teach others</td>
</tr>
<tr>
<td></td>
<td>Work effectively within a multi-professional team</td>
</tr>
<tr>
<td></td>
<td>Protect patients and improve care</td>
</tr>
</tbody>
</table>

Table 1.5. The GMC’s outcomes for graduates.

The GMC has made a number of publications to achieve such goals. Promoting Excellence (GMC, 2016b) focuses on the standards for medical education and
training in the UK, Outcome for Graduates (GMC, 2015) sets out the knowledge, skills and behaviours that new UK medical graduates must be able to demonstrate and Achieving Good Medical Practice (GMC, 2016a) outlines the professionalism outcomes expected of the medical students. Similar to the GDC, the GMC also sets the patient safety at the core of its standards and emphasis that “just as good medical students and doctors make the care of their patients their first concern, so must the organisations that educate and train medical students and doctors” (GMC, 2016b).

![Figure 1.2. GMC's professional standards.](image)

Second to the patient’s safety, the medical students are expected to excel in three generic outcomes: The doctor as a scholar and a scientist, the doctor as a practitioner and the doctor as a professional (Table 1.5). In addition to this the medical students are expected to behave within set professional standards consisting of four major domains, outlined in Figure 1.2.
1.4.1.3 The Scottish Doctor

In 1999 the Scottish Deans’ Medical Education Group (SDMEG) was formed to discuss and implement the learning outcome recommendations by the GMC (Scottish Deans’ Medical Education Group, 2008). Almost a year later, the SDMEG published its first set of outcomes in the form of a document known as the Scottish Doctor – Learning Outcomes for the Medical Undergraduate in Scotland: a foundation for competent and reflective practitioners.

Figure 1.3. The Scottish Doctor learning outcomes

These outcomes were based on three primary elements suggested by Harden (Harden et al., 1999): what the doctor is able to do, how the doctor approaches their practice, and the doctor as a professional (Simpson et al., 2002). These primary elements were further subdivided into 12 domains (Figure 1.3), which
were in respect further divided into learning outcomes in the context of themes and actions, known as levels 3 and 4 respectively.

In 2007 the Scottish Doctor underwent a cross-referencing exercise to map its learning outcomes against the GMC’s Tomorrow’s Doctor (Ellaway et al., 2007). This was to validate their learning outcomes and cross check that all the GMC’s learning outcomes are covered in the Scottish Doctor. The outcome strengthened many of the learning outcomes highlighted in the Scottish doctor but also confirmed a number of areas of controversy: The Scottish Doctor acknowledged that it is impossible to describe all the requirements of a competent doctor in a single document, accepted some personal interpretation of their outcomes by the deans of the medical schools and hence some degree of variability in how such outcomes are taught and assessed, and finally agreed that the document should remain fluid and subject to changes as the practice and beliefs of the educators changes over time.

1.4.2 Canada

In Canada the majority of the medical schools follow a competency-based curriculum. Such curricula are governed based on a framework suggested by the Royal Collage of Physicians and Surgeons of Canada (RCPSCan), known as the CanMEDS (CanMEDS, 2005). The framework was initially designed in 2005 (Frank and Danoff, 2007) and consisted of a number of roles, competencies and enabling competencies. The framework underwent some changes in 2015 (CanMEDS, 2015), to address some of the shortfalls of the 2005 version. This document remains the gold standard of competency-based medical education (CBME) for the Canadian medical schools.
The competency framework for dentistry, on the other hand, is formulated and governed by the National Dental Examining Board of Canada (NDEB).

1.4.2.1 The CanMEDS 2015

The CanMEDS competency framework, proposed and created by the RCSCan, functions based on a CBE model. The framework is consisted of seven “roles”, with “medical expert” being in the heart of the model (Figure 1.4). These roles describe properties and attitudes of a certified medical practitioner: a medical expert, a professional, a communicator, a collaborator, a scholar, a health advocate and a leader (CanMEDS, 2015). The leadership property is a substitute for being a manager in the previous version of this document (CanMEDS, 2005).

Each role within the framework consists of several competencies. Each competency defines the qualities or abilities of a clinician that are required to be mastered. Since the competencies are defined in broad terminology, each competency is further comprised of a number of “enabling competencies”. Each enabling competency is an observable ability of a healthcare professional that develops through stages of expertise from novice to master.

There are certain points in time during the medical training that the students are expected to have acquired certain competencies. When there is a time factor attached to a number of competencies, they are defined as “milestones” and are described as the expected ability of a healthcare professional at that stage of expertise. A number of milestones can gather together for the purpose of teaching and assessment, resulting in the concept of the Entrustable Professional Activates (EPA).
1.4.2.2 Entrustable Professional Activity

The ultimate goal of any CBME model is to produce medical practitioners who are capable of independent day-to-day medical practice competently. For this reason the CanMEDS framework suggests that when the students have reached the appropriate level of competence, they can be trusted with a number of key skills of the field. This concept argues that the level of supervision has a direct but reverse correlation with the competence of the student (Ten Cate, 2013), in essence when competence is achieved, no or very little supervision is required.
While the competencies describe the abilities of a physician, the EPAs on the other hand, are descriptors of work. For the EPAs to be valid, they have to focus on a task of high importance for the daily practice (core business), be prone to error when undertaken and should sample a number of competency roles within the framework. Since the EPAs are consisted of several milestones, once they are satisfactorily achieved, the student can be deemed competent in all of the assessed competencies and their enabling competencies. For this reason the CanMEDS defines competence as when a professional activity is mastered on a threshold level that permits the student to be trusted to act unsupervised.

1.4.2.3 The NDEB

The NDEB regulates the certification of the newly qualified dental practitioners in Canada as well as the dentists who have qualified from a dental school not recognized by the board. The NDEB defines a competent newly qualified dental practitioner as someone who is “able to provide oral healthcare for the benefit of individual patients and communities in a culturally sensitive manner” (NDEB, 2005a). The NDEB expects their day-1 dentists to “be able to apply foundation knowledge and skills to justify their decisions and actions and to evaluate outcomes. Therefore, foundation knowledge, skills and professional behaviour are understood to be a part of every competency.”

The NDEB ties the links between having competency and self-evaluation and insists that being able to self-evaluate is the prerequisite for competency; therefore, in addition to the knowledge, skills set and professionalism, the NDEB expects their newly qualified dentists to be able to evaluate the quality of their own work and its effectiveness.
The NDEB also expects their dentists to act in an ethical manner and be obliged by the legal requirements at the national and provincial level. It lists a total of 47 items (NDEB, 2005b) that every dentist should demonstrate competency at upon graduation. This list had been populated as a result of the joint effort between the NDEB, Association of Canadian Faculties of Dentistry (ACFD/AFDC), the Commission on Dental Accreditation of Canada (CDAC), and the Canadian Dental Association’s Council on Education (CDA Council) and validated by surveying 731 dentists, but with a 43% response rate (Gerrow et al., 2006).

These 47 competencies (Table 1.6), also referred to as competencies for a beginning dental practitioner (CBDP) create a framework for ACFD/AFDC to design their curricula and develop teaching strategies locally as well as to setup the blueprint of their assessment. The NDEB uses the same CBDP to blueprint its own certification exams for the accredited and non-accredited dental institutions nationally (Neumann and Macneil, 2007).

<table>
<thead>
<tr>
<th>Competencies for a beginning dental practitioner</th>
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<tbody>
<tr>
<td>1 Recognize the determinants of oral health in individuals and populations and the role of dentists in health promotion, including the disadvantaged.</td>
</tr>
<tr>
<td>2 Recognize the relationship between general health and oral health.</td>
</tr>
<tr>
<td>3 Evaluate the scientific literature and justify management recommendations based on the level of evidence available.</td>
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<tr>
<td>4 Communicate effectively with patients, parents or guardians, staff, peers, other health professionals and the public.</td>
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<td>32</td>
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</tbody>
</table>
| 34 | Manage dental caries, tooth defects and esthetic problems and, when restoration is warranted, use techniques that conserve tooth structure and
<table>
<thead>
<tr>
<th>Competency Number</th>
<th>Competency Description</th>
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<tbody>
<tr>
<td>35</td>
<td>Preserve pulp vitality to restore form and function.</td>
</tr>
<tr>
<td>36</td>
<td>Manage patients with orofacial pain and/or dysfunction.</td>
</tr>
<tr>
<td>37</td>
<td>Manage surgical procedures related to oral soft and hard tissues and their complications.</td>
</tr>
<tr>
<td>38</td>
<td>Manage trauma to the orofacial complex.</td>
</tr>
<tr>
<td>39</td>
<td>Manage abnormalities of orofacial growth and development and treat minor orthodontic problems.</td>
</tr>
<tr>
<td>40</td>
<td>Recognize and manage functional and non-functional occlusion.</td>
</tr>
<tr>
<td>41</td>
<td>Select and, where indicated, prescribe appropriate biomaterials for patient treatment.</td>
</tr>
<tr>
<td>42</td>
<td>Manage partially and completely edentulous patients with prosthodontic needs including the provision of fixed, removable and implant prostheses.</td>
</tr>
<tr>
<td>43</td>
<td>Make records required for use in the laboratory fabrication of dental prostheses and appliances.</td>
</tr>
<tr>
<td>44</td>
<td>Design a dental prosthesis or appliance, write a laboratory prescription and evaluate laboratory products.</td>
</tr>
<tr>
<td>45</td>
<td>Apply accepted principles of ethics and jurisprudence to maintain standards and advance knowledge and skills.</td>
</tr>
<tr>
<td>46</td>
<td>Apply basic principles of practice administration, financial and personnel management to a dental practice.</td>
</tr>
<tr>
<td>47</td>
<td>Demonstrate professional behaviour that is ethical, supercedes self-interest, strives for excellence, is committed to continued professional development and is accountable to individual patients, society and the profession.</td>
</tr>
</tbody>
</table>

Table 1.6. Competencies for a beginning dental practitioner in Canada.
The NDEB, however, has been subject to criticism for not aligning their exam blueprints to what is taught in the dental schools (Neumann and Macneil, 2007) and they have been encouraged to “focus on competencies and critical thinking skills essential for future practice”. The argument challenges the NDEB for not having enough dental educators in its consistency and advises for more collaborative work with the dental schools.

Due to the similar critics, in light with the numerous items of competency in the model and inspired by the developments in the CanMEDS, the ACFD (Association of Canadian Faculties of Dentistry, 2016) has proposed a new framework, consisting of five main competencies for a competent beginning general dentist. These competencies include patient-centred care, professionalism, communication and collaboration, practice and information management and finally, health promotion (Figure 1.5).

This framework uses the American model of the competencies for the new general dentist (ADEA, 2011) and defines competence as “a complex behaviour or ability essential for the general dentist to begin independent, unsupervised practice”. In this model each competency is consisted of several components, each component has several examples of indicators that could be observed, and they are all mapped against the NDEB’s requirements of knowledge, skills and attitudes (KSA) for the general dentist (NDEB, 2014).
1.4.3 The USA

In the United States, medicine is a graduate-entry programme, usually run over four years. The programmes offer either a Doctor of Medicine (MD) or a Doctor of Osteopathic Medicine (DOM) degree. The programmes leading to an MD are accredited by the Liaison Committee on Medical Education (LCME), which is sponsored by the AAMC (Association of American Medical Colleges, 2017). The programmes leading to a DOM are accredited by the Commission on Osteopathic College Accreditation (COCA), which is sponsored by the AOA (American Osteopathic Association, 2017) (American Osteopathic Association,
The medical licences, however, are granted by individual states, instead of a federal governmental body.

The local micro-management of the medical licensure has been subject to criticism for years with financial implications to the federal government and safety concerns for the patients (Kavic, 2002); therefore, the residency programmes have started incorporating six core competencies into their curriculum as suggested by the American Board of Medical Specialties (ABMS).

The practice of dentistry, however, is overseen by several agencies including the American Dental Association (ADA), the Commission on Dental Accreditation and the regional boards. Ultimate licensure is the responsibility of individual states. The dental programmes are run over four years: the first two being focused on pre-clinical skills and didactic teaching while the final two years are clinically dominant.

The dental students are expected to take the Part I of the National Board Dental Examination (NBDE) at the end of their second year and the Part II exam during their fourth year. Most states expect their candidates to pass a regional board exam as well before they are eligible to receive their licence.

On the other hand the American Dental Education Association (ADEA), calling themselves “the voice of dental education” (ADEA, 2017), has proposed a set of competencies essential for the new general dentist (ADEA, 2011). Although the ADEA has no executive authority but it provides the allied dental schools with advise on best practice.
1.4.3.1 The ABMS

In 1999 the Accreditation Council for Graduate Medical Education (ACGME) proposed six core competencies (ACGME, 2017) essential for a graduating resident. These core competencies were endorsed by the ABMS and all the residency programmes in the US became obliged to implement them within their curriculum. These core competencies consisted of: patient care and procedural skills, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.

Each of these competencies has their individual outcome descriptor and they are further subdivided into a total of 27 observable outcomes measures (Table 1.7). The ACGME also made it mandatory for the programme directors to appoint a Clinical Competency Committee (CCC). The role of the CCC is to review all resident evaluations semi-annually, prepare and ensure the reporting of Milestones evaluations of each resident semi-annually to ACGME and advise the program director regarding resident progress, including promotion, remediation, and dismissal (ACGME, 2017).

<table>
<thead>
<tr>
<th>Core competency</th>
<th>Measurable outcome</th>
</tr>
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<tbody>
<tr>
<td>Patient Care and Procedural Skills</td>
<td>Residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health.</td>
</tr>
<tr>
<td></td>
<td>Residents must be able to competently perform all medical, diagnostic, and surgical procedures</td>
</tr>
<tr>
<td>Medical Knowledge</td>
<td>Residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiological and social-behavioural sciences, as well as the application of this knowledge to patient care.</td>
</tr>
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<td>-------------------</td>
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</tbody>
</table>
| Practice-based Learning and Improvement | Identify strengths, deficiencies, and limits in one's knowledge and expertise.  
Set learning and improvement goals.  
Identify and perform appropriate learning activities.  
Systematically analyse practice using quality improvement methods, and implement changes with the goal of practice improvement.  
Incorporate formative evaluation feedback into daily practice.  
Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems.  
Use information technology to optimize learning.  
Participate in the education of patients, families, students, residents and other health professionals. |
| Interpersonal and Communication Skills | Communicate effectively with patients, families, and the public, as appropriate, across a broad range of socioeconomic and cultural backgrounds.  
Communicate effectively with physicians, other health professionals, and health related agencies.  
Work effectively as a member or leader of a health care team or other professional group. |
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<tbody>
<tr>
<td>Act in a consultative role to other physicians and health professionals.</td>
<td></td>
</tr>
<tr>
<td>Maintain comprehensive, timely, and legible medical records, if applicable.</td>
<td></td>
</tr>
<tr>
<td><strong>Professionalism</strong></td>
<td>Compassion, integrity, and respect for others</td>
</tr>
<tr>
<td>Responsiveness to patient needs that supersedes self-interest.</td>
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</tr>
<tr>
<td>Respect for patient privacy and autonomy.</td>
<td></td>
</tr>
<tr>
<td>Accountability to patients, society and the profession.</td>
<td></td>
</tr>
<tr>
<td>Sensitivity and responsiveness to a diverse patient population, including but not limited to diversity in gender, age, culture, race, religion, disabilities, and sexual orientation</td>
<td></td>
</tr>
<tr>
<td><strong>Systems-based Practice</strong></td>
<td>Work effectively in various health care delivery settings and systems relevant to their clinical specialty.</td>
</tr>
<tr>
<td>Coordinate patient care within the health care system relevant to their clinical specialty.</td>
<td></td>
</tr>
<tr>
<td>Incorporate considerations of cost awareness and risk benefit analysis in-patient and/or population-based care as appropriate.</td>
<td></td>
</tr>
<tr>
<td>Advocate for quality patient care and optimal patient care systems.</td>
<td></td>
</tr>
<tr>
<td>Work in inter-professional teams to enhance patient safety and improve patient care quality.</td>
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</tr>
<tr>
<td>Participate in identifying system errors and implementing potential systems solutions.</td>
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Table 1.7. The ACGME core competencies.
In 2011, the American Hospital Association (AHA) asked its regional policy boards, governing councils, and committees to review the ACGME and ABMS core competencies with regards to their importance and implication within their institutions (Combes and Arespacochaga, 2012). They also discussed if such competencies are truly essential for their newly qualified physicians before entry to the medical field. The results indicated that there are missing competencies within the ACGME’s proposed framework and the AHA recommended the addition of a number of additional competencies in the context of the “skills required for the next generation of health care delivery”. These skills are summarized in Table 1.8.

### 1.4.3.2 The ADEA

The ADEA has members from all the 76 American and Canadian dental schools and provides advise for issues influencing education, research and the delivery of oral health care. Its roles include research, advocacy, meetings and communications, and is the home for the Journal of Dental Education (ADEA, 2017).

<table>
<thead>
<tr>
<th>AHA additional competencies</th>
<th>Leadership training</th>
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<tbody>
<tr>
<td></td>
<td>Systems theory and analysis</td>
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<tr>
<td></td>
<td>Cross-disciplinary training/multidisciplinary teams</td>
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<td></td>
<td>Understanding and respecting the skills of other practitioners</td>
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<td></td>
<td>Population health management</td>
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Table 1.8. AHA skills for the next generation of health care delivery.

<table>
<thead>
<tr>
<th>Skill</th>
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<tbody>
<tr>
<td>Palliative care/end-of-life</td>
</tr>
<tr>
<td>Resource management/medical economics</td>
</tr>
<tr>
<td>Health policy and regulation</td>
</tr>
<tr>
<td>Less &quot;captain of the ship&quot; and more “member/leader of the team”</td>
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<tr>
<td>Empathy/customer service</td>
</tr>
<tr>
<td>Time management</td>
</tr>
<tr>
<td>Conflict management</td>
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<tr>
<td>Giving performance feedback</td>
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<tr>
<td>Understanding cultural and economic diversity</td>
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<tr>
<td>Emotional intelligence</td>
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</table>

Figure 1.6. The ADEA competencies for the new general dentist.
In 2008, the ADEA House of Delegates approved a set of competencies essential for the newly qualified dental practitioners (ADEA, 2011). The ADEA defines competency as “a complex behaviour or ability essential for the general dentist to begin independent, unsupervised dental practice; it assumes that all behaviours and skills are performed with a degree of quality consistent with patient well-being and that the general dentist can self-evaluate treatment effectiveness” and expects their newly qualified dentists to be competent at: critical thinking, professionalism, communication and interpersonal skills, health promotion, practice management and informatics, and patient care; the latter further sub-divided into Assessment, Diagnosis, and Treatment Planning skills and Establishment and Maintenance of Oral Health (Figure 1.6).

1.4.4 Australia

The Medical Board of Australia regulates the medical profession in this country. The board, also known as the National Board, is supported by the Australian Health Practitioner Regulation Agency (AHPRA) and is responsible for developing standards, codes and guidelines for the profession. In addition to this, there are state and territory boards and committees that have delegated power to make individual registration and notification decisions based on the national policies and standards set by the National Board (Medical Board of Australia, 2015).

The AHPRA also supports the Dental Board of Australia (DBA) with responsibilities similar to the National Board: to develop standards, codes and guidelines for the profession. There are eight State and Territory Registration
and Notification Committees working under the DBA and provide registration and notification services at local level (Dental Board of Australia, 2015).

1.4.4.1 The National Board

The Medical Board of Australia has produced several documents on standards for medical profession and codes of conduct but there is no proposal for essential competencies. The Australian Medical Association (AMA), however, has a position statement debating the choice of competency-based medical education within the curricula of the medical schools. The AMA acknowledges that although the CBME has its own strengths but its limitations outweighs its benefits and therefore encourages that medical schools consider using such methodologies with caution (AMA, 2010).

The AMA argues that by using the CBME, simple procedural skills can be taught and assessed but a qualifying medical student requires an integration of congestive knowledge, skills and decision-making skills to render him safe to practice medicine; a complex entity that cannot be easily assessed using CBME. This may result in doctors who may be capable of performing certain skills but not competent as a whole (Donoff, 2009). The AMA worries that the CBME may have adverse effects on the quality of the outcome of the training as medical students are assessed against ability to perform certain procedures instead of meeting certain standards and qualities of care (Kerka, 1998).

The AMA acknowledges that some medical schools may choose to adapt a CBME curriculum and credits the CanMEDS framework but draws the attention of the deans to the significant limitations of such frameworks and insists that "safeguards must be put in place to ensure that high standards of medical
While the medical undergraduate training in Australia is not in favour of competency frameworks and CBME, this position changes immediately post graduation where the Confederation of Postgraduate Medical Education Councils (CPMEC) proposes a set of competencies essential for junior doctors in their first two years after graduation, also known as the “prevocational training”. This framework known as the Australian Curriculum Framework (ACF) consists of five domains (Figure 1.7) but CPMEC insists that the junior doctors should use the suggested competencies “as a self-assessment tool to identify strengths, weaknesses and opportunities for learning and professional development. {These competencies} can then be used as a basis for monitoring {their own} progress during the prevocational years” (CPMEC, 2010a).

The CPMEC, however, repeatedly notifies their users that their set of competencies are “potentially” useful and the CPMEC will be subject to no legal action should any harm to patients occur by using their framework. The statement reads: “the following resources have been identified by members of
the ACF Teaching and Education Working Party (TEWP) as being potentially useful for Junior Medical Officers and/or medical educators. Neither the TEWP nor CPMEC have authenticated information contained in these resources and will not be liable for any loss or damage of any kind to any person caused by use of the information, however caused or suffered" (CPMEC, 2010b).

Inspired by the ACF model, the Australian Medical Assessment Collaboration (AMAC) produced an assessment framework (AMAC, 2012) that targets the assessment of the ACF domains in the contexts of “content domains” and “process domains” (Figure 1.8). The AMAC explains that the purpose of the framework is to (1) assist in development of assessment items that are fit for purpose and (2) help classify existing assessment items into their correct category of assessment.

Figure 1.8. Australian Medical Assessment Collaboration Assessment Framework.
1.4.4.2 The DBA

In 1993, the Australian Dental Council (ADC) was formed as an independent external accreditation entity for the DBA (ADC, 2010). Their roles included development of accreditation standards, policies and procedures for programs of study in dentistry as well as overseeing the assessment of the knowledge, clinical skills and professional attributes of overseas trained dental practitioners who are seeking registration to practise in Australia.

The ADC defines a competent newly qualified dentist as “a scientifically grounded, technically skilled, socially sensitive, professionally minded practitioner who adheres to high standards of professional conduct and ethics and who can function safely and effectively as a member of the healthcare team on graduation and throughout their professional career” (ADC, 2016). Competency, on the other hand is defined as “knowledge, experience, critical thinking and problem-solving skills, professionalism, ethical values, diagnostic and technical and procedural skills. These components become an integrated whole during the delivery of patient care by the competent practitioner. Competency assumes that all behaviours are performed with a degree of quality consistent with patient well-being and that the practitioner self-evaluates treatment effectiveness. The term covers the complex combination of knowledge and understanding, skills and attitudes needed by the graduate. Competencies are outcomes of clinical training and experience”.

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The ADC divides the competencies required for a newly qualified dentist into six main domains, with the "patient care" domain further subdivided into three subdomains (Table 1.9). These domains and subdomains are split into a total of 59 descriptors, each describing what is expected of a competent dentist upon graduation using a broad set of terminology (ADC, 2016).

<table>
<thead>
<tr>
<th>Domain</th>
<th>Sub-domain</th>
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<tbody>
<tr>
<td>Professionalism</td>
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<tr>
<td>Communication and Leadership</td>
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</tr>
<tr>
<td>Critical Thinking</td>
<td></td>
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<tr>
<td>Health Promotion</td>
<td></td>
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<tr>
<td>Scientific and Clinical Knowledge</td>
<td></td>
</tr>
<tr>
<td>Patient Care</td>
<td>Clinical Information Gathering</td>
</tr>
<tr>
<td></td>
<td>Diagnosis and Management Planning</td>
</tr>
<tr>
<td></td>
<td>Clinical Treatment and Evaluation</td>
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Table 1.9. ADC’s domains of competency for a newly qualified dentist

It was interesting to note that the ADC had an emphasis on two concepts that were not commonly seen in the competency frameworks of the other organizations: the financial consent and media. The financial consent is included within the “diagnosis and management planning” subdomain and requires the dentist to be able to "obtain and record patient financial consent for treatment" and the media is included within the “communication and leadership” domain, expecting a competent dentist to be able to “communicate responsibly and professionally when using media”. When trying to define media the ADC was explicit that the media includes the modern social networking platforms, including Facebook, Twitter, LinkedIn, e-mails and Short Message Services (SMS).
1.5 Role of assessment in CBE

Assessment is not an afterthought but a critical part of the teaching and learning process. A well-designed assessment not only distinguishes between the passed and failed candidates but also can encourage learning by affirming the areas of strength and highlighting the areas that require improvement. Over the past few decades, the teaching methods have been subject to considerable changes. The educationalists better understand how adults learn (Reed et al., 2014) and have tried to create teaching methods that suit this cohort of learners better than ever before (Biggs, 2011; Bligh et al., 2001; Dent et al., 2017; Fish and Coles, 2005; Kern and Thomas, 1998; Oliver et al., 2008; Schulz et al., 2013). The technology has also been subject to massive improvement and many teaching methods have started to incorporate technology into their stem (Shahriari Rad, 2013).

On the other hand, our generation of patients are changing; our patients are much more aware of their rights, have higher expectations of the healthcare system and have a rather low threshold of filing legal actions against the clinicians (Vincent et al., 1994). As a result, regulatory bodies are emphasising producing ‘competent’ graduates and are forcing medical and dental schools to ensure that their training and assessment systems achieves this goal.

However, this statement is much easier said than done. Designing a “perfect” system of assessment is not an easy task. Medical literature on assessment is rich and several authors have suggested different instruments and tools for assessing medical and dental students at different levels (Epstein, 2007;
Epstein and Hundert, 2002; Hager et al., 2006; Hodges et al., 1999; Kane, 1992; LaDuca et al., 1984; McMullan et al., 2003; Pugh et al., 2015; Smith et al., 2003; van der Vleuten, 1996) but what is the best way to assess students to ensure that they are competent?

1.6 Definition of assessment

Although it is generally believed that assessment is a fundamental part of the education process, however, it has been defined very differently amongst the educationalists. On one extreme, assessment can be considered as a simple certification process leading to a pass/fail decision; whilst on the other extreme it is considered as an important part of the evaluative or feedback action in education. Scholars (Schuwirth and van der Vleuten, 2010) have defined assessment as “any purported and formal action to obtain information about the competence and performance of a candidate” and this would be the definition used throughout this piece of work.

Assessment is never taken without a purpose; hence, depending on the outcome goal, assessment can be divided into summative and formative. Summative assessment is conducted for decision-making or certification purposes. Formative assessment is more related to the feedback function of the assessment and is usually used to inform the students of their performance. Educationalists have different points of view on mixing the two types. Some argue that pure summative assessment with only a pass/fail mark does not help the students to recognize their strength and weaknesses. If a student fails, they do not have an idea on what they need to improve in their education. On the
other hand, pure formative assessment will not be taken seriously (Schuwirth and van der Vleuten, 2010).

Once the purpose of the assessment is defined, it is important to choose a method of assessment that clearly reflects the purpose. To date, many assessment tools have been created and are in use. To evaluate and compare these tools, educationalists have come up with several test properties. The most popular properties are described below:

1.6.1 Reliability

“The reliability of a method reflects the reproducibility of its results” (Schuwirth and van der Vleuten, 2010). When a test is highly reliable, it is highly likely that it produces the same result each time it is run. This similarity can be explored from three slightly different angles: the absolute score, the relativity and the boundary. Here are some examples to explain these:

Example 1 – the absolute score: David score 78% in a test. If David were to sit a similar but different test (also called a parallel test), would he score 78% again?

Example 2 – the relativity: In a class of students, David has the best score. Lucie comes second and Nick has the worst performance. If the class were given a parallel test, would the ranking remain the same?

Example 3 – the boundary: In a sitting, David passes the test with distinction. The cut-off score for distinction was 70%. In a parallel test would David pass with distinction again?
The fact of the matter is that in reality we do not run a parallel test; therefore we need to incorporate mathematical techniques to help us calculate the reliability score of a test. Generally there are two models designed for this purpose: (1) the test-retest model, analyses the same candidate’s performance in the same test on two different occasions while (2) the parallel testing model assesses the same candidate using different tests with questions that are thought to be similar. Either way, a reliable test should give very similar results on both occasions. Mathematically, psychometricians model the responses of candidates in different ways with three broad approaches (Schuwirth and van der Vleuten, 2010):

1.6.1.1 Classical test theory (CTT)
There is an assumption that each student has a true ability or score, however, due to different measurement errors, the candidate does not gain the exact same mark when an identical test is used on two occasions. The similarity of the marks is used to measure the reliability, which becomes higher as the measurement errors become lower.

A similar approach is used for comparing parallel tests. CTT works best with multiple-choice tests where all candidates answer identical questions. Its major drawback is the fact that reliability calculated from a group of students cannot easily be expanded onto other groups. The reliability results can further get compromised if there are a few outstanding bad students within the sample group. CTT reliability is also very misleading as a description of the accuracy of a cut-off score (pass / fail boundary) in high-stakes examinations (Schuwirth and van der Vleuten, 2010).
1.6.1.2 Generalizability theory (GT)

In a typical clinical examination, there are several factors that introduce variability: the examiners are different and behave differently, clinical scenarios may defer from one candidate to another, and some candidates may perform better in certain case scenarios than others. GT generalizes CTT to include such components and works better in these types of clinical examinations.

A measure equivalent to reliability (or called “generalizability” when this theory is used) can be calculated: in effect, how similar would a candidates’ mark be with different examiners and different scenarios? GT allows sophisticated calculations of the effects of different types of exam for example: would the exam be more generalizable with more stations and fewer examiners per station? The untested assumption is that examiners and candidates will behave in precisely the same way in such new situations. As with CTT, GT estimates of generalizability cannot be easily translated into new situations (Schuwirth and van der Vleuten, 2010).

1.6.1.3 Rasch modelling (RM) and item-response theory (IRT)

RM starts with the assumption that every test item has a particular difficulty, with the probability of a candidate answering an item correctly depending on the item’s difficulty and the ability of the candidate. Mathematical modelling allows the item difficulties to be calculated, as well as candidates’ abilities. A new test comprised of previously used items from an item bank used in different combinations can have its reliability calculated before the test is used. The reliability can also be calculated for candidates of differing ability; for example,
fourth-year students rather than third-year (Schuwirth and van der Vleuten, 2010).

IRT is an extension of RM that not only calculates the difficulty of items, but also calculates discriminative value and chance-guessing rates. IRT requires large data sets and is best used for large-scale examinations with thousand-plus candidates. RM, however, is robust with small numbers. RM, however, cannot handle clinical situations with different scenarios and examiners (Schuwirth and van der Vleuten, 2010). The major problem for RM and IRT is not the conceptual basis, which is rigorous, powerful and realistic, but the poor mathematical and statistical skills of those in charge of the assessment (Schuwirth and van der Vleuten, 2010).

It is important to note that the largest source of poor reliability is sampling error. Usually a test is comprised of samples of questions from a range of possible questions. Because items can differ in difficulty, and different people can find different items difficult, sampling error arises; for example David does better in ‘Occlusion’ while Nick does better in ‘Removable Prostheses’.

The same applies to other assessment modalities, for example, the examiner’s choice of questions in oral or short essay examinations. One can conclude that as sampling error is such a major issue, brief assessments and assessments based on the observation of only one examiner are very likely to have poor reliability.

The other point to consider is the relationship between reliability and objectivity. A common misconception is that subjective assessment is always unreliable
and objective assessment is always reliable (van der Vleuten et al., 1991). This is not generally true and the following two examples will illustrate why:

Example 1: A one-item multiple-choice examination is objective but it only has one item and cannot be reliable.

Example 2: A panel of examiners is supposed to mark students on their alginate impression taking. Two candidates are selected, one from the 2nd year BDS class and one from the 5th year BDS class. After the impressions are shown to the panel, the panel recognizes the work done by the 5th year dental student to be superior to the 2nd year student’s. If another student is selected from the 5th year group and the exam repeated, the panel would reach the same decision. Here, although the nature of the assessment is subjective but it is highly reliable.

In conclusion, reliability depends highly on careful sampling. It relies on sufficient large sample through all possible sources of error, for example, items, examiners, and test occasions.

1.6.2 Validity

Validity is defined as “the extent to which the competence that the assessment claims to measure is actually being measured” (Schuwirth and van der Vleuten, 2010). It is important to highlight that this is not always easy to demonstrate and to determine the validity of a test method, evidence should be collected from different angles.

In the same way that a scale is used to measure weight, not height or temperature, it is very important to remember that each assessment method is
only valid to measure a certain aspect of competence; therefore, the first step is
to determine exactly for what purpose an assessment method is valid.

