Rubrics 101: A Primer for Rubric Development in Dental Education

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Abstract: Identifying and implementing effective methods for assessing dental student performance are ongoing challenges for dental educators. Questions related to grading and assessment are common among faculty and students alike. Faculty members who are well-trained clinicians or scientists often have little formal training in education. In addition, assessment of performance brings with it an element of subjectivity. Questions about assessment and grading are most likely to arise when expectations are unclear or the rationale for the grade awarded is not articulated. The authors propose that one solution to assessment dilemmas can be found in the use of rubrics: scaled tools with levels of achievement and clearly defined criteria placed in a grid. Rubrics establish clear rules for evaluation and define the criteria for performance. Rubrics speak to both teaching and learning expectations and outcomes and can provide faculty members with a tool that can be useful in evaluating dental student performance. Rubrics can also provide students with clear expectations of performance, an opportunity to self-assess, and timely, detailed feedback. The purpose of this article is to define a rubric, apply the steps of rubric development as described in the educational literature to dental student assessment, present two examples of rubric implementation for assessing student progress toward competence, and recommend electronic resources for rubric development.

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Does this sound familiar? "Why didn't I get an 'A'?" "Exactly where did I lose points?" "What could I have done to get a better grade?" Questions related to grading and assessment seem commonplace among current students in dentistry. Some would suggest that questioning grades is a behavior attributable to grade inflation and a student body accustomed to reward for less than commendable performance. Others might suggest questioning to be the natural by-product of poor teaching or the use of dubious assessment tools. Faculty members who are well trained as clinicians or scientists often have little formal training in education. They may be unaccustomed to having their authority questioned and may rely on grading by instinct. When asked to give evidence for educational decisions, they are at a loss to respond to questions like those posed above. In this article, we support a simple solution: announce the rules up front so that everyone, both students and faculty, will know and agree on standards before the performance ever begins. Such statements of grading standards may be called rubrics. Rubrics can establish clear rules for evaluation and define the criteria that differentiate acceptable, outstanding, or other designated levels of performance. We propose that teachers at every level of instruction can benefit from using rubrics as the basis for their educational evaluations.

There is little doubt that assessment is growing in importance. Identifying and implementing effective methods for evaluating the progression of dental student performance from matriculation to competence is an ongoing challenge for dental educators. In 2005, the American Dental Education Association's Commission on Change and Innovation in Dental Education (ADEA CCI) established several task forces, including one on student outcome assessment.[1] The Dental Student Assessment Toolbox, one result of this task force's work, introduced alternatives

to the typical multiple-choice examination format used by most dental educators to assess competence at that time.[2] In 2010, the 87th ADEA Annual Session & Exhibition focused on assessment with its theme of "Assessment: Portraits of Change," and more than thirty individual programs and numerous poster presentations addressed issues related to assessment of students.

We offered one of those presentations on assessment in a collaborative effort between the Section of Dental Informatics and the Section of Comprehensive Care and General Dentistry. The presentation addressed the general use of rubrics as an assessment tool as well as their broader application in dental education. An informal survey of the audience revealed a wide range of familiarity with rubrics, from those with no previous exposure to those actively employing rubrics within their institutions. This variability prompted us to share our presentation in more detail through this article. We suggest here that, when implemented properly, a rubric may preempt many questions like those listed in the first paragraph. The purpose of this article is to define a rubric, apply the steps of rubric development as described in the educational literature to dental student assessment, present two examples of rubric implementation for assessing student progress toward competence, and provide electronic resources related to rubric development.

Why Rubrics?

A rubric is essentially a scaled tool with levels of achievement and clearly defined criteria related to each level and placed in a grid. Rubrics differ from simple checklists and rating scales by including descriptions of each criterion for each level of performance. Rubrics are typically used to assess some type of performance, product, or procedure.[3] In dental education, when students perform procedures in the preclinical or clinical environment or present a case orally or in writing, an element of subjectivity is unavoidable. The purpose of a rubric is to specify teaching and learning outcomes for both teacher and student, thereby reducing the subjectivity inherent in these assessments. Rubrics can be used in both formative and summative assessments, where formative assessment is generally a means to provide feedback to the learner with suggestions for improvement and summative assessment typically involves some type of judgment of student progress.[4]

As Knight accurately observes, evaluation is not equal to grading.[5] Evaluation can be more formative in nature, while grading is often more summative. The two, however, often coexist in the dental education environment. The dilemma frequently encountered is this: "How can I, as a faculty member, provide (formative) feedback to nurture student development and still arrive at a (summative) grade for the course?" Rubrics may provide an opportunity to address both. Walvoord states that "rubrics translate informed professional judgment into numerical ratings on a scale . . . creating the advantage that these ratings can now be communicated and compared."[6] Rubrics can foster consistency among grading faculty members and provide detailed feedback to students. Students are also given a mechanism by which they can self-assess using the same criteria as the faculty, promoting self-awareness and critical thinking about their own learning.[7]

