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Validation of the National Board Dental Hygiene Examination

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The National Board Dental Hygiene Examination program is a part of the process for licensing dental hygienists. The examination assesses theoretical and applied knowledge in the basic biomedical, dental, and dental hygiene sciences, as well as community health. Standards for licensure examinations recommend that test publishers demonstrate a relationship between examination content and actual practice.

Method. To this end, a validity study was conducted, which involved the definition of the domain of entry-level dental hygiene practice using 56 competencies; the conduct of a practice analysis survey designed to rate the importance of these competencies; and the linking of competencies to content elements in accordance with the competencies' importance ratings. Of the 3941 surveys distributed, 1841 participants responded and, of these, 1284 were full-time practitioners. The importance ratings for the competencies were translated into numbers of items. The number of items devoted to each competency was distributed across all applicable elements of the existing content specifications based upon the knowledge needed to support the realization of the competency.

Results and Discussion. The findings confirmed the adequacy of the content specifications in effect prior to 2005. However, based on this validity study, 2 sub areas of relatively little significance were eliminated, and 2 new areas were introduced. Specifically, Clinical Testing under Assessing Patient Characteristics (one item) and Professional Methods of Administering Fluorides under Using Preventive Agents (one item) were eliminated, and Dental Hygiene Treatment Strategies was incorporated with 4 items, and Professional Responsibilities was added with a total of 28 items.

Keywords: dental hygiene licensure, National Board Dental Hygiene Examination, practice analysis, professional licensure, Rasch rating scale analysis, validity

Introduction

The Joint Commission on National Dental Examinations is the agency of the American Dental Association that is responsible for the conduct of the National Board Dental Hygiene Examination program. The purpose of this program is to provide state boards with information on the qualifications of individuals who seek licensure to practice dental hygiene¹. In light of this purpose, the content of the Dental Hygiene Examination has been formulated to evaluate the licensure candidates' theoretical and applied knowledge in the basic biomedical, behavioral, dental, and dental hygiene sciences, as well as in community health and research principles, and to evaluate their ability to apply the knowledge in a problem solving context.¹

Validation of their examinations is an important responsibility of testing agencies; it is an ongoing process of gathering evidence from a variety of sources to support the interpretation and use of examination scores for a clearly stated purpose. For examinations involved in the credentialing process, the primary source of validity evidence is related to the appropriateness, ie, representativeness and relevance, of the content of the examination. For the Dental Hygiene Examination, the content is appropriate if it assesses the theoretical and applied knowledge required for the successful entry-level practice of dental hygiene. The overall licensure process is multi-layered. Measures of clinical competency, ie, clinical demonstrations, are beyond the scope of the National Board Dental Hygiene Examination program.

The content of the Dental Hygiene Examination has evolved over time to reflect the ever-changing theoretical knowledge base and nature of practice. Prior to 2005, recommendations regarding the content have come from essentially 2 sources. First, the educators and practitioners who served on the test construction committees recommended modifications to the content specifications based upon their knowledge of developments in the subject matter included on the examination and developments in accepted dental hygiene practice. Second, those professionals attending various regional and national forums focused on dental and dental hygiene issues recommended modifications. Regardless of the source, the Joint Commission is ultimately responsible for evaluating the appropriateness of these recommendations through its standing Committee on Dental Hygiene. While the Joint Commission has successfully used this approach to determining and validating the content of the Dental Hygiene Examination, the *Standards for Educational and Psychological Testing* recommends that to demonstrate validity evidence a strong linkage between examination content and practice be established for credentialing examinations.² The *Standards* indicate that one mechanism for demonstrating this linkage is to base the content of the examination on the findings of a practice analysis. In response to this recommendation, the Joint Commission conducted a validity study, which involved a practice analysis as it relates to entry-level practice, and applied the findings of this practice analysis to confirming the Dental Hygiene Examination content specifications. The purpose of this article is to describe the overall validation process, including the comprehensive definition of the domain of dental hygiene practice, the dental hygiene practice analysis, the procedure used to link the findings of the practice analysis to the content specifications, and the modifications to the content that were indicated by the findings.

Method

National Board Dental Hygiene Examination

The Dental Hygiene Examination is a comprehensive examination that consists of 350, 4 or 5 alternative multiple-choice items contained in 2 components.¹ Component A includes 200 case-independent items, and Component B includes 150 case-dependent items. The case-independent component of the examination also includes 20 items distributed across approximately 4 testlets. For the purposes of the Dental Hygiene Examination, testlets typically consist of brief scenarios describing community health activities. These scenarios consist of a paragraph of less than 100 words, and they contain information that is necessary in order for the candidate to endorse the correct responses to the items associated with the scenarios. The case-dependent component consists of from 12 to 15 dental hygiene patient cases with from 12 to 15 multiple choice items associated with each case. The case material includes patient histories, dental charts, radiographs, and clinical photographs, when appropriate. For each edition, Component B includes at least one case that addresses geriatric, adult-periodontal, pediatric, special needs, and medically compromised patients. The case-independent component addresses the scientific basis for dental hygiene, provision of dental hygiene services, and community health activities, while the case-dependent component addresses only the provision of dental hygiene services.

Phases in the Validation Process

As shown in Table 1, there are a number of phases involved in the overall process of validating the Dental Hygiene Examination. The first step is to define the domain of entry-level dental hygiene practice. For the purposes of this validity study, defining the domain is accomplished through the delineation of competencies. The second phase involves gathering information related to the importance of each of the competencies through the use of a survey of recently licensed dental hygienists. The third phase involves forging a link between the competencies and the content specifications. The link between the competencies and the content is based on the judgments of a panel of experts using a 2-dimension model.

