Criteria Referenced Student Self-Assesment in Restorative Dentistry

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SUMMARY

The application of criteria referenced assessment has been previously reported, however, criteria referenced self-assessment has not yet been studied. The objective of this study was to develop and use clear and explicit criteria, linked to a level of competency and a score, as well as a checklist, for student self-assessment in Restorative Dentistry. A comparison of student self-assessment and supervisor-assessment was also undertaken to determine the validity and reliability of the criteria.

Six levels of competency were adapted from the literature and a criterion was developed for each level of competency and used for student self-assessment of clinical procedures in Restorative Dentistry (BChD IV and BChD V). Each level of competency was given a score: U = Unqualified (0), NBQ = Not becoming Qualified (1), BQB = Becoming Qualified as a Beginner (2), BQL = Becoming Qualified as a Learner (3), Q = Qualified (4), E = Exceptional (5). The students used the criteria on the assessment form, to assess themselves accordingly (U, NBQ, BQB, BQL, Q, E) and this was compared to the supervisor assessment using the same criteria. The results were subjected to a Spearman Rank-Order Correlation test. The Spearman Correlation Coefficient for the BChD V group was 0.882 and 0.927 for the BChD IV group in the first semester and 0.923 for the BChD V group and 0.900 for the BChD IV group in the second semester. The results were highly significant ($p < 0.05$). There were no significant differences between student self-assessment and supervisor-assessment. The criteria referenced assessment system used to assess clinical competency in Restorative Dentistry is valid and reliable.

INTRODUCTION

Competency is defined as having the necessary skills, understanding, professional values and knowledge to do something successfully.[1,2,3] This has led to many dental academic institutions internationally adopting a competency based clinical curriculum that focuses more on desired learning outcomes.[1,4,5-9] In order to assess the success of the curriculum and the competency of the individual at the conclusion of training, an appropriate assessment system is a prerequisite for success, and the need to develop more consistent methods of assessment to evaluate clinical performance has been well documented.[3, 6, 7]

Many methods of assessment have been described in the literature,[2, 8, 10-15] but many of these are not appropriate to the overall culture of an institution or more specifically to the science, art and culture of dentistry. Training in Restorative Dentistry requires the performance of clinical procedures on patients, and in the dental clinical environment, supervisors are responsible for defining and evaluating student competence. Previously the responsibility for defining competency was the duty of the supervisor, however one of the characteristics of a competent individual is the ability to assess his or her own competency.[2]

Self-assessment is an important and integral part of any learning process. It is also important to remember that professional attitudes of dental practitioners are usually formed as dental students and student self-assessment helps them to make judgements about themselves and their competence. When students are assessed it is also important that they know why they are being assessed and the reason for them receiving that assessment mark.[10] Previous traditional methods of clinical assessment resulted in students receiving an assessment mark that was determined by their supervisor. This type of assessment is one sided, subjective, lacks validity and reliability and offers no feedback to the student and therefore does little for enhancing the learning process.

Student learning is largely assessment driven and repetition drives the learning process,[9, 15] therefore a fair and objective method of self-assessment is necessary to drive the learning process. Since students also need to know why they are being assessed, it is imperative that for each assessment, students receive feedback whilst also comparing their self-assessment with the supervisor assessment to determine the validity and reliability of the assessment. The use of a checklist in Restorative Dentistry, consisting of procedural steps can provide instant feedback during clinical assessment, thereby assisting the learning process,[10, 14] as well as improving the reliability and validity of the assessment.

An opportunity should therefore be created in the competency based clinical curriculum for students to practice self-assessment. The application and use of a criteria-referenced assessment can create such an opportunity.[9] A criteria referenced assessment also contributes to the validity and reliability of the assessment, as well as to supervisor calibration.[8,10] The application of criteria referenced assessment has been reported previously,[8,10] however, criteria referenced self-assessment in Restorative Dentistry has not been studied. There are many challenges involved in the development of competency-based assessment and it is difficult to find an assessment system that is reliable, valid, feasible and appropriate for restorative dental procedures.

This paper describes a system of assessment that was developed with the aim of meeting this challenge using clear and explicit criteria linked to a level of competency and score, as well as a checklist to provide feedback, to assess clinical competency in Restorative Dentistry. A comparison of student self-assessment and supervisor-assessment was also undertaken to determine the validity and reliability of the criteria.