A number of studies have demonstrated the positive impact that well-designed rubrics have on dental students' preclinical learning.[8-10] Learning is facilitated when students receive feedback from assessment methods that are consistent and based on meaningful, explicit criteria. Lack of uniformity, uncertainty regarding importance, and lack of well-defined assessment criteria are some of the more commonly expressed concerns among students.[11,12] In one study, the most frequently recorded student suggestions for improving assessment were "'improve consistency and objectivity'; 'develop and use criteria and standards'; 'improve the quality of feedback given to students'; and 'train staff [faculty] how to assess.'"[12] Rubrics have the potential to address all of these concerns.

For faculty members, rubrics can assist in refining their teaching skills so they may become more effective instructors. A study using rubrics to assess aseptic technique among a group of pharmacy students not only demonstrated a decrease in errors among students once the rubric was implemented, but identified areas of instruction in which students globally struggled with technique, allowing the faculty to adjust the curriculum accordingly. A rubric can provide faculty members with evidence of whether a change of teaching strategy has positively impacted student learning.[13] The result of such assessments can also provide invaluable documentation of scholastic merit for faculty promotion and tenure consideration.

Creating and using rubrics can create a dialogue among members of the teaching team. Agreement among raters is improved when members of the team

collaborate to create the rubric, resulting in a shared definition of acceptable student performance. In addition, a group review of student performance can increase consistency among raters, addressing the tendency of individuals to focus on different aspects of the clinical observation.[14]

Rubric Development

A clear description of the procedure or skill to be assessed should be written before embarking on development of the rubric. This description may be incorporated into the rubric itself or exist as a separate document. In addition to this description, a rubric generally contains three parts, which make up the rubric grid:[7]

1. A *scale* of the *levels* of performance, such as "competent," "developing," "novice" or "excellent," "needs improvement," "critical error." These items are aligned horizontally at the top of the grid (Table 1).
2. The *dimensions* or "evaluative criteria" for the task.[3] For example, as part of a clinical procedure, the dimensions might include items such as "patient education," "infection control," and "documentation." These items are aligned vertically at the left of the grid and can be weighted to express the importance of the item to the task, if desired.
3. A *description* of the dimensions, or the "quality definitions,"[3] of each criterion. These descriptors are placed in the grid where each scale (level) intersects with a dimension. This description defines the behaviors that differentiate between the "excellent" level vs. the "needs improvement" level vs. the "critical error" level.

Stevens and Levi describe four key steps in construction of a rubric.[7] Reflection, the first step, provides the opportunity to think about what the faculty member wants from the students, how he or she will know when students have met expectations, how students have responded to instruction and assessment in the past, why this assignment or assessment is being created, and other similar issues. Reflection also helps one determine what type of rubric is needed and whether a faculty member needs to start fresh or can adapt an existing rubric to fit his or her needs. Reflection can lead to a discussion with colleagues and/or students as the rubric develops through the remaining steps of the process. Although rubrics can be developed alone, courses that involve multiple faculty members, typical of dental education, can benefit the most from involving the stakeholders, as discussed at the end of this section.[7]

The second step is listing: defining the specific learning issues (objectives) to be accomplished. Educational psychologists distinguish between two types of knowledge—procedural (skills) and declarative (content)—and the two types differ greatly in how they are acquired and assessed. Faculty members should ask whether the assessment is about knowledge content or skills—or both. Objectives will vary depending on the level of the learner, the goals for the particular student or assignment, and the type of knowledge to be assessed. Hierarchies like Bloom's taxonomy can help faculty members

Table 1. Scales, dimensions, and descriptions in one section of the finalized rubric

	Excellent	Needs Improvement	Critical Error
Patient Education	Dismisses the patient with appropriate home care procedures specific to care provided.	Requires faculty prompting to provide the patient with appropriate home care procedures specific to care provided.	Dismisses the patient without appropriate home care procedures specific to care provided.
Infection Control	Independently demonstrates proper infection control techniques.	Requires assistance to demonstrate proper infection control techniques.	Does not demonstrate proper infection control techniques.
Documentation	Obtains appropriate patient consent for the procedure. *And* Documentation is thorough and accurate.	Requires faculty prompting to obtain appropriate patient consent for the procedure. *Or* Requires assistance to thoroughly and accurately document.	Initiates procedure without obtaining appropriate patient consent. *Or* Critical patient information is not documented or is inaccurate.

define the level and type of learning expected in a particular situation.[15] That process helps clarify the specific objective for faculty and student alike. The act of defining expectations leads naturally into a description of the top level of performance, or quality definition, for each objective and allows a relatively easy identification of the bottom quality definition by contrast. The performance that relates to levels in between the top and bottom levels will then become more apparent.[16,17]

The third step is grouping and labeling. Based on the first two steps, items representing similar performance expectations are grouped together and labeled, forming the dimensions of the rubric. For example, expectations for a student's patient record entry might include items such as accuracy, completeness, and proper sequencing of events and can be grouped together and labeled under the dimension of "documentation."