The final phases of the process involve the review and approval of the revised content specifications by the Joint Commission through its standing Committee on Dental Hygiene and the application of the revised content specifications to designing and developing the examination.

Table 1. Phases involved in the National Board Dental Hygiene Examination validity study

Phase	Activity	Responsible Agency
1	Define the domain of entry-level dental hygiene practice based on a synthesis of the competencies included in the <i>Competencies for Entry Into the Profession of Dental Hygiene</i> promulgated by the American Dental Education Association and Competencies described in the <i>Accreditation Standards for Dental Hygiene Programs</i> of the Commission on Dental Accreditation.	Committee on Dental Hygiene and Joint Commission on National Dental Examinations
2	Conduct practice analysis survey of 3,941 dental hygienists to elicit ratings of importance of competencies to patient care within the practice of dental hygiene.	ADA Survey Center
3	Two-dimensional model used to distribute the 350 test items across competencies to the content elements that support the competencies.	Expert Panel – comprised of an educator, four full-time practicing dental hygienists representing the various regions of the country, and the joint commissioner representing the American Dental Hygienists' Association
4	Review and approval of the content specifications.	Committee on Dental Hygiene and Joint Commission on National Dental Examinations [March 2004]
5	Revised examination specifications implemented.	[January 2005]

Domain of Entry-level Dental Hygiene Practice

To conduct a comprehensive validity study that supports the use of Dental Hygiene Examination scores in the licensure process, it is necessary to define the domain of entry-level practice. To lay the ground work for the validity study, 2 committees were convened. One of these was the Committee on Dental Hygiene, which is a standing committee of the Joint Commission, and the other was an ad hoc test construction committee. The Committee on Dental Hygiene was composed of 3 dental practitioners and one dental educator, as well as 3 dental hygienists. The dental practitioners were members of the Joint Commission, and the 3 dental hygienists were appointed to the Joint Commission by the American Dental Hygienists' Association. The members of the Committee on Dental Hygiene were selected to participate in the validity study based on their expertise in the clinical practice of dentistry and dental hygiene. The *ad hoc* test construction committee included 3 dental and 3 dental hygiene educators, as well as one basic scientist. Both committees met together to share information regarding the overall purpose and goals of the examination program relative to dental hygiene practice. The committees defined the broad purpose of entry-level dental hygiene care to be: *Health Promotion and Disease Prevention*.

The Committee on Dental Hygiene then met separately and synthesized 56 competencies important for the recently licensed dental hygienist based upon the Accreditation Standards published by the Commission on Dental Accreditation of the American Dental Association and the *Competencies for Entry into the Profession of Dental Hygiene* promulgated by the American Dental Education Association.^{3,4} The domain of dental hygiene practice was defined in terms of entry-level competencies because the examination content is designed to address the theoretical knowledge that supports successful entry-level clinical practice. These 56 competencies were grouped into 3 categories, which included professionalism, patient/client care, and community health involvement. The competencies are listed in Table 2a, ,2b, 2c

Table 2. The domain of initial dental hygiene practice as defined by 56 competencies in the area of health promotion/disease prevention

Health Promotion and Disease Prevention

Professionalism		N	\bar{X}	σ
1.	Apply a professional code of ethics to dental hygiene practice.	1238	4.77	0.49
2.	Adhere to state and federal laws.	1237	4.85	0.42
3.	Assume responsibility for dental hygiene care.	1229	4.73	0.52
4.	Provide dental hygiene services based on accepted standards of care.	1238	4.74	0.48
5.	Evaluate scientific literature and other sources of information to make decisions about dental hygiene treatment.	1234	4.09	0.76
6.	Perform self-assessment for life-long learning and professional growth.	1233	4.15	0.86
7.	Participate in professional organizations.	1213	3.14	1.16
8.	Participate in community service activities.	1163	2.80	1.11
9.	Provide quality assurance mechanisms for health services.	1198	4.13	0.85
10.	Provide care to all clients using an individualized approach that is empathetic and caring.	1237	4.71	0.55
11.	Identify career options and practice settings.	1144	3.30	1.23
Patient/Client Care				
12.	Provide dental hygiene care to promote patient/client health and wellness.	1234	4.81	0.45
13.	Provide evidence-based practice using critical thinking and decision-making skills.	1233	4.58	0.63
14.	Maintain accurate, consistent and complete records.	1235	4.80	0.48
<i>Collect and analyze data to identify patient needs and oral health problems.</i>				
15.	Obtain medical histories.	1236	4.93	0.29
16.	Obtain dental, psychosocial, and behavioral histories.	1234	4.41	0.70
17.	Perform head and neck examination.	1226	4.44	0.74
18.	Perform intra-oral examination.	1239	4.80	0.47
19.	Measure and record vital signs.	1193	3.80	0.93
20.	Perform periodontal examination.	1235	4.83	0.45
21.	Obtain and interpret radiographs.	1237	4.83	0.44
22.	Perform dental indices.	1179	3.91	0.96
23.	Perform a risk assessment for oral diseases and oral habits.	1219	4.24	0.83