The objectives of this study were:

1. To develop appropriate criteria for student self-assessment of clinical competency in Restorative Dentistry.

2. To compare the student's self-assessment with the assessments of their supervisor's using these criteria.
3. To determine the validity and reliability of the criteria.

MATERIALS AND METHODS

The student population for this study was the 2004 BChD IV (n=59) and BChD V (n=39) undergraduate dental students at the School of Dentistry, University of Pretoria. Six levels of competency were adapted from the literature associated with medical and dental education and a criterion was developed for each level of competency. Each level of competency was given a score: U = Unqualified (0), NBQ = Not becoming Qualified (1), BQB = Becoming Qualified as a Beginner (2), BQL = Becoming Qualified as a Learner (3), Q = Qualified (4), E = Exceptional (5). The criteria were described as follows:

(U): Unqualified: Student observed/ assisted with procedure (ie. Supervisor completed entire procedure/ all steps/ procedure or step was carried out unsatisfactorily/ not timeously). Cannot progress to next experience.
(NBQ): Not Becoming Qualified: Student needed considerable** help and guidance (ie. **Supervisor assisted with 2 steps or more but not all steps). Needs considerable help and guidance to progress to next experience.
(BQB): Becoming Qualified as a Beginner: Student needed little* help and guidance (ie. *Supervisor assisted with 1 step). Needs a little help and guidance to progress to next experience.
(BQL): Becoming Qualified as a Learner: Student needed guidance only (ie. Supervisor assisted with guidance only). Needs a little more experience.
(Q): Qualified: Student completed procedure independently and satisfactorily without help or guidance (ie. Supervisor did not assist with help or guidance). Can progress to next experience.
(E): Exceptional: Student completed procedure independently and exceptionally without help or guidance (ie. The procedure carried out by the student conformed to the ideal criteria specified for specific restorations). Can progress to next experience.
An additional criterion, (NZ): Not Zero, was included without a score for students that are absent with permission or when their patient did not attend.

Supervisors were calibrated at a workshop that taught them how to use the new assessment system consistently. Nineteen calibrated supervisors were used to assess clinical competence of dental procedures in Restorative Dentistry. The nineteen supervisors were then calibrated on the definitions of unsatisfactory, not timeously, help and guidance. Unsatisfactory implies that the student has compromised the intended procedure irreversibly. Not timeously means that the student did not complete the procedure within the allocated session time. Help implies that the supervisor completed a procedural step or the entire procedure and guidance implies that the student was instructed to make corrections or changes without receiving any help with the procedure. Students were required to know the ideal criteria for a specific restoration as specified in the Odontology curriculum or learning content, before commencing with clinical procedures.

The new assessment form consists of a formative and a summative component. The formative side of the form (Figure 1) has a blank table that is used by the student to write down the steps of the procedure. These steps must then be checked and approved by the supervisor before the student can commence with the procedure. There is also space provided for comments by the supervisor for each of the steps listed. At the bottom of the form a space is provided for student self-assessment as well as the student's signature to acknowledge his or her self-assessment. The summative side of the form (Figure 2) has four checklists, consisting of questions, so that the supervisors can indicate if each step has been completed satisfactorily (yes) or not (no). Immediate feedback would be enhanced by written comment as appropriate. The checklists were applicable to the disciplines of Basic Restorative Dentistry, Paedodontics, Endodontics and Crown and Bridge Dentistry. A space is provided for the supervisor's assessment and signature at the bottom of the form as well as for any final comment on the completed procedure.

The students were introduced to the new assessment system at the beginning of the first semester in 2004 before the commencement of procedures in the clinical ward. They were also trained on how to interpret and use the criteria. The students used the criteria on the assessment form, to assess themselves accordingly (U, NBQ, BQB, BQL, Q, E) and the supervisor assessment was used independently of the student assessment using the same criteria. Students were instructed to perform the self-assessment immediately on completing the procedure. The supervisors were instructed to assess the student's competence immediately after the student self-assessment without viewing the student's assessment. The student self-assessment is then compared with the supervisor assessment. The supervisor then briefly discusses the assessment with the student so that the student can understand why he or she is receiving a particular assessment. The results of each assessment are recorded on the assessment form and captured on a data-base (Microsoft Excel®) for further analysis.

STATISTICAL ANALYSIS

1080 assessments were recorded for the BChD IV students and 840 assessments were recorded for the BChD V students in the first semester. 1680 assessments were recorded for the BChD IV students and 1601 assessments were recorded for the BChD V students in the second semester. Data analysis was performed using a Spearman Rank-Order Correlation Test. Comparisons were made between student self-assessment and supervisor assessments.