The final step is application: applying the dimensions and descriptions to create the final form of the rubric. The labels for the dimensions now comprise the left column. The objectives are incorporated into the descriptions (quality definitions) within the rubric grid, as shown in Table 1.

As each evaluation criterion and quality definition are written, care must be taken to avoid unclear and judgmental language. Writing that uses the language of specific, objective evaluation will help avoid introducing subjective opinion. For example, describing the highest level of performance for providing home care instructions as "home care instructions were excellent" is more subjective than "home care instructions were appropriate to the procedure performed." Similarly, "vital signs were recorded accurately" is more specific than "vital signs were recorded." Ongoing evaluation of the effectiveness of the rubric and feedback from users will help to refine and improve the language.

When developing the rubric, it is important to decide how many performance levels are appropriate for each skill in the scale. Consideration should be given to identifying levels that are appropriate and understandable to both the teacher and the learner. In most cases, three to five levels are recommended. Again, faculty members developing the rubric may want to think seriously about how the users will interpret the language. Will "critical error" be better received as a descriptor by students and faculty members than the word "unacceptable"? Ideally, the language would be tested for interpretation, using a few students and faculty members in informal focus groups prior to deploying the rubric coursewide.

It is recommended that care be taken to ensure that errors are not counted more than once. For example, an error in hand-washing in the category of "infection control" should not also be part of the descriptor in the category of "professionalism." Such an overlap in scoring of the rubric may create a kind of double jeopardy, resulting in an inadvertent grade reduction.[16]

The length of the finalized rubric is another important consideration throughout the development process. A rubric ideally serves as a guide to faculty members without inundating them with unnecessary detail. A useful rubric is one that allows an educator to focus on the evaluation of criteria important to the task without having to shuffle through pages of paper. Popham suggests that a rubric should rarely exceed one or two pages.[3]

Collaboration with students, faculty, and/or other members of the teaching team during one or more of the above steps is a key consideration in the development of a rubric. There are those who suggest that seeking student input is like having the fox guard the hen house, but assessment experts such as Stevens and Levi contend that there are solid reasons for student collaboration in developing rubrics.[7] First, co-development can prevent misunderstandings and misinterpretations before the rubric is used to evaluate student work. The result is greater satisfaction among students and faculty members. Second, collaboration increases student awareness of themselves as stakeholders in the educational process, fostering greater professionalism.[18,19] And third, inclusion may actually reduce the faculty workload by letting students do some of the work.

Involving faculty members in the development of the rubric also provides benefits. When multiple faculty members are involved in teaching and evaluation using the rubric, collaboration provides an opportunity to discuss goals and teaching practices and to define the knowledge and skills expected for the performance being evaluated.[7] Faculty members have the opportunity to discuss differences, clarify misunderstandings, and develop a sense of ownership in the evaluation process, increasing the likelihood of arriving at a rubric that will be acceptable to all. As with students, the time involved to develop the rubric increases when stakeholders are included, but the benefits derived generally outweigh this investment in time.

Additional Considerations

Rubrics need to include criteria that are valid and reliable. As described in the Dental Student Assessment Toolbox, validity refers to the use of evidence-supported criteria that ensure the performance in question is, in fact, the performance being measured. Reliability refers to consistency in measurement across several performance events.[1] While an in-depth review of validity and reliability is beyond the scope of this article, Knight and Licari et al. present excellent reviews for establishing valid and reliable criteria.[10,11]

Calibration of faculty members on the use of rubrics is recommended to help achieve reliable results. In a review article on the sources of bias in clinical performance evaluations for medical students, Williams et al. noted that more research is needed to identify the effectiveness—and cost-effectiveness—of rater calibration and training.[14] In their review, different types of training programs and their effects were described. Results indicated that training programs that provided raters with samples of behavior for each of the dimensions on the evaluation form and allowed opportunities for practice and feedback were most successful at improving the accuracy of ratings and observations. Providing faculty with the assessment instrument prior to implementation also increased rater accuracy. For example, providing prepared teeth that represent each level of performance on a rubric for operative procedures can be made available to faculty members who are asked to use the rubric to assess each preparation.[20] Results can be compared and differences discussed and clarified. Such discussion can not only help to increase consistency among faculty members but can also lead to needed modifications to the rubric. With time constraints, the economic environment, faculty shortages, and the number of part-time faculty members in dental education, the ability to calibrate faculty remains a challenge. Williams et al., in their recommendations, suggest that, at a minimum, raters be given the opportunity to become familiar with the form before they need to use it in their evaluations.[14]