<i>Establish goals and treatment strategies to facilitate optimal oral health.</i>			
24. Determine a dental hygiene diagnosis.	1225	4.64	0.61
25. Develop a dental hygiene treatment plan.	1229	4.66	0.59
26. Obtain informed consent.	1223	4.67	0.67
27. Communicate a dental hygiene case presentation.	1182	4.15	0.98
<i>Provide treatment to achieve and maintain oral health.</i>			
28. Adhere to established infection control protocol.	1241	4.94	0.28
29. Implement and monitor environmental safety programs.	1186	4.34	0.87
30. Perform periodontal debridement and scaling procedures.	1237	4.86	0.40
31. Incorporate pain management techniques.	1226	4.52	0.66
32. Apply chemotherapeutic agents.	1164	4.17	0.79
33. Administer fluoride therapy.	1229	4.35	0.73
34. Apply pit and fissure sealants.	1201	4.34	0.73
35. Perform coronal polishing.	1211	3.83	1.05
36. Provide care of oral prostheses.	1223	4.23	0.79
37. Provide care and maintenance of restorations.	1187	4.23	0.84
38. Provide nutritional counseling.	1197	3.78	0.84
<i>Evaluate the extent to which treatment goals have been achieved.</i>			
39. Use and compare indices.	1148	3.75	0.94
40. Re-evaluate oral and periodontal health status.	1236	4.73	0.53
41. Evaluate treatment needs.	1233	4.69	0.52
42. Establish a recall schedule and determine necessary referrals.	1233	4.75	0.48
43. Evaluate patient satisfaction with treatment outcomes.	1235	4.43	0.68
44. Refer patients/clients who may have a systemic, psychological, and/or social problem for comprehensive patient/client evaluation.	1174	4.30	0.82
45. Perform basic cardiac life support.	1160	4.79	0.58
Community Health Involvement			
46. Promote oral and general health and wellness to the public.	1169	4.14	0.83
47. Communicate effectively both verbally and in writing.	1197	4.51	0.68
48. Assess the oral health needs of the community.	1075	3.71	0.91
49. Identify the availability and quality of community resources and services.	1077	3.72	0.84
50. Develop community-based disease prevention and health maintenance strategies.	1024	3.68	0.93
51. Provide screening, referral, and educational services.	1080	4.01	0.89
52. Provide community oral health services in a variety of settings.	1013	3.78	0.92
53. Evaluate opportunities for improving access to care in a variety of settings.	1013	3.81	0.91
54. Evaluate reimbursement mechanisms and their impact on the patient's/client's access to oral health care.	1024	3.65	0.92
55. Evaluate the outcomes of community-based programs and plan for future activities.	982	3.56	0.94
56. Utilize professional and social networks and resources to increase access to care.	1047	3.82	0.92

1. Examination consists of 350 items: 200 case independent and 150 case dependent items.
2. Demographic notes on the respondents (1,841) to the sample of 3,941.
 Practice: Full Time=1,284 (69.7%), Part Time=491 (26.7%), Not Practicing=61 (3.3%), N=5 (0.3%)
 Award: Certificate=55 (3.0%), Associate Deg=1,456 (79.1%), Bachelor Deg=321 (17.4%), N=9 (0.5%)

The test construction committee convened separately to develop recommendations related to the structure and length of the Dental Hygiene Examination and to develop relevant demographic questions for the practice analysis survey that might prove useful in the interpretation of participants' data. This committee, and subsequently the Joint Commission, deemed the current structure and length of the examination to be appropriate, and, therefore, the overall validation process was based on the examination as it is currently configured.

Practice Analysis Survey

To determine the importance of each competency to the practice of dental hygiene, a survey instrument was developed and distributed to a sample of dental hygienists. The survey included several questions gathering general and personal information along with information on the practice environment. This information was used to guarantee the integrity of the sample parameters, ie, the information was used to ensure the degree to which the sample represents the population. The remainder of the survey listed the competencies. The participants were to rate each competency for its importance to patient care using a 5-level rating scale. The following descriptors define the five levels of the rating scale.

This competency is:

5: critical to patient care. Without this competency, the resulting patient care would be clearly unacceptable.

4: important to patient care. Without this competency, the resulting patient care would be compromised.

3: moderately important to patient care. Without this competency, the resulting patient care would be clinically acceptable but less than ideal.

2: unimportant to patient care. Without this competency, the resulting patient care would only be slightly affected.

1: very unimportant to patient care. Without this competency, the resulting patient care would not be affected.

In some instances, a particular competency might be unrelated to the participants' practice of dental hygiene. For these competencies, the participants were directed to circle N/A, for Not Applicable.

Sample

With regard to sampling procedure, a stratified random sample was drawn so that the number of survey participants from each licensing jurisdiction was proportional to the number of candidates residing in that jurisdiction at the time of application for the examination. The population consisted of those candidates who were enrolled in accredited dental hygiene programs and who passed the Dental Hygiene Examination during the years from 1997 through 2001. The addresses of candidates were drawn from the Joint Commission's electronic application files. The baseline percentage of candidates included in the survey per year was set at 10%, which was deemed appropriate to obtain a reasonable number of returned surveys and stable findings. Because some of the addresses included in the file were likely to be outdated, the size of the sample for each year was expanded, especially for the out years. The numbers of candidates included in the survey sample are given in Table 3. The American Dental Association's Survey Center arranged for the production and distribution of the instrument. There were 5 mailings. A pre-letter was distributed describing the importance of the practice analysis and soliciting participation. The second mailing consisted of the survey, and the subsequent three mailings consisted of reminder notices. Data collection ended on February 21, 2003.