RESULTS

Comparisons between the student and supervisor assessments for the first and second semesters are graphically illustrated (Figures 3a and 3b and Figures 4a and 4b). The results indicate a significant correlation between the student assessments and that of their supervisors.

The Spearman Correlation Coefficient for the BChD V group was 0.882 and 0.927 for the BChD IV group in the first semester. The Spearman Correlation Coefficient for the BChD V group was 0.923 and 0.900 for the BChD IV group in the second semester. The results were highly significant ($p < 0.05$). The scores that were entered into the database were then converted into percentages (U=0%, NBQ=15%, BQB=30%, BQL=45%, Q=67%, E=75%) by using the formula (Score/6.7 X 100) in Microsoft Excel®. The percentages were totalled and the average calculated to determine the final continuous clinical assessment mark. The required level of competency mark considered acceptable was 60%.

BChD V (n=39): 840 continuous clinical assessments were recorded and documented in the first semester and 1601 continuous clinical assessments in the

Restorative Dentistry: Assessment Form

Student name	Patient name	Medical status (patient)			Patient number	Date
		Compromised	Y	N		

Diagnosis of condition to be treated:						
Planned treatment (procedure/s):					**Clinical codes:**	
Procedural steps (to be completed by student)			**Y**	**N**	**Supervisor comment**	

_____

Signature of supervising staff member (must be signed prior to commencing procedure).

Local anaesthetic:	**Xylotox 2 % :**	**1. _____ 2. _____ 3. _____**
	Carbocaine 3 %:	**1. _____ 2. _____ 3. _____**

Consent & signature of supervisor must be obtained prior to collecting local anaesthetic.

Student self assessment: _____ Student signature: _____

Clinical competency criteria:		
Category	**Score**	**Clinical competency**
(U)	**0**	**Unqualified:** Student observed/ assisted with procedure **(ie. Supervisor completed entire procedure/ all steps/ procedure or step was carried out unsatisfactorily/ not timeously). Incompetent:** Cannot progress to next experience.
(NBQ)	**1**	**Not Becoming Qualified:** Student needed considerable* help & guidance **(ie.*Supervisor assisted with 2 steps or more but not all steps). Novice:** Needs considerable help & guidance to progress to next experience.
(BQB)	**2**	**Becoming Qualified as a Beginner:** Student needed little** help & guidance **(ie.**Supervisor assisted with 1 step). Beginner:** Needs a little help & guidance to progress to next experience.
(BQL)	**3**	**Becoming Qualified as a Learner:** Student needed guidance only **(ie. Supervisor assisted with guidance only). Learner:** Needs a little more experience.
(Q)	**4**	**Qualified:** Student completed procedure independently & satisfactorily without help or guidance **(ie. Supervisor did not assist with help or guidance). Competent:** Can progress to next experience.
(E)	**5**	**Exceptional:** Student completed procedure independently & exceptionally without help or guidance **(ie. Procedure conforms to ideal criteria for specific restoration/s). Expert:** Can progress to next experience.
(NZ)		Not zero: Student present **(no patient available/ assisting / procedure beyond students capability/ valid & reliable excuse for not being present).**

Figure 1: Formative side of assessment form.

Restoration (Each step must be checked by supervisor)	Y	N	Root Canal Treatment (Each step must be checked by supervisor)
Satisfactory infection control procedures & preparation of materials & equipment?			Satisfactory infection control procedures & preparation of materials & equipment?
Correct interpretation of medical, dental history & general health during each visit (indicated compromised health)?			Correct interpretation of medical, dental history & general health (compromised health indicated)?
Correct interpretation of radiographs & special tests (vitality testing)?			Correct interpretation of radiographs & health of pulp & periodontium & clinical tests (vitality testing)?
Successful initial phase therapy procedures if necessary?			Successful administering of local anaesthetic (if necessary) & correct technique used?
Successful caries removal (infected tooth structure & cavity preparation (including shade selection) ?			Successful caries removal (infected tooth structure/ cavity prep: access opening, straight line access)?
Satisfactory isolation procedures (moisture control) & placement of matrices?			Correct use of rubber-dam & other moisture control techniques?
Correct use & placement of base/ lining or application of bonding agents?			Successful removal of: coronal pulp / gross pulp debridement/ for emergency/ paedodontic procedures?
Satisfactory placement & condensation of restoration?			Successful placement of master-file/ master cone to working length: attained in each canal?
Correct occlusal adjustment procedures (centric, lateral & protrusive)?			Obturation / placement of CaOH paste/ corticosteroid paste in emergency/ paedodontic procedures?
Satisfactory finishing & polishing of restoration including anatomy & colour of restoration?			Correct placement of lining over obturated root canals? (if necessary for the procedure)
Satisfactory professionalism, communication, attitude & dress code?			Satisfactory placement of: restorative material/ SS crown /amalgam/ resin (incl. marginal seal/ occlusion)?
Satisfactory record keeping & administration?			Satisfactory professionalism, communication, attitude & dress code?
Satisfactory record keeping & administration?			Satisfactory record keeping & administration?