The time required for developing and implementing an effective rubric with feedback, changes, and reevaluation may seem daunting to faculty members whose workloads leave little room for another new task, but the benefits routinely offset the investment. Once a rubric has been validated, changes should be implemented with caution, as frequent changes can prevent meaningful collection of results.[14] The greatest challenge for dental faculty members with a limited background in educational methodology may be the transition from theory of rubric use to its actual creation. Faculty development in rubric writing from instructional design experts may alleviate some of these concerns and make the process easier.

Examples of Rubric Implementation

Two examples of rubrics currently in use at our institutions are presented here. The first closely follows the steps outlined in this narrative and is used for the daily clinical evaluation of students as they progress through skill development in the assessment and diagnosis of patients. The second example highlights the versatility of the rubric. It is based on the same principles described, but is adapted in a unique way for assessing and grading critical thinking skills in a case-based didactic course in prosthodontics. The primary difference between the two is that the second example is a grading rubric used in a testing situation and, therefore, does not provide the criteria (answers) to the students prior to the examination.

Table 2 is the rubric used in the oral diagnosis portion of the clinical courses of Oral Diagnosis and Treatment Planning at the University of Pittsburgh during the third and fourth clinical years in the comprehensive care area. The rubric was developed with a small group of participating faculty members and presented to the department faculty as part of a series of small-group calibration sessions. Copies of the rubric were laminated and hung in each of the patient treatment areas as a reference for both faculty and students. For students, the rubric was presented at small-group student meetings by their team leader, and a copy was posted on the course management site (Blackboard). An electronic grade form that includes the scales and dimensions for the rubric is incorporated into axiUm (the electronic health record used by the school), and faculty members are prompted to complete the assessment each time an initial or recall examination is completed by a student. The overall grade earned is calculated in the system based on the scale for third- and fourth-year students (Table 3). The scale incorporates a certain degree of leniency for third-year students new to the clinic, so that faculty members can more consistently evaluate

Table 2. Oral diagnosis rubric used at the University of Pittsburgh

Evaluative Criteria	Performance Levels: Honors Level (must meet all listed criteria)	Progressing Satisfactorily (+)	Needs Improvement (-)	Critical Error
I. Health History a. Chief complaint	–Independently identifies the chief complaint. **And** –Independently identifies appropriate diagnostic tests. **And** –Correctly establishes a differential or definitive diagnosis based on data collected.	–Independently identifies the chief complaint. **And** –Requires assistance to identify appropriate diagnostic tests. **Or** –Requires assistance to correctly establish a differential or definitive diagnosis based on data collected.	Requires assistance to: –identify the chief complaint. **And** –identify appropriate diagnostic tests. **Or** –correctly establish a differential or definitive diagnosis based on data collected.	–Is unable to identify the chief complaint. **Or** –Is unable to identify appropriate diagnostic tests. **Or** –Is unable to correctly establish a differential or definitive diagnosis.
b. Comprehensive health history/HH (dental, medical, medications, and social/behavioral history)	–Independently obtains a comprehensive HH or update. **And** –Independently interprets the HH to recognize: 1. oral and systemic disease, 2. medication details, 3. deviations from normal, 4. the impact on dental care, and 5. appropriate management (consults/follow-up/tests). **And** –The ASA designation is correct.	–Independently obtains a comprehensive HH or update. **And** –Requires assistance to interpret the HH in one area. **And** –The ASA designation is correct.	–Requires assistance to obtain a comprehensive HH or update. **Or** –Requires assistance to interpret the HH in two or three areas. **And** –The ASA designation is correct.	–The HH is grossly incomplete or not updated or with little recognition of the need for a comprehensive history or update. **Or** –Fails to identify, interpret, or manage health problems that may have a significant impact on the delivery of dental care. **Or** –The ASA designation is inaccurate.
c. Risk factors	Independently: –completes a diet and risk factor assessment. **And** –interprets the diet and risk factor assessment and establishes the correct level of risk. **And** –discusses with the patient and faculty the relationship between identified risk factors and oral disease.	–Independently completes a diet and risk factor assessment. **And** Requires assistance to: –interpret the assessment and establish the correct level of risk. **Or** –discuss with the patient or faculty the relationship between identified risk factors and oral disease.	Requires assistance to: –complete a diet and risk factor assessment. **And** –interpret the assessment and establish the correct level of risk. **Or** –discuss with the patient or faculty the relationship between identified risk factors and oral disease.	–Does not complete the diet or risk factor assessment. **Or** –Is unable to interpret the assessment to establish the correct level of risk. **Or** –Is unable to discuss the relationship between identified risk factors and oral disease.
II. Physical Examination a. Vital signs	Independently: –obtains and records vital signs accurately. **And** –interprets findings as normal or abnormal.	–Independently obtains and records vital signs accurately. **And** –Independently interprets findings as normal or abnormal.	Requires assistance to: –obtain and/or record vital signs accurately. **Or** –interpret findings as normal or abnormal.	–Vital signs are inaccurate or not obtained. **Or** –Is unable to interpret findings correctly.

