



Technical Report

Assessment of Fundamental Knowledge -
2016

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Introduction

The purpose of this Technical Report is to demonstrate that the NDEB is adhering to the standards for high stakes testing organizations outlined in the *Standards for Educational and Psychological Testing*.

Organizations, such as the NDEB, who administer high-stakes examinations, must be concerned with reliability and validity because these measures are required in making pass/fail decisions affecting candidates for licensure or certification. Fairness to examinees and protection of the public are the foremost concerns for the NDEB and the NDEB has an obligation to inform the Provincial Dental Regulatory Authorities (DRAs) that it is providing the highest quality examination program possible.

This Technical Report is a summary of the processes followed by the NDEB to develop, administer, and score the Assessment of Fundamental Knowledge administered in 2016 in compliance with widely accepted testing standards, and to provide a summary of the information needed to support the validity and reliability of the assessment. For additional detailed information, key references are included in Appendix C.

The processes described in this report may differ from those used in other years.

Part A - Background and Overview

History

In 1906, under the auspices of The Canadian Dental Association (CDA), the Dominion Dental Council was formed to conduct national written examinations, the successful completion of which would grant a candidate a Dominion Dental Council certificate. This certificate could then be presented to the Provincial Dental Regulatory Authorities (DRAs) as evidence of the candidate's ability to meet a basic national standard of competence. Some DRAs were prepared to grant licenses to practice on the basis of the certificate; however, others chose to accept the certificate as an academic base only and required the candidate to pass additional provincial practical tests.

The Dominion Dental Council proved to be ineffective. A name change to The Dental Council of Canada in 1950 along with attempts to improve the efficiency of the examination mechanism still failed to attract strong support from the DRAs despite the fact that the DRAs agreed with the general concept. The DRAs wanted to be free of provincial licensing examinations provided a reliable national examination system could be established.

In 1951, the CDA encouraged the ten DRAs to develop a satisfactory plan for a National Examining Board. Its purpose was to provide a facility by which members of the profession could become eligible, on a national basis, to apply for practice privileges in the province of their choice. The result was the incorporation of The National Dental Examining Board of Canada (NDEB) in 1952 by an Act of Parliament of Canada. The Act was supported by all ten DRAs and by the CDA: this support continues today.

Purpose

The NDEB was established by an Act of Parliament in 1952 (Appendix A) with a mandate to establish the qualifying conditions for a national standard of competence for general dentists and to issue certificates to dentists who successfully meet this standard. The Act was supported by all ten provincial regulatory authorities and by the Canadian Dental Association (CDA). Since that time, provincial regulatory authorities have accepted the NDEB certificate as evidence of having met the national standard.

Structure

The NDEB comprises twelve members. Each DRA appoints one member, and two members are appointed by the Commission on Dental Accreditation of Canada (CDAC). In 1994, the Board designated representatives from the Royal College of Dentists of Canada (RCDC) and the CDA. In 2004, the Board designated a representative from the Canadian Dental Regulatory Authorities Federation (CDRAF) as an official observer and appointed a Public Representative. The full Board meets twice a year. The NDEB also has standing committees that deal with examinations, appeals, finances, nominations, research and

By-Laws. The NDEB is a non-profit organization supported by fees charged to candidates and participants.

Certification

Eligibility

The NDEB grants certification to candidates who have successfully completed the Certification Process. The NDEB's By-Laws define a candidate as follows:

- A. a person who is a graduate of an Accredited Program and not more than 60 months has elapsed since the date of graduation;
- B. a person who is a graduate of a Non-Accredited Program and who has successfully completed a Qualifying Program and not more than 60 months has elapsed since the date of such successful completion of a Qualifying Program;
- C. a person who is a graduate of a Non-Accredited Program and who has successfully completed the Board Equivalency Process and not more than 60 months has elapsed since the date of such successful completion of the Board Equivalency Process;
- D. a person who has failed either the Written Examination or OSCE three times and has successfully completed the requirements described in By-law 15.02; or
- E. a person, for the purpose of taking the Written Examination and OSCE who is within three months of his or her expected graduation from an Accredited Program, or a Qualifying Program.

No other individual may take the certification examinations.

Graduates of Accredited Dental Programs

Prior to 1971, a graduate of an undergraduate dental program in Canada was required to successfully complete the NDEB Written Examination consisting of constructed-response questions in order to be certified. This policy was changed in 1971, when the NDEB decided to recognize the examinations and evaluation administered by Canadian Faculties of Dentistry and issue certificates to current graduates of these faculties without further examination. The condition for certification established at this time was graduation from an undergraduate dental program approved by the CDAC.

In 1988, concern was expressed by several DRAs about the validity of establishing candidate's clinical competence on the basis of dental program accreditation. This concern intensified by the extension of the dental program accreditation cycle from five to seven years. Therefore, in 1989, the NDEB established a committee "to explore whether the granting of a certificate on the basis of accreditation alone continues to be acceptable." This committee (Certification Review Committee or CRC) presented its report at the 1990 NDEB Annual Meeting. The report stated that candidate's certification based on dental program

accreditation alone was no longer acceptable, a finding that was further supported in the Parker Report (Parker, 1990).

In 1994, the NDEB modified the certification process so that graduates of accredited Canadian dental programs were required to pass the Written Examination and the OSCE.

Over time, formal reciprocal agreements between accrediting organizations have been established resulting in graduates from accredited dental programs in the U.S., Ireland, Australia and New Zealand being considered “accredited graduates”. To be certified, these graduates must pass the Written Examination and the OSCE within a specified period.

The NDEB, through its representatives on the CDAC and through an appointee on each undergraduate program survey team, actively participates in the accreditation process. In addition, the NDEB gives an annual grant to the CDAC to be applied to accreditation costs of undergraduate dental programs in Canada, the U.S., Australia, New Zealand, and Ireland.

Graduates of Non-Accredited Dental Programs

Until December 31, 1999, graduates of non-accredited dental programs were certified by passing a series of examinations that consisted of the Written Examination and a three-part Clinical Examination, or by successfully completing an accredited Qualifying or Degree Completion Program at an accredited university and then successfully completing the Written Examination and the OSCE.

Starting January 1, 2000, graduates of non-accredited dental programs were required to successfully complete a Qualifying or Degree Completion Program prior to being eligible for the Certification Process.