Comprehensive Patient Care Examination (CPC) (Each step must be checked by supervisor)	Y	N	Crown & Bridge (Each step must be checked by supervisor)
Satisfactory infection control procedures & preparation of materials & equipment?			Satisfactory infection control procedures & preparation of materials & equipment?
Successful data gathering of personal information & patients main compliant?			Correct interpretation of medical, dental history & general health (indicated compromised health)?
Successful interpretation of medical & dental history (compromised health indicated)?			Correct interpretation of radiographs & special tests (vitality testing)?
Extra-oral and intra-oral examination successfully completed?			Successful administering of local anaesthetic (if necessary) & correct technique used?
Successfully incorporated specific diagnostic tests (vitality tests etc)?			Successful caries removal/ preparation/ reduction procedures (including core build-up/ GP removal)?
Correct interpretation of radiographs & special tests?			Satisfactory isolation procedures & placement of retraction cord (if necessary)?
Demonstrates ability to compile ideal treatment plan for specific patient (considers time & cost factors)?			Correct use & placement of impression materials & application of impression tray?
Demonstrates ability to communicate diagnosis & treatment options to patient?			Correct recording of impression/ placement/ cementing of restoration/ post and core (direct/ indirect)?
Satisfactory professionalism, communication skills, dress code & attitude?			Satisfactory temp. / perm. restoration (incl. occlusal adjustment procedures (centric, lateral & protrusive)?
Satisfactory record keeping & administration Skills?			Correct finishing & polishing of restoration including anatomy & colour of restoration & marginal seal?
Written & verbal consent from patient?			Satisfactory professionalism, communication, attitude & dress code (including lab instructions)?
			Satisfactory record keeping & administration?

NB: Steps that are not checked/ approved by supervisors result in evaluations of Unqualified (U). (eg: administration of local anaesthetic without supervisors consent/ approval etc.) Repeat offenders will be suspended from all clinical activities & re-instated only on recommendation from the Head of the Department.

Supervisor comments

_____

Supervisor assessment _____ Supervisor signature _____

Figure 2: Summative side of assessment form.

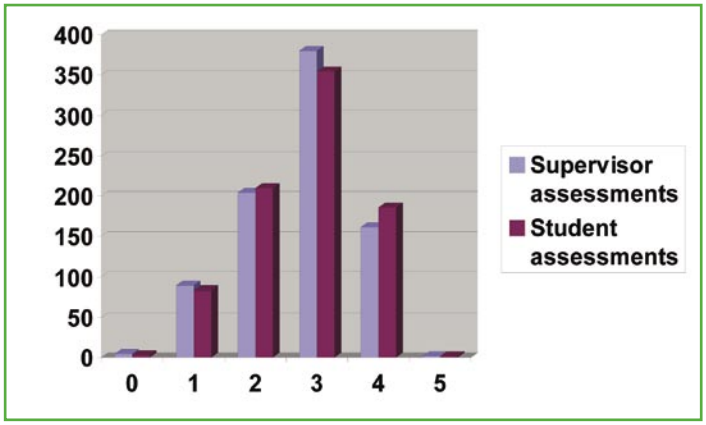

Figure 3 a: Graphical illustration of Student vs Supervisor assessments (1st semester: BChD V).