	And –recognizes the significance and management of findings.	**And** –Requires assistance to recognize the significance and/or management of findings.	**Or** –recognize the significance and/or management of findings.	**Or** –Fails to recognize the significance and/or management of findings.
b. Head, neck, and oral soft tissues	–Correctly performs a comprehensive physical assessment. **And** –Independently recognizes normal structures and deviations from normal.	–Correctly performs a comprehensive physical assessment. **And** –Requires assistance to recognize normal structures and/or deviations from normal.	–Requires assistance to perform a comprehensive physical assessment. **And** –Requires assistance to recognize normal structures and/or deviations from normal.	–The physical assessment is grossly incomplete. **Or** –Fails to differentiate between normal structures and deviations from normal.
c. PSR	–Independently obtains and records the PSR accurately. **And** –Independently recognizes the significance and management of PSR findings.	–Independently obtains and records the PSR accurately. **And** –Requires assistance to recognize the significance and/or management of findings.	Requires assistance to: –obtain and/or record the PSR accurately. **Or** –recognize the significance and/or management of findings.	–The PSR is inaccurate or not obtained. **Or** –Fails to recognize the significance and/or management of findings.
III. Case Presentation	–Independently presents patient case. **And** –Case presentation is complete and includes: 1. A concise but thorough summary of findings. 2. Demonstration of an understanding of findings. 3. Recognition of the impact findings may have on dental care. 4. An understanding of the use and impact identified medications have on dental care. 5. An understanding of the impact identified risk factors have on dental care.	–Presents patient case with faculty prompting. **And** –One or two errors occur during case presentation. **And** –Is able to accurately answer pertinent follow-up questions presented by faculty. **And** –Critical medical history topics are understood.	–Three or more errors occur during case presentation. **Or** –Requires faculty prompting to answer pertinent follow-up questions. **And** –Critical medical history topics are understood.	–Is unable to answer pertinent follow-up questions. **Or** –Critical medical history topics are not understood.
IV. Radiographic Assessment a. Prescription	–Independently prescribes appropriate radiographs. **And** –Radiographic prescriptions are based on exam findings/PSR. **And** –Radiographic prescriptions reflect an understanding of the established guidelines.	–Requires assistance to prescribe appropriate radiographs. **Or** –Requires assistance to base prescription on exam findings. **Or** –With assistance, can reflect an understanding of the established guidelines.	–Requires assistance to prescribe appropriate radiographs. **And** –Radiographic prescriptions are not based on exam findings. **Or** –Radiographic prescriptions do not reflect an understanding of the established guidelines.	–Radiographs are not prescribed appropriately. **Or** –Radiographic prescriptions are not based on exam findings. **Or** –Radiographic prescriptions do not reflect an understanding of the established guidelines.

(continued)

Table 2. Oral diagnosis rubric used at the University of Pittsburgh *(continued)*

	Performance Levels			
Evaluative Criteria	Honors Level (must meet all listed criteria)	Progressing Satisfactorily (+)	Needs Improvement (-)	Critical Error
b. Interpretation	–Independently interprets radiographic findings. **And** –Independently arrives at a differential and/or definitive diagnosis. **And** –Findings and diagnoses are documented in the EHR.	–Independently interprets radiographic findings. **And** –Requires assistance to arrive at a differential and/or definitive diagnosis. **And** –Findings and diagnoses are documented in the EHR.	Requires assistance to: –accurately interpret radiographic findings. **And** –arrive at a differential and/or definitive diagnosis. **Or** –document findings and diagnoses in the EHR.	–Radiographic findings are not interpreted accurately. **Or** –Is unable to arrive at a differential and/or definitive diagnosis. **Or** –Does not document findings and diagnoses in the EHR.
V. Documentation	Not Applicable	–Obtains the patient signature on the health history. **And** –Documentation is thorough and accurate.	–Obtains the patient signature on the health history. **And** –Requires assistance with documentation.	–Does not obtain the patient signature on the health history. **Or** –Critical patient information is not documented.
VI. Infection Control	Not Applicable	–Independently demonstrates proper infection control techniques.	–Requires assistance to demonstrate proper infection control techniques.	–Cannot demonstrate proper infection control techniques.
VII. Professionalism	Not Applicable	–Dress is in compliance with SDM Policy/Procedures. **And** –Behavior is in compliance with SDM Policy/Procedures and the ADA Code of Ethics. **And** –Reports to appointment as scheduled. **And** –Does not proceed until all indicated steps are checked by the attending faculty member. **And** –Required supplies and materials are readily available.	–Requires one reminder related to the dress code. **And** –Behavior is in compliance with SDM Policy/Procedures and the ADA Code of Ethics. **And** –Reports to appointment as scheduled. **And** –Does not proceed until all indicated steps are checked by the attending faculty member. **Or** –Time taken to acquire necessary supplies does not adversely impact patient care.	–Requires more than one reminder related to the dress code. **Or** –Behavior is not in compliance with SDM Policy/Procedures and ADA Code of Ethics. **Or** –Reports late to scheduled appointment. **Or** –Proceeds with patient care without having indicated steps checked by the attending faculty member. **Or** –Time taken to acquire necessary supplies adversely impacts patient care.