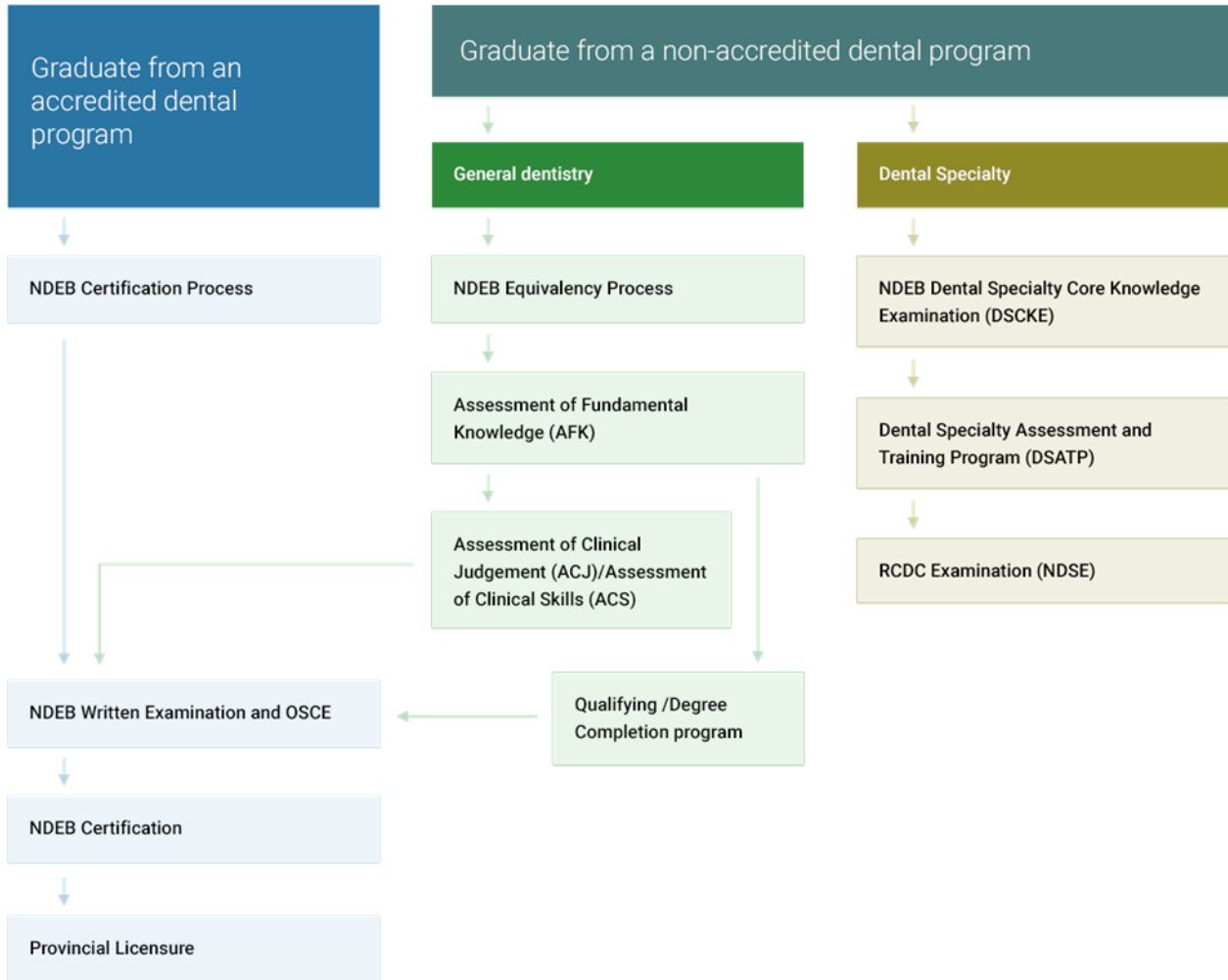
With the adoption of the Agreement on Internal Trade in 2009, all professions and trades essentially have labour mobility (portability) in Canada. In dentistry, after numerous meetings, and intense and lengthy negotiations, the CDRAF unanimously requested that the NDEB implement a new process based on the previous Ordre des dentistes du Québec (ODQ) Equivalency Process. The new process was to be integrated with the admission process for Qualifying/Degree Completion Programs. The NDEB Equivalency Process was implemented in 2011.

Conditions for Receiving a Certificate

Successful completion of NDEB’s Written Examination and OSCE is one of the conditions for receiving a licence to practice dentistry in Canada. A candidate, as defined under NDEB’s published By-Laws (NDEB, 2016), is granted a certificate upon presentation of the following documentation:

- evidence of graduation from an Accredited Program or successful completion of a Qualifying Program or NDEB Equivalency Process, and
- evidence that the candidate has passed the Written Examination and OSCE.

The following diagram illustrates the pathways to obtaining NDEB certification and licensure as a dentist in Canada.



Competencies for a Beginning Dental Practitioner in Canada

In 1993, the NDEB, in cooperation with the Association of Canadian Faculties of Dentistry (ACFD), CDA and CDAC, conducted a process to establish "Competencies for the Beginning Dental Practitioner in Canada". These competencies, which were the first nationally accepted competencies, were used to establish examination blueprints, guide educational programs, and were included in accreditation requirements. They have also been used as a resource for many national and international processes in dentistry and in other professions.

In 2004, the NDEB initiated a review process that resulted in the revision of the competency document (Appendix B). The competency document was developed through wide-ranging consultation and validated by a demographically representative sample of over 730 dentists from across Canada. This document, which has been accepted by the NDEB, ACFD, CDA and CDAC, is used in the establishment of blueprints for all the NDEB examinations and assessments. The competency and blueprint development process has been published in a peer-reviewed journal and validated by external experts (Gerrow, Murphy & Boyd, 2007).

The validation survey involved asking dentists to rate the importance of each competency on a 5-point scale. These ratings were then used during a workshop to finalize the competency profile and develop the examination blueprint. The examination blueprint contains weightings for the various competency areas of the examination or assessment. The examination blueprint forms part of a more comprehensive document called the Protocol that includes additional information such as the format of the examination and administration processes.

The competencies for examinations and assessments and the accompanying blueprints are currently being revised and re-validated in order to account for changes in the practice of dentistry and the evolution of the profession in Canada (NDEB, 2005). The revised competencies and blueprint will be implemented following an appropriate transition and communication plan with all stakeholders, including examinees.

Languages

All examinations and assessments are administered in English and French. This includes all forms and preparation materials. The NDEB website is also bilingual. The ability to communicate in English or French is an occupational requirement to support safe and effective practice; therefore, the examinations and assessments are not available in any other language. In addition, testing accommodations are not granted to examinees based on English or French language fluency.

Assistance to Other Organizations

The NDEB provides consultation and existing examination-related material to the DRAs on request. Beginning in 1998, at the request of the DRAs, the NDEB assisted the ACFD in the administration of the Eligibility Examination, which was an admission requirement for Qualifying/Degree Completion Programs. In 2001, formal agreements between the NDEB and the ACFD were signed. These agreements related to the administration of the Eligibility Examination and to administrative services provided by the NDEB for the ACFD. With the implementation of the NDEB Equivalency Process, the last Eligibility Examination was administered in February 2010. In October 2014, the NDEB signed a collaborative agreement with the Dental Council-New Zealand whereby the Dental Council-New Zealand recognizes the results of the NDEB Equivalency Process for registration as a general dentist in New Zealand. Prior to signing this agreement, the Dental Council-New Zealand considered multiple options during the due diligence process (Dental Council-New Zealand, 2014). The NDEB also provides examination services on request to the DRAs, Canadian Faculties of Dentistry and has formal agreements for provision of services with the Ordre des dentistes du Québec.

Summary

Each year, the NDEB assesses its certification, examination, and assessment procedures and the responses of the candidates and participants, making adjustments where indicated to improve the validity and reliability of examinations and assessments. The Examinations Committee annually reviews the standards and procedures of the respective examinations and assessments and makes recommendations to the Board. The Board reviews these recommendations and ensures they align with the current NDEB strategic plan.