Table 3. Sample for the National Board Dental Hygiene Examination practice analysis

Year	Total Candidates	Percentage Sampled	Sample
2001	5,303	14%	742
2000	4,966	15%	749
1999	4,881	16%	781
1998	4,783	17%	813
1997	4,742	18%	854
Total	24,675	16%	3,939

Rasch Rating Scale Analysis

The ratings provided by the full-time practicing dental hygienists were averaged for each competency. In addition to means, standard deviations were computed. While these means are estimates of the importance of each competency, they are not on an interval scale of measurement, which is important in determining the number of items to devote to each competency. Because of this, the ratings provided by the practicing dental hygienists were submitted to a Rasch model rating scale analysis using the computer program WINSTEPS.⁵ The analysis converted the ratings to Rasch calibrations of importance. These calibrations are on an interval level scale of measurement with a mean of 0.00 and a typical range of from -3.00 to +3.00 logits, ie, log odds units. Using the rating scale analysis, each competency is placed on a measurement scale that is characterized by consistently and uniformly increasing importance to patient care. The relative differences among the importance levels of the competencies are mirrored in the calibrations. Specifically, if the actual difference in importance between 2 competencies is the same as the actual difference between 2 other competencies, the differences in the calibrations between the first and second sets will be the same. The Rasch rating scale model can be expressed as:

where n is the agreeability of the rater, δ_i is the endorsability of the competency, and τ_k is the difficulty of the k th threshold.⁶ For the purpose of this study, agreeability might best be interpreted as the tendency of the participating dental hygienists to provide higher or lower ratings for the competencies, and endorsability might best be interpreted as the relative importance of the dental hygiene competencies. The difficulty of the threshold provides information on the viability of each of the 5 levels of the rating scale.⁴

As observed above, the calibrations resulting from the rating scale analysis are on an interval scale of measurement. This characteristic of the calibrations is crucial to this study because it allows for the transformation of calibrations to percentages of examination items using the linear transformation $y = ax + b$, where a and b are constants, x is the importance calibration associated with each competency, and y is the percentage of items devoted to each competency.^{7,8} Using simultaneous equations, it is possible to determine the 2 constants. In order to solve the equations, it is necessary to set, *a priori*, the maximum and minimum percentages of items devoted to each competency. For the purposes of this practice analysis, the maximum and minimum were set at 5.0% and 0.0%, respectively. The selection of these particular maximum and minimum percentages was based on the 2-fold principle that the greatest number of competencies should be represented in the examination specifications and that the important competencies should be adequately supported by relevant content.⁷

As observed by Lunz, Stahl, and James, the total of the transformed percentages typically will not be 100%.⁷ Because of this, it is necessary to adjust the percentages using a correction factor of the form: $R = 1 / \sum y$ where R is the correction factor and y is the percentage of items devoted to each competency.⁷ Finally, it was necessary to determine the number of items to devote to each competency. This was accomplished by multiplying the percentage associated with each competency by 350, which is the approved number of items on the Dental Hygiene Examination.

Two-dimensional Model Linking Competencies and Content

A 2-dimensional model was used as the framework for demonstrating the linkage between the examination content and clinical practice.^{7,9} This model is depicted in Figure 1. The horizontal dimension of the model consisted of competencies underlying the initial practice of dental hygiene, and the vertical dimension consisted of the current list of content elements assessed by the examination. There are 2 aspects of this model that are important to successfully validating the examination. First, the importance of each competency to patient care determines the number of items devoted to that competency. Second, the number of items devoted to each competency is distributed across the existing content elements in accordance with the extent to which the theoretical and applied knowledge associated with the content support the competency.

Content	Competency					
	1	2	3	4	...	56
	†	†	†	†		†
Scientific Basis for Dental Hygiene Practice (60)	‡					
1.0. Anatomic Sciences (17)						
1.1. Anatomy (12)						
1.2. Histology & Embryology (5)						
2.0. Physiology (5)						
3.0. Biochemistry and Nutrition (6)						
4.0. Microbiology and Immunology (10)						
5.0. Pathology (12)						
5.1. General (5)						
5.2. Oral (7)						
6.0. Pharmacology (10)						
Provision of Clinical Dental Hygiene Services (120)						
Community Health/Research Principles (20)						

† Number of items devoted to each competency, which is based on the practice analysis survey findings.
 ‡ Each cell shows the number of items devoted to each content element that supports each competency.

Figure 1. Two-dimensional model underlying the validity study

Once it was determined how many items were required to support each competency, it was necessary to distribute these items across the existing content specifications. Relating competencies to examination content is difficult, at best. To overcome this difficulty, a panel of experts was convened, and this panel used the 2-dimensional model described above to forge the appropriate links. Essentially, the panel distributed the items devoted to individual competencies to the content elements that involve the theoretical and applied knowledge that support that competency. The number of items devoted to existing content elements, ie, elements in effect prior to 2005, could be increased or decreased depending on the competencies, and content elements could be added or removed.

The Joint Commission determined the qualifications of the panel members when it directed that a validity study be conducted. The members included 4 full-time practicing dental hygienists, 1 dental hygiene educator/test constructor, and the Joint Commissioner representing the American Dental Hygienists' Association. The Joint Commission selected the members based on geographic distribution and practice experience. As shown in Table 1, the final phases of the validation process involved the review of the revised content specifications by the Joint Commission through its standing Committee on Dental Hygiene.

Results

Using the outcomes of the committees' deliberations and synthesis of competencies, the practice analysis survey was developed and distributed. Of the 3941 surveys distributed, responses were received from 1841 participants. Of these 1841, 1284 or 69.7% were involved in full-time practice, 491 or 26.7% were involved in part time practice, 61 or 3.3% were not currently practicing, and 5 or 0.3% did not respond to this question. The 1284 full-time responding practitioners were distributed across licensing jurisdictions in proportion to the number of practicing dental hygienists in those

jurisdictions. With regard to the educational attainments of the dental hygienists in the sample of full-time practitioners 38 or 3.0% held a certificate, 1013 or 78.9% held an associate degree, and 232 or 18.1% held a bachelor's degree. One respondent did not indicate his/her award. The Committee on Research and Development, which had responsibility for advising the conduct of the practice analysis and overall validity study, considered this distribution of awards for the dental hygienists in the sample reflective of the educational attainments of the population of dental hygienists. Because the respondent sub-sample was representative of the population, it was deemed unnecessary to explore nonresponse bias.