Table 3. Oral diagnosis rubric grade scale

GRADE SCALE
(negative marks take precedence over honors marks)

Third-Year Students

3 or 4 honors marks=100	2 negative (-) marks=84
1 or 2 honors marks=96	3 negative (-) marks=80
All plus (+) marks=92	4 negative (-) marks=75
1 negative (-) mark=88	5 or more negative marks or 1 or more critical error(s)=69

Fourth-Year Students

3 or 4 honors marks=100	2 negative (-) marks=78
1 or 2 honors marks=92	3 negative (-) marks=70
All plus (+) marks=88	4 or more negative (-) marks or 1 or more critical error(s)=69
1 negative (-) mark=84	

NO CREDIT if any one of the following occurs:

- Score of 69
- Faculty intervention that is excessive given educational level

COMPETENCY PROGRESSION EXAMINATION

3 or 4 honors marks=100	1 negative (-) mark=84
1 or 2 honors marks=92	2 or more negative (-) marks or 1 or more critical error(s) or student/faculty
All plus (+) marks=88	impression deviates in 3 or more areas=69

FINAL SENIOR COMPETENCY

3 or 4 honors marks=100	1 or more negative (-) marks or 1 or more critical error(s) or
1 or 2 honors marks=92	student/faculty impression deviates in 3 or more areas=69
All plus (+) marks=88	

FACULY INTERVENTION: if excessive given educational level=0

what they observe without weighing how a student's experience level would influence the assessment. The scale provides a notable exception: a critical error is considered critical in any year. The same form is used for assessment of final competence in the clinical environment. To be considered competent, students must be assessed at the honors or satisfactory level in each dimension. Students also use the rubric to self-assess prior to faculty evaluation. The rubric has been introduced to first- and second-year students for use in clinical exposures to patient assessment as part of a broader clinical curricular revision. These less-experienced students are asked to self-assess prior to receiving feedback from faculty via the rubric, and the rubric for these students is used as a purely formative assessment. In this way, students become familiar with the assessment tool before it is used in formative and summative assessments in the third and fourth years. Another example of a rubric used for formative assessment in diagnosis and treatment planning can be found in a 2008 article by Licari et al.[11]

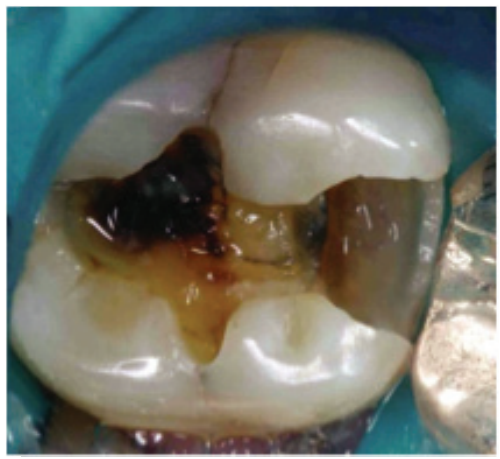
The second example is a testing rubric designed to assess critical thinking skills in a third-year didactic fixed prosthodontic course at the University of Texas Health Science Center at San Antonio. Its author originally used a scenario-based short essay format without a rubric, but found the grading process to be inherently subjective and time-intensive. While grading exams in the presence of his daughter, a middle school teacher, she asked, "Dad, why aren't you using a rubric?" After an abridged education in the theory of rubrics, the case example was devised and is the one now used in the course (Figure 1 and Table 4). This grading rubric is more than an answer key; it is a highly structured tool that evolved from the reflection, listing, grouping, and application described above and provides a systematic method for evaluating a student's thought process in a targeted area.