In addition to this ongoing internal review, the NDEB has initiated several external evaluation procedures over the years. These are described in Appendix D.

Examinations and Assessments

This section of the Technical Report outlines the full examination and assessment processes in order to demonstrate all of the aspects needed to obtain an NDEB certificate.

Current Examinations for Graduates of Accredited Programs

Written Examination

The purpose of the Written Examination is to assess those aspects of the Competencies for a Beginning Dental Practitioner in Canada that can be evaluated through multiple-choice formats. The content categories that form the blueprint for the Written Examination are based on the 47 competencies. The Written Examination assesses the following constructs: basic science knowledge and applied clinical science knowledge and judgement including diagnosis, treatment planning, prognosis, treatment methods, and clinical decision making.

The Written Examination consists of two books, each with 150 single answer multiple-choice questions. Each book is given in a 2.5 hour (150-minute) examination session. The sessions are held in the morning and afternoon of one day at established examination centres. Generally, candidates complete the Written Examination with time remaining. Consequently, there is no evidence that the Written Examination is a speeded test.

The NDEB website displays the examination blueprint, a list of reference texts commonly used in Canadian dental programs, and all necessary logistical details. Approximately 3,500 questions, including many used on past examinations are also available on the NDEB website (www.ndeb-bned.ca). These released questions are updated annually.

Objective Structured Clinical Examination (OSCE)

The OSCE is a one-day station-type examination administered the day after the Written Examination. It is designed to test aspects of clinical judgement. OSCE stations generally have two questions, and require the candidate to review the information supplied (e.g. patient history, photographs, radiographic images, casts, models) and answer multiple response type questions. Each question has up to 15 answer options and one or more correct answer(s). Some stations may require the candidate to review the information supplied and write an acceptable prescription for a medication commonly prescribed by general dentists in Canada. Candidates have five minutes at each station to answer the questions. After five minutes, the candidates move to the next station.

Current Assessments for Graduates of Non-Accredited Programs (NDEB Equivalency Process)

Graduates of non-accredited dental programs are required to complete the NDEB Equivalency Process or a two-year Degree Completion Program prior to being eligible to participate in the Certification Process.

Self-Assessment

Prior to applying for the Equivalency Process, individuals are advised to go on the NDEB website and complete a 100-item self-assessment. Guidance is provided to individuals based on their self-assessment results.

Credential Verification

The NDEB performs an in depth credential verification procedure for each individual applicant prior to approving the applicant as a participant in the NDEB Equivalency Process.

Assessment of Fundamental Knowledge (AFK)

The AFK consists of two books, each with 150 multiple-choice questions. Each book is given in a three-hour session. The sessions are held in the morning and afternoon of one day.

The AFK tests biomedical science knowledge and applied clinical science knowledge. Prior to the assessment, participants are advised to go on the NDEB website to look at the blueprint and a list of reference texts commonly used in Canadian dental programs along with all necessary logistical details.

Assessment of Clinical Skills (ACS)

During the two-day ACS, participants perform simulated dental procedures on manikins in a clinical setting.

Each day participants receive:

- a typodont mounted in a manikin on a dental chair.
- a detailed list of requirements specifying tooth numbers and surfaces.

Participants are required to perform 12 requirements over the two days. Calibrated Examiners evaluate the requirements anonymously.

Assessment of Clinical Judgement (ACJ)

The ACJ consists of three books given in a single day.

Books 1A and 1B - Diagnosis, Treatment Planning and Clinical Decision Making

These components contain single and multi-answer multiple choice questions, and evaluate the participant's ability to formulate a diagnosis and to make clinical decisions. Patient histories, dental charts, and photographs may be provided for patients of all ages, including those with special needs.

Book 2 - Radiographic Interpretation

This component contains multi answer multiple choice questions and evaluates the participant's knowledge in oral radiology and ability to make a radiographic interpretation and diagnosis using radiographic images.

Part B - Test Construction Process and Validity Procedure

Examinations Committee

The Examinations Committee of the Board consists of nine members appointed by the Board. One of these members may be the Public Representative. No more than two persons can be recommended to be members by each of the Ordre des dentistes du Québec and the ACFD. Staff support for the Committee includes the Executive Director, Director of Examinations, In House Legal Counsel, the Operational Managers, and the Chief Examiners for all assessments and examinations (for more information, please refer to NDEB's By-Laws (NDEB, 2015)).

Examinations Committee members must abide by a terms of reference document that forms part of the NDEB By-Laws (NDEB, 2015). According to the terms of reference, the Examinations Committee members must be elected by the NDEB Board. Term limits and other administrative processes are also outlined in the terms of reference.

The Examinations Committee ensures the examinations and assessments are conducted in a fair and equitable manner for all concerned. Each year, the Examinations Committee of the Board shall:

- Review the standards and procedures of all examinations and assessments and make recommendations to the Board on all matters concerning the examinations and assessments.
- Review the passing standard for each examination and assessment, and make a recommendation to the Board.
- Review a roster of possible Examiners suggested by representatives of accredited programs located in Canada and by the Provincial Dental Regulatory Authorities, the Canadian Forces Dental Services and the Dental Council of New Zealand. The Committee shall recommend a list of Examiners to permit the Board to appoint a sufficient number of Examiners to develop, construct, validate, administer and evaluate all of the examinations and assessments offered to candidates and participants by the Board.
- Recommend to the Board, Chief Examiners for each of the Board's examinations and assessments.
- Review the protocols for each of the Board's examinations and assessments, and submit the protocols to the Board for approval.
- Make decisions regarding voiding the results of a person's examination or assessment, and whether the person has the privilege of repeating the examination or assessment.

Suggestions for changes to the protocols are initiated by staff and the Chief Examiners. The NDEB Examinations Committee may also recommend to the Board future changes to the structure or format of the examinations and assessments.

Individuals recommended for appointment as Examiners by the DRAs, the Deans and Directors of the dental programs in Canada, and the Canadian Forces Dental Services are reviewed by the Examinations Committee and nominations are forwarded to the Board for appointment. This appointment process ensures that Examiners represent various areas of practice and come from across Canada.

On recommendation of the Examinations Committee, the Board appoints consultants who are recognized for their expertise and/or experience in examination and assessment development.

The results of the examinations and assessments are reported to the Examinations Committee so it can ensure consistency of the examinations and assessments over each administration. This is to ensure that the performance required to meet the standardized passing score is the same for each version and that participants and candidates results from different versions are comparable.

Examination and assessment integrity is maintained by the Committee through the review of summaries of reports from Test Administrators, Presiding Examiners and Assessment Supervisors on irregularities identified during an administration. If an examinee is reported to have compromised the process by cheating or violating the regulations, the Committee has the authority to void the results of that candidate's or participant's examination and to prohibit the examinee from taking the examination/assessment in the future.

Staff Support

The Director of Examinations, who reports to the Executive Director and Registrar, is responsible for staff supervision and the implementation of all policies approved by the Board to ensure the process operates efficiently and effectively.

The Chief Examiner is responsible for the development of the examination or assessment including coordination of question development, question selection, monitoring the item bank and results within the guidelines and parameters established by the NDEB as stipulated in the protocol (NDEB, 2016).