The range in mean ratings for the competencies was from a low of 2.80 to a high of 4.94, with an overall mean of 4.27. The mean ratings were found to be 4.13, 4.46, and 3.85 for the categories Professionalism, Patient/Client Care, and Community Health Involvement, respectively. The lowest mean rating was associated with the competency "Participate in community service activities," and the highest mean rating was associated with the competency "Adhere to established infection control protocol." The number of practicing dental hygienists providing ratings, the mean ratings, and the associated standard deviations appear in Table 2a, 2b, 2c.

The ratings provided by the practicing dental hygienists were submitted to the Rasch calibration program WINSTEPS.⁵ The results of the analysis showed the relative value or contribution of the 5 levels of the rating scale as well as the calibrations, or endorsability, for each of the 56 competencies. The curves shown in Figure 2 indicate the probability of endorsing each of the levels of the rating scale for each difference estimate.⁶ Each of the 5 levels shown in Figure 2 should peak in an orderly fashion along the continuum of ever-increasing rater agreeability. Rating scale level 4 overlaps with the 2 adjacent levels, and it does not show a clear peak indicating that it has a relatively low probability of occurrence. While not severe in this instance, this structure suggests that participants are experiencing some difficulty in distinguishing between levels 3 and 4 and between levels 4 and 5. In severe instances, ie, where the probability of a particular level of the rating scale is flat, the rating scale should be collapsed and data reanalyzed.⁶ However, this rating scale structure clearly indicates that the 5 levels are functioning in an acceptable manner.

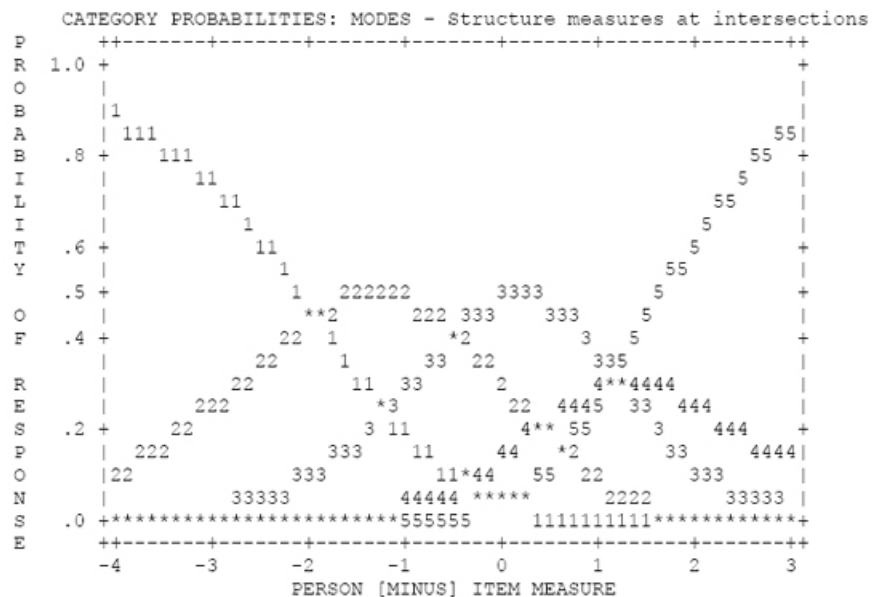


Figure 2. Rating scale structure

Once the viability of the rating scale was confirmed as robust, the calibrations were converted to percentages and numbers of items. Item calibrations are shown in Figure 3. This conversion was accomplished by solving the simultaneous equations that appear below.