Validity has been defined in numerous ways and in its most simplest way it is
divided into two main categories:

1.6.2.1 Content validity (direct validity)
An exam should be representative of the whole testable domain. For example,
an examination on the ‘Temporomandibular Disorders’ should not be consisted
of only items on ‘Anatomy of the Articulatory System’. To ensure adequate
coverage, a test is usually made based on a ‘blueprint’. The blueprint is a matrix
in which the test maker determines how many items per subject or category are
to be asked. Another issue to remember is the relevance of the items. Only
relevant items contribute to the content validity of the examination.

1.6.2.2 Construct validity (indirect validity)
A construct is a personal psychological characteristic that cannot be observed
directly but which is assumed to exist. A typical example is the notion of
intelligence. We assume this construct to have certain characteristics: more
intelligent people can learn faster, have superior memory skills and are better
able to solve problems than less intelligent people. If we were to design a new
test to measure intelligence, we would hope that people who learn faster
outperform people who learn more slowly, and demonstrating this would
contribute to the validity of our new test. Applying this principle to tests for
medical problem solving means that for a test to have good construct validity, it
would be necessary for people who solve problems more expertly to outperform
those who are less good problem solvers (Schuwirth and van der Vleuten, 2010).

1.6.3 Educational impact

There is a belief that assessment has a major impact on students learning behaviour (Newble and Jaeger, 1983; Frederiksen, 1984) and hence the saying “Students don’t do what you expect; students do what you inspect”. This is normal human behaviour and we are all susceptible to these external motivators. The driving influence of assessment is a powerful tool to ensure that students learn what and how their teachers want them to learn. To maximize this effect, it is important to bear in mind that assessment influences students’ learning in several ways: through its content, its format, the scheduling of examinations and the regulatory structure of the assessment programme.

The influence of content is obvious. Items that come frequently in examinations are perceived to be more important by the students. Literature, however, has different views in regards to format. Some studies showed that the students prepare differently for different formats of examinations, especially multiple-choice versus open-ended (Stalenhoef-Halling et al., 1990) and some showed that they in fact prepare similarly and the difference is in the perception of the student (Hakstian, 1971). Therefore, it is recommended that different formats of assessment to be used. This way the student will not get used to one type of preparation.

A typical problem with scheduling concerns annual examination periods. When several examinations are held during the same few weeks, the students will not have enough time to adequately prepare for all of them; therefore, they will
strategically choose the ones for which they prepare well over the ones they don't. From the faculty point of view, this is a waste of precious resources as time and money is put to construct a high quality examination that is not taken seriously. Therefore it is better to spread the examinations than to cluster them. Because educational impact is such a major effect of assessment, it is also seen as part of validity, specifically termed “consequential validity” (Schuwirth and van der Vleuten, 2010).

### 1.6.4 Cost-effectiveness

To assess the cost-effectiveness of a test, two factors need to be considered: what is to be assessed and how it is to be assessed. Only then an evaluation can be done to demonstrate the method of interest is optimally cost-effective or not. The most important factors compromising cost-efficiency are misconceptions based on tradition and intuition, poorly infrastructural support and lack of collaboration (Schuwirth and van der Vleuten, 2010).

Some of the traditional exams include unstructured viva voce examinations, and open-ended questions. The unstructured viva voce exams have poor reliability (Swanson, 1987a) and are often used to access factual knowledge, which can be assessed using more cost-effective methods. It is important to note that oral examinations have their place in medical education but they should only be used when they have an added value over other formats (Wass et al., 2003). There is also this common belief that open-ended questions assess the students on higher-order cognitive skills that multiple-questions cannot; however, the literature concludes that the matter of question format is quite unimportant and what matters is the content of the examination (Maatsch and Huang, 1986; Norman et al., 1987; Schuwirth et al., 1996). Having said that, open-ended
questions have their own place in medical education. They do work very well when creativity or spontaneous generation of the answer is required (Schuwirth and van der Vleuten, 2010).

Examples of poor infrastructural support that compromises cost-effectiveness include lack of good item banking and absence of a centralized management and administrative support for the logistics and administration of examinations. The consequences are that the ‘expensive’ academic members of staff carry out work that could be done just as well – or even better – by administrative personnel.

Also, many dental schools have comparable curricula and comparable objectives. Sharing test materials will reduce costs and prevents everyone inventing the wheel (van der Vleuten et al., 2004). Unfortunately collaboration is not easy. Careful planning, commitment of all partners and some sort of pre-investment are pre-requisites for successful collaboration.

1.6.5 Acceptability

Creating a test cannot be done in isolation. Even the best assessment method is useless if teachers and students do not subscribe to it; therefore, for an assessment to be acceptable, a careful balance between what might be educationally and scientifically superior and what is acceptable by the stakeholders should be struck.
1.7 Popular assessment instruments

A perfect assessment method does not exist and no single assessment instrument can test all aspects of medical competence and performance. Each instrument has its own strengths and weaknesses. A good assessment programme therefore should utilize different methods of assessment to assess the students from several angles (Schuwirth et al., 2002; Van der Vleuten and Schuwirth, 2005a). The following text reviews the commonly used forms of assessment and their strengths and weaknesses.

1.7.1 Written assessment instruments

There are several written assessment tools in use. Some are case-based, some are context-free. Some are open-ended and some use multiple choice. As a general rule, the amount of time it takes to answer a question has a negative impact on the reliability of the test (Schuwirth and van der Vleuten, 2010). A test can only sample from a domain of possible options; therefore, the sample should be large enough to be reliable. This means that a test with more items is more likely to be reliable. This immediately questions the reliability of open-ended questions as they require more answering time; therefore, essays are generally less reliable per hour of testing time than short-answer questions.

Validity, however, is a much more complex issue in written items. Many people think that open-ended questions test higher-order cognitive skills while the multiple choice questions can test only factual knowledge. This is a widespread misconception: the question format is quite unimportant with respect to validity, where as the question content is very important (Maatsch and Huang, 1986; Norman et al., 1987; Schuwirth et al., 1996); in other words, what you ask is
important not how you record the answer. Naturally some contents do not fit certain formats, therefore, careful consideration of content is essential.

A further and important distinction related to context. Context-rich items contain a case description and questions that ask for essential decisions or an evaluation of the problem. Typical examples of these are extended-matching items or key-feature approach items (Bordage, 1987; Case and Swanson, 1993; Page et al., 1995). Context-free items do not have a case description and simply ask for general knowledge while context-rich approaches test application of knowledge and problem-solving (Schuwirth et al., 2001).

Another aspect of educational impact is the influence that the format of assessment has on its test makers. If for example, all tests were supposed to be in multiple-choice format, test makers would create items that fit this format only and questions, which require spontaneous generation of answers will be omitted. On the other hand, if only open-ended questions were used, it will result in increased workload for the faculty to mark them, therefore they will start asking simple questions that are easier to mark. This can potentially lead to neglecting some important aspects of the course.

Cost-effectiveness is also a very important aspect to consider. Amongst the written assessment formats, the multiple-choice-based assessments are highly cost-effective. They might be slightly more difficult to produce but then the use of technology makes them easier to score. This can play an important role when dealing with a large class. From the view point of cost-effectiveness, open-ended questions have a place only if other more efficient methods will not suffice.
1.7.2 Objective structured clinical examinations and simulated patients

Objective Structured Clinical examinations (OSCEs) and simulated patient (SP)-based examinations have become very popular for the assessment of practical skills (Harden and Gleeson, 1979; Stillman et al., 1980). Both of these assessments are based on a series of structured cases. In an OSCE, the candidate enters rooms or stations and is expected to perform a task, usually of a clinical nature. The candidate would be then marked against a checklist. The time for each station is fixed and once the time is up, there would be a signal, indicating that the candidates are supposed to move on to the next station.

OSCEs and SP-based examinations were created to address the unstructured observations on the clinic. Their design is aimed to overcome three issues in regards to the unreliability of the observed practice (Newble and Swanson, 1988): (1) by adding structure to the observations they become more reliable, (2) more observations can be made per hour of examining, allowing wider and more effective sampling, and (3) the examiners get sampled as the candidates move between the stations.

While the biggest threat to reliability of a test is having too small of a sample, sampling across many cases in an OSCE becomes a great advantage. In terms of validity, there are two factors to consider: the length of the station and use of checklists versus global rating scales. Longer cases will have more content but one may argue that this will jeopardize reliability; however, this is not necessary the case. It has been recommended that the length of the station should be determined according to the content of the station and therefore it can vary from 5 to 20 minutes (Varkey et al., 2008). The type of the skill to be assessed can determine the use of checklists or global rating scales. Some authors suggest
use of checklists for assessing technical skills and global ratings for more complicated tasks; for example a short patient contact (Schuwirth and van der Vleuten, 2010).

In general OSCEs are taken very seriously by the students and have shown to have a high impact on students’ learning behaviour but they are expensive to run and should be used efficiently (Schuwirth and van der Vleuten, 2010). On the other hand, there is always a threat of students gaining access to the checklists and therefore, learn the checklist rather than the actual procedure.

1.7.3 Oral examinations

Oral examinations come in a variety of formats: from completely unstructured to highly structured, case based examinations. The oral examinations have been considered to be unreliable and expensive; however, it has been recommended that there is room for an oral examination in a programme if it is used correctly and for the correct purposes (Wass et al., 2003). It has been recommended that the oral exams should have some structure to improve their reliability; however, too much structure can have a negative effect. Also, the examiners should be trained to cover a variety of topics instead of asking questions on their own speciality (Schuwirth and van der Vleuten, 2010).

The oral exams are expensive to run and therefore if they are planned, they need to be aimed at examining aspects that cannot be examined otherwise, such as hypothesis generation, explanation, problem solving, and metacognition. If the intention is to assess factual knowledge, this can be achieved using far less expensive methods.
The same as many other types of examinations, students can prepare strategically for the oral exams by finding out who the examiners are and what their favourite subject consist of.

1.7.4 Work-based assessment

Similar to OSCEs that assess students in a simulated environment, work-based assessment instruments, such as mini-CEX (Clinical Evaluation Exercise) and 360-degree feedback assess candidates in their professional environment (Magnier et al., 2012; Norcini et al., 1995). Mini-CEX uses a generic form that the examiner uses to rate candidate’s patient encounter. The assessment can cover several aspects, for example: history taking, patient management, examination, and communication. The 360-degree feedback uses rating scales and is filled in by people from different levels who have been involved in or have witnessed provision of care by the student. These could be colleagues, nurses, technicians, or patients.

Similar to OSCE, for the mini-CEX to be reliable, sampling is the key; therefore, a sufficient number should be provided (roughly 7 to 10) and a variety of cases should be observed and this has to be done by more than one examiner (Norcini et al., 1995; Williams et al., 2003).

The 360-degree assessment is not based on direct observation but on judgment in retrospect. Naturally this judgment can be very unreliable but two aspects compensate for this drawback in this tool: the fact that a number of judges provide feedback and also the fact that the judges are not asked for global impression but to give a judgment about specific aspects of someone’s strengths and weaknesses (Schuwirth and van der Vleuten, 2010).
These instruments are not only aimed at measuring candidate’s competence but also are used as means to provide extensive feedback. This feedback is supposed to have an influence on candidate’s learning. Also, these instruments are not supposed to be completed if the observer has not directly observed the candidate during the procedure; therefore, they can change the culture in those educational environments where direct observation is not routinely done (Schuwirth and van der Vleuten, 2010).

1.7.5 Portfolios

From the assessment point of view, the word portfolio can be used to describe two assessment methods: (1) portfolios as an instrument to measure the reflective ability of the candidate, and (2) portfolios as an instrument to collate assessment information from various sources.

In both cases, the portfolio is used as an “archive” as well as a place to “analysis” the outcome. The analysis contains a self-assessment of strengths and weaknesses, learning goals and learning plan (Schuwirth and van der Vleuten, 2010). The reflective portfolio focuses on self-assessment; it assesses the extent to which the self-assessment demonstrates a good reflective ability. The archive portfolio gathers all the assessment information about the candidate.

Portfolios are expensive: they are time consuming to make and assess, especially if more than one judge is needed for marking. Training of the assessors to use global criteria for judging the portfolio is a more cost-effective approach. It may be more efficient to use single judges in all the straightforward
cases and reserve double marking for the cases that there are doubts about the results (Driessen et al., 2005).

1.8 How to choose the right tool for assessment?

In 1990, Miller (Miller, 1990) proposed his pyramid of hierarchy of the clinical competence (Figure 1.9). The pyramid was used to categorize the methods of assessment. Knowledge (knows) is at the lowest level of the pyramid followed by competence (knows how), performance (shows how) and action (does). In the past, many institutions believed that knowledge base is all that needs to be assessed, largely through objective test methods, which used to dominate institutional and specialty board examination systems. However, “there is nothing more useless than a merely well informed man” (Whitehead, 1959). This highlights that although assessment of the knowledge is important but there is more to medicine than just knowing and there should be other tools available to assess trainee doctors in higher levels.

Figure 1.9. Miller's pyramid of competency.
The trainees should be able to know how to use the knowledge they acquired. They should have the skills to be able to gain information from a variety of human and laboratory sources; should be able to process and analyse this data and reach a diagnosis. They should be able to discuss their findings and formulate a treatment plan and present this to their patient and their carers.

There are a number of assessment tools available to probe such skills, however, none of them have shown that there is a relationship between the fact that when a trainee knows how to do a procedure, he or she can also show how is it done on a patient. There have been claims that this level can be assessed by observing a trainee in the clinical setting during their routine patient encounters, however, the danger is that these judgments can be made without direct observation of the trainee doctors or without adequate sampling of the clinical problems. These judgments can potentially assess the ‘outcome’ of a clinical encounter rather than the accuracy of the process through which a diagnosis was reached or a procedure was done.

Work-based assessment tools represent the top two sections of the pyramid. What seems to remain unanswered is that how accurately these tools can predict what a trainee doctor does when he or she is working independently in the future. When these tools are used by trained assessors using standardized checklists or rating scales and a direct observation of the candidate is made, a high level of reliability would be achieved; however, most of these tools fail to demonstrate enough sampling and therefore cannot be used when a conclusive decision needs making over a student’s clinical performance (Schuwirth and van der Vleuten, 2010).
Albino et al. conducted a comprehensive review of the literature published on assessment of competence in dental education (Albino et al., 2008) followed by a survey of the assessment strategies of all the dental schools in the US with an aim to tag different assessment methods to different levels of cognition and performance. Their work is summarized in Figure 1.10. Based on their literature review they chose 17 assessment methods to be suitable for use in the dental education setting. These methods ranged from context-free MCQs aimed at assessing recall knowledge to longitudinal evaluations aimed at assessing students’ performance on the clinic.

They also divided the required competencies of a dental student into six domains: biomedical knowledge, professional behaviour, personal qualities, concern for patient’s well-being, patient examination skills, patient interviewing and communication skills, ordering and interpreting diagnostic tests, performing...
technical procedures, and resource use and functioning within the healthcare system and aimed to tag the most commonly used assessment tools to these domains. This work is summarized in Table 1.10.

From their survey of the US dental schools it was interesting to note that the context-free and case-based MCQs were the most popular methods of assessment, totalling 28% of all the methods used. Daily evaluations on the clinic and competency tests were next in the rank with 12% and 11% respectively. OSCEs were 13th on the list, used by 3% of the course directors in the US (Albino et al., 2008).

1.9 Where are we? What is the challenge?

Most of the modern curriculum design methods are student-centred and outcome-based. When the medical and dental educators use such curricula, the outcome is usually set as professional competence. A review of the regulatory bodies of four English-speaking advanced countries revealed that, although one may expect that these countries should have similar goals of training in mind, there are several differences; presumably due to differences in the healthcare systems and needs of the patient groups.

On one side of the spectrum, Canada is leading in the field of CBE, with their theories tried and tested for the past 12 years. In contrast, Australia had a very cautious approach towards CBE, claiming that such curricula result in students sacrificing quality and clinical excellence for the sake of paperwork exercises and collecting signatures.
Table 1.10. What domains of competence can be evaluated with assessment methods commonly used in health professions education?


The GDC in the UK, as the sole regulatory body for the dental professions, has put “patient safety” in the forefront of its outcomes expected of a newly qualified dentist, which is in line with several other regulatory bodies. On the other hand, however, the GDC expects the newly qualified dentist to demonstrated observed
and assessed competences in four domains: clinical, communication, professionalism, and management and leadership; far less granular than many of the other regulatory bodies.

Although it is possible that the less granular outcomes specified by the GDC are just a consolidated version of the same expected competencies, this is unlikely to be the case. For example, in CanMEDS there are several competencies nested within the domain of “medical expert” that seem essential to any medical or dental profession but are not listed within the competencies of the GDC, including “critical thinking”, “decision making”, “continuity of care”, and “prioritization of professional responsibilities”. One may argue that we are training dentists who are just competent by the standards of the GDC but at the same time hoping that the dental schools are having the extra essential outcomes covered somewhere in their own curricula.

Also after a decade of CanMEDS being in use, they concluded that their “management and leadership” domain should be replaced with “leadership” only. They argue that “management” is an advanced skill, gained by several years of experience and directed training. A newly qualified doctor may not be a competent manager; however, they found “leadership” a necessary skill for the newly qualified doctors, as they need to “lead” the medical team who is working with them. In contrast, the GDC is expecting newly qualified dentists to be leaders and managers in their day 1 of the practice. If this is the expectation, are our dentists trained to such standards?

On the other hand, the literature on assessment methods and their properties, place of use, and pros and cons is rich but are we utilizing the right tools and practicing based on the best practice recommendations?
In this project we aim to address a number of uncertainties:

(1) While there is abundant of data available from regulatory bodies on their “wish list” of competence for their newly qualified doctors and dentists but we do not know how the profile of such newly qualified clinicians look in reality. The GDC, as the sole regulatory body for the dental profession, has its own “wish list” of competency domains. Our goal is to understand how competent the UK new dentists really are and therefore we aim to explore how the trainers perceive competence and what does that tell us about assessment.

(2) When it comes to assessment of competence, students are a major stakeholder being at the centre of the assessment process. It is important to explore their point of view of being competent and more importantly to explore what assessment methods are the most reflective in demonstrating how competent they are.

(3) Based on our understanding of competence and assessment of competence of the UK dentists, we aim to explore what assessment tools are used nationwide and explore if their use complies with the best practice recommendations.

(4) If considered best practice, we would like to explore if there are any ways to improve on the methods of assessment that we use to assess competence; and finally,

(5) We aim to explore if there is a completely new way to assess and record competence.
Chapter 2
2 Competency: the expectations

2.1 The Dental Foundation training

All the newly registered dentists in the UK are required to spend a year as a Foundation Dentist (FD) in a supervised environment before they are allowed to treat NHS patients independently (COPDENT, 2016). This supervised environment is usually within an NHS general dental practice setting with the practice owner acting as the Educational Supervisor (ES).

The ESs undergo a strict selection process and receive extensive training before they are permitted to recruit dentists on the Dental Foundation Training programme (DFT). The Health Education England (HEE) is responsible for the salary of the FD, making the DFT an opportunity for the FDs to practice NHS dentistry under supervision without financial pressures.

2.2 Competency of the “Safe Beginner”

The outcome of dental education in the UK is producing dentists who are “safe beginners”. Such safe beginners are no threat to the safety of the patients but still have gaps in their knowledge and skills. The GDC describes such a safe beginner as “a rounded professional who, in addition to being a competent clinician, will have the range of professional skills required to begin working as part of a dental team and be well prepared for independent practice. They will be able to assess their own capabilities and limitations, act within these boundaries and will know when to request support and advice” (GDC, 2011b).
The safe beginner should possess a total of 150 prescribed competencies upon graduation, demonstrated under the umbrella of four main domains (GDC, 2011b). While under such prescriptive regulations one may expect that all the newly qualified dentists should demonstrate adequate minimum standards but anecdotal evidence and “world of mouth” of the ESs suggests otherwise. It is not known what level of competence the newly graduate dentists possess and more importantly, what the ESs expect.

There is no evidence in the literature to support the validity of the GDC’s 150 competencies nor there exist any publications on the expectations of the ESs of their trainees on their day 1.

**Aim:**
To understand the expectations and experiences of Educational Supervisors (ESs) regarding the competence of Foundation Dentists

**Objectives:**
1. To explore the common areas of clinical competence
2. To explore the common areas of lack of competence
3. To understand how ESs deal when lack of competence is observed
4. To explore if there is a relationship between the school of graduation and clinical competence of the foundation dentist
The following paper is written in preparation for submission to the European Journal of Dental Education.

The references are included in the Reference Chapter of this thesis to avoid duplication of the data.

List of authors:

Mr Reza Vahid Roudsari
DDS MSc PGDip MFDS FDS (Rest Dent)
Clinical Lecturer and Consultant in Restorative Dentistry. Assessment Lead for the BDS and BSc OHS Programmes.

Professor Nick Grey
BDS, MDSc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education. Faculty Associate Dean for Teaching and Learning. National Teaching Fellow.

Dr Lucie Byrne-Davis
PhD CPsychol
HCPC Registered Health Psychologist. Lecturer in Assessment and Psychometrics. Academic lead for phase 1 assessments

1 Division of Dentistry, JR Moore Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PL

2 Division of Medicine, Stopford Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PT
A qualitative interview study of the expectations and experiences of Educational Supervisors regarding the competence of Foundation Dentists

Background

In the UK, the GDC is responsible for the regulation of the dental profession. All the graduates in dentistry or the allied professions need to seek registration with the GDC to be able to work in the UK. The registered dentists are obliged to respect the standards set by the GDC (GDC, 2013b) and work within their scope of practice (GDC, 2013a). The GDC has placed “patient safety” in the forefront of these standards (GDC, 2013b) and has made it the responsibility of the dental schools to ensure that their graduates preserve the safety of their patients (GDC, 2011b).

The GDC has named such newly qualified dentists as “safe beginners”. Such beginners are clinically competent, can work as part of the dental team and are ready for independent practice without jeopardizing the safety of the public (GDC, 2011b). Many of the UK graduates opt for a year of DFT whereby they get the opportunity to see and treat NHS patients under the supervision of an ES (COPDENT, 2016). The ES is a trained experienced clinician who takes the responsibility of supervising and educating the safe beginner dentist for a period of 12 months.

The selection process for the ESs is comprehensive and the suitable candidates should demonstrate wealth of knowledge and expertise in the field before they
are able to take on such a role. The ESs are further supported by the Health Education England (HEE) via their allocated Training Programme Director (TPD). The ESs receive training on how to introduce the Foundation Dentists (FDs) into the practice, how to manage their workload and also how to deal with the FDs in difficulty (COPDENT, 2015).

Before UK dentists are graduated, the GDC expects the dental schools to assess and record the successful completion of a number of competencies under the four domains of clinical competence, professionalism, communication, and management and leadership (GDC, 2011b). One may assume that the UK graduates should be competent in all of the competencies mentioned by the GDC; however, no research has been conducted in an attempt to draw a picture of what the ESs expect of a day-1 dentist and what they really look like. The evidence published so far on the UK graduates has been dominantly on “confidence” and not the “competence” of the graduates and predominantly based on questioners with low return rate and hence poor validity and generalizability (Gilmour et al., 2016; Honey et al., 2011).

The aim of this qualitative study is to analyse the expectations of the ESs of their new FDs and explore the true abilities of such new beginners in the UK general dental setting.

**Materials and methods**

Favourable ethical approval was sought for this study (ref 13244, Appendix 9.1.1). The Postgraduate Dental Dean for HEE North West was contacted about the study and invited to contribute towards advertisement of the project to the current ESs. Qualitative methods were selected for this study to allow the
development of independent, substantive themes exploring ES’s expectations of the competencies of the day-1 dentists. It also permitted further exploration of their experience of the actual competency of the FDs.

Qualitative research may be described as arts-oriented rather than scientifically oriented. It is primarily concerned with words and their meanings in different contexts whereas quantitative research is predominantly concerned with numbers and their significance (Bush et al., 2013). Summarising themes, rather than counting and measuring, is the keystone of qualitative research. Instead of testing hypotheses through the use of experiments or surveys and applying statistics or mathematics to the data collected, qualitative researchers collect and analyse the themes in observations, transcripts or documents (Edmunds and Brown, 2012).

<table>
<thead>
<tr>
<th>Experience of being an ES</th>
<th>&lt; 5 years</th>
<th>5 – 10 years</th>
<th>&gt; 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience of having a trainee in difficulty</td>
<td>Yes</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>

Table 2.1. Purposive sampling matrix

To improve the generalizability of the study, purposive sampling was done using the matrix illustrated in Table 2.1. For this reason, the postgraduate dean was asked to personally approach the ESs who fit the matrix in addition to their advertisement by email. This ensured that ESs with a range of experience were invited to the study and those who have had experience of FDs in difficulty are also included. The study advertisement and the Participant Information Package (PIP) was sent to all the ESs under the remit of the HEE Manchester Office.
The advertisement, recruitment and data collection occurred between March 2014 and December 2016. The ESs contacted the researcher via email. A mutually agreed time was selected for the researcher to travel to the dental practice of the ES. Informed consent was obtained and the data collection was done using structured one-to-one interviews by a single trained researcher (RVR). The interviews were recorded using a digital voice recorder and were transcribed verbatim using an independent professional transcription service. The anonymity and security of the data were assured at all time.

The transcribed data were analysed by the same researcher using a thematic approach and confirmed by the research supervisor (LBD). The initial analysis of the data resulted in small adjustments of the questions in the structured interviews and applied to the future data collections. The interviewees were given the opportunity to raise any issues about the competency of the FDs that were not covered by the questions.

**Results**

A total of five structured interviews were conducted. The interviewed ESs had a range of experience from 3 to 17 years, two of which also had the experience of dealing with trainees in difficulty formally. The analysed data resulted in a number of emerging themes that are discussed here.

**The profile of the UK day-1 dentist**

The analysis of the data revealed that the ESs have a very clear expectation of their starting FD. This newly qualified dentist possesses a number of abilities and lacks many, predominantly due to lack of experience in the dental school. In the ESs’ point of view such profile is not equal to incompetency but how a newly
qualified dentist usually looks like. Having said that, it became apparent that such expectations are domain-specific, which are presented here.

**Diagnostic and treatment planning skills**

The ESs agreed that taking history, examination skills, interpretation of the diagnostic tests and finally formulating a sound treatment plan are among the bare minimum expectations of a starting FD. They agreed that communication skills needed to build rapport with a patient and taking the relevant history is an absolute pre-requisite for being able to perform such tasks. The ESs confirm that “one thing (that they) like (to see the FD is doing) is (building) relationship with patients”. “{The FDs} got to be capable of greeting patients” and “taking a good medical history {and they should be able to} interpret that medical history.”

The ESs emphasized that they expect their FDs to be comfortable and confident in performing examination “of child and adult {patients}” for both “dentate and edentulous {mouths}”. They expect them to have a working knowledge of running the diagnostic tests, although they admit that FDs may struggle with running the diagnostic tools and machines initially. This is simply due to the differences in the technology used in the Dental Schools and the practices:

> “they might have to learn the actual individual machines that are in a practice, 
> but they should have a working knowledge of what they are using.”

Once the FDs have collected all the relevant information through history, examination and diagnostic tests, they should have the ability to “connect the dots”, interpret all that information and reach a diagnosis. Based on this the FD should be able to formulate a sound treatment plan for that individual patient. This treatment plan, however, may or may not be fully doable by the FD under
their limited range of clinical skills and expertise but they should be aware of when, where and how to seek help for the items of the plan that is beyond their scope of practice or skills set.

“… so I would expect them to be able to make correct, sort of, diagnosis of … dental disease, I suppose within reason, you know, there maybe the odd unusual thing that … they might struggle with, but for the vast majority of cases … I would expect them to be able to make correct … diagnosis.

{Then they should be able to} draw up some form of suitable treatment plan suitable for an individual patient and then be able to, you know, either undertake the procedures that they’ve decided in that treatment plan or know which areas that they are suitable to treat and where they could find help to complete the treatment plan if there’s something they feel they aren’t suitable to carry out for that person.”

“They know a lot of the theory, ‘cause obviously they’re fresh out of dental school, they have a lot of theoretical knowledge. And, again, they need to know when to approach me and ask for advice”

The ESs interviewed in this study were involved with direct supervision of over 60 FDs between them during the years of their service and they can confirm that the UK graduates are generally very strong at diagnostic and treatment planning skills:

“… and, you know, my experience is the majority of the foundation dentists I’ve had, the basics of taking history, coming up with diagnosis, and stuff like that,
they’ve been pretty good really. It tends to be certain aspects of, perhaps, dentistry that either they feel less confident in or competent in, sorry.”

Compliance with the regulations

Another important domain was the compliance with the regulatory bodies. This on its own not only emphasized the need for a working knowledge of the existence of such regulations and their content but also a practical approach on how to implement such recommendations into the practice:

“… and to be aware of regulations. I think that’s a fundamental issue!”

Although the GDC is the main regulatory body for all the practicing dentists in the UK; however, their name was not mentioned by the ESs; presumably due to the fact that compliance with the GDC is assumed by default. Among the regulatory bodies mentioned, Faculty of General Dental Practitioners (FGDP) was one:

“Try and follow the faculty, or the FGDP. Certainly an awareness of that, we’re happy to fine-tune that…”

Such an expectation can indirectly demonstrate that the ESs are expecting their FDs to have an evidenced-based approach into their practice. The website of the FGDP is an excellent resource of documentations, publications and guidelines, all tailored at the level of the general dental practitioners (GDPs). This includes publications on good practice guidelines on clinical examination and record keeping, antimicrobial prescribing, and key skills in primary dental care. The website also provides a comprehensive list of training courses, all
Pitched at the GDP level, offering hours of verifiable CPD (Continuous Professional Development points).

There is no doubt that compliance with such regulatory bodies demonstrates the FD's ability to practice according to the best practice guidelines and ensures that their clinical management is “patient safe” as described by the ESs.

**Ability to provide conservative dentistry**

All the ESs unanimously agreed that they expect their FDs to be competent at providing direct restorations. The ESs described this as “simple cons”; however, when they were further questioned to elaborate on the range of the cavity designs that they classify within this category, it was apparent that all the possible forms of the direct restorations are included:

“I would expect them to be able to do pretty much all sorts of fillings using different filling materials….”

“… cons, yeah, expect them to be able to form simple cons, which is single surface, multi-surface. Large cuspal replacements, yeah, I’d expect them to be able to…certainly, yeah…be able to perform. That’s not to say they won’t improve that procedure in the coming 12 months, but certainly be able to perform {that}….”

The direct restorations are generally classified into simple and complex categories; the former being cavities or defects involving up to 3 surfaces of the teeth while the latter includes cavities that require auxiliary forms of retention or grant cuspal protection, both using a direct restorative material.
Based on the interviews, such a thing as the minimal level of competency in the subject of direct restorations does not exist. The DFs are expected to be able to “perform” at the “complex” level; although it is acknowledged that their experience increases over the period of the Dental Foundation Training and they will get “better” at performing such restorations.

**Ability to provide oral surgery**

The “*simple extractions*” was a keyword used in abundance by the ESs, however, it proved difficult to draw a line at what level the ESs categorize an extraction to be “simple”. One ES defined the simple extraction as needing to remove a tooth that has an almost intact clinical crown or with minimal damage:

“… *Simple extractions, yes, and when I say simple…they’ve got a full crown or minimal destruction*”

However, not all the teeth with fully formed and intact clinical crowns are simple to extract. Several other clinical, biological and anatomical factors can render an extraction difficult; for example, extraction of an intact upper first molar tooth in a young adult Afro-Caribbean male may not be possible without planning for a surgical approach in the outset. All the ESs, however, confirmed that “extraction” is a competency that FDs usually start with limited experience. According to the ESs this lack of experience should not be interpreted as the lack of competence:

“I don’t think any of them, I’ve never, I haven’t had somebody who I would class as incompetent, but people have needed more experience, that need their hand holding a bit.”
Upon further exploration, the ESs explained that such lack of experience mainly roots into a reduction in the number of the patients going through the Dental Schools to receive treatment and they were firm believers that all the DFs who are qualified with a BDS are competent; otherwise the Dental Schools would have stopped them:

“… {The FDs come to us with} very little experience in general. This year, between the two practices we had three {FDs} and I think they'd done less than ten {extractions} between the three of them prior to coming into practice.”

“They all know exactly what they are doing as far as taking teeth out, but the confidence levels of being able to take the teeth out vary drastically. I don't think from one school to the next, I think it's pure and simply down to how much experience they've had, how many they've taken out and what they've experienced.

They can all fully explain what they need to do and how to do it, but sometimes some of them need more of a hands-on help than others. I wouldn't say they are coming out incompetent of not being able to take a tooth, they can take a tooth out, but some teeth are harder than others”

“… I'd be frightened if I thought somebody was incompetent – how did they get the BDS?”

This is not because the ESs are putting all their trust into the decisions made by the Dental Schools but instead their own perception of the process of training a young dentist: they see the Dental Foundation Training as an integrated part of the overall educational pathway of a qualifying dentist.
“… and at that stage in their development, I don’t know whether I would call it underperformance, or whether that’s just… they’ve been issued with a BDS so they are competent at the five year stage, then it’s our job to add value or to progress them in those 12 months, so that at the end of the 12 month period, they are certainly more competent. Again, is there a level of competency? I don’t know….”