The Examinations and Assessments Managers, in consultation with the Director of Examinations, prepare and administer the examinations/assessments and manage the operational delivery, including arrangements with staff, preparing protocols and instructions for Test Administrators, correspondence with Examiners, production and translation of the examinations/assessments, and the maintenance of the question bank. The Managers are supported by coordinators and an assistant.

The Manager-Credential Verification and Program Services (CVPS) makes arrangements with hosting institutions and with specific individuals who are trained to administer the examinations/assessments at test centres. These arrangements are made annually.

All staff is responsible for carrying out directives from the Examinations Committee as approved by the Board.

Item Development and Selection

The examination/assessment development process follows the NDEB's development plan that is contained in the Examiners Manual (NDEB, 2016), and contains high level information on the processes used to support the creation of defensible examination content. Specific elements of that plan are detailed below.

Examiners who are dental specialists/content experts at Canadian Faculties of Dentistry are sent copies of the Examiner's Manual (NDEB, 2016) and other preparatory material for review prior to a question development workshop. During the workshop, Examiners are trained in question construction, then construct, and criticize potential new items in their discipline. Examiners are directed to write items that assess higher cognitive processes such as application and problem solving, and are further instructed to avoid recall questions whenever possible. Examiners are also asked to avoid trivial questions. New items are reviewed and revised by a group of subject matter experts prior to being eligible for use on an examination/assessment. In addition, all new items are reviewed and, if required, edited by the Chief Examiner and senior staff.

Examiners who are practicing general dentists recommended by the Provincial Dental Regulatory Authorities select all of the items for every examination/assessment in accordance with a blueprint. The results of past item analyses are used as a guide in the item selection process. Items are selected based on a number of criteria including consistency with the blueprint, taxonomy of cognitive levels, the need for anchor items and statistical properties of the items. NDEB staff members build a draft version of the examination/assessment.

The NDEB collects and retains information on Examiners involved in the development and approval of the examination/assessment, including demographic characteristics and practice areas.

Item Review, Verification and Translation

After items have been selected and a draft examination/assessment form is built, the items are reviewed and translated using a multi-stage process.

This first draft is reviewed and validated by groups of trained Examiners who verify the technical accuracy of the items. They may also consult with additional subject matter experts when required. This includes identifying item enemies, and verifying the representativeness of the content domain and the significance of the content being tested (NDEB, 2010). During this review, questions are subjected to intensive review to verify the wording and the correct answer. Should a question need to be reworded, it is either revised for the examination or replaced. The review focuses on three things. First, the technical content of the question is verified to ensure that it is consistent with best practices and supported by the literature. Second, a sensitivity review is done to ensure that the question content is not offensive and does not discriminate against candidate subgroups. Third, a language review is done to ensure that the content does not exceed the language level needed to practice dentistry safely and effectively in Canada.

Items are then translated by dentists familiar with the vocabulary used on the examinations/assessments. The questions and the translations are then reviewed by a group including bilingual subject matter experts who are approved by the Ordre de dentistes du Québec (ODQ). In addition, the NDEB has developed a detailed glossary of translated terms (NDEB 2015b). This glossary is updated annually. This process ensures that examinees writing in either official language have an equal opportunity to demonstrate their competence. In some cases, the French translation may identify difficulties in the English version of the question and this will lead to a revision of the English wording.

Following the first review, NDEB staff members input required revisions and build a second draft examination/assessment. During a second review, trained Examiners including bilingual Examiners approved by the ODQ verify that all the changes have been made to the questions and that the French translation is accurate. NDEB staff members input the changes and produce revised copies of items so that all items are finalized during the review.

Following the second review, NDEB staff members produce the examination/assessment in the final format that will be used. During a final review, trained Examiners, including bilingual Examiners approved by the ODQ, verify that all questions are correct in both languages and that the formatting of the document is correct. NDEB staff members input the changes and produce revised copies so that the examination/assessment can be approved at the end of the review session.

Test Validity and Reliability

The primary purpose of establishing content validity of credentialing examinations is to show that the process underlying their development is a valid reflection of that part of professional competence that the examinations purport to assess. That is, construct validity is about the relationships between the construct of professional competence and examination. The examination and assessment content categories reflect both educational programs and the requirements of practice, and general practitioners select the content for the examinations and assessments. In addition, each form is built to match the blueprint approved annually by the Board and contained in the protocols.

In addition to the logical basis for asserting construct validity, the NDEB has carried out several studies, both internal and published, that support validity claims (Appendix D).

Test reliability refers to the degree to which examination/assessment scores for a group of examinees are consistent over repeated administration of the test, and are therefore considered to be dependable and consistent for an individual examinee. Reliability is estimated using a reliability coefficient, which is a unit-free indicator that reflects the degree to which scores are free of random measurement error. Based on the data provided in the results section of this Technical Manual, the NDEB examinations and assessments display evidence of continued strong reliability.

Documentation

Evidence of test validity is collected through multiple means, one of which is the documentation of development and administration procedures. The NDEB makes these documents publicly available. Only confidential material or material that could jeopardize the integrity of the examination/assessment is retained internally. These documents are also updated frequently (generally on an annual basis) to reflect the most recent information. References for these documents can be found in Appendix C. In order to support the various sources of validity evidence, NDEB produces the following documents:

NDEB By-Laws (NDEB, 2016)

The NDEB By-laws contain a number of sections related to the NDEB's examination and assessment programs. Examples of relevant information include:

- Certification eligibility
- The Board's certification and equivalency processes
- Examinations and assessments
- Conduct and appeals policies
- Terms of Reference for various examination-related committees

The By-Laws are available free of charge on NDEB's website (www.ndeb-bned.ca).

Competencies for a Beginning Dental Practitioner in Canada (NDEB, 2005)

This document outlines the body of knowledge that is assessed by the NDEB's examinations and assessments. A clearly outlined body of knowledge is key to establishing the content validity of examinations and assessments by providing a link between practice and the examination. This document is available in English and French on NDEB's website (www.ndeb-bned.ca).

Assessment of Fundamental Knowledge Protocol (NDEB, 2016)

Updated annually, the Assessment of Fundamental Knowledge (AFK) Protocol contains all of the information the participant needs in order to prepare to write the AFK. In addition to providing logistical information for the participant, this document is also meant to reduce construct irrelevant variance related to testing. The document details the purpose and intended use of the assessment. Participants acquire advance information on assessment content, instructions and other procedures. At a high level, the AFK Protocol contains the following information:

- Content and format
- Schedule
- Validation of registration
- Instructions
- Sample questions
- Reference texts
- Examination regulations
- Passing standard
- Results
- Appeals and rescores
- Repeats

This document is available in English and French free of charge on NDEB's website (www.ndeb-bned.ca) and is posted in every participant's online profile once the participant has registered for the AFK.

Examiner's Manual Written and AFK (NDEB 2016)

Reviewed and updated annually, the Examiner's Manual for the Written and AFK is an internal document provided to examiners and outlines the question writing philosophy and guidelines for question format and style.