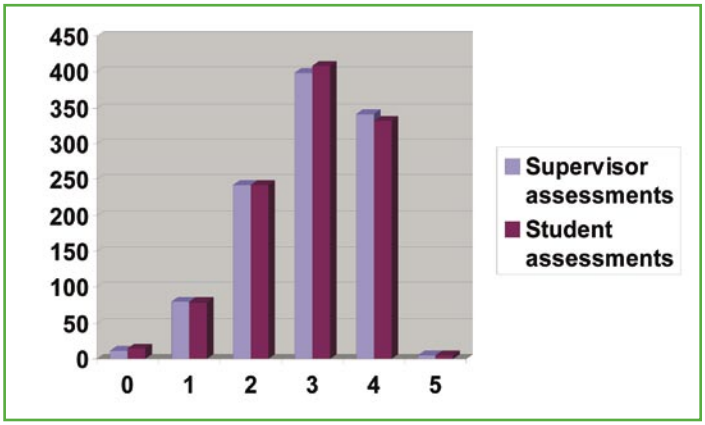

Figure 4 a: Graphical illustration of Student vs Supervisor assessments (1st semester: BChD IV).

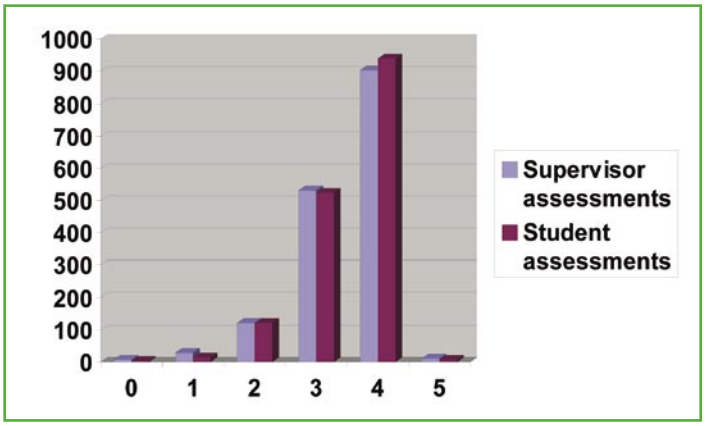

Figure 3 b: Graphical illustration of Student vs Supervisor assessments (2nd semester: BChD V).

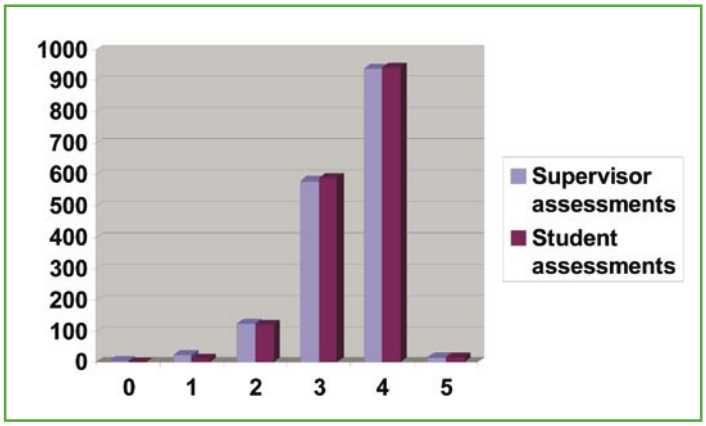

Figure 4 b: Graphical illustration of Student vs Supervisor assessments (2nd semester: BChD IV).

second semester. The class average for the first semester was 55%. Fourteen students obtained a continuous clinical assessment mark above 60% and 25 students obtained a mark below 60% in the first semester. 25 students were below the required level of competency in the first semester. The class average for the second semester was 66%. In the second semester 38 students obtained marks above 60% and only one student obtained a mark below 60%.

Therefore only one student was below the required level of competency in the second semester. As a combined average for the first and second semester 27 students obtained marks above 60% and 12 students obtained marks below 60% with marks ranging from 52% to 74%. Only 27 students achieved the required level of competency and continuous clinical assessment mark for procedures in Restorative Dentistry with the class average at 61%. The comparison of the first and second semester assessments showed an improvement of marks in the second semester indicating that student clinical competency had improved.

BChD IV (n=59): 1080 clinical assessments were recorded and documented in the first semester and 1680 continuous clinical assessments in the second semester. The class average for the first semester was 62%. 42 students obtained a mark above 60% and seventeen students obtained a mark below 60% in the first semester. Seventeen students were below the required level of competency in the first semester. The class average for the second semester was 69%. 56 students obtained a mark above 60% and only three students obtained a mark below 60%. Three students were below the required level of competency in the second semester. As a combined average for the first and second semester 55 students obtained a mark above 60% and 4 students obtained a mark below 60% with marks ranging from 54% to 78%. Only 55 students achieved the required level of competency and continuous clinical assessment mark for procedures in Restorative Dentistry with the class average at 65%. The comparison of the first and second semester assessments showed an improvement of marks in the second semester indicating that student clinical competency had improved.