None of the ESs, however, expected their FDs to be competent in surgical extractions. They confirm that the usual pattern for the FDs is to have seen some surgical extractions during their time in the Dental School but they may or may not have had any experience in doing one, let alone being competent at it. One ES mentioned that he found it surprising when one of his FDs was able to perform surgical extractions upon joining the practice.

All the ESs, however, expected that “at the end of the {Dental Foundation} year {the FD} should be competent in raising a flap, take the bone away, closing it up, and be proficient to an extent”.

**Ability to provide endodontics**

All of the ESs agreed that their FDs should be competent at performing root canal treatment for single-rooted teeth; however, there was some disagreement between their expectations when it came to the molar endodontics. Although most of the ESs would like their FDs to be competent in root canal treatment of the molar teeth, the reality is in contrast to their wish:
“Molar… yeah, they should be able to perform molar endodontics, {but} less well, because experience has taught me that is one of the procedures they all struggle on, initially.”

The ESs suggest that this might be due to a flaw in the structure of many Dental Schools whereby they have abolished the “requirement” for molar endodontics:

“I think molar root treatment is limited experience. They don’t have any requirements – well, some dental schools don’t. I think they’re …they’re the ones that stick out.”

Further probing revealed that the most common areas of struggle in the molar endodontics are the “access” and the “use of rotatory instruments”. Therefore, all of the ESs have “pots of extracted teeth” and “endo blocks” in their practices for the purpose of training their FDs:

“{I am} not necessarily saying they’re incompetent, but they find that their knowledge is a little lacking in certainly …rotary instruments, or something like that. So we run hands on sessions with them and we, you know, we try and make sure that they feel more confident before they do actually carry it out.”

**Ability to provide indirect restorations**

All of the ESs expected their FDs to be able to prepare a crown, however, they set the bar of their expectations as low as having a “good idea of how to do it and tell {the ES} how they are going to do it”. Interestingly the ESs would class a FD to be competent in crown preparation if they are able to “tell” the ES how it is done. Of course most of the ESs preferred to observe the FD when preparing their first few crowns:
“… I’d expect them to be able to crown prep. Possibly not necessarily the diagnosis or treatment planning of it, but once we’ve decided that, yes, this is going to be… I would want to watch their first one or two, but yeah, they should be able to mechanistically prepare a tooth for crowning.”

However, when preparation for bridgework, post-retained core, or veneers was expected, the ESs felt that this would be beyond the scope of practice of a newly graduated dentist:

“… but I think things like veneers, multiple crowns, bridge work is probably more advanced, which they can learn during a foundation year.”

Once again, the ESs did not consider such deficiencies in performance as lack of competence but more a matter of the lack of experience:

“… there was a couple of foundation dentists whose crown preparations, and stuff, needed a little bit of extra help on and, again, probably rather than saying they were incompetent, they just had little experience of doing it, you know, things like post crowns, we might have had some foundation dentists who have maybe done one…no, I think there was somebody who had never done a post crown of any sort, you know, indirect, none at all.”

**Competence in providing dentures**

The ESs expected the FDs to be competent in making dentures, both complete and partial. Interestingly, the ESs were expecting the FDs to be competent in making acrylic partial dentures and not the chrome-cobalt dentures:
“Dentures… they’ve all done some dentures but you may find they haven’t got any experience of chrome-cobalt dentures, so again, I would expect a working knowledge…”

“…{with partial dentures} they don’t really seem to know what the goal is, you know, it’s almost like…things that you think are fairly obvious… you’re just trying to put the patient back where you found them and they don’t seem to get that…”

The ESs would arrange a number of tutorials to go through the steps of the partial denture construction, its design principles and the corresponding clinical aspects to ensure that the FDs can perform this task adequately.

**Ability to anaesthetise the patient**

Although the ESs wished that their FDs would be competent in performing any type of local anaesthesia injections; however, their experience confirmed that achieving inferior nerve blocks is a common area where lack of competence is witnessed and the ESs have to almost certainly always educate their FDs on this basic task:

“… I feel like I’ve had to teach almost all of them how to do an ID block successfully, because even when they are working, they don’t know why, and they don’t know how! So they’re giving their ID blocks kind of a little bit like on a wing and a prayer in the hopes it’s in the right spot and it works most of the time, but most of them really don’t know anatomically what they’re trying to achieve, where they want the end of the needle to be, and how can they have a really confident sense that that’s where it is. So I feel like almost all of them, ID blocks is a big stumbling block, and I think it’s poorly taught at undergraduate level…..”

**Professionalism**
Professionalism was an emerging theme when the ESs were trying to shape the profile of a competent new dentist. When further explored, the ESs defined professionalism to illustrate an array of personal properties: “time-keeping”, appropriate “dress code”, “standards of hygiene” and “treating patients and staff with respect” were some of the examples mentioned by the ES:

“…I’d expect them to be respectful of the patient and the staff. That will have gone through induction, quite strongly, what we expect of them…”

Generally the ESs would provide the FDs with a comprehensive induction to the practice with the details of what is expected of them professionally. From that moment on they would monitor “patterns” of lack of professionalism, however, it was interesting to note that the ESs generally had a very low tolerance when lack of professionalism was witnessed and would act on it almost immediately by reporting the FD to the TPD:

“… some people oversleep. It can…you can tolerate something, but if it was a pattern, you…well, the first one, you’d have to say, you know, I would be straight up … but I think, sort of, standard of dress, standard of hygiene, standard of talking to the patients, relationships with the staff – one single trigger, I would be on it….”

“… the way he speaks to a nurse, that initially would be something I would look at, and keep in house. If it was a recurrent issue, then obviously, and despite my efforts, then it was still an issue, yes, it would be something I would mention {to the TPD}….”
“… yes, any professionalism issues, (or) ethical issues that I felt were outside of my jurisdiction {I will inform the TPD}.”

**Lack of competence**

When analysing the data it became apparent that the ESs have a very distinct definition of clinical competence; a definition that is not necessarily associated with performance. From their point of view, the FDs are graduated with BDS with variable degree of competence in different types of procedures. They described their FD possessing variable degrees of competence as being “partially competent” or “fully competent”. For a FD to be fully competent in a selected procedure, the two variables of “procedure type” and “experience” come to play:

“… although, yes, he was competent, and I would have no concerns over his competency in a lot of areas, it was his clinical experience which I’d had more of an issue with, and obviously the more experience I witnessed, the biggest chance of some form of, in your word, incompetency, or lack of competency coming to the surface….”

The ESs expected to see “full competency” in diagnostic and treatment planning skills, non-surgical extractions, single-rooted endodontics, direct restorations, crown preparations and acrylic dentures while they expected “partial competency” in surgical extractions, molar endodontics, bridgework, and provision of chrome-cobalt removable partial dentures. In their opinion the dental students graduate with abundance of knowledge and some experience in the former list of procedural items while their hands-on experience in the latter list is extremely limited.
The ESs believe that their responsibility is to identify the areas of “partial competency” in FDs and by directing the correct cohort of patients to them during their DFT year, allow them to “experience” such items and therefore facilitate their transition towards “full competency”. From the ESs’ point of view, if the FDs have a working knowledge of how things are done, they are “competent”; however, they need the “experience” factor in order to become “fully competent”:

“… I don’t feel that any of them have been incompetent, they’ve been capable of doing the job, they’ve had the knowledge level to do it, they just needed the experience, so that’s what I feel my job is, to give them that experience in a protecting manner to begin with and then as the year goes on take the protection away a little bit and they feel that they are standing on their own two feet.”

“… they knew the knowledge level again was there, but the experience of it was missing. That to me is not incompetence, that is a fault of the system and is it a fault of the system, I’ll just shut the door and get the right patients through the door or if you’ve got to pull somebody back until they get that experience…..”

During the interviews, the ESs had a defensive approach towards the term “incompetent”. In their eyes, a FD cannot be “incompetent”. They further elaborated that the Health Education England (HEE) discourages them from using the term “incompetent” and instead the phrase “dentist in difficulty” was the suitable replacement to describe a FD who is not competent. For the purpose of this study, the ESs agreed to use the terms “incompetent” or “lacking competency” to describe a FD who requires further remedial action by the ES as
a consequence of their action or performance being below the expected standards set by the ES.

With this definition in mind, a number of characteristics or actions were explored that rendered a FD incompetent:

**Actual or potential harm to the patient**

Patient safety was a major theme that emerged from all of the interviews. The ESs took the safety and well-being of their patients very seriously and had several approaches to ensure that their patients are subject to no harm:

“... if somebody comes to me with a bit of lack of knowledge about a certain aspect, well, you know, they’ve got a year to learn that, perhaps, as long as in the process of learning it, they’re not doing any harm to any patient....”

For this reason an actual or a potential harm to the patient sparked an immediate action from the ES. In almost all such cases, the TPD would have been informed or consulted; however, the severity of the incident would dictate the level of the remedial response and the speed of the escalation to the HEE. For example, “never events”\(^2\) sparked such high levels of remedial response and rapid escalation:

“... I would probably go through my...we call it TPD, training programme director, and I would ask their advice; but that is the Deanery, yeah. I think that's a fundamental issue. That worries me about...when I said about safety before, that's not safe....”

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\(^2\) **Never Events** are serious incidents that are wholly preventable as guidance or safety recommendations that provide strong systemic protective barriers are available at a national level and should have been implemented by all healthcare providers.
In all cases, however, the ESs emphasized that they would explore the FD’s understanding first: was their action due to a serious lack of knowledge or was it simply due to human error:

“... I think in all cases the first thing is you talk to them and see is it either a complete lack in the knowledge, is it something they are doing? Is that knowledge lacked so bad that I need to actually go back to the FD and say look they need almost an education programme separate to the DFT year and I know that's had to happen on a couple of cases, fortunately not for us....”

It was also noted from all of the interviews that an experienced nurse who had been involved with DFT for years, always assists the FD. The advantage of using such nurses is that they will inform the ES should they feel that harm to a patient is likely:

“... we've got a lot of nursing staff who are used to it, so one {of the} things {that} I say to the new dentists when they come in is: look, they are going to look out for your help and security. If they feel you've got a problem, they'll politely just say, would you like me to get such and such? Now if you ignore that and they still think you need to get somebody, they'll just come and get me.

It's not that they are undermining them but they've experienced enough themselves to see he needs help here or she needs help. That happened maybe this year once, last year once and it's just because they can't see above the trees, they are too focussed....”
The never events are preventable in nature; therefore, when the ESs were asked on their management strategy for such scenarios, they would have stopped the FD immediately and started the remedial processes there and then:

“… I suppose it depends on the seriousness, I mean if someone who is about to take a tooth out on somebody who was on Warfarin with an INR, something like six or seven could be life threatening, I'd be straight to them saying just stop, we need a chat here, what do you think you've done wrong? Let's go through it.

We'd have to really look because that is life threatening to a patient....

Now again that doesn't mean they might have a gap in their knowledge there, that's very easily corrected, but you start to worry that’s indicative, that they've got an overall lack of knowledge or understanding. I think in that situation if it was a life threatening situation I'd be straight away talking to our TPD."

Inability to reflect

The ESs unanimously agreed that the FDs are inexperienced at the start of the DFT and therefore they are expected to make mistakes; however, the ESs expected the FDs to have an understanding of where they had gone wrong and to be able to reflect on the event. Where a FD fails to demonstrate such understanding, the ES would treat that as a serious lack of competence that would sparkle remedial actions:

“… I think it's not just what they've done, it's how they respond to it. It's that self-reflection and if somebody is so blasé they don't think they've done anything wrong then yes, it's going upstairs. If anything, you'd want the Deanery asking their Dental School how they got through....”
“... {My FD} struggled very badly with endodontics, and the biggest thing for me was that she was not a reflective practitioner, so she didn't understand what she was doing wrong, and that’s one of the most difficult things I think for any educational supervisor.”

Usually such inability to reflect was the offspring of serious lack of knowledge, a finding best described by one of the ES as being “clueless”:

“... The threshold is, you know, when I said to her, look, you’ve perforated here, and then afterwards I showed her where she should have been, she was on the wrong side, this is where it is, and then afterwards when she said to me, you don’t think I’ve found another canal, and I thought, this person is clueless, she doesn’t know any anatomy, she doesn’t know what to expect, she’s got no feeling for what’s going on...”

This theme emerged several times during the interviews in a variety of forms. The ESs have an active role in training of the FDs, therefore they use every opportunity to discuss the FD's performance with them. This can be done informally, simply going through selected cases between the patients or formally, in the context of a Work Based Assessment (WBA), Case-based Discussion (CbD) and Direct Observation of the Procedural Skills (DOPS) being the most common ones.

As a general rule of thumb, the ES would explore their DF’s depth of knowledge and understating of the procedures, in any of the above contexts. This becomes even more crucial if the discussion is happening after an incident or an event not gone to plan. For when such lack of knowledge or understanding is identified, the remedial plan was almost identical among all the ESs interviewed; however,
they unanimously agreed that if serious lack of understating or inability to reflect is witnessed, the incident should be escalated to the TPD and HEE immediately which may have serious consequences for the FD:

“... you know, when discussing a case with them, if they were coming up with ideas or whatever, that were just far out and inappropriate, I would then be, you know, quite concerned about that...”

“... I think {at} the level of incompetence with that, I think that {I} would stop them working full stop! I’d say well we need to have a serious word with the deanery here....”

Resistance to help

The “resistance to help” was an interesting concept mentioned during the interviews. Although one may argue that this concept is an offspring of the “inability to reflect”; however, they should be looked at as two separate entities.

A FD will not be able to reflect on their performance if they don’t understand the procedure in the first place; however, usually they accept advice from the ESs and commence their remedial plan. The situation can become worse, however, if the FD refuses help and does not recognize that something has gone wrong. In such cases even a minor incident can be treated with the same response magnitude as a serious incident:

“... if they were resistant to any help, you would have to involve the Deanery immediately.”
The resistance to help may also source into deeper issues than simply lack of understanding; such a phenomenon may be a reflection of serious professionalism issues, where most of the ESs have very low tolerance of.

**Recurrent mistakes**

Mistakes do happen. Some mistakes are as a result of genuine human error: tiredness, hunger, nerves, and anxiety can all have a contributory effect; “*sometimes the instrument slips!*” On the other hand, some mistakes are offspring of lack of knowledge or lack of experience.

ESs are understanding of the above and always investigate incidents: was it due to human error? If so, how could they help, if they could help at all? Was it due to lack of knowledge? Then tutorials should be arranged. Was it due to the lack of experience? Then the FD should have practice hands-on with extracted teeth or plastic teeth until they show that they are mastering the task. They would have more intense supervision with carefully selected patients until they show signs of competence:

“… *She couldn’t do an access cavity and she couldn’t find canals. She perforated on many occasions, more than one, as far as I know maybe five times….*”

“… *I suppose if it was the first time you said that, I might think … you know, I might be giving you the benefit of the doubt … so I would go, like, you know, I would try and get the knowledge out of them, I would ask them probing questions to see … do they understand that? … I would challenge them that way and if they’re going, like, … {I’ve} never heard of {that} or something like
that, then that would make me a bit worried… I would then think, oh, it’s just
going to be quite hard work, because, you know, I’m going to have to watch
what they’re doing quite closely and I maybe have to … get back to some basics
and … help increase their knowledge or whatever….”

The challenge is, however, if the same mistakes start to reoccur. Recurrent
errors don’t simply project a lack of knowledge or experience; they have roots
deep into the lack of understanding:

“… if it proves that it’s something that’s happening again and again, then it does
start to smack of incompetence and that’s where we’ve got to refer an
educational need and may well have to say to the Dean they need to go on
some course here about identifying caries because even when we are showing
it to them they are not seeing it….”

“… you can make a mistake … but to not to learn from that mistake, well… then
that’s, you know, you’re not taking on board what this whole foundation training
year is all about…..”

Lack of professionalism
Throughout the interviews it was noted that the ESs have a very low tolerance
towards incidents of lack of professionalism; professionalism being any personal
qualities or attitudes of the FD that form their professional image. Some of the
keywords mentioned by the ESs included “being on time”, “having an acceptable
dress code”, “having good standards of hygiene”, “having good social skills”,
“talking to staff and patients with respect”.
When the FD failed to demonstrate any of the above, in particular when such failure started to emerge as a recurring pattern, this was classified as lack of competence and dealt with seriously:

“...you know, I think if anything escalated...but basic standards of timekeeping, hygiene, presentation, are paramount.”

It was interesting to note that the ESs treated ‘confidence’ as a subcategory of ‘professionalism’. In one real example of the FD in difficulty lacked confidence. The ‘lack of confidence’ was regarded as a sign of her lack of competence; which not only had roots in the FD’s serious lack of knowledge but also reflected their inability to manage their staff and patients:

“...She lacked confidence, so she didn’t inspire confidence in her patients or the nurse, so they never felt like there was a grown-up in charge in the surgery...She was always very pleasant, but both the patients and the nurses who worked with her felt that they didn’t feel confident in her decision-making, in her communication, even though she was pleasant...”

At the same time, the ES confirmed that such incidents of ‘lack of confidence’ are complex constructs to look at where you may find roots deep into cultural issues:

“...it’s difficult especially in cultures where children are kept very much, you know, they’re not independent thinkers at a young age, and so it’s almost that they’re used to being told what to do and then you want them to be professional, and it’s a huge jump, it’s like jumping from childhood to adulthood and then from adulthood to professionalism, and they’re going from childhood to
professionalism overnight, so I can see why people struggle with that transition."

Understandably the ESs confirmed that they have worked extremely hard to build their business and shape the profile of their practices; therefore, they cannot tolerate if a FD starts to compromise such image with their lack of professionalism:

“… certainly events of professionalism, … every practice has its own philosophy and its own identity, and as a practice owner, you have to protect that. You have to protect your staff, your patients…. Introducing somebody into the … you welcome them into the practice, but you’ve got to know that they are not going to spoil the party."

Events that require consulting the defence union

Generally the ESs had a very supportive approach towards managing the mistakes or incidents made by their FDs; however, they agreed that if the incident is severe enough to grant consulting one’s defence union then this should be treated seriously and possibility as a sign of lack of competence.

Usually dentists contact their defence union once a patient has made a legal action against them or the possibility of a legal action exists; either way, this is indicative of potential or actual harm to the patient or professional mismanagement:

“… but the problem with that is that, most likely the patient would lose the tooth. It could go into a challenge, a legal challenge… and I think it’s only fair to make the Deanery aware at an early stage."
Incidents that happen late in the training process

The ESs perceive “full competence” to be made of the “procedural knowledge and understating” and “experience” factors. The experience increases with time while the supervision decreases over time. For this reason, the ES react to the very same incidents differently depending on when during the period of training they have occurred.

For a new FD, an incident can be labelled due to their lack of experience, where “full competency” is not expected in the outset. The remedial action would involve tutorials and opportunities to gain further clinical experience while if the same incident happens later on during the DFT, it will spark a much larger response with potentially a full formal audit to back up the investigation and advise from the TPD:

“… right, if that was day one, I might be tempted to put that down to nerves and lack of {experience}…if it was day 364, I think that’s probably a serious issue. Because it’s not just what’s happened, it’s the whole idea of, there are so many faults with that, that had happened in that procedure. I would again, yeah, I would have to deconstruct and try and work out why what had happened had happened.

I definitely would involve the TPD on that. I would closely monitor, we’d do an audit trail of medical histories, see if this was literally a one off, or if this is a pattern. And if this is a guy who’s not taking medical histories, again, if it’s in the early stages, it’s possibly something we might be able to do something about, but if it’s late on and it’s something that you know they should have been doing,
yeah, that begins to open up a new point on the FD’s practising soul, if I can put it like that…!

One example of such incidents is the ‘retained caries’ after the cavity preparation for direct restorations. The ESs usually expect the FDs to miss caries on the early stages of their DFT; however, they expect them to become better and eventually “fully competent” in removing caries over time. One failing to show progress on this will trigger remedial actions before they are allowed to treat similar patients or the ES will become heavily involved in their direct supervision. In addition to the usual remedial pathway, some ESs would start “nursing” for the FD to ensure that they are observing the FD very closely and can provide immediate feedback and correct any mistakes.

Definition of competence
The ESs described a competent dentist as a dentist who is able to “perform what is expected of a dentist”, however, when the data was probed further, several characteristics and properties started to emerge to describe such clinician: safe, aware of own abilities and limitations, experienced, punctual, and presentable. It was understood that the ESs’ expectation of a competent dentist does not limit to their clinical capabilities but also takes their professionalism and ability to reflect into account. The ESs were keen to describe them as “patient safe” and “that they know accurately, their limitations, so that they’re very keen and able of when to seek advice”. The ESs admitted that although it is desirable for them to welcome FDs with experience to their practices; however, this was not necessarily the case in reality and what they expect of their FDs.

“… well, ideally, a spectrum of experience, which isn’t always the case, and to be able to work probably with minimal supervision
One ES confirms that “{he} likes a new graduate to obviously be enthusiastic, but the key to {them} is to know when to ask {for} advice. {He}’d rather be approached too often than too little, initially”.

How do ESs monitor FD’s performance?

During the interviews it became apparent that the ESs use a variety of sources to create a full picture of their FD’s skills and abilities. To further discuss these sources, it would be logical to explain how the FDs are introduced into their DFT:

The majority of the ESs invite the FDs to join the practice prior to their formal start date; the FDs normally graduate from their Dental Schools by the end of July while the DFT starts in September. This time gap provides an excellent opportunity for an early informal start.

During the informal start period (usually for about two weeks), the FD will get the opportunity to have an induction to the practice, meet the staff, shadow the receptionist and get familiarized with the computerized booking system, shadow the current FD to get an idea of how their patient flow works, and finally shadow their ES.

All of the ESs were very keen for their FDs to observe them upon their start, regardless of an early start or not. The ESs, however, agreed that they would not want the FD to get the impression that they are back to the Dental School; therefore, they would start to see patients on their very first day. According to
the ESs the FDs are keen to start seeing patients as soon as possible. One ES used to have his FDs shadow him for a day or two before starting their own lists but he explained that one FD described those days as the “worst days of his life”:

“… The very first young dentist I had here …, we didn't give him a list in the first couple of hours and he said that's the worst thing that ever happened to him because he was so nervous, he just wanted to see a patient…..”

The first two weeks of the DFT are very lightly booked, both for the FD and for the ES. This allows the ES to have several direct observation of their FD. All of the ESs mentioned that they allocate a senior nurse to assist the FD. Such senior nurses have usually been involved with several FDs before and are well aware of their capabilities. The nurses are trained to stop the FD should they suspect that harm to the patient is likely or the FD needs help from the ES.

Now-a-days most of the dental practices operate with computerized booking systems, it is possible for the ES to remotely monitor the FD; in the sense that they will have live access to the patient list of their FD and can monitor if they are keeping with time or not. If they feel that their FD is taking longer than expected for a certain procedure, they will call into their FD’s surgery to check if any input from the ES is needed:

“… I mean one of the things would be, because I can look on their computer and see what x-rays they have taken. If I'm looking on the computer and thinking right that patient has got six cavities, they have said there is only two, straight away it's like, right oh God, we need to have chat. That's the first place because
I can look from a distance if you like, that needs to go out, let’s have a look at this....”

All of the FDs are expected to complete a portfolio and the WBAs are an integrated part of this portfolio and a requirement. As a consequence the FD will have regular WBAs with their ES. Since a senior nurse assists the FDs, the nurse will have a say in the type of the cases that the FD selected for the WBA to ensure appropriate cases are selected in terms of difficulty and complexity.

Patients and reception staff are also valuable sources of information gathering for the ES. Patients are asked on regular basis to provide feedback on the performance of all of the staff and the FDs are no exception. A pattern of unsatisfied patient feedback will become alarming to the ES. The receptionist will also report back to the ES should a patient refuses to be booked back with the FD:

“...we've got what we call the frontline scanners, who are the receptionists and nurses, feedback from them in the first couple of weeks, to see if they are running to time, or if they're over running, or if we've over booked, under booked, and what patients are saying. We would then alter the book accordingly. So it's definitely a team based approach....”

How do ESs deal with lack of competence?

During the interviews it was understood that all of the ESs follow a very similar thought process when they are faced with lack of competence. In their opinion, safety of the patient and their staff has the highest priority; therefore, if the actions of a FD compromise this, the consequences will be serious and
immediate for the FD. One ES confirmed that he would not allow his FD see any patients until he has gone through further training.

Serious issues of lack of professionalism or patterns of lack of professionalism were also incidents that granted high level of response from the ES and rapid escalation of the matters to the TPD. During the interviews it was felt that the ESs did not consider “professionalism” a separate entity to the clinical competence but an integrated and significant part of it.

All of the ESs adopted a root-cause analysis approach, trying to “deconstruct” the event using multi-sources of information. This included interviews with the staff involved as well as the FD. Generally the ESs had a firm belief that their FDs “cannot” be incompetent and therefore any shortfalls in their clinical performance was attributed to their lack of experience. They would probe the FD’s knowledge to ensure that they knew how the procedure should had been done and aim for targeted training to prepare them for further experience; this included in-house tutorials and in-house exercise on extracted or plastic teeth in the first instance and HEE-run courses in the next stage, if needed:

“…Well, we stopped her at that point doing any access cavities, she was no longer allowed to do access cavities in the practice. She had to get one of us to do it for her, or it was somebody that we’d already seen and we’d opened it up.

And we set up a whole load of teeth - all different, you know, anteriors, premolars, posteriors, in stone, and we made her do about 20 access cavities on extracted teeth…”

All of the ESs confirmed that they would increase the direct observation of their FDs while in the remedial phase so they can ensure that the experience that
they are providing their FD with is positive and productive. Once the FD improves, the level of supervision decreases.

The School of graduation and the level of competence

The final theme to explore was a possible correlation between the school of graduation and the competence of the new density. Most of ESs agreed that the school of graduation does not have a direct effect but instead an indirect effect based on the level of the entry and their setup:

Graduate-entry schools

The ESs felt that “age” is an important factor in the level of competence. Although all of the dental students are subject to the same length of education at the dental schools but the ESs felt that mature students would make better use of their time in training and therefore gain more experience; acknowledging “experience” as being a prerequisite for competency:

“… The only thing I will say that's made a difference is - and it's nothing to do with the dental schools or that - it's an age thing. {My FD’s} competency levels and communication skills were a lot better than any of the normal graduates. Now I put that done to age as much as anything because obviously {the others} are 23… {He was} more mature, so he was able to talk to people better….”

For this reason, as a general rule of thumb, the FDs from graduate-entry schools would prove to be more competent upon start. Once again, it was difficult to clarify if this was due to the age and maturity of the FD or in fact the Dental School itself:
“… but I would say, I don’t know whether it’s a feature of their age, but I’ve been very impressed with graduate dentists....”

**Outreach-based schools**

The ESs felt that the Dental Schools with heavy outreach programmes produce more competent graduates. At the same time, the three UK graduate-entry schools are predominately outreach-based, making it even harder to distinguish to real reason for this superiority:

“... Just the difference in the numbers the {outreach-based school} students have done, is significant. You know, you are talking extractions, {the FD} when he came to us had done 80/90 extractions.... We’ve had low numbers from {a traditional school} to high numbers from {the same traditional school}....”

“... I've tried to think about it, to see if it's the dental school, ... the way it's very much patient NHS based. They all go out and do work on clinics, and they've very knowledgeable about the UDA system for instance. But, ... is it the course or is it because they've got that extra three, four, five years maturity...?”

In ESs' opinion, the outreach gives the dental students a much better sense of how the “outside world” operates and therefore a better experience compared to the dental school.

On the other hand, one ES blames the competency-based curricula as one of the reasons for inferior experience levels of the students, simply due to the fact that such curricula allows the students progress throughout the BDS years with very limited clinical supervision. Potentially students can graduate without
having done some procedure and therefore lacking the most valuable “experience” factor:

“… What I sometimes don’t understand is the problem-based learning. I mean, I understand it, and I think there is an opportunity for some students to hide a little bit…”

“… I think it’s possible, I do think it’s possible to get through your undergraduate dental course, you know, just reaching the, you know, the minimal targets, if you like, and then there’s other students who are just more thorough, or whatever, and they get more out of that and when they come out, they’ve got a much vaster experience….”

The ESs also explain that the dental schools no longer accept large number of patients for treatment and this potentially can be another factor that does not allow the students acquire the required experience; in contrast, this is not a problem with the outreach centres and therefore such centres can provide abundance of experience to their students:

“… Their actual experience of the hands-on dentistry I think is getting less and less… well, that’s based on what the, because they give us feedback on the, how many of everything they’ve done, the numbers are decreasing. They are coming to us saying I’ve only done so much of this and so much of that. If you go back and look at the FD from 2005… and he said, you know, I had to do 20 of those and I’ve got somebody in there who has only done two. It’s different….”

“… So the more times you experience a situation or a problem and find a way of solving it that’s suitable for patients, you learn by those experiences and so
maybe the dental schools are not exposing students to as many experiences as 
would be ideal for a new graduate and, you know, … I think they’re coming out 
with quite good knowledge, quite good, you know, knowledge and they know the 
facts, and stuff like that, but the clinical experiences that they have are maybe a 
little bit limited…”

Discussion

We aimed to explore the competency profile of newly graduated dentists in the 
UK. To do so, we analysed the expectations of the ESs of their newly qualified 
FDs. Although the literature does not provide us with a universally accepted 
definition of competence (Frank et al., 2010a; Frank et al., 2010b; Gibbons, 
1980; Harden et al., 1999; Harris et al., 2010; Iobst et al., 2010; Jolly, 2012; 
McGaghie, 1978; Morcke et al., 2013; Orgill and Simpson, 2014) but our results 
demonstrated that our ESs had a very image of a competent dentist upon 
joining the DFT: a patient-safe professional who has a sound understanding of the 
examination, diagnostic, procedural and ethical principals in dentistry but is not 
necessary capable of providing certain aspects of the general density. This 
professional is en-route to gain more experience, understands when things go 
wrong and can reflect and learn.

The traditional thinking believed that once a clinician reaches the top level of the 
Miller’s pyramid of competency (Miller, 1990), they could be labelled competent; 
however, it can be argued that such competencies are usually observed in a 
controlled examination or clinical environment and cannot not be generalized 
(Grant, 1979; Norman et al., 2014a). Once the clinicians are independent, their 
behaviour may change. They may be presented with similar patients but with
considerably higher levels of complexity. The added time-pressure of the real world practice and the increased anxiety levels of the clinician or staff may also have an influence on the performance of the clinician (Rethans et al., 1991).

To accommodate such complex interactions, the terminology “professional competence” has been suggested (Epstein and Hundert, 2002; Kane, 1992; van der Vleuten and Schuwirth, 2005b; van der Vleuten, 1996). A clinician is professionally competent when they are able to manage their patients and team competently and independently. Therefore, professional competency is not only looking at the clinical competence but also looking at the clinician as a professional and a team leader who is able to perform without need for supervision (Ten Cate, 2013).

In this study we noted that the ESs treated competency in a task-specific context and on a spectrum of abilities instead of a bar to jump over. In their opinion sound understating was the ticket to ensure that their trainees were not incompetent. Once this was satisfied, the FD could be “partially competent” if they had limited experience in a given task or “fully competent” if they had abundance of experience and had seen and done the given procedure with different levels of complexity. Expecting a spectrum for the level of competence instead of treating it as a bar is not a new concept (Benner, 1984) but an area that is being looked at again in the modern medical education (Lowry et al., 2013).

ESs agreed that ‘professionalism’ is a crucial part of the “full competency” and they reported that they have a very low tolerance of lack of professionalism. Hence, regardless of how competent the FD are in clinical procedures, if lack of
professionalism is witnessed, they are not deemed “fully competent”; or in other words: they lack ‘professional competence’. The ESs admit that it is hard work to establish and run a team of dental professionals, including the dentists, therapists, technicians, nurses and supporting staff. The team remains functional only if its members adhere to the rules of the practice and its ethics. Lack of professionalism impairs the function of the dental team and renders the dental care pathway non-functional.

The findings concord with the medical education literature (Hafferty and Castellani, 2010; Hodges et al., 2011; Van De Camp et al., 2004), which states that clinicians should demonstrate a range of inter-personal, intra-personal and societal qualities to be seen as professionals. Honesty, trustworthiness, ethical practice, caring attitude, respect for patients and colleagues, team playing, accountability and adhering to norms are examples of such qualities and expectations (Taylor, 2017).

The ‘clinical competence’ was regarded as an integrated part of the ‘professional competence’. When focusing on the ‘clinical competence’ alone, the analyses revealed that such competencies are procedural-dependent and are consisted of three integral parts: procedural knowledge, the complexity of the task and the experience of the clinician. It became evident that the ESs expected the FDs to show ‘clinical competence’ in a number of clinical procedures; while they were expected to start with knowledge about a number of procedures, thus they were not seen as clinically competent due to lack of experience.