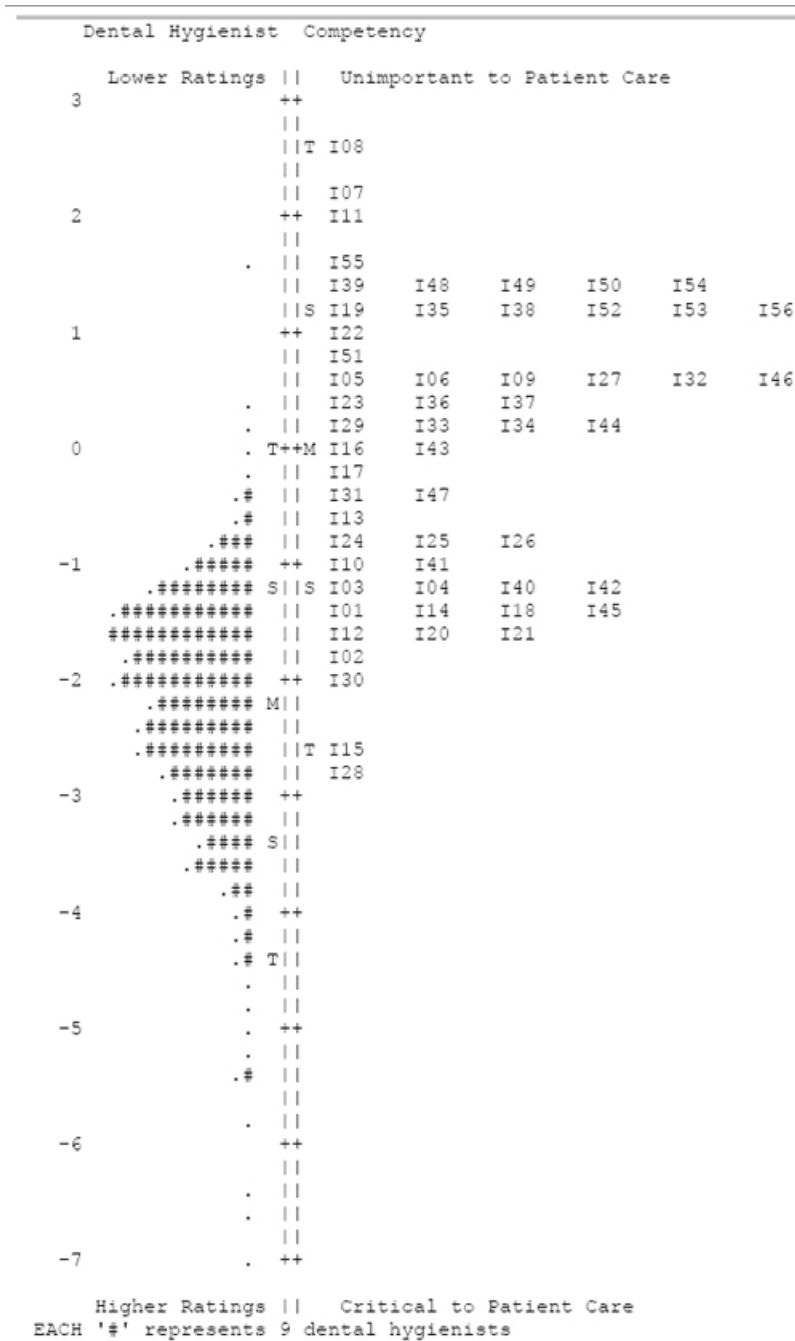


Figure 3. Map of importance of the competencies for patient care

$$0.05 = a + 2.80b$$

$$0.00 = a + (-2.68)b$$

The values of 0.05 and 0.00, which appear on the left sides of the equations, represent the percentages of items devoted to the most and least important competencies, respectively. The 2.80 value is the Rasch calibration associated with the competency rated most important by the survey participants, and the -2.68 is associated with the least important. Solving

these equations yields the translation formula: $y = 0.024 + 0.009x$, where x is the Rasch calibration and y is the percentage of items.

As anticipated, applying this translation formula directly to the calibrations resulted in an over estimation of the percentages and associated numbers of items devoted to the competencies. Using the translation equation, a total of 134% or 470 items would result rather than 100% and 350 items. To make the appropriate adjustments, the correction factor was applied as follows.

$$R = 1 / \Sigma y$$

$$R = 1 / 1.344$$

$$R = 0.744$$

The application of the correction factor resulted in transforming these estimates to the appropriate percentages and numbers of items. The percentage and number of items devoted to each competency appear in Table 4a, 4b.

Table 4. Corrected percentages and number of items devoted to each competency

Competency	Percent†	Number‡
Professionalism		
1	2.7	9
2	3.0	11
3	2.5	9
4	2.6	9
5	1.3	5
6	1.4	5
7	0.3	1
8	0.0	0
9	1.4	5
10	2.5	9
11	0.4	2
Patient/Client Care		
12	2.8	10
13	2.1	7
14	2.8	10
15	3.6	12
16	1.8	6
17	1.9	7
18	2.8	10
19	1.0	3
20	2.9	10
21	2.9	10
22	1.1	4
23	1.5	5
24	2.3	8
25	2.3	8
26	2.4	8
27	1.4	5
28	3.7	13
29	1.7	6
30	3.1	11
31	2.0	7
32	1.4	5
33	1.7	6
34	1.7	6
35	1.0	4
36	1.5	5

37	1.5	5
38	0.9	3
39	0.9	3
40	2.5	9
41	2.4	9
42	2.6	9
43	1.8	6
44	1.6	6
45	2.7	10

Community Health Involvement

46	1.4	5
47	2.0	7
48	0.8	3
49	0.8	3
50	0.8	3
51	1.2	4
52	0.9	3
53	0.9	3
54	0.8	3
55	0.7	2
56	1.0	3

† Rounded to the nearest 10th. ‡ Rounded to the nearest whole number.

During the third phase, the expert panel convened to forge the link between the competencies and the individual content elements. The panel was provided with a 2-dimensional matrix reflecting the model. One dimension consisted of a list of the competencies and the numbers of items devoted to each competency and the other dimension consisted of the traditional content elements, ie, those in place prior to 2005. The panel distributed the items allocated to each competency to the content elements in the specifications that relate to the theoretical and applied knowledge necessary to support that competency. The panel members made an initial set of assignments of items to content elements. Then, it refined its assignments by making a number of minor adjustments. Following the adjustments, the panel achieved full consensus. In some instances, traditional content elements were eliminated, eg, Clinical Testing subsumed under Assessing Patient Characteristics. In other instances, content elements were introduced for the first time, eg, Dental Hygiene Treatment Strategies was included under Planning and Managing Dental Hygiene Care, which is an element subsumed under Provision of Clinical Dental Hygiene Services. Also, the various responsibilities of the dental hygienist that were dispersed throughout the specifications in effect prior to 2005 were grouped together and expanded under the category of Professional Responsibility. This category was introduced under Provision of Clinical Dental Hygiene Services and under Case Dependent Items. The distribution of items under the traditional content specifications and under the practice analysis for the major categories appears in Table 5.