Instructions and Regulations for Test Administrators – Assessment of Fundamental Knowledge (NDEB, 2016)

The purpose of this document is to describe, in detail, the procedures to follow before, during and after the administration of the AFK. This document ensures that participants have a similar experience when completing the assessment, regardless of where they write. The document also enhances security by providing a detailed quality assurance protocol. Participants are also reminded on numerous occasions

that having someone else take the assessment for them, disclosure of confidential examination material, or engagement in any other form of cheating is unacceptable and that such behavior may result in sanctions. This document contains:

- Instructions prior to the assessment
- Instructions for assessment day (which includes verbal participant instructions)
- Procedures to follow during the writing of the assessment
- Procedures to follow at the end of the assessment
- Instructions following the assessment

Examination/Assessment Production and Security

Following the final review, NDEB staff members produce four versions of the examination/assessment using an automated process that produces a random pattern of questions in each of the four versions. These books contain identical items but are presented in a different order to limit potential cheating. The Chief Examiner, and a bilingual Examiner approved by the ODQ, review each version to ensure that the format and numbering of questions and distractors in each version is correct. The Chief Examiner and a bilingual Examiner approve the final versions by initialing each page of each version.

Prior to printing, the appropriate cover page and instruction pages are added to the documents. All printing is done on site. Documents that have been finalized are saved as .PDF files in a specific directory. The originals of the finalized documents, which include examiner initials, are copied on a specific on-site printer. After printing the batches of books, a random check of documents is performed by two staff members in order to verify that no errors have been made during the printing process.

Computer generated labels indicating names, NDEB identification numbers, and assigned seat numbers are affixed to the front of each book.

Testing Accommodations

In the case of testing accommodations approved by the NDEB pursuant to its published By-Laws (NDEB, 2016) and procedures, test forms or administration conditions may be modified in order to accommodate examinees requiring testing accommodations. The purpose of testing accommodations is to remove construct-irrelevant barriers that would interfere with an examinee's ability to demonstrate their competence. Accommodations may be provided for a disability, medical condition or religious reason. Examinees must submit a written request prior to the registration deadline and are required to provide supporting documentation. Accommodations may include an alternate writing date, separate examination room, large print booklets, special coloured paper or longer examination times. The number of requests for these types of accommodations is small, and as such, the NDEB is unable to establish the validity of these modified examination forms for this specific population. Testing accommodations represent the only allowable variations in administration conditions, and these variations are documented in detail. In recent years, the number of examination accommodations has been increasing, and most accommodations involve no modifications to examination materials.

Pilot Testing

As part of an additional quality control step, the NDEB embeds new questions into examinations/assessments as pilot test items. These items are new and have not been properly evaluated by the examinee population. Pilot items that perform well from a statistical perspective count toward the examinee's score, while those items that do not perform well are not counted. Items are generally voided for the following reasons:

- The item difficulty index is very low, indicating that on average, candidates were unable to respond to the question or that the question was written unclearly.
- The item has negative item discrimination indicating that poorly-performing candidates responded correctly to the item more frequently than highly-performing candidates.
- The analysis of response patterns for the distractors provides strong evidence that the item is unclear or ambiguous.

In addition, item statistics are used to improve items for future use. Due to the NDEB's pilot testing methodology, items are exposed to a live candidate population, which includes all relevant subgroups.

Locations and Procedures

The AFK and ACJ are administered two times a year as established by Board policy. Each assessment is administered over the course of one day. All assessments are written in a distraction-free and comfortable environment where participants are optimally able to demonstrate their competence on the assessments.

The assessments are held at centres across the country, as well as in various centres outside of Canada provided a minimum number of registrations are received.

The NDEB tries to accommodate location preferences but may have to offer alternative locations due to space limitation at some assessment sites. In these cases, participants are assigned to the centre closest to their location.

The NDEB provides Test administrators and invigilators with extensive documentation on policies and procedures related to the assessment day (NDEB, 2016). This ensures that in all cases, –the same administration procedures are used for all participants regardless of location.

At the start of the assessment, the Test Administrator or a designated invigilator reads participants a series of standardized instructions. These instructions include regulations and time limits. The instructions are consistent across all testing centres. Participants are also provided with a confidentiality statement for signature, written instructions and detailed directions on how to complete their paper-based answer sheet. This ensures that participants can complete the test in the manner that the NDEB intended and allows participants the opportunity to optimally demonstrate their competence.

On-site Security

The Test Administrator at each location is responsible for reserving rooms appropriate for the AFK and ACJ, and for hiring and training invigilators (NDEB, 2016). The Test Administrator stores all examination material in a secure, locked area. After the completion of the assessments, all materials are returned to the NDEB office by courier. NDEB staff verifies the return of all materials including individually labeled books, identification cards, and, answer score sheets. These security measures help maintain the integrity of the assessments by limiting exposure to assessment items before and after the administration of the assessments.

Preparation Materials

Participants have access to the AFK and ACJ Protocols (NDEB, 2016) on the NDEB's website and through the NDEB's online portal. The Protocols contains such things as the content and format of the assessment, instructions, sample questions and assessment regulations. Through the NDEB website, participants can access released questions, a list of textbook commonly used in Canadian faculties of dentistry, and detailed instructions on how to formally request testing accommodations.

Scoring

Each of the three hundred multiple-choice items is scored as correct (1) or incorrect (0). All answer sheets are scored centrally at NDEB offices using a scanning program. A number of quality assurance steps are taken to ensure that the scoring is done accurately. For example, high and low scores are manually verified to ensure accuracy. In addition, a sample of answer sheets is also selected for manual verification. Questions that are flagged as not answered by an examinee are reviewed manually if there are more than two occurrences per book. All these processes are contained in a detailed procedures manual (NDEB, 2010). Item analyses are carried out to flag potentially problematic items. Flagged items are reviewed by experts, and if necessary, eliminated or rekeyed. A raw examination score is then re-calculated for each examinee.

Standards for Pass/Fail

It is the NDEB's statutory obligation to certify only those who are qualified to enter the dental profession in Canada. In the interest of public health, the NDEB establishes standards necessary to ensure competency.

Based on the recommendation of an expert committee, in January 2015, the NDEB introduced a standardized passing score of 75 for all of its examinations and assessments. This change brought the NDEB in line with international standards. The new passing score has no impact on the difficulty or reliability of the NDEB's examinations or assessments.

The AFK is scored on a percent correct. The equating and re-scaling process, including the norm population, is further described in Maguire (2004). A full description of the equating procedure, described in Maguire (2004), is provided in Appendix F.

In addition to the passing score, scores are also re-scaled using the procedure described in detail in Maguire (2004). In order to ensure fairness, a number of data quality assurance steps are taken to ensure that the equating and re-scaling is done in a fair manner while respecting the statistical assumptions that underlie these mathematical procedures.

Review Procedures and Policy Following the Statistical Analysis of NDEB Examinations and Assessments

After verification and scanning of answer score sheets and reviewing any procedural abnormalities, an initial statistical analysis is performed. Reports generated from the initial statistical analysis are provided to the Chief Examiner and other attendees at a post administration review workshop. During this workshop, the following reports are reviewed:

- Candidate Performance by Exam Summary
- Question Performance by Exam Summary
- Exam Performance Detail
- Question Performance – Top/Low/Biserial Distribution (Condensed) (required for examinations/assessments which include multi-answer test items)

During the review, the correctness of all answer keys is verified and non-performing or compromised items are eliminated from the examination/assessment. A final statistical analysis is then performed and results calculated with those items removed.