Students are given the case description and asked the following question: "Given the scenario provided, how would you restore #18? Justify your restoration choice." To answer the question, a student must apply foundation knowledge from dental anatomy, oral pathology, occlusion, operative dentistry, endodontics, and fixed prosthodontics. An ideal answer would mirror a logical thought process,

CC: Mild pain area #18 with chewing

52 year old male. Pulp #18 responds vital to cold without lingering pain. Pain reproduced with isolated load on MF & ML cusps #18. No pocketing greater than 3 mm #18. No apparent caries. Moderate occlusal load potential.

Mildly symptomatic #18



Restoration removed #18

Figure 1. Case example in fixed prosthodontics didactic course at the University of Texas Health Science Center at San Antonio

Table 4. Sample rubric for fixed prosthodontics critical thinking case (scenario #18) at the University of Texas Health Science Center at San Antonio

Diagnosis Restoration Rationale	Onlay, Partial Veneer	Interim Crown, ReEval	Buildup, Cast Metal Crown	Complex Amalgam	Buildup, Metal Occ PFM	Buildup, Porc Occ PFM	Buildup, Ceramic Crown
Incomplete tooth fracture	+5	+5	+5	+5	+5	+5	+5
Restoration choice	+5	+4	+4	+3	+2	+1	+1
Ferrule effect	+5	+5	+5	+5	+5	+5	+5
Tooth conservation	+2		+1	+1			
Esthetics non-issue	+2		+2	+2			
Cost v. longevity	+1		+1	+2	+1		
Predictability		+5					
Expediency	+1	+1		+1			
Strength/longevity	+3		+2	+1	+1	+1	
Esthetics						+1	+1
Maximum total points	+24	+20	+20	+20	+15	+13	+12

beginning with a critical assessment of the given information and arrival at a diagnosis of "reversible pulpitis secondary to incomplete tooth fracture." With that diagnosis, endodontic treatment of #18 is inappropriate, but some type of restoration with a ferrule effect is indicated to prevent crack propagation. The question is worth twenty total points. An accurate diagnosis is the first step in choosing an appropriate treatment, and five points are awarded in this grading rubric; zero points are awarded if the diagnosis is incorrect. Similarly, recognition of the need to create a ferrule effect to prevent crack propagation is central to selecting and justifying treatment; five points are awarded for that recognition. Half of the credit for the entire question is awarded for a correct diagnosis and an understanding of the need to cover the occlusal surface, since those concepts require assimilation of information from a broad clinical exposure. Selection of restorations that fail to cover the occlusal surface or that use direct composite or glass ionomer for occlusal coverage are not appropriate for the given scenario, and no points are awarded for either of those choices.

Credit for the selected restorative technique (five points) is awarded based on an assessment of tooth structure preservation, recognition of the low esthetic concern, analysis of restoration cost versus longevity, predictability of the method, clinical expediency, and material strength and esthetics. The remaining five points from the rubric reward justification of the chosen method of restoration compared to the alternatives, because choosing the correct restoration requires a systematic application of the considerations listed. Logical and transparent critical thinking are rewarded on a par with the "correctness" of the restoration chosen. As shown in Table 4, a maximum point value is assigned for each option proportional to its approximation of ideal. A poor restoration choice cannot be rationalized to clinical acceptability. Extra credit is available for more complete answers (twenty-four maximum points for a fully justified metal onlay, for example). The potential for extra credit is reserved for student insights that are of merit, as it is common for students to justify treatment using arguments that are novel and sound but not anticipated when the rubric was devised. The grade, therefore, represents a more objective assessment of the student's progress in critical evaluation of the point in question. Grading with this rubric requires half of the time previously devoted to scoring, and student critiques suggest the grading is accomplished with much greater objectivity.

Technology Resources for Rubric Development

A large number of electronic resources are available to assist with rubric development, a few of which will be mentioned here. Many are targeted for the elementary or secondary level (K–12), but they can easily be adapted to higher education. These resources tend to fall into two categories: 1) relatively simple rubric templates with reminders and prompts, in which the user picks a format and fills in the blanks, for either online or printed use; and 2) rubric-builders that are online and may be embedded within a testing program to allow item banking in a database and tracking of student responses.

RubiStar (rubistar.4teachers.org/index.php) is a good example of the first category. It is a free service, originally funded by a grant from the Department of Education, and it offers a set of ready-made online templates for a wide variety of subjects (e.g., science lab reports, writing an essay, making a presentation). After selecting a template, the user can either select scales and dimensions from a drop-down menu or type them into the grid along with their descriptions. The site also provides support material, such as a tutorial and guides for creating quality rubrics.