Dental students are introduced to history taking and examination from the very early stages of their education. During their five years, they will be exposed to
hundreds of episodes whereby they are expected to take a history from their patients and perform a dental examination. During their training period, they will be exposed to a variety of patients with variable difficulty, both at personal managerial level as well as clinical. A combination of these repeated exposures to patients with variable complexity provides the students with abundance of experience, making them clinically competent in history taking and examination.

In contrast, dental students may graduate from the dental school, having done only one or two molar root canal treatments. The ESs had no doubt about the “procedural knowledge” of their FDs; however, they would expect them to become “fully competent” once they have done several molar endodontics during their DFT time period. When the ESs were probed deeper, it was noted that once they question the “procedural knowledge” of their FDs, they start to categorize their FD into the “incompetent” category and will start a remedial programme to address this.

A working example was when the FD has perforated the pulpal floor and was still drilling the underlying bone away. The ESs unanimously agreed that the FD has serious lack of procedural knowledge because they are even unable to distinguish between a haemorrhagic pulp and the bleeding bone. Furthermore the ESs were concerned that their FD has no spatial operative awareness or whereabouts of the dental anatomy. Such FDs would be stopped immediately and were not allowed to see a patient with similar needs unless their procedural knowledge was proved to be acceptable.

Targeted training and tutorials were the standard parts of the remedial pathway followed by hands-on exercise in controlled environments; i.e. on plastic teeth or extracted teeth. Once the ESs were confident that the FD has the base procedural knowledge, they were happy for them to start increasing their
experience by seeing patients in need of that procedure. The ESs would have a period of “close monitoring” before they reduce the amount of supervision and finally “sign the FD off” as being competent in doing that given procedure.

It was also interesting to note that there was a direct relationship between the intensity of the supervision and lack of clinical competence, when experience is considered as an integral part of the competence (Figure 2.1). The FDs start the DFT with an intense supervision period. Although the ESs assumed sound knowledge for most of the clinical procedures; however, they would only reduce the intensity of the supervision once they have observed a number of procedures successfully carried out by the FD. Once the FD has performed several of the same procedures with a variety of complexity, the ESs were happy to let the FD act independently with minimal or no supervision. This is an accord with the current move towards the entrustable professional activities (Ten Cate, 2013), a new philosophy in the medical education and an alien concept in the dental education!

Since the “experience” factor is such an important construct of the clinical competency, it is not surprising why the ESs were expecting the FDs from the outreach-based schools to start the DFT at a better position, and being seen as more competent. The outreach clinics are run by the general dental practitioners and closely mimic the very same setting as the DFT practices. The workflow in the two settings is almost identical, allowing a rapid turnover of the patients and therefore a larger gain of experience for the FD.
Figure 2.1. The relationship between the clinical competence and intensity of the supervision. The procedural knowledge, task complexity and experience are integral parts of the clinical competence. As clinical competence increases, the need for supervision decreases.

In contrast, the dental schools are complex institutions with several layers of clinical specialities and managerial bodies sharing the same infrastructure but delivering different services. The patient pathways are considerably slower in the dental schools due to complex nature of the referral systems and the workforce networks. When patients are allocated to the students, the pace of the treatment is incredibly slow compared to the outreach practices: all the instruments and materials are dispensed via a central dispensary in the dental schools while the instruments are readily available in the outreach surgeries. The students have to queue for their tutors while the outreach tutor is responsible for a limited number of students and readily available. The outreach clinics work base on the Unit of Dental Activity (UDA) system and there is time
pressure to complete the treatment for the patients while in the dental schools such pressure does not exist.

In average, a dental student will be able to see one patient in one session (4 hours length) while the same student is capable of seeing and treating three patients in the outreach within the same timeframe. For this reason, there is opportunity for the dental students to gain a much greater level of experience while treating patients in the outreach. Therefore it may the reason why graduates from the outreach-based schools are expected to be more clinically competent at the start of the DFT.

In general it could be concluded that a FD becomes ‘professionally competent’ when they are acting professionally and are ‘clinically competent’. The professionalism being a complex blend of personal, inter-personal and societal properties, while the clinical competence being abundance of procedural knowledge, exposure to variable complexities and experience.

When a FD is ‘professionally competent’ they are seen as being capable of independent practice; however, one element that was very lightly discussed at the interviews was the ‘leadership’. Most of the regulatory bodies perceive the ‘leadership’ factor to be an essential skill that any dental student should master before graduation but apparently such skills are not amongst the skills expected of a FD. In fact one may argue that while the FD is working under the supervision of an ES, they are not faced with many opportunities to learn or expand their existing leadership skills. If such an argument is correct, the question that rises is that when should they be exposed to such skills?

Looking into the Preparing for Practice document (GDC, 2011a), “Management and Leadership” is one of the four key elements that describes a “safe
beginner”; in other words a young dentist who has just graduated and is about to start the DFT. On the other hand, however, in the very same document, the word “leadership” has appeared only once in the Intended Learning Outcomes (ILOs) for dentists:

“ILO 10.4. Recognise the significance of own management and leadership role and the range of skills and knowledge required to do this effectively.”

The ILO 10.4 is one of the eight ILOs under the umbrella of “managing self” and except for this single ILO, the others are merely descriptions of properties of the ‘professionalism’ element, described earlier in this text. During the interviews, one of the ESs had an underperforming FD who was clearly lacking confidence. As a consequence she demonstrates no leadership in the surgery; however, this argument could have several facades: is lacking confidence equal to lacking leadership? Or is lack of confidence the fruit of lack of professionalism? Or is the lack of confidence the consequence of poor knowledge and understanding?

Following the above argument, this question remains unanswered: do dental students need to learn leadership skills before they can be considered “safe beginners”? Based on the interviews conducted and the findings of this study, the answer could be a “no!”.

Limitations
The study was conducted within the North West deanery of England. The samples of ES interviewed may not be a true reflection of all the ESs in the UK but the ES recruited had the experience of supervising 60 FDs between them. Although most of the FDs were from the North part of the England but the ESs had experience of training FDs from almost all of the other UK dental schools. It
is highly unlikely that other ESs in the UK are experiencing a very different pattern of FD behaviour in their setting.

During the interviews a total of five ESs were interviewed. To ensure rigour, purposive sampling was used and the data started to get saturated in a fairly short period of time; however, potentially more ESs could have been recruited.

**Conclusions**

Considering the limitations of this study the following conclusions can be:

1. Professional competence is a construct consisted of two integrated key elements: professionalism and clinical competence

2. Clinical competence is procedural-based; in other words a clinician can be clinically competent in a number of procedures and lack competence in some others.

3. To achieve clinical competence, the three integral elements of procedural knowledge, exposure to variable complexity and experience should be present in abundance.

4. There seems to be a direct correlation between the intensity of supervision and lack of clinical competence.

5. “Management skills” do not appear to be a key element to define a “safe beginner” as suggested by the GDC
Chapter 3
3 Competency: the perception

3.1 The metacognitive process

Metacognition refers to one’s understanding and awareness of their own knowledge; in simple words what one knows or does not know, and in more complex context one’s ability to understand, control, and manipulate their cognitive processes (Meichenbaum, 1985). Metacognition is the ability to use prior knowledge to plan a strategy for approaching a learning task, take necessary steps to problem solve, reflect on and evaluate results, and modify one’s approach as needed (TEAL, 2012).

In other words, metacognition is “thinking about thinking” (Flavell, 1979) and is the knowledge of an individual about their own cognition and its structure and operation. Most of the modern curricula design methods place students at the centre of their philosophies (Bligh et al., 2001; Dent et al., 2017; Fish and Coles, 2005; Oliver et al., 2008) and make them in charge of their own learning. For a student to be successful in such a self-regulatory process they need to be able to fulfil two separate tasks (Eva et al., 2004): first they need to recognize that a gap in their knowledge, skills or competencies exists (self-assessment) and second, they must have the skills to learn independently to address those deficiencies (self directed learning).

In an ideal world students enrolled on a CBE programme have high metacognitive skills, can evaluate and self-assess their own work, are aware of their own weaknesses and can plan how to improve those shortfalls. But are we living in an ideal world and our selection process filter applicants effectively to leave us with such students?
3.2 Can the students see where they are heading?

Although every year several papers are published based on data obtained from students’ self-assessment, however, there is strong evidence to show that there is no correlation between students’ performance and what they think of themselves (Colthart et al., 2008; Eva et al., 2004; Eva and Regehr, 2005; Gordon, 1991; Ward et al., 2003). Despite the fact that most of the clinical curricula are designed with the student at the centre and rely on their metacognition; however, literature sheds light on deficit in this skill and therefore questioning such research.

If the students cannot recognize that they are lacking competence in a given domain, they will take no actions in ratification of their weakness and therefore will not achieve the desired outcome: competence. This can potentially serve as a threat for outcome-based curricula where competency is set as the desired outcome.

Despite all the arguments against the use of perceptions and self-assessments in research, it must be acknowledged that students are stakeholders of any educational programme and their thoughts and understandings should be valued, or at least explored. We have established that the ESs define a professionally competent FD as a professional dentist who is clinically competent, where knowledge of the task, experience and exposure to variable task difficulties are prerequisites of their clinical competence.

What we do not know, however, is how students imagine a competent dentist. The aim of this study is to explore the perception of dental students of a day-1
dentist. As a secondary aim we are interested in exploring students’ opinion on what assessment tools most accurately reflected how competent they were during their training.

**Aim:**
To understand the dental students’ experience of their assessment to define their competence

**Objectives:**
1. To explore the clinical areas that the students feel competent in
2. To explore the clinical areas that the students lack competence in
3. To understand the profile of a newly qualified dentist from the student’s point of view
4. To understand which assessment methods better reflect the students’ level of competence
The following paper is written in preparation for submission to the European Journal of Dental Education.

The references are included in the Reference Chapter of this thesis to avoid duplication of the data.

List of authors:

**Mr Reza Vahid Roudsari**
DDS MSc PGDip MFDS FDS (Rest Dent)
Clinical Lecturer and Consultant in Restorative Dentistry. Assessment Lead for the BDS and BSc OHS Programmes.

**Professor Nick Grey**
BDS, MDsc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education. Faculty Associate Dean for Teaching and Learning. National Teaching Fellow.

**Dr Lucie Byrne-Davis**
PhD CPsychol
HCPC Registered Health Psychologist. Lecturer in Assessment and Psychometrics. Academic lead for phase 1 assessments

1 Division of Dentistry, JR Moore Building, Faculty of Biomedical Sciences The University of Manchester, Oxford Road, Manchester M13 9PL

2 Division of Medicine, Stopford Building, Faculty of Biomedical Sciences The University of Manchester, Oxford Road, Manchester M13 9PT
A qualitative study of dental students’ experience of their assessment to define their competence

Background

Professional competence can be defined as “the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served” (Epstein and Hundert, 2002). In this model, competence has several domains and qualities. Cognitive skills are required to acquire base knowledge, and technique functions are prerequisite for core skill mastery. An integrative function links the cognitive pieces together and aid in management of uncertainties and problem solving. A moral function makes the clinician act like a professional and the relationship function makes the individual operate as part of a larger team. Habit of mind is another domain, which is attributed to attentiveness, critical curiosity, and willingness to acknowledge and correct errors.

Since the introduction of the outcome-based curricula (Brightwell and Grant, 2013; Frank et al., 2010b; Gibbons, 1980; Harris et al., 2010; Iobst et al., 2010; Lurie, 2012; McGaghie, 1978; Morcke et al., 2013; Orgill and Simpson, 2014; Scicluna et al., 2012; Spady, 1977) and the drive towards assessment of competence as the ultimate outcome of the medical and dental education, it has become apparent that the assessment of such a complex model is not an easy task (Bok et al., 2013b; Ginsburg et al., 2010; Holmboe et al., 2010; Lurie et al., 2011; Norman et al., 2014b).
Despite all the challenges, the regulators are keen for the newly qualified physicians and dentists to be competent in managing their patients in the real clinical setting independently (GDC, 2011b; GMC, 2015; GMC, 2016b; Scottish Deans’ Medical Education Group, 2008) and have set the production of such competent and independent clinicians the ultimate goal of the medical and dental education.

The regulatory bodies, however, are aware that it is almost impossible to produce such clinicians within the five to six years of undergraduate training and therefore, the GDC, for example has proposed the term “safe beginner” (GDC, 2011b) and has made it mandatory for the newly qualified dentists to spend twelve months of closely supervised period before they are eligible to see NHS patients unsupervised (COPDENT, 2016).

The dental literature, however, is scarce of evidence to support production of competent dentists prior to the dental foundation training. Most of the publications focus on “confidence” of the graduates and not their “competence” (Gilmour et al., 2016; Honey et al., 2011), utilizing weak methodologies predominantly based on questionnaires and qualitative analyses of the free-text comments. From the trainers point of view and based on a recent qualitative study, however, it has been shown that the majority of the newly qualified dentists are far from being competent, in particular due to lack of experience in a number of key dental procedures; for example, endodontics and extraction of teeth with difficulty levels of moderate to hard (Roudsari, 2017).

What is unknown, however, is how dental students perceive competence and the aim of this qualitative study is to explore their perception on how a day-1 dentist would look like. The secondary aim of this study is to explore what
assessment methods have been the most successful in reflecting a true picture of their competence during the undergraduate years.

**Methods and materials**

The study received favourable ethical approval (ref 13245, Appendix 9.2). Qualitative method was chosen to allow us explore student’s perception of own competencies without being confined to limited number of questions usually found on a traditional questionnaire. It also allowed us to understand what assessment methods had served best in reflecting those abilities.

A thematic analytic approach was chosen (Thorne, 2000) that allowed interpretation and presentation of the data into emerging themes. The study was conducted in a single dental school. Purposive sampling method was used to approach a number of recently graduated BDS students to attend the one-to-one structured interviews. Of the four newly qualified dentists approached, one had passed the BDS with honours, one had failed their first sitting of the exams and passed in the resit. The other two participants had passed their BDS within the clear pass boundary.

The student representatives of the five BDS years were approached and asked to invite their peers to attend the focus-group interviews. All the participants received the participant information package at least two weeks prior to the date of the interviews. They were reminded of the aims and objectives of the research before the start of the interviews and were asked to sign the consent form.
The one-to-one interviews were conducted first since the newly graduated students were leaving us to start their DFT. The one-to-one style was chosen due to convenience, as the interviewees did not have timetabled activities at the dental school. The focus-group style was chosen for the existing students since the researcher was interested in exploring the experience of the groups of the students as a whole and in a social construct instead of personal opinions.

The interviews were conducted in a structured format by a single trained interviewer (RVR). The interviews were recorded using a digital voice recorder and sent for verbatim transcription to an independent transcription service provider. The interviews were analysed in a thematic manner by a single researcher (RVR). The preliminary analysis of the data resulted in changes to the questions of the structured questionnaires in preparation for the future interviews. The analyses data were discussed and verified by a second researcher (LBD).

**Results**

The one-to-one interviews were conducted and analysed between June and December 2014. A total of four newly qualified dentists were interviewed on a one-to-one basis. A total of 24 students representing BDS years 2, 4 and 5 attended the focus group discussions \((k=3, n_1=9, n_2=5, n_3=10)\). The focus group discussions were conducted between October 2016 and January 2017.

When the transcribed data were analysed a number of themes emerged that are going to be discussed here:

**Profile of a competent dentist**
The students used several phrases to define how a ‘competent dentist’ looks like; for example, in their opinion a competent dentist is a dentist who is “capable of performing day to day dentistry”, and “is good at making diagnoses” and “formulating treatment plans”. The competent dentist “can justify their actions” and is “aware of the pros and cons of their treatment options”. Although most of such descriptions were based on clinical skills and proficiencies but from the analyses of the data three key functions emerged to describe competency: ability to reproduce good outcome, ability to predict task difficulty and ability to self-reflect.

Competency was tightly linked with being able to reproduce good results. Students agreed that occasionally good outcome could be the result of having an easy case mix while the consistency in reproducing good results mean that they have enough experience to be able to produce good outcome in any situation:

“…Competency is making sure that you’re capable of doing a particular procedure or making sure that you are aware of the technical sides of it and why you’re doing it and at least that you’ve done it a couple of times, for you to be able to repeat that procedure as well…."

The other aspect of competency was the ability to correctly predict the difficulty of a task. Students felt that such ability is once again closely related to the experience factor and is only mastered through exposure to performing a given task with variety of complexity levels.

“… with oral surgery, I really cannot tell. I took a tooth out today, which I thought was going to be a difficult one. It came out easily, but last week, I attempted to
take a tooth out, which, you know, {…} I didn't think was going to be difficult, but I ended up fracturing and it turned to a surgical, so {…} I don't think I know my limits yet in oral surgery, just because of my lack of experience. Had I had that experience, I would have just said, I think this a case for someone more experienced or a specialist maybe, but I don't know that yet….”

Mastering such ability also results in the ability to self-reflect. The students felt that once they are confident to check their own work, they have reached the required level of competency.

“… I felt confident to check my own work and then call the tutor over and just say, I think this fine, are you happy with this, and they’d say, yes, it's fine....”

Link between competence and experience

It was interesting that no links between the number of times a task was attempted and the perception of competence could be established. Some students felt competent in doing indirect restorations, in particular crown preparations while their only experience of such procedures was merely limited to clinical skills setting and sometimes one episode of clinical exposure; however, those students felt that “they know the principals behind it and they can deal with it in any clinical situations”.

One student had the same perception about endodontics; he felt that he knows the principals behind the endodontics and despite the fact that he had done only one molar endo he felt that he is competent doing molar endodontics in general.
While all of the students felt that their competency in orthodontics is purely limited to knowing when to refer the patient, one student admitted that he is “competent at orthodontics” and this is due to the fact that he has a special interest into orthodontics:

“… Ortho, yeah, I really love ortho. In terms of competence, yeah, I’d say I’m competent. I wouldn’t say I’m very good at it because lack of experience with orthodontics….”

This was in clear contrast to what the majority of other students perceived of their competency in orthodontics:

“… We’ve not really done any ortho; so just like sort of observation. Otherwise I’d say…yeah, I’d say I’ve got used to sort of assessing patients very basically, like so with the dental health component and things….”

**Common areas of lack of competence**

Molar endodontics was the first procedure mentioned in over 90% of the interviews as an area that students had lack of competence. This was in particular true about creating the access cavity and locating the canals:

“… I think for me its more locating canals, so that also is to do with access. I guess having good loups and things like that probably will help in the future but yeah, I struggled in that aspect, even in DCAS when we’re extirpating pulps I have struggled with access and locating canals, ‘cause it is always so varied…”

“…The only area that I lack confidence in is probably endo, just because I understand the theory and the principles behind it, but I don’t feel I’ve had
enough experience {…} I think I only did about three whilst I was a student, but out of those I did one molar endo and two single-rooted endos, so, you know, it’s…I don’t think having two of one makes me any more competent than one, but I feel more confident doing a single rooted…”

It was evident that this lack of experience had also resulted in the student feeling that they would not be able to manage all such procedures independently as they were uncertain of what complexities and challenges they may encounter. Although a satisfactory episode of clinical encounter boosts the students’ confidence, this is far away from making them feel competent:

“… I think it’s the difference between confidence and competence. So I was feeling quite confident after {my first endo} but not necessarily competent because the next time I did it maybe I had a bit more difficulty. So I felt like I hadn’t yet learnt how to overcome the difficulties…”

The second most common area of lack of competency was indirect restorations, in particular when the students were tasked to make bridgework. Once again such lack of competence was mostly attributed to the lack of experience:

“… I would say that my sort of weakness is crowns and bridges still, like I’ve not done enough of those….”

Interestingly, this lack of experience was not due to limited clinical time but instead the holistic approach that the dental school had adopted to provide treatment to its patients: once students accepted a patient from a given waiting list, they had to provide the patient with all of the prevention, stabilization and
treatment needs. This approach resulted in several months of maintenance before the intended procedure could be attempted.

“… Because that’s something that if you were to go and look at all the different students, that’s one thing that they always get a patient of the student waiting list and they’re like, oh, I really need a multi rooted endo or I really just need a single rooted endo to get my competency signed. But the problem is when you do that, you don’t just take on the patient who needs single rooted endo, you take on a patient that needs everything else, scaling, root planning, and everything else, extractions, then the endo. So by the time it comes to the endo, it’s the end of the year and then you get into the pickle where, oh, I can’t sign my competency…”

Oral surgery was a controversial area where while some students felt competent and confident about it while others were apprehensive:

“… I’ve never done a flap before. I’ve only observed one. {So if my trainer asks me to raise a flap} I wouldn’t…yeah, I’ll be honest, I wouldn’t feel comfortable. So I would have to see it in front of me and I would expect my trainer to stand with me when I do it the next time, actually watch me do it, yeah…..”

**How students’ perception of competency changes with time**

It was interesting to observe that students in their final BDS year or in the FD training admitted that their perception of competency had changes over time. One student admitted that while he felt competent doing direct restorative work in BDS year 3, he felt that he had done a sub-standard job when he reviewed the same patient in year 5:
“... Well, my third year patient who I first... when I... we started doing amalgam and the composites in third year, and so when I was doing fillings on him, I thought I was doing them well 'cause I did them in skills and second year, so I thought, yeah, I'm doing them great and then I remember I brought him in in fifth year and he was... unfortunately his amalgam had fallen out and I had to replace it and I realised it was really poor compared to what I've done now {...} but I guess it's all practice and experience. And I feel that within the last 18 months I've definitely realised that whatever work I did in third year hasn't been great compared to what I've done in fifth year....”

A newly qualified dentist admitted that he was not aware of his own lack of competence until his ES put on the spotlight, expecting him to perform a surgical extraction independently:

“... as part of my Foundation training, we have to do two cases, one restorative case, which I feel comfortable doing, but one surgical case... oral surgery case. When I asked the training programme director, you know, what do you mean by surgical case, and he said, it has to be flap raising and maybe bone removal for the extraction and then suturing up, and, you know, that's one area that I didn't even think that undergrads or non-dentists would do....”

Expectation from the Foundation year

‘Experience’ was a commonly used word whenever the students were discussing competency or lack of it; therefore, it was not surprising to understand that their primary expectation of their DFT was to gain more clinical experience:
“… I’m expecting to just get a lot of experience in all aspects of dentistry, obviously in general practise, it’s not just focused on one specific area, it’s everything, whoever walks through your door, it’s what you’re going to be doing. So, yeah, I hope to gain a lot of experience in terms of dentistry, learning more about myself as a clinician as well to see what I’m good at and what I’m not good at because while I was an undergraduate student, I haven’t really been exposed to so much dentistry….”

The students also unanimously admitted that they are slow at performing clinical dentistry and one thing that they were hoping to achieve during their DFT was to become more efficient and fast.

“… I want to be able to get a lot more practice at becoming efficient. We’re very used to having three-hour appointments and getting everything checked. So it’s just more about being able to be good at bread and butter dentistry; so be good at basic things and being able to do it efficiently and providing them with quality work. I also want to be a bit more exposed to the complex side of things that I haven’t been able to put into practice while I’ve been in dental school, such as the molar endo….”

It was interestingly to observe that the students felt that the DFT is a continuation phase of their development and they were willing to admit to their weaknesses and inefficiencies with the hope that such areas could be improved upon during their one-year of training:

“… So I would tell my… I’m pretty sure that my trainer will come to me and ask me what is a weakness, what is a strength. So I’ll just be honest and I’d kind
of…yeah, I’ll make sure that I do a lot of crowns and bridges just because I think that’s a very big thing in dentistry anyway, especially general practice {…} Just from what I’ve heard people say once you’ve done about 20 like you’ve kind of mastered…."

**Role of the outreach clinics**

All of the students in their fourth year and above had the experience of the outreach and found such a setting very helpful in two specific aspects: their similarity to the general dental practice and their efficacy. A typical outreach clinic consisted of four dental chairs with dedicated nursing staff under the supervision of an experienced tutor. Each student would have two or three patients booked per session.

This was in contrast to the setting at the dental hospital where students are paired with peer instead of an experienced qualified nurse, book a single patient over a period of three hours and have to share the same tutor with 8 to 12 other students.

“… {The outreach} definitely gave us a good insight into what it’s like to be out there in general practice. And it also made us a lot more efficient because we weren’t waiting around a lot more for tutors…..”

**Do different assessment styles reflect how competent a student is?**

Students were asked if our assessment system truly reflected how competent they felt. There was a considerable discrepancy between the answers given by
the students in earlier years to those in final year to those who had recently
graduated.

Those who were graduated found almost all of the exams beneficial and truly
reflective of their abilities. The only exception was the MCQs where they felt that
the questions ‘surprised them’ in many occasions, asked for unnecessary
details, and had a vague blueprint.

“… the MCQ that we have each year, since first year, has been very much
based on really minor little details that don’t really matter, like you spend so
much time studying and learning about a lot of guidelines and stuff and MCQ
just ends up kind of examining you on all the little, little details….”

“… I mean in first and second year, we learnt a lot about body and health, so I
can understand why there’s a lot of minor details in the MCQ then, but I think
that the MCQ the last couple of years has just been very varied and it’s…I can’t
really explain it but it’s just not that relevant, and it’s just very little details that
we’ve overlooked because we don’t think we’re going to be examined on it
’cause there’s a lot more other important things that we think we’re going to be
asked on and then it’s just actually those little minor details….”

The students felt that those who are the top performers of their cohort are
unable to be the top scorers in the MCQs:

“The people that are consistently top of OSCE and SAP aren’t in MCQ I think a
lot of the time, so I don’t think it is truly reflective…”

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The graduated students felt that the Unseen Cases, OSCEs and Short Answer question Papers (SAPs) were truly reflective of their abilities and felt that when they were fair, the students found these exams a ‘fun’ and enjoyable experience.

“… So I think that’s what annoys people rather than the style of exam because OSCEs I think, you know, if it’s a fair OSCE it’s actually quite fun and the same with an SAQ. Any exam when it’s fair and when it’s like, you know, the questions you should know the answers to it makes it a quite nice exam…”

Students in earlier years found almost all of the exams unfair and stressful. Interestingly the two emerging factors that fuelled such dissatisfaction were ‘spelling and grammar errors in the exam papers’ and the ‘vague blueprint’:

“… Sometimes I feel like, especially in our paper, like when you see mistakes and things like you have somebody, the invigilator coming and saying, everybody please stop, there’s a mistake in Question 52, whatever, I feel like there’s just no sort of…no real thoughts….”

“… It’s just like one question can mean two different things and then you don’t know what the answer is, and then everybody’s wondering how they just got that completely wrong because they’ve answered it a different way. Sometimes it would just be nice if we know that somebody’s checked the questions {…} because sometimes there’s missing words, they’ve got spelling mistakes…..”

“… I find it stressful in the exam period is the sheer amount of information across the different years. There’s no cut of between knowledge per year. It’s like do I need to know in fifth year all the anatomy? No, I don’t. But it might come
up in the exam so I’ll learn it anyway. And then it will be embryology. Where’s the cut off per year for the exams…or what do I need to know for my exams? I find that transition quite difficult. You end up learning everything about everything from the genes, embryo, all that side of it….”

“…but if we were given like a specification of what to learn throughout the year, then perhaps we’d be able to, for example, copy dentures, if copy dentures was on a list somewhere, then everyone would sit down and learn it. Whereas, not just because you’re lazy, you just genuinely don’t think to learn that, because you’ve not been taught it at any point. So you don’t think it will come up in the exam….”

In regards to the blueprinting the students were quite rightfully concerned that they may be even subject to unfair standard setting and bench marking. The students argued that since no cut-off exists to define the exact boundaries of required theoretical and clinical knowledge, those involved in the bench marking of the exam papers will set the expectations too high for the cohort, not knowing that certain topics had not been covered.

“…we’re going to tutors and being like…talking about the ferrule question, and all the tutors were like, why didn’t you know that? And we were all like, we weren’t taught it by anyone. But each of the tutors seemed to have thought we should have known that. So if you’ve got that kind of case, then the pass mark would be higher for that question, right. But then, obviously, we don’t know that…”

It was, however, interesting to note that the perception of the students of their exams in early years of the BDS was immature and judgemental rather than
logical. One instance was their opinion of a written coursework material where the students were expected to write an assignment on prevention advise given to a patient in need of oral hygiene instruction and preventive measures. As part of this coursework the students were given lectures and invited to attend workshops on how to run a database search for evidence, extract and appraise that evidence and write up an assignment:

“…Yeah, we had everything around it but not right, this is what your essay’s going to be about and I want you to write like this. We had a woman who told us how to write an essay, which is fair enough, but it’s really general. We had a woman about prevention, which again is good, but it’s really general, and one about behaviour, which again is good, but really general {…} And there was this like workshop kind of thing where we had these journals or we had to read and then we were in groups and we stood and answered the questions {…} I still don’t get the point of that. Why do we look at journals to…? I get that you need to know what a good journal’s like and what you need to be looking out for so you can put them in your essays, but we spent probably a {…} whole week was about it but we didn’t learn a single thing….”

MCQs

The results on the opinion of the students on their MCQ exams were varied. While some students found this exam reflective or their own competence, many found it irrelevant.

“… I think really it does distinguish between students who are, like, just pass students and honours and then distinction candidates. So I think it’s good in
terms of that and I think the questions are quite varied and I don’t think it’s not reflected of our competence, I think it is. And we do get ample time as well to do them. So I think, yeah, I think it does reflect our competence…”

The most common concern with this style of the exam was inclusion of questions that students felt either ‘too difficult’ focusing on minute details or ‘irrelevant’ asking for knowledge that in their opinion had little or no value.

“… I think the questions, some of them are absolutely ridiculous. For example, there was a question, it says things like…there’s a question I had in year two because there was a resit and it said, what has the most sugar in, and the answers were orange juice…there was options like beer, but then you were comparing fruit syrup and orange juice and white wine, and they’re all lots of sugar in, and you think that’s blind luck. There’s no one in this room that could answer that question right now I don’t think…..”

The second most common concern was related to the blueprinting of the exam. Since the dental school ran a pan-dental style exam, covering all subjects in one comprehensive paper, the students struggled to focus on the domains that the questions were addressing. The blueprint of the exam was not disclosed to the students and hence left them baffled on what to expect to see on the examination paper:

“… sometimes you do leave an exam and you think, oh, I studied this, this and this and I didn’t get asked….”

“…There’s a lot of things that we haven’t been taught, or haven’t been told to learn. But because it’s a multiple choice, you still have a go and try and do
something. But there are a lot of questions that we’ve not been taught, or never come up in any lectures, never thought that it would ever come up. But then they do come up…”

For these reasons many students believed that failing the MCQ style exams does not prove that one lacks knowledge or understanding but instead it means that they did not focus their revisions on the correct domains, where asked about unnecessary details or were baffled by the structure of the question items themselves where the wording of the distractors made the choice between two options very difficult:

“… MCQ, it’s always like whenever people fail MCQ I don’t think it’s because they knew nothing, I think it’s because they had two answers which were very close…”

SAQs

The majority of the students found the SAQs highly reflective of their clinical knowledge and problem solving skills. In their opinion the fact that you need to write the information down was a great advantage over the MCQ style papers where the choice between two options could result in a total loss of marks. They also found this style to be highly discriminative since the ‘luck’ factor is removed from the exam compared to the MCQ.

“… If I was to weigh them up I would say the SAQ was a lot more important as a way of examining us than the MCQ is, just because of the way they’ve both been formatted…..”
“… With the SAQs you either know the knowledge or you don’t and if you know the knowledge, then wicked. You know, it’s testing our competence that we know the knowledge, the theory behind what we’re doing. If you don’t know it then it really does separate those that actually do the revision and others that don’t…”

The students also confirmed that they felt that the questions in the SAQs are mostly relevant and fair and found this style an appropriate tool to identify the areas of gap in their knowledge. Some students confirmed that the SAQs made them go back to their revision materials and learn new pieces of information.

“… They’ve asked good questions and I thought that’s been a good way to assess our knowledge….”

“… so this recent SAQ we had, there was a question that I went back and looked at and I realised actually yeah, then I found where to find information….”

**OSCEs**

OSCEs were the favourite style of assessment for many of the students interviewed. They found that OSCEs truly reflect how competent they feel they are and they were generally happy with the structure of the exams. They felt that the stations assess their clinical skills as well as their communication skills very well and for many, the OSCEs helped improved their confidence as a clinician:

“… I think some of the stations are very, very good at testing you. For example suturing, you know, although you can’t test in a real mouth, I think it you
know...you have to do it and if you can do it, great, it shows you’ve got basic competence…”

“… I think it’s good because it really builds your confidence as a clinician because that’s something that we’re going to be doing {...} We’re going to be, you know, speaking to patients one on one and having that from first year and getting that experience is really good. So I think that moulds into good OSCE techniques because it’s what we’re going to be doing for the rest of our lives….”

Some also found this style of assessment a helpful method to prepare them for the DFT interviews, in particular they found it a useful tool to build on their communication skills.

“… they’ve been good. The fourth year OSCE was really good ‘cause it gave us a good foothold into what the DF interview was going to be like, and it was a lot more communication based. So I think that was good….”