DISCUSSION

Dental schools need to ensure that they produce dentists that are genuinely competent. The move towards a competency based dental curriculum demands that the outcomes that are measured are done so using an assessment system that uses valid and reliable assessment tools that enhance learning. Understanding the differences between the levels of competencies and how to successfully mentor students from passive to active learners must be mastered and practised by faculty.[16]

The previous assessment system where a supervisor determined the assessment mark that a student received was inadequate for assessing clinical competency accurately and the techniques employed to allocate an assessment to a student were subjective and variable. Assessment systems that allow supervisors to simply allocate a summative assessment that they see fit are not appropriate for a curriculum that is geared towards a competency based approach. Furthermore these types of assessment systems are difficult to calibrate, susceptible to individual faculty personalities, and offer insufficient teaching opportunities and discussion time with students.[17]

This study compared the student's self-assessment with the assessment of their supervisors' using specific, unambiguous and explicit criteria. The reliability and validity of the criteria was also assessed by analyzing the results of the first semester and comparing it to the results of the second semester. The results showed that students improved on their scores in the second semester compared to those of the first semester indicating that they performed more competently as a result of the experiences acquired in the first semester. The correlation values for the first and second semesters indicate that the supervisor's assessment tended to strongly agree with the student's self-assessments.

Reliability is measured as a correlation with 1 being perfect reliability and a below 0.5 value as unreliable. A reliable correlation value means when measurements are repeated the new results are consistent with the first measurements for the same assessment tool on similar individuals. The validity of an assessment is the process of accumulating evidence about how well the assessment system measures what it is supposed to measure. A comparison of the first and second semester results revealed both concurrent and predictive validity respectively.

The significant correlation values indicate that the criteria used for student self-assessment are appropriate for the assessment of clinical competence and are reliable and valid. Students and supervisors were able to use the criteria developed consistently for student self-assessment in Restorative Dentistry. Feedback from the tutors indicated that the students were performing procedures more competently. Feedback from the students via a questionnaire indicated that the majority of students preferred the new assessment system.

Other than being reliable and valid, an assessment system that assesses clinical competence of dental procedures should also be formative as well as summative. Formative assessment has a strong positive effect on student learning and also improves a students' summative assessment.[18] Formative assessment occurs when feedback is given to the student that allows a self-reflective process to take place. The formative assessment in this study was accomplished by using a checklist and providing a supervisor comment if appropriate and the summative assessment was accomplished by allocating a score to each level of competency.

Successful design of a reliable and consistent assessment system depends highly on the extent of understanding how trainees must learn and perform in the workplace.[15] The dental curriculum was in need of a reliable assessment system that would consistently assess the performance of dental procedures by undergraduate students. The development and use of a criteria referenced self-assessment tool accomplished this successfully. Furthermore, the criteria developed for assessment satisfies the requirements of a valid and reliable assessment system suggested by several authors.[15-21]

The George Miller pyramid of competence suggests that assessment tools used to assess students knowledge and competence should always be adequate.[15] Miller's assessment pyramid consists of: a student knows (knowledge base) at the base of the pyramid, a student knows how (application of the knowledge) above the base of the pyramid, a student shows how at the next level and a student does (performs procedures) at the top of the pyramid.

Our assessment system is not very dissimilar and consists of a pyramid of competence that defines levels of competence described as follows (from the base to the top); (U) Unsatisfactory, (NBQ) Not Becoming Qualified, (BQB) Becoming Qualified as a Beginner, (BQL) Becoming Qualified as a Learner, (Q) Qualified and (E) Exceptional. The sophisticated methods needed to design an assessment system that endeavours to address key issues such as formative teaching, summative assessment, blueprinting, validity, reliability and standard setting is extremely valuable and offers an alternative to the previous traditional subjective assessment methods of the past. The use of the criteria referenced assessment system has addressed these issues and has been used with great success for assessing the clinical competence of undergraduates in Restorative Dentistry at the University of Pretoria. Its application in other clinical disciplines of dentistry is yet to be explored.

CONCLUSIONS

1. The criteria developed for student self-assessment of clinical competency was appropriate for use in Restorative Dentistry.
2. There were no significant differences between student self-assessment and supervisor-assessment.
3. The criteria referenced assessment system developed for student self-assessment of clinical competency in Restorative Dentistry is valid and reliable.

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