Table 5. Distribution of items under the traditional content specifications and under the practice analysis

		Distribution	
		TC†	PA‡
<i>Case-Independent Items</i>			
Scientific Basis for Dental Hygiene Practice		60	60
1.0.	Anatomic Sciences	17	15
2.0.	Physiology	5	4
3.0.	Biochemistry and Nutrition	6	7
4.0.	Microbiology and Immunology	10	11
5.0.	Pathology	12	13
6.0.	Pharmacology	10	10
Provision of Clinical Dental Hygiene Services		120	116
1.0.	Assessing Patient Characteristics	23	16
2.0.	Obtaining and Interpreting Radiographs	19	14
3.0.	Planning and Managing Dental Hygiene Care*	30	34
4.0.	Performing Periodontal Procedures	27	19
5.0.	Using Preventive Agents	12	9
6.0.	Providing Supportive Treatment Services	9	7
7.0.	Professional Responsibility	0	17
Community Health/Research Principles		20	24
1.0.	Promoting Health and Preventing Disease Within Groups	4	5
2.0.	Participating in Community Programs	8	11
3.0.	Analyzing Scientific Literature understanding Concepts and Applying Research Results	8	8
<i>Case Dependent Items**</i>		150	150
1.0.	Assessing patient characteristics	37	35
2.0.	Obtaining and interpreting radiographs	15	16
3.0.	Planning and managing dental hygiene care	38	43
4.0.	Performing periodontal procedures	30	21
5.0.	Using preventive agents	15	13
6.0.	Providing supportive treatment service	15	11
7.0.	Professional Responsibility	0	11

† Traditional content specification. ‡ Content specifications under the practice analysis.

* Four new items on Treatment Strategies included under this general area. ** Approximations.

During Phase 4, the overall validity study, the practice analysis methodologies, and the content specifications resulting from the work of the panel were approved by the Joint Commission through its standing Committee on Research and Development and its Committee on Dental Hygiene. The new specification became effective in January of 2005.¹⁰

Discussion

One of the central responsibilities of a testing agency involved in credentialing is to gather evidence from a variety of sources to demonstrate that the scores resulting from the administration of its examination are aligned with a particular purpose, ie, the scores are valid for use in evaluating the qualifications of candidates for certification or licensure. One source of information regarding the validity of scores is the findings of studies, which are designed to address the particular purposes of the examination.

The first step in conducting validity research is to confirm that the domain of practice has been carefully and fully defined. In this study, the domain of entry-level dental hygiene practice was defined in terms of competencies rather than other possible components such as specific job tasks. Further, to guarantee that the domain was fully defined, a committee of experts in the various aspects of dental hygiene, ie, the Joint Commission's Committee on Dental Hygiene, met and synthesized the set of competencies from 2 separate sources. This was accomplished during Phase 1 and supports the basic assertion that the domain was adequately defined, ie, the competencies were considered expressive of the essential knowledge, skills, and abilities of the newly licensed dental hygienist. To the extent that the competencies are comprehensive, the findings of the practice analysis are durable. The Joint Commission determined that the 56 competencies adequately represent the domain of dental hygiene practice and approved their use as the basic ingredient of the practice analysis survey. The findings of research support the assumption that the competencies were sufficiently comprehensive to adequately represent the domain of knowledge, abilities, and problem solving skills necessary to successful entry-level practice of dental hygiene.¹¹

Phase 2 of this validity study involved estimating the importance of each of the 56 competencies. Estimating their relative importance is essential because it is the basis for determining the various content elements to be included in the specifications and the emphasis to place on the elements in sampling candidate knowledge. To ensure the adequacy of the survey process, a stratified random sample of recently examined dental hygienists was drawn. The sample was limited to relatively recent graduates to avoid potential bias in responses by dental hygienists whose perspective on practice may be influenced by cumulative practice experience and additional formal and/or informal education. The sample was drawn across a 5-year period of time, with higher percentages of participants sampled from the earlier years to compensate for the potential lower response rate attributable to dated addresses for candidates and other ineffable factors. The sample was drawn from the files of the Joint Commission in such a way that each state was sampled in accordance with the percentage of candidates testing from that state. The overall sample of 16% of all candidates was deemed sufficient by Survey Center staff to arrive at stable estimates of importance. This judgment was supported by the response rate that was found to be 75.6%, after adjusting for unclaimed and undeliverable surveys.

By virtue of being included in the list of 56 competencies synthesized by experts who deemed them to be important to practitioners, the survey findings indicated that some competencies are relatively more important to patient care than others. The mean ratings for the competencies varied across the range of scale values from 2.80 to 4.94, which suggests that all competencies were at least moderately important to patient care. In the general area of Professionalism, the competency "Participate in community service activities" was considered unimportant and received a mean rating of 2.80, while the competency "Adhere to state and federal laws" was considered important and received a mean rating of 4.85. In the area of Patient/Client Care, the competency "Use and compare indices" received a mean rating of 3.75, and "Adhere to established infection control protocol" received a rating of 4.94. This high rating can no doubt be attributable to the ever-increasing emphasis placed on infection control procedures. In the area of Community Health Involvement, the least important competency was found to be "Evaluate the outcomes of community-based programs and plan for future activities" at a mean rating of 3.56, and the competency "Communicate effectively both verbally and in writing" was found to be relatively important at 4.51. Of the 3 major areas, the mean rating for all competencies included in the area of Patient/Client Care was the highest at 4.46, and the mean for competencies included in Community Health Involvement was 3.85. The mean rating for Professionalism was 4.13. These mean ratings suggest that practicing dental hygienists place the most importance on those competencies directly associated with individual patient care. This finding might reflect an artifact of the survey instrument itself, however, because the rating scale defined importance in terms of patient care. Therefore, competencies directly addressing essential abilities related to patient care would be rated as more important. Different results might have been found if the rating scale referred to the practice of dental hygiene more broadly. Patient care was used in the survey to determine importance because it relates directly to the purpose of the Dental Hygiene Examination: to determine whether candidates are minimally competent to deliver safe patient care. Relatively lower importance ratings given to certain competencies unrelated to patient care or to the Dental Hygiene Examination should not be construed as lessening their value as goals in the education of dental hygienists since the purpose and goals of dental hygiene education are broader than the specific purpose of the Dental Hygiene Examination.