In contrast, a limited number of students found the OSCEs a stressful experience. They felt that the stress caused by the exam makes them perform worse and hence the results of their OSCE is not a true representation of how competent they are.

“… I personally always hated OSCEs. I think the stress always gets you. You know, it might potentially make you perform less {...} Just a point on the OSCE actually; the one that I really felt like not confident on was the suturing and that’s just because I was very stressed, like I was…I don’t know, I was really like nervous. So I didn’t do well and I think he might have passed me anyway but I
don’t feel like I deserve to be passed and obviously suturing on a bit of like foam

is different to suturing in the mouth…”

Unseen cases

For the graduated students who had the experience of the Unseen cases, the Structured Oral Examination assessment method was on top of the list of favourites. The students felt that this style of assessment was very good at reflecting their true clinical knowledge and reasoning abilities. Almost all of the graduated students wished that this style of assessment was not limited to the final year and could be implemented in the fourth BDS year as well.

“…it’s actually quite good to sit down with an examiner and talk about treatment and why you’re doing something. I think it’s a really good way of examining. If it was done earlier as well; cause that’s what we’re going to be doing in the future; being able to have a patient; a case, and figure out a treatment plan; figure out why you’re doing it. I think third and fourth years need to be exposed to that a lot more earlier on…”

As part of the assessment process, the students were also given four to five prompt questions at the preparation stage and were asked those questions. The students found this strategy very positive, helping them focus on particular areas of questioning during their prep time:

“…I think it’s good that, the way I really do, is we have four prompt questions or four/five prompt questions as to what the case will be about. So in terms of being fair, I think it is, they are quite fair…..”
One student, however, found this style of examination very stressful and felt that she was not able to perform as well as she had hoped to. The same student had the same anxiety problem with the OSCEs in the previous years.

**Seen cases**

The Seen cases were another Structured Oral Examination assessment method, which was based on reflective write up of three patients treated by the students, one of which would be present for the clinical review by the examiners. The students found the reflective component of the assessment to have great value. It made them search for new knowledge and evidence to back up their actions and actively encouraged their learning:

“… when I was writing up my cases personally, like the last...my three cases, I learnt a lot about why I was doing things {...}, 'cause I knew that I had to make sure that...in case I was going to be examined on why I did this, why I did that, it made me go up and make sure that I knew why I was doing something.

Whereas in years three and four, sometimes you just do it and you don’t know why you’re doing it. So if in the back of your head in year three, you know, okay I need to write this up and make sure I know why I’m doing it so that I can present it, I think that would really, yeah, that would definitely teach me a lot and when I was writing them up I realised that I’d missed things at the beginning that I should have done such as little things like special investigations or paying attention to perio, and if that’d been drilled into us more from a younger age I think that would, yeah, I think that would be really beneficial actually....”

Despite the fact that the students found the style of questioning very good in assessing their clinical knowledge and potentially their clinical reasoning, however, they found the presence of a patient on the clinic of little or no value.
In their opinion the examiners’ clinical assessment of the patient was superficial, not giving them an insight into their true clinical skills or abilities.

“… yes, I think they were asking us and testing our competence in academic knowledge. I’m not sure about clinical skill in, you know, manual skill, because I didn’t feel that they looked close enough at sort of crown margins and things like that, so in terms of testing...you know, assessing my clinical skills, I’m not sure, but academically, yeah definitely…”

It was interesting to note that many students found the Structured Oral exams an enjoyable experience. Such students treated these assessment methods as an opportunity to ‘show off’ their academic knowledge, manual skills and clinical reasoning instead of treating them as a stressful exam:

“… I don’t know if I’m probably the only one who says that but I really enjoyed the vivas because it’s something that you’re passionate about and you’re getting tested on it. It really gives you the chance to show off your knowledge but you can’t really show off in an MCQ or SAQ…”

On the other hand, however, although the students admitted that they sounded confident during the exams and demonstrated good academic knowledge but deep down they knew that they are not competent as they had limited clinical experience, questioning such styles of assessment in evaluating clinical competence.

“… I felt very confident when I was doing my seen exam and even my patient said to me, she went you sounded very confident like you knew what you were talking about, and I think it’s true. Like a lot of people do know what they’re
talking about but because of lack of clinical experience we still can’t say we’re amazing…”

Competency tests
In each BDS year the students were expected to be ‘signed off’ on a number of competency tests. The students needed to approach clinical tutors and ask them to observe them while performing the competency test. At the end of the observation period they would either received a signature to mark the completion of that competency test or were marked as failed and asked to perform the task again in future on a different patient.

Generally none of the students supported such style of assessment and in their opinion they found little or no merit in running them. For most students the competency tests were nothing more than mere “paperwork” with no benefit to the students:

“… at the end of the day, it’s like they’re just, oh, you’ve seen the signature on the form and if you’ve handed it in, you’ve handed it in but it doesn’t actually reflect that you’re competent. Because I’ve only, for example, done one multi-rooted endo but I don’t feel like I’m competent in it. But the paperwork says I am…”

Some students pointed out that one of the major flaws with the competency tests may be due to the fact that there is no prerequisite of number of previous attempts before one can attempt a test. In their opinion students should only be allowed to attempt a competency test once they have done than given procedure a few times and can demonstrate a record of it.
“… but I think there’s a flaw in that. Say, for example, two students, student A and student B, student A might have done six multi-rooted endos, student B might have done one, student B might not be good at it but they’ve done it but it doesn’t necessarily mean they’re competent. Student A has done a lot of root canal treatments. They may display some form of competence, so I think there’s a flaw in that. But it doesn’t mean to say that student B doesn’t know how to do it, it just means that they may not be fully competent….”

This lack of target made the students feel inferior to other students graduating from dental schools that have targets prior to their competency assessment tests:

“I would definitely make sure that we don’t just have one competency to sign off. So, for example, we might have had a big folder in fourth year saying, you need to do like 35 competencies. There was only ever one of each procedure which I thought was a very big flaw because when you compare it to students from like Leeds University or anything like that, like you said, they have to go through maybe 10/20 before they have targets basically from each. When they come out of dental school theoretically you might be on the same level but I think clinically they might actually be more superior to us….”

In Manchester, some clinical procedures are broken down into several competencies. For example, construction of a set of complete denture required six visit and hence is attached to six unique competency tests. Some tutors would not sign a student off until the set of denture is delivered and reviewed, leaving the tests unsigned until the end of the academic year. This had left some students in a difficult situation when they had a change of tutor or their treatment was ran over to the next academic year.
“… And also I know of people, for example, the denture one, which is like five or six competencies, so third year or fourth year they’ve done all of it and then reviewed in another year with a different tutor, but because that tutor hasn’t seen it and followed it through they’re not signing it off, so you have to get a whole new denture patient in, and that’s not fair….”

Longitudinal assessment on the clinic

At the start of the interview process, the dental school was using LiftUPP software package; however, this system was changed and replaced with iDentity system as the interviews were being conducted. The two systems although have similarities but also demonstrate fundamental differences.

The LiftUPP system is initiated by the clinical tutors in the sense that each clinical tutor has a list of students on their iPads where they are required to click on before a procedure can be selected. Once a student is selected, the tutor is presented with a comprehensive list of procedural possibilities. Once the correct procedure is selected, the tutor is required to assess the student on a number of structured steps, each scoring between 1 and 6; where 5 is the score given to a competent clinician.

As a result, each student will receive several marks on the several clinical steps of one procedure. The system then selects the lowest mark graded by the tutor and returns it as the overall outcome result for that given procedure.

The iDentity, in contrast, is initiated by the student. Although there is a list of procedures to choose from, the students have to enter only one self-reflective score for each of these four domains: knowledge, skills, professionalism, and
patient feedback. The student selects the supervising tutor from a list of possibilities for their grades to be verified. Only in that stage the tutors will gain access to grading of the student where they can either confirm the self-assessment grades or alter them. The grading is against set descriptors on six different categories that although are defined by alphabetic symbols but practically mimic the numeric grades of the LiftUPP.

Regardless of the system used, it became apparent that the students felt that their clinical tutors took this exercise very lightly. The students felt that the most common grade awarded was 4 (which is equivalent to satisfactory but done with verbal prompts), which was irrespective of their quality of work.

“…I think what we do in clinics and how we're assessed on the iPads maybe should be more important {…} it would be good to have maybe once a month where we're really actually assessed rather than it just being oh yeah, that was all right; that was okay; four, four, four. Do you know what I mean, like? I think that'd be quite a good way of assessing us….”

The students also confirmed that in many cases the clinical tutors were not even involved in several steps of the procedure and the mark awarded to them was not at all a reflection of how good they were.

“…It seems like the tutor should be observing every single stage of the treatment; instead, I know in final year, the tutors just let me get on with it and just said, you know, if you need us, then you call us, so I don't see how the grading, you know how they could be grading us, when they haven't seen us do anything. I mean, for all they know, I could have not irrigated at all and just put
It also became apparent that there is significant discrepancy between the clinical tutors at the dental hospital and the outreach clinics in terms of how the grades are interpreted and used. While the tutors at the dental hospital are much more inclined to grade students at the ‘independent’ category (equivalent to competent), the outreach tutors have a much more conservative approach towards labelling any student as ‘independent’.

“…my outreach tutors have said, no one will be getting anything better than intervention done, because they were like none of you are good enough for that. And then it’s kind of like, well, what’s the point of having the other ones then, if you’re just going to say…? {…} I think, outreach, they have kind of set their…they’ve said between themselves, that they’re not going to give anybody like independent or any better than what is it ‘satisfactory’ {…} but then you see like some tutors, they’ll give you independent for everything, sort of in hospital.

So I think it’s more standardisation needed in the hospital….”

Since the introduction of the electronic portfolio systems over four years ago, the dental school has held several calibration sessions for the clinical tutors, reminding them of the benchmark against which the students should be assessed. While the benchmark has reminded the day-1-dentist over several years, it was surprising to understand that some tutors assess the students against the criterion not agreed by the dental school.
“…I think, where the discrepancy is, is if a tutor’s marking like, oh, that’s really good for a fourth year filling, or whereas other tutors are marking it as, I can do better. So it’s like more that, like I think that just needs to be defined….”

“I think some of the tutors had different opinions on what each number meant. So some people come out and have sixes and some people were like we weren’t allowed to have sixes....”

It also came as a surprise to understand that the discrepancy in interpretation of the grades was not restricted to the clinical tutors but also the students. This is despite the fact that such descriptors are readily available on the electronic portfolio systems and also displaced on the noticeboards on every clinical area.

“… we didn’t even see what the numbers were for and they just give it to us and expect us just to sign this but we didn’t even know what it’s about....”

CAT
Depending on the focus of each BDS year, the students were asked to submit a written coursework in the form of an assignment or a modified essay. Out of all such assessment items, the Critically Appraised Topic (CAT) in the BDS year 4 was the most popular amongst the students. In this module, the students learn how to formulate a research question, how to systematically search for evidence, how to evaluate the strength of the evidence and finally how to appraise the literature to answer their research question.

“… I really enjoyed the CAT, that helped me...well, I learnt how to read a paper, so, you know, that’s really useful….”
A limited number of modules were assessed using a poster presentation, merely in the first two BDS years. The students generally found poster presentation as a method of assessment invalid and not fit for the purpose, mainly due the fact that the majority of the grading and feedback was focused on the presentation skills and aesthetics of the poster produced instead of the academic value of the materials covered.

“… the poster thing, it wasn’t really like a scientific poster, it was like some of the feedback we got it was like so much to do with how our poster looked and how bright it was and how pretty we made it, and honestly they just wanted the briefest amount of basic knowledge. So it’s not really something you’d expect to do…”

**Does feedback on assessment have a role in making students competent?**

**Mock exams**

The students receive a number of mock exams, including OSCE, SAQ, MCQ and spotter. The students had a positive view towards the mock OSCE since the examiners were able to offer immediate feedback to the students.

“… I think in a way, that’s good because it makes you realise you’ve got gaps in your knowledge that you do need to pick up on, and I think that’s why mocks are quite good to have because it gives you that kick up the bum a little bit to make you realise that actually now I’ve still got to go back and look at that…..”

The students’ views towards other mock exams, however, were very different. The students receive the overall mark for each of these exams; however, they
were concerned that there may be little value in such exams if they do not know what the right answers were.

“… Even the practice MCQ that we get around January, you’ll find out if you go the question right or wrong, but if you got it wrong you won’t know what the correct answer is {…} It’s hard to progress if you don’t know the answer, how are we supposed to progress on knowledge in a way…?“

Some students were also very concerned that some of the mock exams are not a true representation of the summative exams. An example was the mock spotter exam where the students found the questions to be very simple and superficial compared to the summative exam.

“… It’s like {in the mock exam} they {were only asking to} name the basic things, so they’ll be like name this muscle, but then in our actual one we had so many questions on different veins and arteries and you were just looking at it like we haven’t gone through this {…} I feel like the mock gave you some kind of false sense of security….“

**Feedback on the summative exams**

The school provides students with electronic item-based feedback on the SAP and OSCE exams. The feedback is given to the students via an in-house electronic database called CEDAR. The students have a unique log in whereby they can view their personal data on their performance in the assessment.

Once a student logs in to the CEDAR system, they are able to view an item-based breakdown of their attempt at the exam. For each question item, they will see a ‘subject heading’ followed by the graphical representation of the
distribution of the marks achieved by that cohort of the students. The student will then be able to see where the pass mark was for that question item and where they stand compared to the pass mark a well as the rest of their class.

The above system had been in operation for the past three academic years and it was interesting to note that the students were not interested in the output data from the CEDAR system but instead they wanted to know ‘specifically’ where they have gone wrong in each question item (or station).

“… For example, SAP is a very clinical exam and it would be really useful to have some feedback from where we went wrong, catastrophically wrong or got a whole question wrong in SAP. We do get OSCE feedback on the CEDAR system, but it has your score, if you’re below average, doesn’t say improvement marks. I know it’s very specific. But when they are checklisting you against the marks we never get to see where you fall down…”

The school normally releases the exam results and the CEDAR feedback after the examination board. Such board can be held up to six weeks after the first summative exam sat. The students felt that timing of feedback is a crucial part of the feedback process and delay in getting it will result in students feeling ‘cheated on’.

“… People seem to feel less cheated when they get the answers immediately afterwards, whereas if you leave it a long length of time and you say this was the feedback, people think, well, I put that or I said that round about, whereas when you’re in the actual theatre you think well, no, fair enough {…} and feedback means much less when it’s distant, away from the time you did it {…} it means nothing {…} Whereas immediate feedback is so much better….”
Properties of effective feedback after assessment

From the interviews four properties emerged to describe an effective feedback; one that encourages learning and results in students discovering the holes in their knowledge and skills, and potentially acts in a positive manner toward competency.

Feedback has to specific

All the students unanimously agreed that the feedback has to specific. The students need to know where the gaps in their knowledge or skills are so they can improve them.

“… Because we get told that we’re wrong but not why we’re wrong…”

The students, however, were acknowledging the security of the exam papers and understood that it may not be possible to provide specific feedback without disclosing the question bank items to the students. The focus group suggested that one potential solution to this problem is the implementation of a ‘debrief’ session after each exam.

“… I think it might be difficult to give everyone specific exam feedback, but perhaps, I don’t know if it would be possible to just go over kind of the structure of like an example of what you might expect to have, say in an OSCE station.”
Because right now, we’re kind of... yeah, we have a general idea, but we don’t really know what the examiners are looking for...."

Another potential solution to this problem was to group similar question items together and provide the student with feedback on their performance on ‘groups’ of questions instead of a generic overall score for the exam paper.

“...Obviously they can’t say each question because of the security of the exam, but if they gave a breakdown, like if they said muscles and stuff and then grouped all the questions and said what you got out of that score it would be really helpful. But nothing like that happens....”

**Feedback has to be recorded**

The students felt that effective feedback should be provided in a recorded medium; for example, written or video recorded. The students confirm that once feedback is provided in the verbal format only, it is easily forgotten or misunderstood, reducing its effectiveness.

“...and like, if somebody has just verbally spoken to us, people might forget it or misinterpret it, and it just becomes a bit of a mess. And people speculate and send each other messages, saying, this is going to happen and that’s going to happen, and no one actually knows. So it’s best if it’s written or as I’ve said, on a lecture and someone can speak about it and then it will be podcasted as well....”
Feedback should be provided in a timely manner

The students felt that late feedback is almost of no value. The school normally provides feedback, which could be as late as six weeks after the exams are sat, which to students’ beliefs it was not effective any more. On the other hand, however, the students felt that immediate feedback has its own disadvantages and may put the students under considerable amount of stress. Generally the students felt that ‘one week after the exam’ is the optimal time for the feedback to be delivered.

“...because I feel like once you’ve come out of the exam and if you had a list of all these things you’d done wrong you’d be like… you’d literally have like a breakdown {...} when you’ve done the exam it’s like you just want to go, you’re done, onto the next one, you can’t go and change anything right now, but like a week later you can reflect and if need be you’ve got to do it again you can learn from that....”

Feedback should come from staff with high authority

It was interesting to note that the students were sensitive to who delivers the feedback. In their opinion feedback is only regarded as serious when it is given by a faculty with high levels authority. Their suggestion was the year leads should be responsible to delivering the examination feedback or debriefing.

Discussion

The initial aim of this study was to understand how dental students perceive competence. Based on the analysed data, the students perceived competency to have three functions:
(1) The procedural function: were the student knows what they are doing, can justify their actions and are able to achieve reproducible acceptable clinical outcome.

(2) The insight to the task difficulty: the student can correctly assess the difficulty of a procedure in the outset.

(3) The self-reflection function: the student can critically appraise their own work.

Nevertheless although the “experience” factor was an important factor in this equation but it was not deemed essential; meaning students felt that it is possible to master a number of procedures with limited clinical experience. An example being the crown preparations where most of the students felt competent despite the fact that most of their training had been inside the clinical skills lab and not on the patient.

The anticipation of the task difficulty was an interesting and important finding. The graduated students agreed that this is a skill mastered only when they are exposed to several episodes of a given task but with a range of difficulty levels. The “experience factor” therefore became an essential part of this function. This was also true for the appraisal function since graduated students admitted that they only realized the poor quality of their previous work when they were given the chance to review them a number of years later, during which period they have had gained more experience.

It was also interesting to note that most of such themes emerged from the interviews conducted with recently graduated students or students in their final
BDS year. It was clearly noticeable that the students in more junior years had a lack of insight into their own competencies and abilities, seeing themselves competent in areas that were commonly regarded as problematic areas by the educational supervisors or senior student. This can potentially be due to the lack of experience since the more junior students had less time on the programme and hence less exposure to the clinics.

This finding was also true not only when the students were questioned about their own competency but also when they commented on their teaching and assessments. Some of the junior students had unrealistic expectations of their teaching and had serious lack of insight into the use of taught materials. This finding can jeopardize any research conducted to assess self-reflection of students, in particular if students of junior years are recruited into the studies.

Concurrently, if one’s opinion on own abilities is not trustworthy, one may question the validity of any exercise involving the self-evaluation or peer-assessment of clinical skills or clinical work in earlier years of training. If a student is unaware of what an ideal outcome looks like, how could they possibly criticise their own work? Arguably for this very reason some researchers have started to ‘calibrate’ their students on ‘self-evaluation’ and ‘peer-assessment’ before they get into a stage that their grades can be regarded as valid (Eva et al., 2004; Eva and Regehr, 2005).

The same argument applied to their perception of the assessment tools used to assess their competence. Those in junior years had a fundamental lack of insight to understand the necessity of many assessment tools while those in senior years or newly graduated had a different point of view to the school’s assessment strategy. From the senior students’ point of view, assessment tools
targeting their clinical reasoning, problem solving, treatment planning, reflection, communication skills and micro clinical skills were best to reflect their competence; the Unseen Cases Structured Oral Examination, OSCE and the Seen Cases Structured Oral Examination being on top of the table. Such tools were earlier described (Albino et al., 2008) to target the ‘show how’ level of Miller’s pyramid of competency (Miller, 1990).

Although the MCQs were the favourite assessment tool used by the US dental schools (Albino et al., 2008), the UK dental students did not find this method of assessment reflective of their knowledge at all. In their opinion such exams are not discriminatory and therefore a poor exam outcome does not mean that they are inferior compared to the rest of the class; but instead indicates that they simply got confused between two very close options. For this reason they were much in favour of assessment tools that required writing information down; SAP for example. In this method the students would either have the knowledge and write it or do not have it and leave it blank. Probably the prohibitive factor for the dental schools for the routine use of the SAP style assessment items is the extensive need for human resources to mark the scripts, making it much less cost-effective in comparison to the MCQs (Schuwirth and van der Vleuten, 2010).

While the competency-based education and assessment of competence are the trendy topics in medical and dental education; however, there are a number of scholars doubting the usefulness of competency tests (Grant, 1979; Norman et al., 2014a; Talbot, 2004). The argument is that the student may sacrifice clinical excellence with paperwork. Our study was not able to explore such claims; however, from the students’ point of view, the competency tests were deemed to be nothing but a mere paperwork exercise. Those in favour of the competency
tests, however, admit that the tests in abundance become frustrating for both the students and the examiners (CanMEDS, 2015) and have moved towards creating bundles of enabling competencies that test performance as a whole; in concept known as “milestones” in the modern medical education. Potentially the students interviewed are suffering from test-overload but this study won’t be able to explore this.

Finally, it was noteworthy that the students in the junior years had serious lack of insight towards their teaching, learning and assessment. Potentially this is due to their lack of experience and the fact that they have not seen the outcome of their studies yet. This phenomenon has been mentioned in the literature (Baxter and Norman, 2011; Colthart et al., 2008; Eva et al., 2004; Eva and Regehr, 2005; Gordon, 1991; Ward et al., 2003) questioning the whole idea of self-reflection. Having said that, our senior students admitted that they started to develop such insight towards the end of their training and an affirmation that they are becoming competent. For this reason it could be suggested that if self-reflective assessment tools are to be used, their use should be reserved for the more senior years.

Limitations of the study

The study was conducted in a single dental school. A large number of students from across different years were recruited into the study; however, one can argue that the generalizability of the study is weak as the students in a different dental school may have a completely different perception of competence and a different point of view on the validity of their exams.

It is also important to note that the assessment strategies in the dental schools are subject to change. The perception of the students discussed in this study is
limited to the style of exams they were exposed to and their perception may become different if the strategy of the exams changes.

**Conclusions**

Within the limitation of this study the following conclusions can be drawn:

1. In students’ opinion, competence is the construct of three functions: clinical ability to produce and reproduce good outcome, ability to predict the difficulty of a clinical task, and ability to self-reflect.

2. Of the available assessment methods, the structured oral exams (Seen or Unseen cases) as well as the OSCE are best to reflect the competence of dental students.

3. Most of the students treat competency tests as a paperwork exercise and do not take it seriously

4. The students in the junior years tend to have a lack of insight towards their teaching, leaning and assessment; therefore the validity of any research targeting this group can be questioned.
Chapter 4
4 Assessment in Competency-Based Dental Education

4.1 Role of assessment in a CBDE curriculum

Summative assessment is used for two main purposes: progression, where high-stake decisions are made to allow students move on to the next level in their education, and second, certification, where students demonstrate achievement of minimal requirements to go on a professional register.

The assessment for progression can also be used as an aide for education and a drive for learning. With effective feedback it highlights the areas of strength and weakness, assisting students to target their leaning on the areas that they need most. When used for the purpose of certification, assessment needs to be robust, valid and reliable to satisfy the regulatory bodies.

In the UK, the GDC regulates the dental profession and all the newly qualified dentists should seek registration with the GDC before they are allowed to work. The GDC requires the dental schools to observe and assess achievement of a range of competencies before students are deemed fit to graduate.

4.2 What we know and what we don't know

A comprehensive survey of the assessment methods used in the US dental schools has been published (Albanese et al., 2008), putting MCQs on the top of most frequent method used. Our findings showed that the MCQs are among the least favourite assessment methods (Roudsari, 2017) with poor validity and poor student satisfaction. What we do not know is what assessment methods are
currently in use in the UK dental schools and if we are working according to the best practice evidence available in the literature.

**Aim:**
To describe the assessment methods used by the UK dental schools

**Objectives:**
1. To identify the most commonly used assessment methods
2. To compare the current practice to the recommendations by the literature
3. To provide a list of recommendations to the dental schools to align their assessment strategy with the recommended best practice
The following paper is written in preparation for submission to the British Dental Journal.

The references are included in the Reference Chapter of this thesis to avoid duplication of the data.

List of authors:

Mr Reza Vahid Roudsari¹
DDS MSc PGDip MFDS FDS (Rest Dent)
Clinical Lecturer and Consultant in Restorative Dentistry. Assessment Lead for the BDS and BSc OHS Programmes.

Professor Nick Grey¹
BDS, MDsc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education. Faculty Associate Dean for Teaching and Learning. National Teaching Fellow.

Dr Lucie Byrne-Davis²
PhD CPsychol
HCPC Registered Health Psychologist. Lecturer in Assessment and Psychometrics. Academic lead for phase 1 assessments

¹ Division of Dentistry, JR Moore Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PL

² Division of Medicine, Stopford Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PT
A survey of the assessment methods used in the UK dental schools

Introduction

The GDC regulates the dental profession in the UK. It provides legislations on the scope of practice of the generalists (GDC, 2013a) and describes the characteristics of a newly qualified dentist (GDC, 2011b). The GDC puts “patient safety” on top of its priorities (GDC, 2013b) and expects dental educators to produce dental professionals who are no compromise to the safety of the population (GDC, 2015). The GDC names such newly graduated dentists as “safe beginners” and acknowledges that such dentists may have gaps in their skills or experience but are aware of their own strengths and limitations and are capable of managing patients to the best of their abilities.

To ensure that the dental educators produce such safe dentists, the GDC is very keen for the dental schools to use robust assessment methods with good validity and reliability (GDC, 2015) to ensure their graduates are not a threat to the public. One assumes that the UK dental schools incorporate a programmatic approach to their assessment strategy (Bok et al., 2013a; van der Vleuten and Schuwirth, 2005b), triangulating several data points, assessing students cognition, skills, attitudes, critical thinking and problem solving to reach decisions on progressions. While data on the assessment methods used in the United States has been published earlier (Albino et al., 2008), no data on the UK dental schools exist.

The aim of this study is to conduct a descriptive analysis of the summative assessment methods used by the UK dental schools followed by a critical analysis of the recent literature on such methods.
**Methods and materials**

The survey received favourable ethical approval (ref 14323, Appendix 9.3.1). All of the 14 UK Dental Schools were approached. An email (Appendix 9.3.2) was sent to the Heads of School (or equivalent) with information on the study (Appendix 9.3.3) and the sample data collection sheet. The Heads of the School (HoS) were asked to provide the research team with the contact details of the appropriate member of the staff who would be able to provide the desired information.

Once the desired member of staff was identified, they were provided with the information on the research project and were asked to provide the relevant assessment information via one of the following means:

- Filling in the data collection form directly
- Submission of their year handbooks (if assessment data was included)
- Submission of their assessment book (or equivalent)
- Submission of their assessment schedule
- Meeting or telephone discussion with the Principal Investigator (PI) so the data collection sheet can be filled in

The data collection sheet consisted of three categories of assessment tools: (1) written items, (2) Observed items and (3) portfolio-based assessment (Appendix 9.3.4). Where possible, data on the stake of the assessment (formative versus summative), number of question items, length of the examination and the month the exam was held in were collected.
The collected data was transferred to the SPSS software (Version 22, SPSS for Macintosh, IBM, Chicago, IL) for descriptive analysis. Excel (Version 14, Microsoft Excel for Mac, Microsoft, Redmond, WA) was used to produce the illustrations.

Results

Out of the 14 dental schools approached, 9 agreed to participate in the study (Figure 4.1). Of the remaining dental schools, 2 refused to participate due to their workload while 3 dental schools did not respond to the email reminders after three attempts. Out of the 9 participating dental schools, one school only provided the assessment information on their BDS year 5 class. One dental school was a graduate-entry institution with no BDS year 1 class.

Figure 4.1 - The geographical distribution of the participating dental schools.
Overall, the most common assessment method used was the MCQ/SBA, which was used in 92.5% of the BDS years. This was followed by the Essay/Assignment items (87.5%), DOPS/Competency tests (67.5%) and SAQ (65%). All of the dental schools used a form of portfolio-based assessment, out of which 52.5% incorporated an electronic version (LIFTUPP or iDentity). The least favourite assessment styles were the True-false questions and Situational Judgement Test (SJT) that were used only in one BDS class followed by role-playing, which was used by a single dental school in two of its BDS years to assess communication skills (Table 4.1).

As expected some assessment styles were most popular towards the higher BDS years, while some were popular at early stages (Figure 4.2, Figure 4.3 and Figure 4.4). Most of the dental schools use structured oral exams to assess seen or unseen clinical cases in the form of an oral examination at their final BDS year. It was also noted that the competency assessment would have a higher weight towards the higher BDS years. The popularity of the OSCE increases towards BDS year 3 but its popularity decreased in higher BDS years. Overall, the BDS year 3 was the year in which the most diverse styles of assessment were used.

Unfortunately only three dental schools provided the data on the stake of their exams and their timings and therefore this data will not be discussed in this write up.

Discussion

Assessment is an integrated and fundamental element of the teaching and learning process. A well-designed assessment system drives learning and helps
the students identify their strengths and weaknesses and encourages them to improve their knowledge, ability and skills. As discussed earlier, the ultimate aim of the dental schools is to produce ‘safe’ dental practitioners, ready to undertake their role as a Foundation Dentist. Such a dentist has proved to their examiners that they are professionally competent; meaning they act like a professional dentist, they have the required knowledge and experience, are able to perform at the level expected of a newly graduate and have enough experience (Chapter 2). Since an individual should possess such a complex arrays of qualities, a single ‘ideal’ assessment method does not exist to capture all of these parameters.

On the other hand, individual assessment methods have their own psychometric strengths and weaknesses and if used appropriately are capable of capturing part of these complex qualities. Once adequate numbers of assessment methods in a verity of styles are used, the data gathered from these methods can be put together in a process referred to as “triangulation” to create a multi-dimensional picture of the abilities (or the lack of abilities) of an individual student.

The design of the curriculum can have a major influence on the way such assessment systems are designed and used. Since the introduction of the Competency-Based Dental Education (DBDE), some UK dental schools have adopted the principals of the CBDE and have aligned their assessment to reflect a ‘programmatic’ approach; this means that such dental schools have a much more fluid and blended approach towards delivery of their materials and hence a blended way of the assessment.
In contrast, dental schools on traditional curriculums have a rigid way of delivering teaching materials, usually in the form of credit-bearing modules, and therefore an assessment method or two at the end of each module. This difference was clearly noticeable when comparing the data between the dental schools. While some had as little as 6 items of assessment in a single BDS year, others could have as many as 27 examinations in a single year. The former dental school being on a CBDE curriculum, assessing the dental students on the clinic using longitudinal methods of assessment which feeds into the mid-year ‘sign-up’ process. At the sign-up, the dental students are allowed to progress only if they can produce sufficient evidence to demonstrate that they are competent for their level of studies and are ready to sit the end of the year exams. These exams occur towards the end of the academic year, are done in a variety of styles but cover materials taught throughout that given BDS year.

On the other hand, the latter type of dental schools has named modules aimed to deliver specific teaching materials and the students are assessed at the end of each module. A typical BDS year is consisted of 180 credits and individual modules carry a credit rating between 7.5 and 30, making those dental schools assessment-heavy throughout the year. It was interesting to note that such dental schools had incorporated selected assessment methods to assess their students in a programmatic way towards their final years; the most common methods being OSCEs, oral exams and reflective practice whereby a range of clinical cases treated by the student was critically appraised.

Baring such differences in mind, the rest of this text will discuss the properties of the assessment tools used by the UK dental schools:
Figure 4.2 Written assessment methods used by the dental schools at different BDS years.

Figure 4.3 Observed assessment methods used by the dental schools at different BDS years.
Figure 4.4 Portfolio-based assessment methods used by the dental schools at different BDS years.
<table>
<thead>
<tr>
<th>Assessment method</th>
<th>Popularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ/SBA</td>
<td>93%</td>
</tr>
<tr>
<td>Essay/Modified essay/Assignment</td>
<td>88%</td>
</tr>
<tr>
<td>DOPs/Competency assessment</td>
<td>68%</td>
</tr>
<tr>
<td>SAQ/SAP/MEQ</td>
<td>65%</td>
</tr>
<tr>
<td>OSCE/OSSE</td>
<td>58%</td>
</tr>
<tr>
<td>LIFT/UP/Dentity</td>
<td>53%</td>
</tr>
<tr>
<td>Reflective write up</td>
<td>38%</td>
</tr>
<tr>
<td>Project presentation</td>
<td>38%</td>
</tr>
<tr>
<td>Skills test</td>
<td>30%</td>
</tr>
<tr>
<td>Portfolio</td>
<td>25%</td>
</tr>
<tr>
<td>Unseen oral exam</td>
<td>23%</td>
</tr>
<tr>
<td>Logbook</td>
<td>23%</td>
</tr>
<tr>
<td>Poster presentation</td>
<td>23%</td>
</tr>
<tr>
<td>EMQ/EMI</td>
<td>20%</td>
</tr>
<tr>
<td>Spotter</td>
<td>20%</td>
</tr>
<tr>
<td>Seen oral exam</td>
<td>18%</td>
</tr>
<tr>
<td>Oral exam</td>
<td>15%</td>
</tr>
<tr>
<td>Long case/Case study</td>
<td>5%</td>
</tr>
<tr>
<td>Role play</td>
<td>5%</td>
</tr>
<tr>
<td>SJT</td>
<td>2.50%</td>
</tr>
<tr>
<td>True-False</td>
<td>2.50%</td>
</tr>
<tr>
<td>Discussion forum</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Table 4.1 The overall popularity of the different assessment methods used by the 9 participating UK dental schools
MCQs
Multiple Choice Questions (MCQs) were the most popular assessment method used between all of the participating dental schools. It was used by all of the dental schools in almost all of their BDS years. The only exception was one dental school that did not use MCQs in its final BDS year and two dental schools removed this method from their 4th BDS year.