Review

- After each administration, using information provided in the Question Performance by Exam Summary report, questions identified by a colour prompt are printed for in-depth review.
- Colour highlights within the report are triggered by the following criteria:

- Difficulty: Less than .3
- Biserial: Less than .05 (unless the Difficulty is greater than .95)
- a Language Fairness Assessment
- Chief Examiners review the identified questions to:
 - confirm the accuracy of the answer key to identify potential ambiguities, including the possibility of multiple correct answers,
 - potential “trick” items or unclear wording
 - identify a possible English – French translation issue
 - establish consistency between images and/or models
 - identify item decay as evidenced by an unusual increase in percent correct. If significant decay in a test item is noted, staff will conduct an internet search to ascertain whether the item has been released to the web in any form, or whether there is evidence of item reconstruction.
- Workshop attendees use their expert judgement to determine if:
 - A question will be voided (i.e. will no longer be used on examinations/assessments) if it is unclear, ambiguous, tricky or if it presents a translation issue.
 - a revision to the answer key is required

Excluding a Question from the Test Equating Process

A question will be excluded from the test-equating process if

- there is evidence of test reconstruction, coupled with significant decay.
- it is released between the date it was used in the reference examination/assessment and the date of the current examination/assessment.

The reason for excluding an item from the test equating process will be documented in writing and stored in the examination/assessment file.

Security Analysis

A test analysis program is applied to the item results of all examinees. Those with extreme values are flagged for attention. In rare cases, examinees are informed that results of the examination/assessment will be delayed pending a review.

Reporting

The results of the assessment are posted on a secure website within six weeks of the administration date. Participants access their results by logging in to their online profile. When results are posted, participants receive an email notification. If there is an anticipated delay in the release of results, participants are notified by email. Participants are informed if they have passed or failed the assessment. Successful participants are given a pass result. Failing participants receive their test equated, re-scaled score on the failed assessment and the pass mark for the assessment. This allows participants to determine how close they were to passing. They are also provided with instructions on how to appeal their score.

Appeals

Within three months of the release of results, examinees who have failed may apply to the Board to have their answer score sheets manually rescored. Two NDEB Staff members perform a manual rescore by comparing the answers on the answer score sheet with the master score sheet. The Examinations/Assessments Manager then verifies the mark. The mark produced by the manual rescore will be the final mark.

Applications for manual rescoring must be accompanied by a filing fee.

Petitions

Within a specified timeframe, examinees may petition the Board or Executive Committee in writing, with an accompanying filing fee, regarding the following:

- Examination or assessment results have been voided
- Candidate has been denied the privilege of repeating an examination or assessment
- Compassionate grounds

Part C - Outcomes Summaries

This report provides summary information on the structure of the AFK, as well as statistical summaries at the item and test levels.

Table of Assessment Items by Category

Root Category	Feb2015	Aug2015	Feb2016	Aug2016
Dental				
Anatomy/Occlusion/Operative	37	35	36	35
Endodontics/Dental Emergencies	22	26	22	24
Foundation Science	67	80	66	74
Multi-Disciplinary		1		
Oral Medicine/Pathology/Oral Facial Pain	13	18	14	14
Oral Surgery/Trauma	15	17	15	19
Orthodontics/Pediatrics	35	35	35	34
Periodontics	16	18	15	18
Pharmacology/Therapeutics/Local Anesthesia	49	25	50	31
Prosthodontics/Implants	23	22	21	23
Miscellaneous**	19	17	19	16
Total Scored	296	294	293	288
Rejected	4	6	7	12
Total	300	300	300	300

**Miscellaneous: "Abuse and Neglect", "Anxious Patient", "Ethics and Jurisprudence", "Geriatrics", "Infection Control", "Informed Consent", "Occupational Hazards", "Prevention", "Radiology", "Records", "Relationship general/oral health", "Scientific Literature", "Special Needs"

AFK Reliability Statistics

	Attempt	AFKFeb2013	AFKFeb2014	AFKFeb2015	AFKAug2015	AFKFeb2016
Number of Candidates	1	753	872	484	421	387
	2	370	316	283	170	192
	3	64	89	80	60	73
	Total	1187	1277	847	651	652
Pass (#)	1	288	394	248	200	164
	2	177	167	141	70	100
	3	34	58	53	32	50
	Total	499	619	442	302	314
Pass (%)	1	38.2	45.2	51.2	47.5	42.4
	2	47.8	52.8	49.8	41.2	52.1
	3	53.1	65.2	66.3	53.3	68.5
	Overall	42.0	48.5	52.2	46.4	48.2
Passing Raw Score (%)		71.9	68.9	69.1	76.1	66.9
Mean Raw Score (%)		66.9	66.8	67.9	72.7	64.2
Range Rescaled	1	27 - 95	32 - 98	31 - 98	31 - 91	34 - 97
	2	34 - 93	37 - 93	37 - 93	33 - 90	38 - 90
	3	42 - 86	45 - 92	46 - 92	49 - 89	43 - 90
	Overall	27 - 95	32 - 98	31 - 98	31 - 91	34 - 97
Mean Rescaled Score		69.2	72.4	73.2	71.3	71.9
Cronbach's Alpha		0.96	0.96	0.96	0.97	0.96

Glossary

AADE	American Association of Dental Examinations
ACFD	Association of Canadian Faculties of Dentistry
ADA	American Dental Association
ADAC	American Dental Association Commission on Dental Accreditation
ADC	Australian Dental Council
AERA	American Educational Research Association
APA	American Psychological Association
CDA	Canadian Dental Association
CDAC	Commission on Dental Accreditation of Canada
CDRAF	Canadian Dental Regulatory Authorities Federation
DRA	Provincial Dental Regulatory Authorities
NCME	National Council on Measurement in Education
NDEB	National Dental Examining Board of Canada
ODQ	Ordre des dentistes du Québec
RCDC	Royal College of Dentists of Canada

Part D – Appendices

Appendix A – Summary of the Act relating to The National Dental Examining Board of Canada originally established in 1952 and revised in 1973.

Preamble to 1952 Act

Whereas the persons hereinafter named have by their petition prayed that it be enacted as hereinafter set forth and it is expedient to grant the prayer of the petition: Therefore Her Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows :

Preamble to 1973 Revision

Whereas The National Dental Examining Board of Canada, hereinafter called "the Board", has by its petition prayed that it be enacted as hereinafter set forth, and it is expedient to grant the prayer of the petition: Therefore Her Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:

1973 Section 1: Name in French

The Board may use, in the transaction of its business, either the name The National Dental Examining Board of Canada or the name Le Bureau national d'examen dentaire du Canada, or both of such names as and when it so elects. It may sue or be sued in either or both of such names, and any transaction, contract or obligation entered into or incurred by the Board in either or both of the said names shall be valid and binding on the Board.