One question that surfaces when using Likert-type rating scales relates to the number of levels of the scale. In the case of this practice analysis survey, the question arises as to whether the 5-point Likert scale was appropriate. If the preliminary analysis suggests that one or more levels of the scale are not functioning, then it is important to collapse the scale and

recode the data accordingly before proceeding to further analyses. Such an approach does not require the survey to be re-administered with fewer scale points. Figure 2 indicates that all 5 levels of the rating scale are functioning, even though level 4 is weak in the sense that participants seem to have some difficulty differentiating between level 3 and 4 and between 4 and 5. Despite this apparent lack of clarity among some levels of the scale, level 4 is functional, and its elimination before further analysis is not necessary or even desirable.

One of the features of the Rasch modeling of rating scale data is that the agreeability of the raters in endorsing competencies as important is shown on the same scale of measurement as the endorsability of competencies as important. Figure 3 shows that rater agreeability, ie, level of concern for patient care issues as articulated by this sample of dental hygienists through their assigned importance ratings, is not uniformly dispersed across the endorsability of this set of competencies. As shown, the mean rating for the participants is higher than the mean rating for the competencies, and the tail of the dental Hygienists' configuration of ratings extends beyond the competencies considered more critical. This implies that the participating dental hygienists considered these competencies to have included the important patient care issues of the day. This finding supports the proposition that the set of competencies originally developed by the Committee on Dental Hygiene describes a comprehensive range of competencies important to the novice dental hygienist and further supports the use of the 56 competencies in this practice analysis.

Following the application of the correction factor to the Rasch rating scale calibrations, the expert panel met to determine the theoretical and applied knowledge necessary to support the fulfillment of the competencies. Essentially, the panel members assigned the items devoted to each competency to the existing supporting content elements. This process required the judgment of members of the expert panel since many competencies could be interpreted as multidisciplinary or interdisciplinary, covering more than a single content area. Overall, there were changes in approximately 20% of the content. This relatively significant percentage change in content can be largely attributable to the reorganization of content under a new area. As such, the change is descriptive of changes in organization in the specifications but is artificially high as a characterization of the addition of new content or the elimination of existing content elements.

While few, if any, of the competencies directly addressed the basic sciences, the panel observed that much of the content in the basic sciences is important for the successful acquisition of some of the competencies. In light of this, the number of items devoted to the "Scientific Basis of Dental Hygiene Practice" remained the same at 60 items. There were relatively insignificant changes in the number of items devoted to most of the subject matter areas, however.

The examination is focused on assessing theoretical and applied knowledge in the basic and dental hygiene clinical sciences. This knowledge tends to support the competencies in the Provision of Clinical Dental Hygiene Services, which is, in turn, supported by the results of the survey. Shifts in the number of items in the traditional content specifications as a function of the practice analysis represent trends that reflect the scope of the competencies and the judgments of the expert panelists. With 2 very noticeable exceptions, the Provision of Dental Hygiene Services remains largely unchanged. The most obvious exception is the introduction of the area of Professional Responsibilities. This new area was assigned 17 items distributed across the general area (1), Ethical principles, including informed consent (8), Regulatory compliance (3), and Patient and professional communication (5). This new category was also introduced into the case-dependent portion of the examination with 11 items. While this content is now localized under one category, professional responsibilities were included in the traditional content specification. The introduction of the category, the integration of items from other areas under this new category, and the overall expansion in the number of items reflect the increased emphasis assigned to this area as a function of 2 factors that include: 1) the number of competencies primarily in the area of Professionalism and 2) the importance ratings assigned by dental hygienists to the competencies related to professionalism and communication.

Another noteworthy change in the content specifications is also subsumed under the Provision of Clinical Dental Hygiene Services. This new category of "Dental Hygiene Treatment Strategies" is included under Planning/Managing Dental Hygiene Care. It consists of "Dental Hygiene Diagnosis" (1), "Treatment Plan" (2), and "Case Presentation" (1). This content directly supports several competencies.

With regard to "Community Health/Research Principles," there was a minor change in the number of items from 20 to 24, for the traditional content and the content under the practice analysis, respectively. The case-dependent portion of the examination remained at 150 items by design. Aside from the addition of 17 items grouped under Professional Responsibility, there were no significant changes to the content.

While the findings of the validity study are the basis for the content specifications, the Joint Commission continues to gather information from test constructors with regard to minor shifts in focus and changes in terminology. The Joint Commission through its Committee on Dental Hygiene evaluates this information and approves of viable changes on an annual basis.

Conclusion

The purpose of this validity study was to gather evidence in support of the use of scores achieved on the National Board Dental Hygiene Examination in the initial phase of the licensure process. The most robust and durable form of evidence is the demonstrated link between examination content and the competencies involved in the entry-level practice of dental hygiene. In general, the study findings indicate that the content specifications in effect prior to 2005 were valid. However, in using this alternative and independent methodology, the study findings demonstrate that an adjustment in approximately 20% of the content specifications resulted in the Dental Hygiene Examination more closely assessing the theoretical and applied knowledge that supports the competencies in accordance with their importance to patient care. Conversely, an agreement of 80% of the specifications from one method to the other is an indication that the traditional content was valid. This is especially true since a substantial part of the 20% is actually an estimate of the reorganization of content.

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Notes

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