Majority of the dental schools used this method in its Single Best Answer (SBA) form, mostly with five possible options to choose from; however, the number of possible options varied between 3 and 5.

The MCQs were very popular with dental schools on a traditional curriculum, assessing knowledge at the end of each module. Such exams would typically have 20 to 40 MCQ items based on the credit weighting of the module. The schools on a CBDE curriculum incorporated MCQs in two possible ways: (1) pan-dental end of year exams, whereby the MCQ paper consisted of 120 to 200 MCQ items and assessed the students on all the topics delivered in that year and (2) themed-papers towards the end of the year, having MCQ items assessing knowledge and understanding of the topics related to the given theme. The most common themes were Restorative Dentistry and Dental Materials, Oral Surgery and Human Diseases, Child Dental Health and Orthodontics, Life Sciences, and Dental Public Health and Biostatistics.

While several best practice guides encourage MCQ item writing to assess higher cognitive knowledge instead of recall knowledge (Bandaranayake, 2008; Campbell, 2011; Crites et al., 2012; McCoubrie, 2004) and some evidence has
supported such achievement (Morrison and Free, 2001; Palmer and Devitt, 2007; Tweed et al., 2013) but the literature has significant concerns towards usefulness of this method of assessment in achieving what is meant to be achieved at graduate levels (Elstein, 1993; Tarrant et al., 2006; Tarrant and Ware, 2008), demonstrating as little as 10% of the items in a paper may be assessing higher cognition. While this study had no means of assessing the quality of MCQ items used in the final years by the dental schools, it is fair to treat the use of this assessment method in the final BDS year with caution based on the available evidence, in particular if the MCQ is used in a pan-dental format that forms a major part of the assessment system.

It was interesting to note that the majority of the dental schools had opted for a five-option MCQ format. The literature supports the use of three-option (Rodriguez, 2005; Sidick et al., 1994) and four-option (Tarrant et al., 2009; Trevisan et al., 1991; Zoanetti et al., 2013) MCQs and shows that although the four-option items perform better overall, but occasionally removing a fourth non-functioning option improves the psychometrics of the item and therefore recommended the use of a variable-option format (Zoanetti et al., 2013) instead of having fixed number of options. While the five-option MCQs is the most popular format among the dental schools, the literature supports the fact that the medical educators have great difficulty writing MCQs with five plausible options (Tarrant et al., 2009) and the psychometric tests prove that frequently one or two options out of five are non-functioning (Tarrant et al., 2009).

**Essays and assignments**

Essays, modified essays and assignments were the second most popular method of assessment, mostly used at the end of a module or a specific course
within the programme. Some dental schools also used this method of assessment at their end of the year exams, mostly in its modified essay format.

Literature advises that the essay questions are easy to set, difficult to mark and demonstrate low reliability (Palmer and Rideout, 1995). The psychometrics values of this style of assessment further decreases if the students are given a choice of questions to select from, which results in students’ strategic learning, question-spotting and undesirable learning patterns (Fowell and Bligh, 1998). To overcome these problems and improve the exam psychometrics, it is recommended that several short essay items to be used instead of one or two long essay questions (Nendaz and Tekian, 1999). In this case it’s been shown that short essays can be used to even assess critical thinking of the students and higher cognitive levels of the knowledge (Day et al., 1990b; Shumway and Harden, 2003).

On the other hand, however, it has been shown that assignments can trigger deep learning when compared to the MCQs (Scouller, 1998) and therefore may be a more favourable style of assessment to be used at the end of a section of the course compared to the MCQs.

**Competency tests**
Competency tests and Direct Observation of Procedural Skills (DOPS) were popular amongst both schools with traditional and CBDE curriculums. The schools had a slightly different approach towards the rigidity of completion of such tests: in some schools completion of a set competency tests was mandatory and essential for student progression while in some schools a set number of competency tests were expected to be completed over 2 or
occasionally 3 BDS years. The information on the number and nature of the competency tests for individual schools was not available to the author; however some schools would only allow students to attempt a competency test once they can provide evidence of previous successful completion of such tasks while some schools allow the first attempt of their student to be treated as a competency test. This first attempt, of course, may well be the first time ever the student attempted to complete the given clinical task.

The Work-Based Assessments (WBAs) refer to the assessment methods used to assess the students on the clinic. Since such tools are designed to observe the students while performing a task, they are regarded as being able to capture the highest level of clinical competence: the performance level. The CBDE curriculums were originally designed around such assessment tools that allowed progression of students when they can satisfy their assessors that they are capable of performing a task in a competent manner (Chambers, 1994; Chambers, 1996; Chambers and Glassman, 1997); however, the evidence questions the reliability of this principle (Frank et al., 2010b; Hawkins et al., 2015) and suggests that the educators are encouraging a tick-box exercise instead of developing competent practitioners (Hodges, 2006).

With this in mind, it becomes worrying to understand that some dental schools allow their students to take a competency test while that occurrence could be their first attempt of doing that procedure on a patient. It is useful to know that this problem is not unique to dentistry but one that medical educators have been struggling with for over three decades (Carraccio et al., 2002). The literature suggests that for such competency tests to be meaningful it is essential to (1) define what areas of competency needs assessment, (2) it has to be clear how
they are assessed and evaluated, and (3) the students and the assessors
should have a buy-in to such assessment methods (Carraccio et al., 2002).

From the above it may be concluded that the dental schools should consider
use of competency tests only after several episodes of satisfactory performance
of a procedure is recorded. All of the dental schools participated in this study
expected their students to keep a clinical logbook; therefore implementation of
this recommendation should not be a difficult task.

SAQ
The Short Answer Question (SAQ) or Short Structured Answer (SSA) exams
were used in nearly 60% of the participating dental schools. Unfortunately the
data collected from the schools did not reveal how many question items were
used in each exam paper and how much time was allocated per question item.

Literature places the SAQs in a position between the MCQs and Essays: they
allow higher levels of congestive knowledge to be assessed compared to the
MCQs while they are not as hard as the essay questions to mark (Shumway and
Harden, 2003). The literature believes that less effort is needed to create new
SAQ items compared to the MCQs and the exam reaches very high reliability
scores post-hoc (Rademakers et al., 2005). There are also suggestions of
availability of software packages that facilitate the marking of the SAQ papers
(Leacock and Chodorow, 2003); however, none of the UK dental schools are
currently taking advantage of such technology.

Compared to the MCQs, the SAQs eliminate the ‘guess factor’ from the exam.
Since the students are expected to write their response, it will tap into the
student's ability to create an original response. On the other hand, the marking of the exam script can be subjective and negatively influenced by the poor handwriting, spelling mistakes and grammar errors (Kramer et al., 2009).

OSCEs

The Objective Structured Clinical Exam (OSCE) is a popular method of assessment amongst both the medical and dental institutions. It was no surprise to understand that the OSCEs are used in 58% of the BDS years nationwide. It was, however, interesting to note that the popularity of the OSCE increases through the BDS years, reaches its peak at year 3 and decreases towards the final year. While all except for one of the dental schools had OSCE in their year 3, two and four dental schools had this exam in their years 1 and 5 respectively.

Since its invention (Harden, 1988) and introduction (Harden and Gleeson, 1979) there has been over 1600 publications on this assessment method alone, making the OSCE one of the most researched assessment methods (Harden, 2016). There have been several publications in support of the validity (Barry et al., 2013; Brown et al., 1999; Hodges, 2003; Nickbakht et al., 2013; Park et al., 2004; Taghva et al., 2010; Varkey et al., 2008), reliability (Brown et al., 1999; Nickbakht et al., 2013; Rahayu et al., 2015; Ramos et al., 2015; Setyonugroho et al., 2015; Taghva et al., 2010) and acceptance (Pierre et al., 2004; Puryer, 2016) of the OSCE despite the fact that it is an expensive exam to run (Brown et al., 2015; Carpenter, 1995) and may not be as ‘objective’ as the educators would like it to be! The creator of the OSCE, refers to this exam as a POSCE (potentially objective structured clinical exam) and emphasises that if the OSCE
is not implemented appropriately, it will deviate from its purpose and will fail to serve what it is meant to (Harden, 2016).

On the other hand, there are doubts on the usefulness of the checklists and suggestions to replace the checklists with global grades. Literature supports this move and confirms that the use of global grades instead of checklist scores results in better generalizability of the exam (Regehr et al., 1999; Cunnington et al., 1996). This, however, compromises the objectivity of the OSCEs and turns them into subjective exams.

Use of borderline regression method for standard setting has attempted to incorporate both the checklist scores as well as the global grades into the equation and hypothetically aims at preserving the objectivity of the OSCE while allowing the subjective judgement of the assessors define the bench mark. Having said that, however, it is known that the perception of bench mark differs between schools when the same OSCE stations are used, regardless of the method of standard setting used (Boursicot et al., 2007).

Although the value in use of the checklist scores or global grades is subject to controversy in the literature but it seems that the phenomenon of a “good OSCE” and “not so good OSCE” (Harden, 2016) really exists. It is the design of the checklist that turns an OSCE station into a “good” or a “not so good” one. Once the checklist items are carefully designed and validated, the psychometrics of the exam shows a better reliability of the checklists compared to the global grades (Cohen et al., 1996).
LiftUPP/iDentity

In the UK, the Dearing Report has recommended to all of the institutions in the higher education to use a form of portfolio to monitor the progress of their students (The National Committee of Inquiry into Higher Education, 1997). It was noted that all of the UK dental schools surveyed were using a form of portfolio to assess and monitor their students, half of which were using an electronic version of such portfolios.

Currently the two market leaders in such electronic portfolio systems are LiftTUPP (LiftUPP, 2017) and iDentity (iDentity, 2017). The LiftUPP system operates using the Mac iOS in the form of an iPad-based application. The clinical tutors initiate the assessment process by choosing the clinical procedure their student is performing. Based on the procedure selected, the student will be assessed on a number of competencies, including clinical, communication, infection control and patient management in a structured way. To score each item of competency, a global grade between 1 and 6 will be awarded, which is dependant on the marking descriptor agreed by the dental school.

The data from the LiftUPP system can be seen and analysed by members of staff with higher authority permissions using a browser-based version of the software, allowing graphical and numeric analysis of the data. The data for each student or the cohort of the students can be tracked in a longitudinal manner, enabling the assessor observe rise or fall of the performance of their students during their progression throughout the BDS years.

The iDentity system, on the other hand, is a browser-based software with adjustment ability to fit to the device it is running on. This system has adopted a different approach to data collection and analysis in the sense that the students
initiate the assessment process instead of their clinical tutors. The students can choose a range of procedures and are expected to grade themselves on four possible themes based on a 6-point global scale. The themes concerned are knowledge, procedural skills, professionalism and patient feedback. Students are expected to enter one score per theme where their scores will be verified or altered at a later stage by their clinical tutors.

The data form the iDentity system can be seen by members of staff with higher access authority on a browser-based system where cumulative progression data for each student is present. Unlike the LiftUPP system, the iDentity software cannot track students’ grades in a longitudinal manner and instead provides the user with an overall feel of the students’ performance.

Despite fundamental differences between the two systems, both software packages satisfy the recommendation by the Dearing Report and the emerging evidence supports their usefulness, ease of use and validity (Cotterill et al., 2011; Dawson et al., 2016; Ellis et al., 2010; Vernazza et al., 2011).

**Seen and Unseen oral exams**

Despite the fact that use of oral exams in the earlier BDS years was scarce but 7 out of the 9 participating schools deployed such exams in their final years. In the Seen Structured Oral Exams, the students were expected to produce a written portfolio of a number of their cases. They were examined by their examiners in a structured manner on a number of themes so that the examiners could test their application of knowledge and skills in the management of the presented cases. The grading is usually made based on a global scale.
In the Unseen Structured Oral Exams, however, the students were provided with a number of cases to study, identify the problems and reach a diagnosis and explain their findings to the examiners with their treatment plan or management strategy. From the questionnaires it was not clear if any of the dental schools incorporated the use of simulated patients or such exams were confined to recorded data, photographs and radiographs without a patient being present. The authors’ school does not use simulated patients in their Unseen exams.

From the above description it can be suggested that the Unseen Structured Oral Exam is conducted in seminar way to the Case-based Discussion (CbD) in the medical schools but with the major difference in its stake. The CbD, originally described as Chart Stimulated Recall (Maatsch et al., 1983), was introduced for the assessment of medical residents. In this assessment style, the trainee was expected to provide their examiner with the case notes of two of their patients. The examiner would assess the trainee on their application of knowledge and skills and would globally grade them. It was shown that five to eight episodes of this test were essential to make this exam reliable (Maatsch et al., 1983) and later on six episodes of assessment was agreed to become the minimum requirement (Norman et al., 1989) for this method of assessment.

Oral examinations (or viva voce) have been used for years to assess the performance of medical students. They have the ability to probe the understanding and clinical reasoning of the candidates (Petrusa, 2002); however, due to major flaws with their reliability, generalizability (Turnbull et al., 1996; Muzzin, 1995) and validity (Davis and Karunathilake, 2005) the traditional unstructured oral exams have been abandoned and replaced with the structured versions of such assessment method. Clinical Evaluation Exercise (Day et al., 1990a) and mini-CEX (Norcini et al., 2003) are examples of two methods that
were introduced and used to replace the traditional viva, both of which assessing the candidate on a patient encounter episode.

The structured oral exam (Morrell, 1984), however, is a method whereby no patients or simulated patients are present and yet adds structure to the style of the traditional viva. In this method a range of questions will be asked by the examiners around pre-defined topics. There are several recommendations (Davis and Karunathilake, 2005) in place to ensure that the structured oral exam does not suffer the same flaws as the traditional viva: (1) this method of assessment is best suited to assess clinical knowledge and problem-solving skills (Anastakis et al., 1991); therefore it should be used appropriately with clear domains of questioning to ensure the intended learning outcomes are targeted; (2) The reliability of the method increases as the number of the episodes of oral exam increases (Stillman et al., 1983; Daelmans et al., 2001) therefore a number of cases should be prepared for this style of exam; (3) It has been shown that the reliability of the exam increases significantly when different examiners are used to assess different cases (Norman, 2000; Swanson, 1987b) therefore use of same examiners to assess different cases should be avoided; (4) These is a significant increase in the reliability of the exam when at least five set questions per case are asked (Amiel et al., 1997); (5) Use of marking descriptor significantly improves the test psychometrics values (Anastakis et al., 1991) and global judgment should be used instead of averaging the item scores (Daelmans et al., 2001); and finally (6) the examiner calibration and training is paramount and a crucial part of the examination process in particular if the aim of the exam is to assess candidates’ clinical judgement (Wakeford et al., 1995; Des Marchais and Jean, 1993).
Another method of oral assessment worthy of mentioning is the Triple Jump Evaluation (TJE) which was introduced in Canada (Smith, 1993) and has been appraised highly (Blake et al., 1995; Albino et al., 2008) in particular due to its assessor acceptability and inter-rater reliability (Navazesh et al., 2014) but hardly used worldwide. The TJE has not been popular amongst the American dental schools (Albino et al., 2008) and the present survey confirms that it is not used in any of the UK dental schools either. This method of assessment follows the structure of the PBL whereby the candidate is presented with information on a clinical case, given a set time to gather all the relevant information and conduct online searches to find appropriate resources to back up their plans of action and finally, present their findings and management proposal to a panel of examiners. With the growing evidence to support this style of assessment, it is wise to recommend that dental schools consider its adoption into their assessment strategy.

Conclusion

The UK dental schools use a variety of assessment methods and styles throughout their BDS years. The number of assessment episodes is mainly influenced by the design of the curriculum and whether they follow a traditional modular-based curriculum or CBDE. Some dental schools have a programmatic approach to assessment hence larger assessments towards the end of the year and covering a range of topics.

Considering the imitations of this study and baring the curriculum differences in mind, we were able to look at the pattern of which of the assessment methods were used among the UK dental schools. In light with the current evidence, the following suggestions can be made:
1. The use of MCQ items in the final BDS years should be treated with caution;

2. MCQ items should be allowed to have variable number of options, ranging from three to five;

3. When essays are used in the end-of-year exams, multiple short essay style should be chosen instead of long essays with one or two questions;

4. The students should not be given the choice to select which short essay questions to answer;

5. Competency tests or DOPS should only be allowed after several satisfactory completions of that given task;

6. For the competency tests and DOPS to be meaningful, there should be a user and assessor buy-in of the method, the assessors should be trained and calibrated and the schools should have a clear policy on when students can take a test and how their performance is judged;

7. SAQs are an acceptable method of assessment, assessing cognitive knowledge and their use is encouraged;

8. The design of the checklist of the OSCE has a significant influence on the psychometrics of the exam and has to be validated carefully;

9. Use of a portfolio system is recommended by the UK government and the schools should ensure compliance;

10. If oral examination is used, it has to be structured in format, have at least five set questions in each case, incorporates several cases examined by different examiners and should be marked globally;

11. The use of TJE can be considered in the final years of the BDS programmes
Chapter 5
5 Setting standards in competency-based assessments

5.1 The day-1-dentist

The GDC uses the term “safe beginner” to describe a newly graduated dentist in the first stage of their career (GDC, 2011b). The GDC acknowledges that such a newly qualified dentist may have gaps in their knowledge, skills and experience but are considered safe to the general public (GDC, 2015). This is not because they are capable of providing a whole range of treatments for their patients (GDC, 2013b) but instead this is because they are able to provide “care” for the population they are responsible for.

Provision of care is not an individual concept but rather a systemic approach delivered by a team or network. Such safe beginners are aware of their own strengths and limitations and are able to refer the patients appropriately and in a timely manner if the care they need cannot be provided in the setting they are practicing. In the UK the newly qualified dentists usually join the Dental Foundation Training (DFT) scheme (COPDENT, 2016) whereby a trained Educational Supervisor (ES) is available should they need guidance or help with management of their patients.

To ensure that a newly qualified dental clinician possesses the right knowledge, skills and attitudes to be considered a safe beginner, the dental schools have the responsibility of implementing appropriate assessment tools that observe, capture and measure such properties (GDC, 2015). The GDC is in particular keen on the
outcomes and therefore competency-based methods of assessment are gaining
popularity (Epstein and Hundert, 2002; Kane, 1992; van der Vleuten, 1996).

The challenge is, however, to decide where to set the bar. If the standards are
brought too low down, students who are not fit to practice may graduate,
compromising public safety and if the bar is set too high, the assessment strategy
becomes unfair and not fit for purpose (Tormey, 2015; Wass et al., 2001).

5.2 The variability of assessment tools and the variability of standards

The idea of standard setting is not new to the field of medicine and dentistry and is
now considered best practice (Ben-David, 2009; McKinley and Norcini, 2014; Norcini,
2003). Based on the method of assessment used, its purpose and its stake a number
of different standard setting philosophies can be used. In general, these philosophies
are divided into three categories: relative, absolute and compromised (Cizek, 1996).

The relative methods function based on the performance of the cohort; in other
words, those who are poor performer in a cohort will be stopped and the better
performers will be allowed to progress. Cohen (Cohen-Schotanus and van der
Vleuten, 2010) and Wijnen (van der Vleuten et al., 1996) are examples of such
methods. Although such methods have great application in admission tests they
have major drawbacks in tests of progression; for example, when only the top 50
candidates in a cohort are needed to enter a programme, use of such methods is
entirely acceptable but in a cohort of very good students, the relatively poor
performing students may well exceed strict selection criteria but are deemed to be
stopped due to the nature of such methods.
The absolute methods, however, rely on expectation of performance based on the expectations of the judges. Angoff (Angoff, 1971) and Ebel (Ebel, 1972) are examples of such methods where a panel of judges discuss assessment items in advance of the examination takes place and predict the performance of borderline (or barley) passing candidates. Since such methods are independent to the performance of the cohort, the failure rate is variable. Hypothetically all the candidates in a cohort can fail or pass a given exam.

The limitation of such absolute methods, however, is the fact that they heavily rely on the skills of the judges predicting how a borderline passing candidate performs in an exam (Clauser et al., 2009; Ebel, 1971). To overcome such limitations, compromised methods of standard setting have been proposed that consider the performance of the cohort as well as the prediction of the judges; Hofstee (Hofstee, 1983) and Cubic Regression (Roudsari, 2016) being two examples. These methods, however, have their own weaknesses as the prediction of the judgements is embedded within their structure.

To move away from predictions, an alternative referencing point should have been created, which gave birth to the Contrasting Group (Huynh, 1976) and Borderline Regression (Wood et al., 2006) methods. In these methods the direct observation of the judges is used. When judges observe an encounter, they form an opinion on the performance of the candidate, which is referred to as the global judgement. Since formation of such global judgement usually requires an observation, these methods of standard setting work best in observed methods of assessment, an OSCE for example.

OSCE is one of the most popular assessment tools used worldwide in the fields of medicine and dentistry (Harden, 2016) with great popularity among the UK dental
schools (Roudsari, 2017) and dental students (Puryer, 2016). What we don’t know, however, is the significance of the global judgement of the judges. Examiner training and calibration has been regarded as recommended practice prior to the OSCE (Park et al., 2015; Pell et al., 2008) but does it influence the global judgement formed by the examiners? If so, does it have any influence on where the pass bar lies?

**Aim:**

To determine if examiner training and calibration has any influence on the pass mark of the OSCE when the borderline regression method is used
The following paper is written in preparation for submission to the European Journal of Dental Education. The abstract of this paper has been accepted for a poster presentation at the Association for Dental Education in Europe conference in August 2017.

The references are included in the Reference Chapter of this thesis to avoid duplication of the data.

List of authors:

**Mr Reza Vahid Roudsari**¹
DDS MSc PGDip MFDS FDS (Rest Dent)
Clinical Lecturer and Consultant in Restorative Dentistry. Assessment Lead for the BDS and BSc OHS Programmes.

**Professor Nick Grey**¹
BDS, MDSc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education. Faculty Associate Dean for Teaching and Learning. National Teaching Fellow.

**Dr Lucie Byrne-Davis**²
PhD CPsychol
HCPC Registered Health Psychologist. Lecturer in Assessment and Psychometrics. Academic lead for phase 1 assessments

¹ Division of Dentistry, JR Moore Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PL

² Division of Medicine, Stopford Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PT
Effect of observer training and calibration on the OSCE pass mark set by borderline regression method

Background

The Objective Structured Clinical Exam (OSCE) is a popular assessment method used to assess clinical competence at the higher levels of Miller’s pyramid (Miller, 1990) with a large body of literature in support of its validity and reliability (Barry et al., 2013; Gerrow et al., 2003; Grand'Maison et al., 1996; Hodges, 2003; Kramer et al., 2002; Pascual Ramos et al., 2015; Vallevand and Violato, 2012). An appropriate method of standard setting allows identification of candidates who fall below a passing standard. The standard setting method used must itself be is valid, defensible and credible (Norcini, 2003).

Many methods of assessment, including OSCE, use the Angoff (Angoff, 1971) or a modified version of the Angoff method (mAngoff) to calculate their cut-off score (Morrison et al., 1996). This method is a test-centred method; i.e. the standard is set by a focus on the test, as opposed to an examinee-centred method, in which the standard is set by a focus on the performance of the examinees (Jaeger, 1989). Test-centred methods tend to be conducted by the faculty themselves, with even a large mAngoff group consisting of less than 10 members (Hurtz and Hertz, 1999b). Examinee-centred methods, however, use data from all the examinees and, in the case of OSCE, from all the examiners; therefore, they are formed by the opinions of more people but typically these people are not core medical or dental school faculty. It is likely that this will lead to differences in standards set in these two ways.
There is growing evidence to demonstrate that the use of test-centred methods in the standard setting of the OSCEs results in lower test reliability and higher root mean square error (RMSE) values than the examinee-centred methods (Kramer et al., 2003; Schoonheim-Klein et al., 2009). The Borderline Regression (BR) method has been suggested as an alternative (Boursicot et al., 2007; Schoonheim-Klein et al., 2009; Wood et al., 2006) with promising increase in the test reliability scores using the generalizability theory.

In the BR method each candidate is given two scores: a global judgement and a score on a checklist. The checklist score is a numeric value based on observed performance of key elements of the station. The global judgement score is categorical and based on the observer’s “professional judgement” of performance. For the purpose of BR, the global judgement must include a category of borderline pass. At the end of the exam, a linear regression between the global mark and the checklist score is calculated. The score on the checklist that corresponds to the borderline pass category is the pass mark for the station. BR is different from mAngoff in the sense that although the judges determine the pass mark but they have the candidates in front of them; However, there is a danger that the use of many judges who are not necessarily core faculty, may result in a pass mark that is less realistic for the level of training of the candidates.

Despite the “objectivity” of the OSCE, the observers do score candidates differently (Cunnington et al., 1996). Several factors contribute to this variability (Yeates et al., 2015; Yeates et al., 2013a; Yeates et al., 2012; Yeates et al., 2013b). Calibration of the observers has been regarded as good practice. In calibration, observers witness performances and compare their scores with the scores of other examiners or the scores that the exam leads would award (Boursicot et al., 2011).
To train and calibrate the observers, several approaches have been suggested from face-to-face meetings (Park et al., 2015; Pell et al., 2008) to eLearning packages (Gormley et al., 2012). However, there is limited evidence to demonstrate the impact of such training on improving the inter-rater variability (Boursicot et al., 2007) and no evidence at all on the impact of calibration on the scoring of dental OSCEs.

We aimed to explore whether calibration training would have an impact on the scoring of OSCEs. Specifically, we explored the impact of calibration on examinee-centred standard setting when compared with test-centred standard setting. In this paper we compare the pass mark set by calibrated and non-calibrated examiners, using the mAngoff stand set pass mark as a point of comparison.

**Materials and Methods**

**An overview**

The aim of this study was to compare the individual station pass marks set by the calibrated (Cal) observers to the pass mark of non-calibrated (nCal) OSCE observers when the BR method was used. However, such comparison was not possible unless another method of standard setting was utilized as a point of comparison. For this reason, the mAngoff method was used to (1) act as a point of reference and (2) take the station variability and station difficulty into account.

For individual stations, the difference between the pass marks set by the BR method to the mAngoff method was calculated and these values were compared between the two Cal and nCal groups.
The setting

Students enrolled on the BDS programme of The University of Manchester are assessed by a variety of formative and summative methods. OSCEs are used in the BDS years 2, 3 and 4, which run on three consecutive mornings within the same week. Two diets of the same exam run in each morning with the students quarantined in between. Each OSCE paper consists of 15 stations, one of which is a ‘Rest’ station. Each diet of the exam runs at three parallel circuits to allow 45 students sit the exam simultaneously. Out of the 14 ‘Active’ stations, a minimum of 7 stations require an observer. The observers come from a diverse background and include consultants, specialist registrars, postgraduate students and part-time clinical teaching staff. Previous to the 2013-14 academic year, the OSCE stations at the School of Dentistry were capped at 10 marks to allow similar weighting between the stations. The simulated patients used to fill in a separate marking sheet to the station observers’. The pass mark for individual stations was determined using the mAngoff method by a panel of senior academic members of staff prior to the exams.

In 2014 the School of Dentistry changed its format of OSCE exams in the sense that (1) the capped total marks for each station was abolished, (2) all the simulated patients scored the candidates based on ‘developing rapport’ and ‘clarity of expressions’ criterion only, which was standardized throughout the stations for all the BDS years and formed part of the overall marks for each station, and (3) introduced the ‘Global Judgement Score’ in addition to the ‘Checklist Score’ to the observers’ marking sheet. The latter was used to allow setting the pass mark for each station using the BR method.
Observer calibration

To train and calibrate the observers, an online training package was developed and launched by the School. The aim of the training package was to inform the observers of the new format of the OSCE, explain the rationale behind using the global judgement score, give them an opportunity to observe and mark a sample OSCE station and remind them of the roles and responsibilities of the observers.

To develop the online calibration station, four actors were used to represent one simulated patient and three students of different levels of competency. The students were briefed to act as ‘Borderline’, ‘Clear Pass’ and ‘Clear Fail’ candidates, all interacting with the same simulated patient to perform the same task. These performances were video recorded and uploaded to the training package as three separate encounters.

Figure 5.1 Screenshot of the training package. The users were given the chance to download and print the marking sheet before viewing videos of actors playing the OSCE station.
The training package was approximately an hour long. It started with voice-over presentations on the overall format of the OSCE as well as the roles and responsibilities of the observers. The users (prospective OSCE observers using the training package) were given a link to download and print three copies of the marking sheet. Once ready, the training continued with the video of the first encounter, expecting the user to fill in the marking sheet without pausing or rewinding the video (Figure 5.1). When the video came to an end, the user was asked to enter their checklist score as well as their global judgement score onto the training package. Once this data was submitted, the user was presented with frequency bars illustrating the data entered by all the users of the training package prior to them (Figure 5.2) so that they can compare their own scores with scores of the other colleagues. This process was repeated three times, allowing the user to observe a total of three different candidates with different abilities performing the same task.

The aim of the training package was to allow the users to compare their own judgement with the summary of the data received by a pool of previous users, expecting a degree of self-moderation. No attempt was made to create a ‘gold standard’ judgement in the training package. To ensure that the first user of the package had enough baseline data to compare themselves against, 10 senior members of staff were asked to use the training package and enter their judgement data prior to the formal release of the package to the end-users.

**Data collection**

Favourable ethical approval for this study was obtained (The University of Manchester Ethics ref 14303). The link to the training package was sent to all of the prospective OSCE observers one month prior to the exams. The observers were asked to send a certificate of the completion of the training to the School Assessment Lead (RVR).
Between the three BDS years, a total of 239 students sat the May 2014 diet of the exams (Table 5.1). 2 students (<1%) did not sit the exams due to mitigating circumstances. Out of the 42 stations, 30 stations were observed stations. A total of 74 observers were used over the 3-day period of the exams to observe 90 stations (30 stations in three circuits). The observers were allocated to their stations by the BDS year leads who were blind to this study.

<table>
<thead>
<tr>
<th></th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>83</td>
<td>88</td>
<td>70</td>
<td>241</td>
</tr>
<tr>
<td>Number of observed stations</td>
<td>11</td>
<td>7</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 5.1 Number of observed stations and students in each BDS year.