1973 Section 2: Existing rights saved

Nothing contained in section 1 shall in any way alter or affect the rights or liabilities of the Board, except as therein expressly provided, or in any way affect any proceeding or judgment now pending, either by or in favour of or against the Board, which, notwithstanding the provisions of section 1, may be prosecuted, continued, completed and enforced as if this Act had not been passed.

Incorporation and Composition (in the 1952 Act)

1. Harold M. Cline, doctor of dental surgery, of the city of Vancouver in the province of British Columbia, Gustave Ratte, doctor of dental surgery, of the city of Quebec in the province of Quebec, and Don W. Gullett, doctor of dental surgery, of the city of Toronto, in the province of Ontario, together with such persons as may hereafter become members of the Board as

hereinafter provided, are incorporated under the name of "The National Dental Examining Board of Canada", hereinafter called "the Board".

2. The persons named in section one of this Act shall be provisional members of the Board with power to organize the Board as in this Act provided.
3. The head office of the Board shall be at the city of Toronto, in the province of Ontario, or at such other place as the Board may determine by by-law from time to time.
4. (1) The Board shall be composed of
 - a. one member appointed as its representative by the appropriate licensing body of each province in Canada;

and

- b. (b) two members appointed by the Council on Dental Education of the Canadian Dental Association.

(2) The term of office for each member of the Board shall be three years, except in respect of the members appointed to constitute the first Board.

(3) The term of office for one-half of the members of the first Board shall be two years and for the other one-half shall be four years; the members constituting each such one-half shall be chosen by lot in such manner as the Board may determine.

(4) A member of the Board on the expiration of his term of office, if properly qualified, shall be eligible for reappointment.

(5) If the appropriate licensing body of any province fails to appoint a member of the Board within a reasonable time a vacancy occurs, the Secretary of the Board shall notify such licensing body and require such licensing body to make such appointment and certify the result to the Board within one month of the date of service of the notice.

(6) All members of the Board shall continue in office until their successors are appointed or until expiration of their term of office if their successors are appointed before the expiration of such term of office.

5. (1) The appropriate licensing body of any province may at any time upon twelve month's notice to the Board, withdraw from participation in and recognition of the activities of the Board, and such licensing body shall not thereafter, so long as such withdrawal continues, be entitled to appoint any representative to the Board.

(2) The Board may upon the application of any licensing body which has so withdrawn, restore the participation and representation of such licensing body.

Purposes of the Board (revised by 1973 Act)

6. The purposes of the Board shall be
 - (a) to establish qualifying conditions for a single national standard certificate of qualification for general practitioner dentists;
 - (b) to establish qualifying conditions for national standard certificates of qualification for dental specialists subject to the approval of The Royal College of Dentists of Canada;
 - (c) to ensure that the rules and regulations governing examinations will be acceptable to all participating licensing bodies and provide for the conducting of examinations in a manner fair and equitable for all concerned; and
 - (d) to promote enactment, with the consent and at the instance of the provincial licensing bodies, of provincial legislation necessary or desirable to supplement the provisions of this Act."

Powers of the Board (revised by 1973 Act)

7. The Board shall have power to
 - (a) establish qualifications for general practitioner dentists to ensure that the qualifications may be recognized by the appropriate licensing bodies in all provinces of Canada;
 - (b) establish, subject to the approval of the Royal College of Dentists of Canada, qualifications for dental specialists, to ensure that, in each case the qualifications may be recognized by the appropriate licensing bodies in all provinces of Canada;
 - (c) establish the conditions under which a general practitioner dentist may obtain and hold a certificate of qualification;
 - (d) establish subject to the approval of The Royal College of Dentists of Canada, the conditions under which a dental specialist may obtain and hold a certificate of qualification;
 - (e) prescribe compulsory examinations as evidence of qualifications for registration, subject to the rights of The Royal College of Dentists of Canada as hereinafter set forth;
 - (f) establish and maintain a body of Examiners to hold examinations and to recommend the granting of certificates of qualification to general practitioner dentists;
 - (g) establish and maintain a body of Examiners appointed by The Royal College of Dentists of Canada to hold examinations and make recommendations concerning the granting of certificates of qualification of properly trained dental specialists;
 - (h) issue certificates of qualification to general practitioner dentists and dental specialists in accordance with the recommendation of the Examiners;
 - (i) establish a register for Canada of general practitioner dentists and dental specialists who have been granted certificates of qualification by the Board;

(j) delete from the register the name of any person whose provincial registration has been cancelled or suspended and to restore such name to the register if and when such cancellation or suspension is reversed, or the period of suspension is terminated; and (k) publish and revise the register from time to time."

Bylaws (1952 Act)

8. (1) The Board may make such By-Laws and regulations, not contrary to law or the provisions of this Act, as it may deem necessary or advisable for
 - (a) the government and management of its business and affairs;
 - (b) the selection and election or appointment and remuneration of officers and employees and prescription of their respective powers and duties;
 - (c) the imposition and collection of dues or fees; and
 - (d) the carrying into effect of the purposes of the Board and its powers under this Act.

- (2) The Board may, from time to time alter or repeal all or any of such By-Laws or regulations as it may see fit.

- (3) No such by-law or regulation shall be enacted, altered or repealed except with the concurrence of two-thirds of the representatives on the Board of the provincial licensing bodies then represented on the Board.

Property (1952 Act)

9. The Board may acquire, own, hold, deal with and dispose of, subject to the provisions of applicable provincial laws, any real and personal estate and property rights and privileges necessary or expedient for the purposes of the Board.

Ability to borrow money (1952 Act)

10. The Board shall have power to
 - (a) borrow money on the credit of the Board when required for the purposes of the Board and to give security for any sum or sums of money so borrowed;and
 - (b) draw, make, accept and endorse all bills of exchange and promissory notes necessary for the purposes of the Board under the hands of such officers as may be designated by the By-Laws and in no case shall it be necessary that the seal of the Board be affixed thereto nor shall the

signing officers be individually responsible therefore, provided that nothing herein shall be construed to authorize the Board to issue notes or bills of exchange payable to bearer or intended to be circulated as money or as notes or bills of a bank.

Certificate of Qualification for Specialists (revised 1973 Act)

"11. (1) The Board shall issue its certificate of qualification to all Fellows of The Royal College of Dentists of Canada who are dental specialists, and whose specialties are recognized by the Canadian Dental Association and who make application for such a certificate within five years from the date on which this Act comes into force.

(2) In the event of the dissolution of The Royal College of Dentists of Canada, all powers conferred upon it herein shall become vested in The National Dental Examining Board. Any reference in this Act to The Royal College of Dentists of Canada or The National Dental Examining Board shall include their successors or assigns."

Appendix B – Competencies for a Beginning Dental Practitioner in Canada

A competent beginning dental practitioner in Canada must be able to provide oral health care for the benefit of individual patients and communities in a culturally sensitive manner.

Competency assumes that all behaviours are supported by foundation knowledge and skills in biomedical, behavioural and clinical dental science and by professional behaviour. Beginning dental practitioners in Canada must be able to apply foundation knowledge and skills to justify their decisions and actions and to evaluate outcomes. Therefore, foundation knowledge, skills and professional behaviour are understood to be a part of every competency.