Teachnology, Inc. (teach-nology.com/web_tools/rubrics/) is also a free site designed for elementary to high school levels. The developers have gathered and made available a great deal of information regarding rubrics and tool construction. This site serves as more of a clearinghouse, providing links to other rubric sites and educational resources.

Flashlight Online 2.0 (www.tltgroup.org/Flashlight/FLO2/rubrics.htm) has been developed by The TLT Group (Teaching, Learning, and Technology), a higher education consulting group that helps college and university educators make better use of technology in their teaching endeavors. Flashlight is best described as an online survey and assessment tool that can be used to create second-generation rubrics. This more advanced feature allows users to create a database or bank of criteria for evaluation. Users can then reuse dimensions and scales that have been written previously (i.e., mix and match items to create rubrics more efficiently). Rubrics and results can also be shared online and presented in expanded or compressed formats. The use of rubrics has proliferated to such an extent that the TLT Group has developed a "rubric for rubrics"—a tool for assessing the quality of a rubric.

Rubrics can also be incorporated into online testing programs used in grading online exams. **Question*mark* Perception** (questionmark.com/us/perception/index.aspx) is such an online testing system. It provides for test authoring, deployment/distribution, test delivery, grading, and item analysis. Question*mark* allows for over twenty different question types, such as multiple-choice, fill-in-the-blank, matching, etc. Almost all are automatically graded by the computer program, but essay and short answer responses demand a human grader and, hence, a rubric. A rubric manager tool within Question*mark* allows the instructor to create rubrics and store them in a bank. During the grading process, graders can read the essay and assign scores using a clever interface that displays the student's essay, the rubric, and the scoring tool on the same screen. **Blackboard Learn 9.1** (blackboard.com/), a popular learning management system, has a test-writing and deployment system that incorporates and displays rubrics. Unfortunately, it does not provide an automatic method for conveying or displaying the rubric to students.

In the future, faculty members can look for advances in artificial intelligence and natural language processing software that will give computers the ability to read, understand, and grade an essay. Such capabilities have actually existed for some time, but a practical and affordable product is not yet available for daily grading purposes.

Summary and Conclusions

Assessment of student competence progression requires consideration of several learning domains, including acquisition of knowledge, application of technical skill, problem-solving capability, and critical-thinking ability.[1] A rubric is only one tool for assessing progression toward clinical competence and should not be considered an assessment cure-all. However, a rubric like the one in Table 2 may prove invaluable in the assessment process because it can provide a clearer picture for students of what is expected and because it defines what the student is expected to do to reach each level. A rubric may be used in a wide variety of assessment domains as a structured approach to creating an objective evaluation of inherently subjective material. Skills such as patient assessment and critical thinking challenge students at the higher levels of learning described in Bloom's taxonomy and, therefore, require a more complex assessment tool to identify and quantify student achievement of those skills.

Rubrics are a means to give detailed feedback in a timely manner and a mechanism by which students can self-assess using the same criteria as faculty. They are a catalyst for students' self-awareness and critical thinking about their own learning. For faculty members, rubrics can help refine teaching skills to help them become more effective educators.[7] Creating and using rubrics can create a dialogue among members of the teaching team, allowing faculty members to discover problems in grading and self-correct. Their use can also provide faculty members with outcome measures that test the positive impact of changes in teaching strategies.

Rubrics can be used to support assessment of clinical competence progression in conjunction with other tools such as portfolios or standardized oral examinations. Portfolios are a valuable method for evaluating student clinical progress, but suffer from limitations of subjectivity among raters and variability in the content submitted.[1] Clearly defined rubrics can help reduce subjectivity, save faculty grading time, and increase student awareness of the content expected in their portfolio submissions.

Designing a rubric to capture the key elements of a skill in an assessment with a grader-friendly format can be a challenge. Rubrics need to include enough detail to guide the faculty members and students without being overly cumbersome. As more and more schools switch to electronic grading in the clinical environment, the ability to have the rubric accessible electronically at the time of grading will be critical in order to promote consistent use across the faculty.

The literature supports the use of rubrics in dental education as an effective tool for assessing clinical skills and student progression toward competence. When rubrics are a part of the preclinical teaching and learning process, studies have documented improved outcomes. Further studies, such as that described by Licari et al., are needed to demonstrate their effectiveness in the clinical environment when students are no longer novice learners, but are not yet at the competent or expert stage of learning.[8,11]

When combined with assessment strategies like those detailed in the Dental Student Assessment Toolbox, rubrics can assist faculty members with both formative and summative assessments. Rubrics can help identify areas of student strengths and weaknesses and simultaneously provide valuable, detailed

feedback to the student. They may also be used to accumulate findings to guide curricular or instructional change. When criteria for levels of performance are clearly defined, the subjectivity inherent in faculty assessment through observation can be minimized.

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