At the end of each diet, the observers were given a questionnaire to provide feedback on the performance of their own station; however, one question specifically asked them if they had done the online calibration and training exercise. This was to cross check the accuracy of the calibration records held by RVR. Based on this data, the observers were divided into the two groups of Cal and nCal (Table 5.2). In total, 58 stations were assessed by the Cal and 32 by the nCal observers. ‘gold standard’ to allow a point of comparison between the Cal and nCal groups and accounted for the variability between the stations as well as their difficulty. Once the entire exam data was in, the following variables were calculated:

The checklist score for each student in each station was calculated using the following equation:

\[
OSCE\% = \frac{\text{Raw Checklist Score}}{\text{Total Station Marks}} \times 100
\]
<table>
<thead>
<tr>
<th>Year</th>
<th>Circuit</th>
<th>Station number - Observer ID (Training status)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>Circuit 1</td>
<td>St1 - 1&lt;sub&gt;(Cal)&lt;/sub&gt;  St2 - 2&lt;sub&gt;(nCal)&lt;/sub&gt;  St3 - 3&lt;sub&gt;(nCal)&lt;/sub&gt;  St4 - 4&lt;sub&gt;(Cal)&lt;/sub&gt;  St5 - 5&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 6&lt;sub&gt;(nCal)&lt;/sub&gt;  St7 - 7&lt;sub&gt;(nCal)&lt;/sub&gt;  St8 - 17&lt;sub&gt;(Cal)&lt;/sub&gt;  St9 - 9&lt;sub&gt;(nCal)&lt;/sub&gt;  St10 - 10&lt;sub&gt;(Cal)&lt;/sub&gt;  St11 - 11&lt;sub&gt;(Cal)&lt;/sub&gt;</td>
</tr>
<tr>
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<td>Circuit 2</td>
<td>St1 - 12&lt;sub&gt;(Cal)&lt;/sub&gt;  St2 - 13&lt;sub&gt;(nCal)&lt;/sub&gt;  St3 - 14&lt;sub&gt;(Cal)&lt;/sub&gt;  St4 - 15&lt;sub&gt;(nCal)&lt;/sub&gt;  St5 - 16&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 8&lt;sub&gt;(nCal)&lt;/sub&gt;  St7 - 18&lt;sub&gt;(nCal)&lt;/sub&gt;  St8 - 19&lt;sub&gt;(Cal)&lt;/sub&gt;  St9 - 20&lt;sub&gt;(nCal)&lt;/sub&gt;  St10 - 21&lt;sub&gt;(Cal)&lt;/sub&gt;  St11 - 22&lt;sub&gt;(nCal)&lt;/sub&gt;</td>
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<tr>
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<td>Circuit 3</td>
<td>St1 - 23&lt;sub&gt;(Cal)&lt;/sub&gt;  St2 - 24&lt;sub&gt;(nCal)&lt;/sub&gt;  St3 - 25&lt;sub&gt;(nCal)&lt;/sub&gt;  St4 - 26&lt;sub&gt;(Cal)&lt;/sub&gt;  St5 - 27&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 28&lt;sub&gt;(nCal)&lt;/sub&gt;  St7 - 29&lt;sub&gt;(Cal)&lt;/sub&gt;  St8 - 30&lt;sub&gt;(Cal)&lt;/sub&gt;  St9 - 31&lt;sub&gt;(nCal)&lt;/sub&gt;  St10 - 32&lt;sub&gt;(nCal)&lt;/sub&gt;  St11 - 33&lt;sub&gt;(nCal)&lt;/sub&gt;</td>
</tr>
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<td>Circuit 1</td>
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<tr>
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<td>St1 - 36&lt;sub&gt;(nCal)&lt;/sub&gt;  St2 - 14&lt;sub&gt;(Cal)&lt;/sub&gt;  St3 - 37&lt;sub&gt;(Cal)&lt;/sub&gt;  St4 - 38&lt;sub&gt;(Cal)&lt;/sub&gt;  St5 - 28&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 33&lt;sub&gt;(Cal)&lt;/sub&gt;  St7 - 71&lt;sub&gt;(nCal)&lt;/sub&gt;</td>
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<td>Year 4</td>
<td>Circuit 1</td>
<td>St1 - 46&lt;sub&gt;(nCal)&lt;/sub&gt;  St2 - 47&lt;sub&gt;(Cal)&lt;/sub&gt;  St3 - 26&lt;sub&gt;(Cal)&lt;/sub&gt;  St4 - 48&lt;sub&gt;(Cal)&lt;/sub&gt;  St5 - 1&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 49&lt;sub&gt;(nCal)&lt;/sub&gt;  St7 - 50&lt;sub&gt;(nCal)&lt;/sub&gt;  St8 - 51&lt;sub&gt;(Cal)&lt;/sub&gt;  St9 - 10&lt;sub&gt;(Cal)&lt;/sub&gt;  St10 - 52&lt;sub&gt;(nCal)&lt;/sub&gt;  St11 - 53&lt;sub&gt;(Cal)&lt;/sub&gt;  St12 - 54&lt;sub&gt;(nCal)&lt;/sub&gt;</td>
</tr>
<tr>
<td>Year 4</td>
<td>Circuit 2</td>
<td>St1 - 55&lt;sub&gt;(nCal)&lt;/sub&gt;  St2 - 56&lt;sub&gt;(nCal)&lt;/sub&gt;  St3 - 44&lt;sub&gt;(Cal)&lt;/sub&gt;  St4 - 15&lt;sub&gt;(nCal)&lt;/sub&gt;  St5 - 57&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 58&lt;sub&gt;(nCal)&lt;/sub&gt;  St7 - 4&lt;sub&gt;(Cal)&lt;/sub&gt;  St8 - 8&lt;sub&gt;(Cal)&lt;/sub&gt;  St9 - 59&lt;sub&gt;(Cal)&lt;/sub&gt;  St10 - 19&lt;sub&gt;(Cal)&lt;/sub&gt;  St11 - 6&lt;sub&gt;(nCal)&lt;/sub&gt;  St12 - 60&lt;sub&gt;(nCal)&lt;/sub&gt;</td>
</tr>
<tr>
<td>Year 4</td>
<td>Circuit 3</td>
<td>St1 - 61&lt;sub&gt;(Cal)&lt;/sub&gt;  St2 - 62&lt;sub&gt;(Cal)&lt;/sub&gt;  St3 - 63&lt;sub&gt;(Cal)&lt;/sub&gt;  St4 - 43&lt;sub&gt;(Cal)&lt;/sub&gt;  St5 - 64&lt;sub&gt;(Cal)&lt;/sub&gt;  St6 - 27&lt;sub&gt;(Cal)&lt;/sub&gt;  St7 - 69&lt;sub&gt;(Cal)&lt;/sub&gt;  St8 - 66&lt;sub&gt;(nCal)&lt;/sub&gt;  St9 - 65&lt;sub&gt;(nCal)&lt;/sub&gt;  St10 - 67&lt;sub&gt;(nCal)&lt;/sub&gt;  St11 - 14&lt;sub&gt;(Cal)&lt;/sub&gt;  St12 - 68&lt;sub&gt;(Cal)&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

Table 5.2 Allocation of the examiners to the observed OSCE stations (St#). Each examiner has a unique ID and is either calibrated (Cal) or non-calibrated (nCal). The written stations are not included.
Figure 5.2 Illustrations of the checklist scores (a) and global judgment scores (b) given by previous users of the training package. This was visible to the user once they had submitted their own scores.
Parallel to this, the exam papers were standard set by six senior members of staff using the mAngoff method. The mAngoff pass mark for each station was set as the

The pass mark for each station set by the mAngoff method was calculated with the following equation:

\[ \text{Angoff}\% = \frac{\text{Station mAngoff}}{\text{Total Station Marks}} \times 100 \]

The difference between the above two variables was calculated per student per station (the variable Diff). The Diff and Global Judgement Score variables were used for the purpose of the BR. On the marking sheet, the observers could choose between the “Clear Fail”, “Borderline Fail”, “Borderline Pass” and “Clear Pass” categories for their global judgment scores. The point between the two borderline groups or the Contrasting Group (CG) point was used for the purpose of this analysis (Figure 5.3). The intersect of the CG point with the regression line resulted in a numeric value that was equal to the difference of the BR standard set pass mark for that given observer to the pass mark set by mAngoff for that station.

Figure 5.3 Example stations; the difference between the BR and mAngoff pass marks were calculated using the borderline regression analysis. The CG point (x=2.5) intersects with the regression line for each of the sample stations. In station 442, the pass mark is 4.5% above the mAngoff pass mark while this value is 19% for the station 421. Please note that the weighting of the dots is not illustrated.
**Statistical analysis**

Spearman test was used to test the statistical significance of the linear regressions. Shapiro-Wilk test was used to confirm the normality of the data for the two Cal and nCal groups prior to comparisons. The difference of the BR pass marks to mAngoff were compared using the 2-tailed independent sample t-test. A p<0.05 at 95% confidence interval was considered statistically significant. Further sub-analysis was done to investigate the latter by BDS year groups using the 2-way ANOVA.

![Figure 5.4 Difference of the BR pass mark to the mAngoff (red line) for the nCal and Cal groups.](image)

**Results**

Throughout the 3 days of the exams, 2359 observations were made; out of which 839 (36%) were done by nCal observers and 1520 (64%) by Cal observers.
stations observed by nCal and 1 station by Cal observers were excluded from the study as the observers had scored ‘clear pass’ for all the candidates; therefore BR analysis was not possible. The 2-tailed Spearman test proved statistical significance for all of the linear regressions, mostly at 0.01 and a few at 0.05 levels of power; however one station in the Cal group was not statistically significant (p>0.05). This station was not excluded from the analysis. The mean of both groups were higher than the mAngoff: 6.45% (SD=9.4) for the nCal and 3.16% (SD=9.8) for the Cal (Figure 5.4). The difference between the two groups, however, was not statistically significant (p>0.05). Figure 5.5 illustrates the Diff values for the two Cal and nCal groups at the Clear Fail, Borderline Fail, Borderline Pass and Clear Pass scales. The sub-analysis of the BR pass marks by the BDS year groups (Figure 5.6) was not significant (P>0.05).

Discussion

Inter-rater variability is one of the several parameters that can influence the reliability of competency-based assessment methods (Boulet et al., 2002; Norcini et al., 1997). Some of such variability can be explained due to the personal differences in the judgement of the observers (Gingerich et al., 2014; Yeates et al., 2013a) while some can be explained secondary to previous encounters and experiences (Yeates et al., 2015; Yeates et al., 2012; Yeates et al., 2013b). To reduce the inter-rater variability, it is recommended that the observers receive appropriate training and calibration (Boursicot et al., 2011); however, previous research has shown that such training does not result in significant improvement in the inter-rater reliability (Cook and Beckman, 2009) and only results in a reduction in the range of scores given by the observers (Holmboe et al., 2004).
One of the primary goals of the OSCE is to exclude such variability by introducing the checklist scoring system (Harden and Gleeson, 1979); but when observers’ global judgement is introduced into the OSCEs for the purpose of standard setting (Dauphinee et al., 1997), the importance of the inter-rater variability becomes paramount. Online training packages have been introduced for the purpose of training and calibration of the OSCE observers (Gormley et al., 2012) but the effect of such training on the OSCE pass mark had not been investigated previously. In this study, we could not show any significant difference between the pass marks set by the two groups; and interestingly both the pass marks were close to the pass mark set by an independent panel of experts using the mAngoff method.
Figure 5.6 Difference of the BR pass mark to the mAngoff (red line) for the nCal and Cal groups by the BDS year groups.

The observed OSCE stations included in this study had an average total mark of 18. A difference of 3% and 6% to the mAngoff score for the Cal and nCal groups equates to a total of 0.5 and 1 marks respectively. In practical terms, such a small difference has a minute, if any, impact on the overall outcome of the exams for the candidates. Generally speaking, organization and run of mAngoff panels is a labour-intensive and time-consuming task and drains valuable human resources (Vahid Roudsari, 2016). 10 to 12 judges are required to achieve optimal standard setting results (Fowell et al., 2008; Hertz and Hertz, 1999a) and ideally such panels consist of senior members of staff, well orientated with the intended learning outcomes of the assessment as well as the characteristics of the borderline passing students (Angoff, 1971). In the current academic climate where the time of such senior members of staff is invaluable, gathering such groups is not an easy task. To standard set using the BR
method, however, no additional expertise, resources or time is required except for the time of a psychometrician to run the analyses. The time required for the observers to make their global judgement is already embedded within the nature of the OSCE examination. Although the direct comparison of the mAngoff to BR method was never the aim of this study; however, our data confirms that the mAngoff can be replaced with the BR method with confidence, which is inline with findings from existing literature (Schoonheim-Klein et al., 2009).

On the other hand, the OSCE observers are more than capable of making sound global judgements (Cunnington et al., 1996) and the results of this study confirms that the difference between the pass marks set by the calibrated and non-calibrated observers is negligible. In this study, 74 observers were involved. The cost of face-to-face training of this group would have been a great burden on the School. The development and launch of an online training package was the next best option, which the School agreed to proceed with. Although the results of this study did not support its usefulness for the purpose of standard setting; however, the free text comments received from the observers were very positive and complimentary. What was interesting to note, however, was the fact that the nCal observers were harder to please: they would award ‘clear fail’ more easily than the calibrated group; a difference of 10.7% or an average of 2 marks, with p<0.05. Despite such differences, when the regression analyses were done, the CG point for both the Cal and nCal groups resulted in pass mark scores very close to one another; confirming that the BR method is a valid method of standard setting for the OSCE regardless of the status of the training of its observers.
Conclusion

Within the limitations of this study it can be concluded that the BR method of standard setting can be used to set the pass mark of the OSCE regardless of the training status of its observer.
6 Can we predict future performance in longitudinal observations of competence?

6.1 Longitudinal observations as a mean of assessment

When assessing professional competence of medical and dental students, the observed methods involving direct supervision of clinical encounters at the workplace setting are among the highly recommended (Albino et al., 2008). While such methods are in use worldwide, there is a trend pushing towards analysing the outcome of such observations in a longitudinal manner instead of in isolation (Prescott · Clements and Vleuten, 2008).

In the UK, more than half of the dental schools have signed up to use LiftUPP system (Roudsari, 2017). The system captures each clinical encounter by the means of a global score between 1 and 6, where the score of 5 is set at the performance level of a day-1 dentist. During the developmental stages of the LiftUPP several strategies were used to interpret and analyse this longitudinal data. Such strategies included calculating an average or median, look at the visual illustration of the data points on a curve, calculating consistence in attaining as core and recently, interpreting the visual illustration of consistency in attaining a score that is above the set benchmark.

Up to this date, there has been no data on a mathematical model that may be capable of producing a value to interpret the pattern of longitudinal data points.
6.2 Bayes’ theorem and its implication in the assessment of competence

In probability theory and statistics, Bayes’ theorem describes “the probability of an event, based on prior knowledge of conditions that might be related to the event” (Vapnik and Vapnik, 1998). The Bayes’ theorem is stated mathematically as the following equation (O’Hagan and Forster, 2004):

$$P(A|B) = \frac{P(B|A).P(A)}{P(B)}$$

where A and B are events and P(B) cannot return as null. P(A) and P(B) are the probabilities of observing A and B without regard to each other; P(A|B) a conditional probability, is the probability of observing event A given that B is true; and P(B|A) is the probability of observing event B given that A is true.

The Bayes’ theorem has its place in the field of medicine (Efron, 2013) and has proved to be particularly useful in assessing the effectiveness of chemotherapy drugs (Larsson and Nygren, 1992), public health (Muscatello et al., 2005; Shephard, 1988) and testing the effectiveness of vaccines (Greaves et al., 1982). The use of this theorem in medical education, however, is scarce and predominantly limited to analysing cognition in problem solving (Elstein and Schwartz, 2002).

What we do not know is if the probability theory of Bayes can be used to predict the future performance of students when multiple past observed encounters have occurred.

**Aim:**

To explore if a Bayesian model can be used to predict future clinical competence of students on a clinical setting
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The references are included in the Reference Chapter of this thesis to avoid duplication of the data.

List of authors:

Mr Reza Vahid Roudsari¹
DDS MSc PGDip MFDS FDS (Rest Dent)
Clinical Lecturer and Consultant in Restorative Dentistry. Assessment Lead for the BDS and BSc OHS Programmes.

Dr Thomas House²
Senior lecture in applied mathematics

Professor Luke Dawson³
BSc BDS PhD FDSRCS(Eng) FHEA MA (TLHE) NTF
Professor of Dental Education.

Dr Lucie Byrne-Davis⁴
PhD CPsychol
HCPC Registered Health Psychologist. Lecturer in Assessment and Psychometrics. Academic lead for phase 1 assessments

¹ Division of Dentistry, JR Moore Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PL

² School of Mathematics, Faculty of Science and Engineering
University of Manchester, Oxford Road, Manchester M13 9PL

³ School of Dentistry, University of Liverpool, Pembroke Place
Liverpool, Merseyside, L3 5PS

⁴ Division of Medicine, Stopford Building, Faculty of Biomedical Sciences
The University of Manchester, Oxford Road, Manchester M13 9PT
The mathematical prediction of future performance

Background

Longitudinal assessment of competence forms the backbone of Competency Based Education (CBE). Once students are observed and assessed over a period of time by multiple examiners performing clinical dentistry on a range of patients in need of a range of treatments with variable task difficulties, it is expected that the faculty form a very thorough picture of the abilities of a given student. In the literature, portfolios have been suggested as valid and reliable methods of assessing competence at the performance levels (McMullan et al., 2003; Schuwirth and van der Vleuten, 2010). Such tools enable students to create a chronological logbook of their clinical activations with comments and/or grades from their clinical tutors and usually followed by reflective statements.

Such formats not only allow sampling of the cases and the examiners but also encourage critical thinking and error recognition among the students (Butler, 2007; Challis, 1999; Van Tartwijk and Driessen, 2009). It is easy to discuss the benefits of such logbooks or portfolios; however, when the assessment of such work is needed, the methods of choice are usually subjective and based on global judgement of the person in charge of assessing the produced work as a whole. Some institutions may adopt a system where such works are assessed against set descriptors. Some may use a panel to reach a global decision or introduce a school policy on flagging the poor submissions (Friedman Ben David et al., 2001). Either way, human factor is fundamental.

With advances in the technology, there has been a tendency to produce and record such portfolios electronically (Butler, 2007; Cotterill et al., 2011; Ellis et al., 2010; iDentity, 2017; LiftUPP, 2017). This will reduce the chance of the data being missed
and creates a core database that facilitates viewing and analysis of the longitudinal data. Currently a number of such electronic portfolio systems are operational in the UK with LiftUPP being the market leader (Roudsari, 2017). The LiftUPP system is an iPad-based system, which allows students to be graded by their clinical tutors based on a 6-point scale. The clinical tutors are responsible for initiating the grading where they have to login to their personal portal, select their student, choose the procedure undertaken and commence grading the student based on objective criterion.

Each procedure in the LiftUPP database consists of several domains, assessing the students abilities intra- and inter-operatively, followed by a number of objective items per domain. For example, if a direct restoration is placed, the student will be assessed on the domains of communication, cross infection control, informed consent, and clinical competence. The clinical competence domain will be further subdivided into items that specifically look into the knowledge, skills and critical thinking abilities of the student’s performance; for example, the quality of the cavity prepared, the condition of the lining material, handling of the restorative dental material within the cavity, recreation of the anatomical morphology, etc.

Similar to an OSCE station, the clinical tutors will award a grade between 1 and 6 to each of these objective items; 1 being dangerous to the safety of the patients or the dental team and 6 being capable of independent practice at day 1 of the Dental Foundation Training. Once the grades are awarded, the clinical tutor will provide the student with verbal and/or written feedback before student authorises the grades received using their personal login details.

Although data gathered on daily basis serve as a mean of providing students with formative feedback; however, the pattern of the cumulative data for each student is used as a mean of determining their suitability for progression towards the middle of
the academic year. The University of Liverpool currently utilizes a “barcode” system where all the data collected for individual students can be graphically displaced and the consistency of the student at remaining above the benchmark assessed. The benchmark is different based on the BDS year the students are in; for example, the benchmark grade for a BDS year 3 student is set at “3”, where students are deemed at the expected level as long as “the work produced is satisfactory with minimal procedural intervention input from the clinical tutor” while the benchmark is set at “5” for BDS year 5 students where they should be “capable of independent practice with minimal supportive affirmation from the tutor”.

Currently the decisions based on the progression of the students are made by a panel, analysing the graphical demonstration of students’ consistency. The aim of this study is to explore mathematical models that may be able to produce a numeric value, predicting the likelihood of competence of the students should they attempt the same procedure again.

Methods and materials

The ethics committee of the University of Manchester consulted and it was confirmed that ethical approval is not required for this study due to its annonimzed and service evaluation nature. The BDS cohort graduated in 2015 from the School of Dentistry, the University of Liverpool was selected and the LiftUPP data related to their last three years on the clinic extracted and anonymized. The data was filtered to only show the students’ grades on simple exodontia that do not require bone removal techniques.

The data for each student included the date the procedure was conducted, the difficulty of the task, the quadrant of the extraction site, the FDI tooth identifier, and
the grade obtained out of 6, 5 being performing at the independent level. Since students received a grade for each objective item in each domain of competency, the data was further filtered to only include the grades related to the extraction technique, excluding all the other domains, for example communication, cross infection control, etc.

The University of Liverpool follows a policy based on the “weakest link” concept whereby the overall outcome grade for each procedure is calculated based on the lowest grade achieved. For example if a given student was proficient in all the elements of the tooth extraction but was not able to choose the elevator effectively, the outcome grade of their procedure would be recorded as the grade awarded to the item assessing the use of an elevator.

The filtered data was encrypted and securely transferred to the School of Mathematics, the University of Manchester. The Bayes theorem was used to develop a unique mathematical model to process the data. For this, the outcome grade for each student at every encounter was treated as binomial (pass for 5 or 6 and fail otherwise), which was then conjugated to a beta distribution on the probabilities. The beta is a value between 0 and 1, 0 being impossible and 1 being 100% likely.

Results

Once all the filters were applied to the raw data, 1766 data points for 65 students were available for analysis: 481 points for year 3, 612 points for year 4 and 673 in the final year. The minimum, maximum and median numbers of extractions done by the students are summarized in Table 6.1. The distribution of the grades awarded is presented in Figure 6.1.
Table 6.1. Each encounter is an episode of tooth extraction. The summary of the data is shown for the cohort by their BDS year.

<table>
<thead>
<tr>
<th>BDS year</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
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<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>14</td>
<td>4</td>
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<td>4</td>
<td>3</td>
<td>33</td>
<td>5</td>
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<td>5</td>
<td>3</td>
<td>27</td>
<td>6</td>
</tr>
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</table>

Figure 6.1. Distribution of the grades awarded.

Since a median of five extractions was done per student, per year, it was not possible to run the mathematical modeling per student and instead the model was run for the whole of the cohort. The outcome is illustrated in Figure 6.2.
Discussion

Since the publication of the Francis report, it is a legal obligation for the medical profession and all those who provide care for patients to stand accountable for what they do so that the public is protected from those who are not fit to provide such services (Francis, 2013). The General Dental Council (GDC) has placed “patient safety” at the forefront of its standards (GDC, 2013b) and has made it compulsory for the dental education providers to ensure their graduates are “safe” (GDC, 2011b).

Once “patient safety” becomes an outcome of an educational curriculum, it becomes the responsibility of the dental schools to ensure such outcome is observed and measured. With the current tendency towards triangulation of the information, programmatic assessment strategies and judgements based on observed competencies, appropriate assessment tools should be selected to ensure this aim is achieved based on defensible grounds.

Arguably patient safety is not just the fruit of clinical competence but rather the professional competence whereby the clinician is not only clinically safe but also has the professional attitudes necessary to provide care for the patient, understand gaps in their knowledge and skills and seek help to ensure the best possible care is provided for the patient.
Figure 6.2. The probability of independent performance in the next encounter for the cohort (solid line). The dotted lines define the confidence interval.
Among the several available assessment tools, those that are designed for the Work-Based Assessment (WBA) have promising face validity, and if used appropriately, demonstrate good reliability. In particular if such WBA tools are used in a programmatic way to form triangulation of the data. The LiftUPP portfolio has a unit structure very similar to the DOPS (Direct Observation of the Procedural Skills). Although it is recommended for the trainees to undertake at least 6 DOPS in each clinical rotation to make the assessment reliable; however, LiftUPP provides an opportunity for DOPS in every single clinical encounter, potentially making the assessment very reliable.

In addition to this, by providing the schools with data from multiple examiners from multiple disciplines, it makes it possible for the schools to draw a comprehensive picture of the performance of individual students during their course of training. Having said that, however, while the multi-assessor function from a diverse speciality background may serve as a strength it may also becomes a threat if the staff buy-in is poor or the calibration and training is inadequate. For this reason the data from the School of Dentistry, the University of Liverpool was selected for this analysis since this school spent the past six years in extensive staff training and calibration, ensuring a good staff buy-in to the system.

On top of this, the data was filtered to include the data on exodontia only, without need of bone removal. This was done for a number of reasons: (1) The LIFTUPP had conducted a national survey to formulate a consensus on the context of the items included in it marking sheet. These items were validated by a number of oral surgeons from across the UK. (2) One of the authors (LD), being an oral surgeon himself, has been heavily involved in the calibration and
training of the clinical tutors on the Oral Surgery department, providing active supervision of the clinical tutors on how they assess and grade the students. For this reason, the data from the oral surgery department was most likely to be reliable. And finally, (3) the simple exodontia is the most common procedure done in the Oral Surgery department, hence it was very likely that enough data points could be available for this study.

Despite these, however, it was noted that each dental student had performed a median of 5 extractions per year, rendering the data inadequate for the analysis to be run at individual level. When such small numbers of available per student, process of the data results in very large confidence interval, making the interpretation of the data meaningless (Figure 6.3).

![Figure 6.3. When the number of data points is too small, the mathematic model produces large confidence interval (the dark lines), making the prediction of the clinical competence impossible. The red line shows the average value.](image)

Due to these limitations, the data was processed at the cohort level, instead of the student level. The readers should be reminded that it will not be appropriate to draw global judgements for the cohort; for example, “the class of 2015 are 85% likely to perform their next tooth extraction competently” as students
graduate with variable levels of competence and clinical expertise and therefore the conclusion should not be generalized to include the whole of the cohort. The only reason the present study combined and processed the data at cohort level was to take advantage of the present data and serve as a “proof of principle”.

In essence the data from this study confirms that once enough data points for selected procedures are available, the mathematical modelling works and therefore, it is capable of awarding a numerical value to each student at any point of time for that given procedure. That numeric value informs the educators what the likelihood of the next encounter being performed with clinical competence at independent level is.

It was also interesting to note that there was a decline in the predictive values for the cohort between the years 3 and 4, 4 and 5, and post graduation (Figure 6.2). In the first instance the authors interpret these gaps to demonstrate a “holiday effect”. The first two declining patterns correspond to the month of August and the third one to the month of June. It was hypothesised that the summer breaks in August result in the students being deskillled and therefore poorer grades; however, the dental students at the University of Liverpool attend the Oral Surgery department in rotations. For example, a given student may attend this rotation in the month of September for four week and in the month of January for another four. For this reason all the students should suffer from this deskillling pattern constantly.

The second potential hypothesis to explain this finding relates to the staff and not the students. The staff calibration and training runs in the first few weeks of the new academic year in the month of September and therefore the clinical tutors may be grading the students more strictly compared to toward the end of
the academic year where both the staff and students may feel more “relaxed” about the whole grading process. Once the training is delivered in the following academic year and the staff are reminded of the marking descriptors, the grading resumes its usual trend.

The third potential explanation is the presence of failing students. These students are usually placed in the bottom quartile of the cohort and if good reliability of the assessment is assumed, they may demonstrate weaker clinical skills compared to the rest of the cohort and hence poorer grades on their performances. Usually these students are provided with extra clinical sessions to catch up with the rest of the group, therefore what illustrates as a declining pattern with wide confidence interval is not in fact a representation of the whole of the cohort but instead the poor and unreliable performance of a selected group of students who have failed their exams.

**Conclusion**

Due to the limited number of extractions done per student per year, it was not possible to run the mathematical modelling at the student-level; however, the process of the data at the cohort level revealed that the hypothesis can work once enough data points are available. For this reason this study can be deemed as the proof of principle for using Bayes theorem to predict the clinical competency of dental students in their next clinical encounter.
Chapter 7
7 Discussion

7.1 The rationale for the research

Assessment of competence has remained a popular topic for the past few decades (Benner, 1984; Epstein and Hundert, 2002; Eraut, 1994; Kane, 1992; Polanyi, 1969; Polanyi, 1974; van der Vleuten, 1996). Over the past many years our perception and understanding of competence has changed. We have realised that competence is not a simple property that one can earn and it is not limited to clinical proficiency (Albanese et al., 2008; Carraccio et al., 2002; Carraccio and Englander, 2013; Chambers, 1994; Frank et al., 2010b; Frenk et al., 2010; Rethans et al., 2002; Yip and Smales, 2000).

Since the introduction of the concept of the professional competence, we perceive a professionally competent clinician not only as a competent physician clinically but also as an individual with professional attitudes, morals and care. Our teachings are emphasising on provision of care in the healthcare and not just treatment and for sure we aim to prepare clinicians for the future and not ambassadors of the past.

We are aiming to produce doctors and dentists who are future-proof; professional clinicians who can think critically and solve the problems they encounter. In other words, we are preparing “rounded” professionals, who are capable of independent practice, who can deal with new circumstances that may arise. Such professionals function in the context of a team, can provide leadership and are good communicators and collaborators (Frank and Danoff, 2007).
Several models have been devised to describe such professionals and tried to draw a picture to illustrate the domains of skills and attitudes one should hold to be considered within such a circle. As we continued to put the pieces together to further complete this picture, we realised that such proficiencies and competencies are not a bar to jump over and instead are presented as a scale. A scale of proficiency highly correlated with experience. The idea of a spectrum of competencies is not new to the medical education and is becoming an essential concept of the milestones (Rekman et al., 2016).

Since our understanding of competency has improved, the regulatory bodies in charge of certification of medics and dentists started to seek for observable outcomes (ADEA, 2011; AMAC, 2012; CPMEC, 2010a; GDC, 2011b; GMC, 2015; NDEB, 2005a; NDEB, 2014; Scottish Deans’ Medical Education Group, 2008); outcomes that are commonly described as competencies. Occasionally these outcomes may have a time factor attached to them or their completion may be required only at the end of the training programme. Sometimes such outcomes are observed and measured directly and sometimes such outcomes are only achieved if the student is trusted to perform and manage the situation without supervision.

The GDC regulates the dental profession in the UK and has suggested that their new registrants should possess a series of competencies grouped under four main domains. What we did not know was how such expected competencies compare to similar regulatory bodies’ in other part of the world or in medicine.

The first part of this project focused on expectations from doctors and dentists in the US, Canada, Australia and of course the UK. While in Australia the regulatory bodies had a very cautious approach towards competency-based
medical education, in contrast Canada seemed headily involved in CBME with over 12 years of practical experience in their CanMEDS framework.

It was obvious that the medical regulatory bodies in the UK are undergoing major structural changes, possibly influenced by the CanMEDS model but also due to light of new evidence in programmatic assessment, entrustable professional activities and milestones. Of course any system has the potential to be misused, and the CBME or CBDE are no exception. Still scholars in the UK and US voice their concern regarding the full incorporation of the CMBE. They argue that such frameworks are undermining 2500 years of medical scholarship and replacing it with paperwork exercise; Exercises that focus on small abilities of the medical or dental students and ignore the full picture.

Once we had a better understanding of what regulatory bodies expect from different corners of the world, we had to focus on the GDC and the expectation of competence from the UK day-1 dentists.

7.2 The Education Supervisors’ view: what we know, what is unknown

We interviewed a selection of the ESs, purposefully selected to provide us with a breadth of experience, supervising FDs for several years. Our ESs believed that competence was not limited to clinical proficiency but a more complex context involving layers of professional behaviour. This finding was consistent with our understanding form the available literature. What came as a surprise, however, was the fact that almost by default our newly graduated dentists are incapable of doing some “bread and butter” skills of dentistry.
The aetiology behind this finding, however, is outside the remit of this project and a whole new study on its own; however, the author, from personal experience of being an educator within a dental school setting can comment that this finding is most likely due to (1) the very skewed patient mix at the dental hospital setting and (2) the setup of the competency-based assessment in the dental school.

Since the dental schools are considered within the secondary care layer of the NHS, patients seen at the dental hospital are predominantly supplied by the referral route only and be default simple procedures, for example simple endodontics, is not within the acceptance criteria of referral. Without enough patients, limited experience of the students is inevitable. “Experience” was an emerging factor from the interview with the ESs as a prerequisite for clinical competence.

On the other hand in the author’s dental school, there is no minimum requirement before a competency test can be attempted. For example, a dental student may proceed with their first endodontics and get a signature on their competency test paper sheet. Since they have received the signature, there is no further requirement for any more endodontics done by the student. Hypothetically, without external pressure and motivation, the students may stop seeking more patients.

7.3 Assessment of competence: the past, today, the future

The next chapters focused on assessment of competence. Firstly, we explored students’ perceptions of competence and which methods of assessment
represented their clinical competence best and secondly, we collated assessment methods from all of the UK dental schools.

Our data showed that most of our students reported that OSCEs and the unseen structured exams were a true reflection of their competence and considered the reflective sections of the seen case presentation as an aide to find the reasoning behind the actions they had taken. The latter, in particular was the construct of their metacognition and their ability to reflect on their own word; an ability that was described earlier on by the ESs as a sign of clinical competence.

Given the students’ perceptions of the OSCE as a crucial assessment method, it was interesting to see that the OSCE was among the assessment methods used by many of the dental schools but many UK dental schools did not include Unseen and Seen case exams, which were seen by students as related to an important area of competence: clinical reasoning, metacognition and problem solving.

7.4 Local impact of our findings

The value of research is in its impact. Over the past four years, the assessment strategy of the School of Dentistry of the University of Manchester has undergone significant changes, informed by our findings. For example, our OSCEs used to have stations capped at maximum of 10 marks and standard set using modified Angoff. Our OSCEs are no longer capped, we award more than 1 mark to selected objective items to allow better discrimination and we made standard setting using the borderline regression our default method. This in addition to a wealth of psychometric tests that accompanied our exams resulted
in an assessment that became an “enjoyable” experience for our students and also highly appraised in the reports of our external examiners.

Our clinical oral exams also underwent substantial changes: their traditional viva style was soon replaced with the structured format, staff training and calibration became a mandatory exercise, and by addition of an extra unseen case, we succeeded in improving the reliability of our exams.

We used to run case-based MCQ exams with five options for a number of years. Based on the recommendations of this project, we are introducing MCQ items with variable number of options, ranging between 3 to 5. The psychometrics of this new exam, however, needs to be carefully examined and compared to the psychometric data of the MCQ papers of the previous years to confirm this change has resulted in an improvement of our assessment system.

What is still pending to be done, however, is the implication of the Bayes' theorem into our longitudinal assessment. Our research confirmed the principal but unless enough data points are gathered unfortunately this method cannot be applied to practice. This, however, can be seen as opportunity for further research where a more frequent clinical skill in dentistry (or medicine) can be selected to test this theory at individual's level.

7.5 Limitations of the research

Probably the most significant limitation of this project was the small sample of the ESs and therefore the conclusions drawn in our research may not be similar to a project run in a much bigger scale in future; however, the five ESs selected had over 30 years of experience between them, supervising over 30 FDs.
Therefore although small in numbers but they were representing years of experience dealing with newly qualified dentist. Also the interviews reached a data saturation point very quickly, emphasising the fact that the ESs most likely shared the same experience.

Also the data from the interviews focused on the competencies, abilities and skills of the UK graduates and may not be applicable to newly graduate dentists of other countries. Multi-centred studies would be able to compare the profile of newly graduate dentists graduated from different countries.

The students interviewed in this study represented a single dental school in the UK and therefore their data may not be a true representation of all of the dental students in the UK and finally we were only able to run our Bayes’ model for the cohort of our students and not at individual level, which was the initial aim of the study.

7.6 The future

Use of mathematical modelling to predict clinical competence based on previous observations is a method never tried before. Although the relevance and importance of longitudinal observations have been suggested before (Prescott et al., 2002) but there have been no practical methods in existence to interpret such data in a robust and defensible manner.

Our results confirmed that the hypothesis is sound, however, due to small number of procedures done per student, it was not possible to explore the data at student level. This is an exciting area of research for future, when enough
data is collected to enable us explore this mathematical model at the students level.

With correct modelling it may also be possible to suggest how many more clinical encounters a given student may need before they are deemed safe to progress to the next stage. This can potentially make a major shift to how clinical skills are tested in the pre-clinical setting, putting an end to end-of-course skills tests.
8 References


Dawson, L., Mason, B., Bissell, V. & Youngson, C. (2016). Calling for a re-evaluation of the data required to credibly demonstrate a dental student is safe and ready to practice. European Journal of Dental Education.


Hodges, B., Regehr, G., McNaughton, N., Tiberius, R. & Hanson, M. (1999). OSCE checklists do not capture increasing levels of expertise. Academic Medicine, 74(10), 1129-34.


9 Appendices

9.1 A qualitative interview study of the expectations and experiences of Educational Supervisors regarding the competence of Foundation Dentists

9.1.1 Ethical approval

[Image]

Secretary to Research Ethics Committee I
Email: kathy.boyle@manchester.ac.uk
Phone: 0161 275 1960

Mr Reza Valid Roudbari
Clinical Lecturer
School of Dentistry
University of Manchester
reza@manchester.ac.uk

ref: ethics/13/44

14 January 2014

Dear Mr Reza Valid Roudbari

Research Ethics Committee 1

Vahid Roudbari, Byrne Davis, Grey: How do vocational trainers deal with incompetent trainees? (ref 13/44)

I write to confirm that the amendments to the participant information sheet and the consent form satisfy the concerns of the Committee and that the above project therefore has ethical approval.

The general conditions remain as stated in the letter of 27th November 2013.

Finally, I would be grateful if you could complete and return the attached form at the end of the project or by December 2014, whichever is earlier. When completing this form, please reference your project as:

"Vahid Roudbari, Byrne Davis, Grey: How do vocational trainers deal with incompetent trainees? (ref 13/44)"

Yours sincerely,

Kathy Boyle
9.1.2 Study advertisement

Recruitment for research study

Dear colleague,

Title: How do educational supervisors deal with incompetent trainees?

You are invited to take part in a study looking at the management of incompetent DF trainees by their responsible trainers. The study has been approved by the University of Manchester Ethics Committee and your details have been obtained from the deanery database.

We are aware that you are a registered DFS Educational Supervisor (DFS), and sharing your experience and opinion will help us tremendously to develop an understanding of what types of challenges DFSs face during their year-long course of interaction with their DF trainers.

As part of this study, you would be asked to take part in one interview lasting up to 60 minutes. The interview would take place in your practice to minimise the disruption to your service. I have attached a Participant Information Sheet with this letter so that you can find out more about the study.

If you have any future questions, then please feel free to contact me on the telephone number or email below:

rec@manchester.ac.uk
T: 0161 275 6606

I will contact your practice in approximately two weeks to confirm the safe arrival of this package and also to ask if you are willing to participate in the study.

Kind regards,

Reza Vahid Rezaei
DFS, MSoc, PGDip, FDS (Res Dent)
Clinical Lecturer and Specialist in Restorative Dentistry
9.1.3 Participant Information Pack

Participant Information Sheet

Version 6.0

**Study Title:** How do dental foundation educational supervisors deal with incompetent trainees?

You are being invited to take part in a study looking at the management of incompetent DF trainees by their responsible educational supervisor (ES). Please read this information sheet carefully and feel free to ask any questions before agreeing to take part in the study.

**What is the aim of this study?**

The DF training is a valuable period in any junior dentist's career. The DF trainees face many major changes in their daily routine, including added responsibilities, intensive workload, and reduced clinical supervision in comparison to their undergraduate years. The dental school aims to prepare its undergraduate students for this important transition by providing them with constant clinical and academic support. The end goal of any dental school is to train junior dentists who are professional and competent; however ‘competency’ is not a ‘black and white’ subject and there has been on-going argument among the dental educators on ‘how competent’ a new graduate should be to be able to work with limited support in their first year of professional life.

As an ES you have a wealth of experience in dealing with new trainees every year. There is no doubt that the DF trainees start with variable strengths and weaknesses that may or may not fulfil your expectations of how a new graduate dentist should be.

This research focuses on your experience and your opinion as an ES. I (the researcher) would like to know your opinion and I would like to make sure your voice is heard. I would also like to know how you manage difficult situations when you encounter an incompetent junior dentist.

**Why have I been chosen?**

You have been selected because you are an ES located in North West England; the target population for this study.
Who will conduct this research?

The research team consists of the following members. This study will form part of Mr Roudsari’s PhD project. Mr Roudsari will conduct the interviews and will be your initial point of contact.

**Research supervisor: Professor Nick Grey**  
BDS, MDSc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education / Faculty Associate Dean for Teaching and Learning / National Teaching Fellow  
School of Dentistry  
The University of Manchester  
Higher Cambridge Street  
Manchester  
M13 9PL

**Research co-supervisor: Dr Lucie Byrne-Davis**  
PhD CPsychol  
HCPC Registered Health Psychologist / Lecturer in Assessment and Psychometrics / Academic lead for phase 1 assessments  
Manchester Medical School  
Stopford Building  
Oxford Road  
Manchester  
M13 9PT

**Principal investigator: Mr Reza Vahid Roudsari**  
DDS MSc PGDip FDS (Rest Dent)  
Clinical Lecturer and Specialist in Restorative Dentistry  
School of Dentistry  
The University of Manchester  
Higher Cambridge Street  
Manchester  
M13 9PL

What am I expected to do if I decide to take part?

You will be contacted by Mr Roudsari to arrange a convenient date and time to meet. The meeting will take place within your own practice setting for your convenience. Mr Roudsari will give you a brief explanation of the study. You can
ask questions if you are not clear about anything. Once you are happy, you will be asked to sign a consent form. This consent form will be stored separately and not with your interview results. The interview will take up to 60 minutes to complete and it will be recorded using a voice recorder.

**What will I be asked during the interview?**

The interview will start with questions on your expectations from a DF trainee. The questions will help me picture your ideal trainee. This initial question will then be followed up to clarify what you think is missing from the current dental undergraduate training programme.

The second part of the interview will focus on exploring personal experience(s) of dealing with situations where you considered a trainee to be incompetent. Hence, I would be interested in discussing with you what happened and more specifically how you managed the situation.

**What happens to the interview results?**

I (Mr Roudsari) will transcribe the interview data and at this point remove all identifying information so that the transcript will only be identifiable via a unique code in the form of a number known only to me (the researcher) and my supervisors. This identifying number will be stored separately from the transcript, which will be located on an encrypted laptop for safety. This number will only be used should you wish to withdraw your data from the study at a later date. Once the recording has been transcribed the recording itself will be destroyed.

**Will I be identifiable to anyone?**

No. There are strict procedures in place to ensure your identity remains confidential. Your consent form and the transcripts will be stored separately. When quoting from the data, all comments used in any publications will be anonymised so that you are not identifiable. All data will be stored for 10 years and then destroyed in line with the University Policy for Managing Data.

**Will the results have any influence on my career?**

The short answer is no; however, there is a small possibility that during the interview, the researcher notices evidence of malpractice either by the trainee or the ES, which may or may not compromise the patient Safety. In such scenarios
the researcher has a legal obligation to provide the trainer with advice and appropriate contact numbers to seek further assistance. He may also be required to follow up the raised matter to ensure the trainer is taking appropriate actions.

**Will I receive any benefit from the study?**

No there will be no personal benefit to you from taking part in this study; however, you will be contributing to our increased understanding of how ESs deal with incompetent trainees. This increased understanding has the capacity to help us improve our teaching at the dental school to ensure students are better prepared to take on a DFT post. Also, the research has the potential to highlight those areas where incompetency is most likely to occur and the strategies that we could put in place to address them.

**Will I get paid for my time?**

Your contribution to this study will be on voluntarily basis and you will **not** be reimbursed for your time.

**Has anyone reviewed this study?**

Yes. The proposal of this study has gone through a rigorous internal review process and has granted the ethical approval from the ethics committee of the University of Manchester.

**How do I show my consent?**

There is a consent form available that you need to sign before the interview. This will be done on the day of the interview after you have asked all your questions and are happy to go ahead. A copy of the consent form is also available for you to read with this information package.

**Can I withdraw my consent?**

Yes. You can withdraw your consent at any time before the results are published. There would be no questions asked. Your data will be excluded from the results. Obviously once the paper is published in a journal it is not possible to exclude your data.
Can I have the interview in the presence of one of my staff?

Yes of course. Please remember that the input from your staff member will not be included in your results unless you confirm them. Also please note that Mr Roudsari will have no control over the breach of your confidentiality if your staff member decides to tell others about the content of your interview; so please be very selective on who you invite to the meeting.

What is the next step?

Your practice will be contacted in nearly two weeks to confirm the safe arrival of this information package. You may confirm your willingness to take part on the phone. Alternatively please use the contact details of Mr Roudsari printed below.

How can I make a complaint?

If you have a concern about any aspect of the study, in the first instance contact the principle investigator, Mr Roudsari. If he is unable to resolve your concern or you wish to make a complaint regarding the study, please contact the University Research Practice and Governance Co-ordinator on 0161 275 7583 or by email to research.complaints@manchester.ac.uk

How can I ask questions?

Please contact Mr Roudsari using the following details:
reza@manchester.ac.uk

School of Dentistry
JR Moore Building
Oxford Road
Manchester M13 9PL
T: 0161 275 6606
9.2 A qualitative study of dental students’ experience of their assessment to define their competence

9.2.1 Ethical approval

Mr Reza Vahid Roudsari
Clinical Lecturer
School of Dentistry
University of Manchester
rro@manchester.ac.uk

Ref: ethics/13245

14 January 2014

Dear Mr Vahid Roudsari

Research Ethics Committee 1

Vahid Roudsari, Byrne-Davis, Grey: Efficacy of the current competency assessment tools: students’ opinion (ref 13245)

I write to confirm that the amendments to the participant information sheet satisfy the concerns of the Committee and that the above project therefore has ethical approval.

The general conditions remain as stated in the letter of 27th November 2013.

Finally, I would be grateful if you could complete and return the attached forms at the end of the project or by December 2014, whichever is earlier. When completing this form, please reference your project.

Vahid Roudsari, Byrne-Davis, Grey: Efficacy of the current competency assessment tools: students’ opinion (ref 13245)

Yours sincerely,

Katy Boyle
Secretary to University Research Ethics Committee
9.2.2 Study advertisement

Dear student,

**Title:** Efficacy of the current competency assessment tools: students' opinion

You are being invited to take part in a research study and give us your opinion about the way you have been assessed throughout your undergraduate training.

We are aware that you are about to step into the professional world of dentistry very soon and sharing your experience and opinions as part of this research will help to shed light on how confident you feel about this and how well you think you have been assessed.

As part of this study you would be asked to take part in one interview lasting up to 60 minutes. I have attached a Participant Information Sheet and Consent Form with this letter so that you can find out more about the study.

If you have any future questions then please feel free to contact me on the telephone number or email below:

Reza Vahid Roudsari  
reza@manchester.ac.uk

Room 1.033, Coupland III Building  
School of Dentistry  
Tel: 0161 275 6606

I am looking forward to hearing from you soon.
9.2.3 Participant Information Pack

Participant Information Sheet

Study Title: Efficacy of the current competency assessment tools: students’ opinion

You are being invited to take part in a study looking at the dental students’ opinion on the efficiency of current assessment methods to assess their clinical competency. Please read this information sheet carefully and feel free to ask any questions before agreeing to take part in the study.

What is the aim of this study?
You have been studying dentistry for the past five years and you are only a few months away from becoming a fully qualified dentist. This will be a big step in your professional life where you will be expected to see and treat patients on your own with minimal help. Over the past few years, the academic and clinical members of staff have tried hard to prepare you for this big step. Their aim has been to turn you into a competent dentist who cares for the patients and has a safe pair of hands.
To make sure that you are ready for this big challenge, you have been assessed several times during the course of your undergraduate studies. You have been assessed using written exam papers, you have done OSCEs, you have done oral exams and you have been observed in the clinic on daily basis.
I (the researcher) am sure that by now you have a very good idea of how good you are. I am certain that you know how competent you are to do dentistry on your own. At the same time I am very interested to find out how well you think the assessments you’ve been through, have correctly captured all your abilities.
Why have I been chosen?

You have been chosen as you are in the final year of the BDS programme at the School of Dentistry of the University of Manchester; the target population for this study.

Who will conduct this research?

The research team consist of the following members. This study will form part of Mr Roudsari’s PhD project. Mr Roudsari will conduct the interviews and will be your initial point of contact.

Research supervisor: Professor Nick Grey
BDS, MDSc, PhD, DRD, MRD, FDSRCSEd, FHEA
Professor of Dental Education / Faculty Associate Dean for Teaching and Learning / National Teaching Fellow
School of Dentistry
The University of Manchester
Higher Cambridge Street
Manchester
M13 9PL

Research co-supervisor: Dr Lucie Byrne-Davis
PhD CPsychol
HCPC Registered Health Psychologist / Lecturer in Assessment and Psychometrics / Academic lead for phase 1 assessments
Manchester Medical School
Stopford Building
Oxford Road
Manchester
M13 9PT

Principal investigator: Mr Reza Vahid Roudsari
DDS MSc PGDip MFDS
Clinical Lecturer / Hon Registrar in Restorative Dentistry
School of Dentistry
The University of Manchester
Higher Cambridge Street
Manchester
M13 9PL
What would I be asked to do if I decide to take part?
You will be contacted by Mr Roudsari to arrange a convenient date and time to meet. Mr Roudsari will give you a brief explanation of the study. You can ask any questions if you are not clear about anything. Once you are happy, you will be asked to sign a consent form. This consent form will be stored separately and not with your interview results. The interview will take up to 60 minutes to complete and it will be recorded using a voice recorder.

What will I be asked during the interview?
The interview will start with questions about how competent you feel. Of course dentistry is a big world and no one can master all the skills; therefore, Mr Roudsari will specifically ask you about selected procedures, for example root canal treatment, complete dentures, simple extractions, etc so you can give him more details about your skills and abilities. He will then ask you about your experience of all the assessments you have been through and will ask about your opinion on the forthcoming final exams. He would like to know if in your opinion those exams are truly assessing your capabilities.

What happens to the interview results?
I (Mr Roudsari) will transcribe the interview data and at this point and remove all identifying information so that the transcript will only be identifiable via a unique code in the form of a number, known only to me (the researcher) and my supervisors. This identifying number will be stored separately from the transcript, which will be located on an encrypted laptop for safety. This number will only be used should you wish to withdraw your data from the study at a later date. Once the recording has been transcribed the recording itself will be destroyed.

Will I be identifiable to anyone?
No. We have strict procedures in place to ensure your identity remains confidential. Your consent form and the transcripts will be stored separately. When quoting from the data all comments used in any publications will be anonymised so that you are not identifiable. All data will be stored for 10 years and then destroyed in line with the University Policy for Managing Data.
Will the results have any influence on my grades?

No. The school will receive a short report of the outcome of the study but the identity of the individual participants will be kept confidential and will not be disclosed to the school under any circumstances. Any matter discussed during the course of your interview will have no effect on how you progress, the academic grades you achieve or the process of your graduation.

Will I receive any benefit from the study?

No there will be no personal benefit to you from taking part in this study, however, your contribution will have a significant effect to our increased understanding of how dental students feel about their exams. This can potentially help us improve our assessment system.

Will I get paid for my time?

Your contribution to this study will be on voluntarily basis and you will not be reimbursed for your time.

Are there any negative consequences for me if I decide to take part?

The simple answer is No. However, there is a very small potential for distress if during the interview you recall an unpleasant memory. This could be related to a distressful experience you had during your previous exams or linked to a sad period of time in your life. In case of severe distress, you may need to be referred to your General Medical Practitioner and therefore their contact details will be asked during the consent process.

Has anyone reviewed this study?

Yes. The proposal of this study has gone through a rigorous internal review process and has granted the ethical approval from the ethics committee of the University of Manchester.

How do I show my consent?

There is a consent form available that you need to sign before the interview. This will be done on the day of the interview after you have asked all your questions and are happy to go ahead. A copy of the consent form is also available for you to read with this information package.
Can I withdraw my consent?
Yes. You can withdraw your consent at any time before the results are published. There would be no questions asked. Your data will be excluded from the results. Obviously once the paper is published in a journal it is not possible to exclude your data.

Can I bring a friend along?
Yes of course. Please remember that the input from your friend will not be included in your results unless you confirm them. Also please note that Mr Roudsari will have no control over the breach of your confidentiality if your friend decides to tell others about the content of your interview; so please be very selective on who you bring along.

What is the next step?
Please contact Mr Roudsari and let him know that you are interested in the study. He will arrange a convenient date and time to meet you for the interview.

How can I make a complaint?
If you have a concern about any aspect of the study, in the first instance contact the principle investigator, Mr Roudsari. If he is unable to resolve your concern or you wish to make a complaint regarding the study, please contact the University Research Practice and Governance Co-ordinator on 0161 275 7583 or by email to research.complaints@manchester.ac.uk

How can I ask questions?
Please contact Mr Roudsari using the following details:
reza@manchester.ac.uk
Room 1.033, Coupland III Building
School of Dentistry
Coupland Street
The University of Manchester
Manchester M13 9PL
T: 0161 275 6606
9.3 Competency: the expectations

9.3.1 Ethical approval

Dear Reza,

Research Ethics Committee 2
Vahid Roudsari, Byrne-Davis: Analysis of the assessment methods used in the UK undergraduate dental education (ref 14323)

I write to confirm that the above project was ethically reviewed at the meeting of the Committee on 17th September and that it was given a favourable ethical opinion.

This approval is effective for a period of five years and if the project continues beyond that period it must be submitted for review. It is the Committee’s practice to warn investigators that they should not depart from the agreed protocol without seeking the approval of the Committee, as any significant deviation could invalidate the insurance arrangements and constitute research misconduct.

I would be grateful if you could complete and return the attached form at the end of the project or by the end of September 2015.

Yours sincerely

Dr T P C Stibbs
Secretary to the University Research Ethics Committee

Enclosed; Report form
9.3.2 Email to the Heads of School

Title: Permission to approach your staff

Dear <name of the Head of School>

Hope you are well. I was wondering if I could have your permission to contact selected members of your staff for my research, please?

In the background of my PhD, I am writing a summary of the assessment methods used within the UK dental schools. With your permission I would like to include data form the University of <change me>, please.

For your information:
• I have attached the data collection form that I will be using.
• I have attached your Participant Information Package.
• I can confirm that the project has favourable ethical approval (The University of Manchester Ethics ref 14323).
• I confirm that all the data collected from your school will be treated in confidence.

If you are happy with the above, I would be the most grateful if you could please put me in touch with either your School Assessment Lead (or equivalent) or one of your Admin staff who can help me with this.

Kind regards
9.3.3 Study information pack

<date>

Dear <name of the head of school>,

Your school is invited to take part in a research study as part of a PhD project looking at the assessment methods used to assess dental students in the UK. Please take time to read the following information and feel free to ask if there is anything that is not clear or if you would like more information. Your cooperation in this matter would be much appreciated.

The research team

Professor Nick Grey  
BDS, MDSc, PhD, DRD, MRD, FDSRCS(Ed), FHEA  
Professor of Dental Education / Faculty Associate Dean for Teaching and Learning / National Teaching Fellow  
School of Dentistry  
The University of Manchester  
Higher Cambridge Street  
Manchester  
M15 6FH

Dr Lucie Byrne-Davis  
PhD CPsychol  
HCPC Registered Health Psychologist / Lecturer in Assessment and Psychometrics / Academic lead for phase 1 assessments  
Manchester Medical School  
Stopford Building  
Oxford Road  
Manchester  
M13 9PT

Mr Reza Vahid Roudsari  
DDS MSc PGDip MFDS FDS (Rest Dent)  
Clinical Lecturer and Specialist in Restorative Dentistry  
Email: Reza@manchester.ac.uk  
School of Dentistry  
The University of Manchester  
Higher Cambridge Street  
Manchester  
M15 6FH
Title
Assessment methods used to assess dental students in the UK

Aims
1. To understand which assessment methods are used to assess undergraduate dental students throughout the UK dental schools
2. To compare the assessment methods in use to the international recommendations for the best practice

The study population
All the dental schools in the UK are included.

Justification for the research
The dental schools in the UK are regulated by the GDC and are expected to design their curriculums in a way that all of the set objectives by the GDC are met. Dental schools, however, are relaxed on the methods of teaching and assessment they chose to utilize as long as they are able to demonstrate that their performance is satisfactory. There are GDC reports on school inspections available online, many of which also contain information on assessment methods used by each dental school; however, this data is subject to rapid changes nationally as the dental schools improve their teaching and assessment techniques. Currently there are no up-to-date documents present to demonstrate which assessment methods are used nationally and also how they are compared to the international recommendations for the best practice in terms of their validity, reliability, and suitability of use.

Your dental school participation
With your permission, the undergraduate administrative team and/or your undergraduate year leads will be contacted. The assumption is that the handbooks given to your dental students contain most the information required on the assessment methods; therefore, in the first instance a request for these handbooks will be made. If not available, or in terms of any questions, an appointment with the appropriate administrator or year lead will be made to discuss these over the phone.
Handling of the data

Data collected from each school will be anonymised, receive a unique identification code (UIC) and treated with confidentiality. The UICs will be stored in a secure room at the University of Manchester and will only be used for the purpose of extraction of the data should a dental school wishes to withdraw from the study. Only the processed data will be used in any form of publication without highlighting any single dental school on their performance.

Right to withdraw

Your dental school may withdraw from this research project at any time prior to the research paper being accepted for publication.

Publication of the data

The research paper will be published in a peer reviewed journal with an interest in dental education. Your dental school will be notified once the paper becomes available online.

Further questions

Please contact Mr Reza Vahid Roudsari using the following contact details:

- Telephone: +44 (0) 161 275 6606
- Email: reza@manchester.ac.uk

Complaints

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to:

The Research Practice and Governance Co-ordinator
Research Office
Christie Building
The University of Manchester
Oxford Road
Manchester M13 9PL

by emailing: Research-Governance@manchester.ac.uk

or by telephoning: 0161 275 7583 or 0161 275 8093
### 9.3.4 Glossary of the assessment terminology used

<table>
<thead>
<tr>
<th>Short form</th>
<th>Full form</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ</td>
<td>Multiple Choice Question</td>
<td>The question item consists of a stem and a number of options to choose from. One or more options may be correct.</td>
</tr>
<tr>
<td>SBA</td>
<td>Single Best Answer</td>
<td>Same as MCQ but only one option can be correct.</td>
</tr>
<tr>
<td>EMQ</td>
<td>Extended Matching Question</td>
<td>A number of options are presented followed by a number of stems. Each stem describes a clinical scenario that the answer can be chosen from the list of the options.</td>
</tr>
<tr>
<td>EMI</td>
<td>Extended Matching Item</td>
<td>The same as EMQ</td>
</tr>
<tr>
<td>SAQ</td>
<td>Short Answer Question</td>
<td>The question item consists of a stem followed by a number of questions. The answer to each question is written by the candidate; usually in the form of short phrases or bullet points.</td>
</tr>
<tr>
<td>SAP</td>
<td>Short Answer Paper</td>
<td>The same as SAQ</td>
</tr>
<tr>
<td>SEQ</td>
<td>Short Essay</td>
<td>The student is given one or more tasks (in the form of clinical scenarios usually) and is expected to write short essays to answer each. The word limit for each task is usually less than 1000 words. The tasks can cover a wide range, for example prescription writing, GDC complaint procedures, Referral letter, etc. If structured, please look at MEQ.</td>
</tr>
<tr>
<td>Essay</td>
<td>Essay</td>
<td>The candidate is given a task and is expected to write 1000 – 4000 words, discussing an argument for and against what they cover. The essay is open-ended in nature.</td>
</tr>
</tbody>
</table>
| Written assessments | MEQ (Modified Essay Question) | Similar to the essay question, the candidate is given a task to write about; however, each task is broken down to a few sections to prompt the candidate what to cover.  
For example, the task asks the candidate to discuss the concepts of occlusion used in making of complete dentures but the candidate is also prompted to cover about the following:
a. Discuss the evidence to support each concept
b. Explain how such methods can be used to improve the stability of the lower denture
c. Discuss how these concepts differ in terms of laboratory work |
| Assignment | Assignment | A written piece of work done based on an observation or performed task. For example, students may be asked to write an assignment on their experience of visiting a General District Hospital. |
| PMP (Patient Management Problem) | Patient Management Problem | Similar to SAQ but the focus of the questions are purely clinical.  
The stem provides the scene and the questions usually cover step-by-step actions that should be taken to manage that scenario in a structured way.  
The expected answer is usually in the form of a paragraph or a few sentences. |
<p>| SJT (Situational Judgment Test) | Situational Judgment Test | The candidate is given a scenario. A number of actions are listed and the candidate is expected to rate each action from highly desirable to very unlikely. |</p>
<table>
<thead>
<tr>
<th>Observed assessments</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OSCE</strong></td>
<td>Objective Structured Clinical Examination</td>
<td>The candidates enter a number of stations. They are expected to complete a task within their time limit. Once the time is up, they move to the next station.</td>
</tr>
<tr>
<td><strong>OSSE</strong></td>
<td>Objective Structured Simulated Examination</td>
<td>Similar to OSCE</td>
</tr>
<tr>
<td><strong>Seen Viva</strong></td>
<td>Seen Clinical Case Oral Exam</td>
<td>The candidate presents a clinical case that they have done on the clinic. The examiner(s) give the candidate a viva on their case. The examiner(s) are free to ask the candidates any questions that they wish to ask. The patient may or may not be present for the exam but the case write-up is always present.</td>
</tr>
<tr>
<td></td>
<td>Seen Clinical Case Viva Voce</td>
<td></td>
</tr>
<tr>
<td><strong>Unseen Viva</strong></td>
<td>Unseen Clinical Case Oral Exam</td>
<td>The candidates are presented with a patient’s history, radiographs, and/or photographs. They are expected to study the information and once ready, undergo a viva by the examiners. In some situations in real patient or a simulated patient may be present.</td>
</tr>
<tr>
<td></td>
<td>Unseen Clinical Case Viva Voce</td>
<td></td>
</tr>
<tr>
<td><strong>Structured</strong></td>
<td>Seen Clinical Case Structured Oral Exam</td>
<td>Similar to Seen Viva but the domains of questions are predefined for the examiner(s). The questions asked are not exactly the same for every candidate but they cover the same domains.</td>
</tr>
<tr>
<td><strong>Structured</strong></td>
<td>Unseen Clinical Case Structured Oral Exam</td>
<td>Similar to Unseen Viva but the domains of questions are predefined for the examiner(s). The questions asked may not be exactly the same for every candidate but they cover the same domains.</td>
</tr>
<tr>
<td>Observed assessments</td>
<td>Description</td>
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</tr>
<tr>
<td><strong>Long Case</strong></td>
<td>The candidate is presented with a real or simulated patient. The candidate is expected to take history, may or may not examine the patient, reach a working diagnosis and formulate a treatment plan. This is done in the absence of the examiner(s) for nearly 30 minutes. The candidate will then be questioned by the examiner(s) who will assess candidate’s findings. The examiner(s) may observe the candidate communicating this information back to the patient. The marking of the candidate is usually global.</td>
<td></td>
</tr>
<tr>
<td><strong>OSLER</strong></td>
<td>Objective Structured Long Examination Record</td>
<td>Similar to the Long Case but done in a structured way; the patient or simulated patient is the same for all the candidates and the examiner(s) ask questions based on predefined domains and use checklists to assess candidates’ performances. Suggested domains are history, physical examination, investigation, management and clinical acumen.</td>
</tr>
<tr>
<td><strong>DOPs</strong></td>
<td>Direct Observation of the Procedures</td>
<td>The candidate is observed while performing a clinical procedure. A structured assessment sheet is then used to assess the candidate’s performance. The feedback is provided to the candidate immediately.</td>
</tr>
<tr>
<td><strong>Mini-CEX</strong></td>
<td>Mini Clinical Evaluation Exercise</td>
<td>The candidate is observed while taking history or interacting with a patient. A structured assessment sheet is then used to assess the candidate’s performance. The feedback is provided to the candidate immediately.</td>
</tr>
<tr>
<td>Observed assessments</td>
<td></td>
<td></td>
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<tr>
<td>MSF</td>
<td>Multi Source Feedback</td>
<td>A structured form is given to a number of people from a range of disciplines (for example clinicians, tutors, nurses, peers, laboratory staff, etc). The feedback provided in the structured forms is returned back to a designated person for viewing and summarizing.</td>
</tr>
<tr>
<td>360</td>
<td>360 Degree Feedback</td>
<td>The same as MSF</td>
</tr>
<tr>
<td>Skills Test</td>
<td>Clinical Skills Test</td>
<td>Test of clinical skills in the pre-clinical setting. The candidates are given one or more tasks to perform on plastic teeth. Clinical tutors or peers assess the outcome.</td>
</tr>
<tr>
<td>Logbook</td>
<td>Logbook</td>
<td>A log of clinical or pre-clinical procedures is presented.</td>
</tr>
<tr>
<td>Portfolio</td>
<td>Portfolio</td>
<td>Consists of a logbook of tasks performed in a clinical or pre-clinical setting. This not only contains the number of procedures done but also a brief write up for each case. The logbook may or may not consist a reflective section.</td>
</tr>
<tr>
<td>Reflective Practice</td>
<td>Reflective Practice</td>
<td>Similar to a portfolio but heavily weighted on the reflection section of the write-ups.</td>
</tr>
<tr>
<td>LIFTUPP</td>
<td>LIFTUPP</td>
<td>The iPad-based LIFTUPP software is used to assess the candidate on the clinic or pre-clinic.</td>
</tr>
<tr>
<td>IDENTITY</td>
<td>IDENTITY</td>
<td>The browser-based IDENTITY software is used to assess the candidate on the clinic or pre-clinic.</td>
</tr>
<tr>
<td>Portfolio-based assessment</td>
<td>Project Presentation</td>
<td>Presentation of a finished project or an experience in front of an audience. The quality of work may be assessed by faculty or peers.</td>
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<tr>
<td>Poster Presentation</td>
<td>Poster Presentation</td>
<td>Presentation of a finished project or an experience in the form of a printed poster. The quality of work may be assessed by faculty or peers.</td>
</tr>
<tr>
<td>Forum</td>
<td>Discussion Forum</td>
<td>The candidate is expected to take part in a discussion group. This can be done either in a small classroom setting or online. The contribution of the candidate is marked by faculty or peers.</td>
</tr>
</tbody>
</table>
9.4 Effect of observer training and calibration on the OSCE pass mark set by borderline regression method

9.4.1 Ethical approval

Dear Reza,

Research Ethics Committee 6
Vahid Roudsari, Byrne-Davis, Yeates: Effect of online calibration on the observers’ performance in OSCEs – a retrospective study (ref 14304).

I write to confirm that the above project has been ethically reviewed and has been given a favourable ethical opinion.

This approval is effective for a period of five years and if the project continues beyond that period it must be submitted for review. It is the Committee’s practice to warn investigators that they should not depart from the agreed protocol without seeking the approval of the Committee, as any significant deviation could invalidate the insurance arrangements and constitute research misconduct.

I would be grateful if you could complete and return the attached form at the end of the project or by the end of August 2015.

Yours sincerely,

Dr T P C Stibbs
Secretary to the University Research Ethics Committee

Enclosed: Report form