Competency also assumes that all behaviours are performed to an acceptable level and that the practitioner can evaluate their quality and effectiveness. Competency cannot be achieved without the ability to self-evaluate. Moreover, there are no degrees of competence: a dentist is either competent or not competent. The competencies below refer to general dental practice and include the management of patients of all ages including those with special needs. It is assumed that all oral health care is provided in an ethical manner, in accordance with legal requirements at the national and provincial level.

A beginning dental practitioner in Canada must be competent to:

1. recognize the determinants of oral health in individuals and populations and the role of dentists in health promotion, including the disadvantaged.
2. recognize the relationship between general health and oral health.
3. evaluate the scientific literature and justify management recommendations based on the level of evidence available.
4. communicate effectively with patients, parents or guardians, staff, peers, other health professionals and the public.
5. identify the patient's chief complaint/concern and obtain the associated history.
6. obtain and interpret a medical, dental and psychosocial history, including a review of systems as necessary, and evaluate physical or psychosocial conditions that may affect dental management.
7. maintain accurate and complete patient records in a confidential manner.
8. prevent the transmission of infectious diseases by following current infection control guidelines.
9. perform a clinical examination.
10. differentiate between normal and abnormal hard and soft tissues of the maxillofacial complex.
11. prescribe and obtain the required diagnostic tests, considering their risks and benefits.
12. perform a radiographic examination.
13. interpret the findings from a patient's history, clinical examination, radiographic examination and from other diagnostic tests and procedures.
14. recognize and manage the anxious or fearful dental patient.
15. recognize signs of abuse and/or neglect and make appropriate reports.
16. assess patient risk (including, but not limited to, diet and tobacco use) for oral disease or injuries.
17. develop a problem list and establish diagnoses.

18. determine the level of expertise required for treatment and formulate a written request for consultation and/or referral when appropriate.
19. develop treatment options based on the evaluation of all relevant data.
20. discuss the findings, diagnoses, etiology, risks, benefits and prognoses of the treatment options, with a view to patient participation in oral health management.
21. develop an appropriate comprehensive, prioritized and sequenced treatment plan.
22. present and discuss the sequence of treatment, estimated fees, payment arrangements, time requirements and the patient's responsibilities for treatment.
23. obtain informed consent including the patient's written acceptance of the treatment plan and any modifications.
24. modify the treatment plan as required during the course of treatment.
25. provide education regarding the risks and prevention of oral disease and injury to encourage the adoption of healthy behaviors.
26. provide therapies for the prevention of oral disease and injury.
27. recognize and institute procedures to minimize occupational hazards related to the practice of dentistry.
28. achieve local anesthesia for dental procedures and manage related complications.
29. determine the indications and contraindications for the use of drugs used in dental practice, their dosages and routes of administration and write prescriptions for drugs used in dentistry.
30. manage dental emergencies.
31. recognize and manage systemic emergencies which may occur in dental practice.
32. manage conditions and diseases of the periodontium, provide periodontal treatment when indicated and monitor treatment outcomes.
33. assess the risk, extent and activity of caries and recommend appropriate non-surgical and surgical therapy.
34. manage dental caries, tooth defects and esthetic problems and, when restoration is warranted, use techniques that conserve tooth structure and preserve pulp vitality to restore form and function.
35. manage patients with orofacial pain and/or dysfunction.
36. manage surgical procedures related to oral soft and hard tissues and their complications
37. manage trauma to the orofacial complex.
38. manage conditions and pathology of the pulp and provide endodontic treatment when indicated.
39. manage abnormalities of orofacial growth and development and treat minor orthodontic problems.
40. recognize and manage functional and non-functional occlusion.
41. select and, where indicated, prescribe appropriate biomaterials for patient treatment.
42. manage partially and completely edentulous patients with prosthodontic needs including the provision of fixed, removable and implant prostheses.
43. make records required for use in the laboratory fabrication of dental prostheses and appliances.
44. design a dental prosthesis or appliance, write a laboratory prescription and evaluate laboratory products.

45. apply accepted principles of ethics and jurisprudence to maintain standards and advance knowledge and skills.
46. apply basic principles of practice administration, financial and personnel management to a dental practice.
47. demonstrate professional behaviour that is ethical, supercedes self-interest, strives for excellence, is committed to continued professional development and is accountable to individual patients, society and the profession.

Definition

To “manage” the oral health care needs of a patient is assumed to include all actions performed by a health care provider that are designed to alter the course of a patient’s condition. Such actions may include providing education, advice, treatment by the dentist, treatment by the dentist after consultation with another health care professional, referral of a patient to another health care professional, monitoring treatment provided, but also may include providing no treatment or observation. “Manage” assumes the use of the least invasive therapy necessary to gain a successful outcome in accordance with patient wishes.

Appendix C – Key Supporting References

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Appendix D – External Evaluation Procedures

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Appendix F – Equating Procedure

Excerpts from Maguire (2004)

Each year, the National Dental Examining Board of Canada administers examinations to graduating students from Canadian Faculties of Dentistry. The results of the examinations are used as part of the credentialing process. In addition, the examination program plays a role in maintaining a national standard of competence for dentists entering practice in Canada. Consistent with the second purpose, it is of interest to trace the performance of candidate cohorts over successive years. Direct comparison of candidates' average performance in successive years could be made but if differences were observed, they could be due to differences in the candidates themselves, to differences between the two examinations (one may be more difficult than the other), or to a combination of both. The process of examination equating attempts to make the examination scores equivalent so that differences between equated scores can be attributed to the difference between cohorts of candidates. In effect, the equating process attempts to answer the question, how would candidates who wrote in 2013 have performed on the 2012 examination?

The equating procedure to be presented below is taken from Angoff (1971, pp579-583). It is based on an examination design in which instruments in successive years consist of two components: a common component (a set of items that appear in both years) and a unique component (sets of items that appear in one year, but not the other). Consider for example the examinations administered in 2012 (year 1) and 2013 (year 2). In 2012 a candidate's score can be thought of as:

$Y_1 = V_1 + U_1$ where V is the score on the common items and U is the score on the unique items. In 2013, a candidate's score would be:

$X_2 = V_2 + W_2$ where V is the score on the common items and W is the score on the unique items.

The goal of the equating process is to find a mathematical function that projects X onto Y or Y onto X . Unlike a regression equation, this function should yield consistent results regardless of the direction in which scores are to be equated, that is, projecting from 2012 to 2013 or from 2013 to 2012.

The general form of the equation for equating scores from 2013 to scores from 2012 is:

$$Y'_2 = bX_2 + a \quad (1)$$

or, if the direction were reversed, the equation would be:

$$X'_1 = \frac{1}{b}(Y_1 - a) \quad (2)$$

For simplicity, we will assume that 2012 will be treated as the base year, and we want to equate the 2012 score to it.

The details of the algebra can be found in Angoff's 1971 chapter, but essentially the functions are based on the supposition of a single combined sample of candidates, i.e. the 2012 group combined with the 2013 group. We will refer to this hypothetical sample as the 'total' group. There are two variables:

1. the scores on Y for all candidates (i.e. the scores on the 2012 examination).
2. the scores on X for all candidates (i.e. the scores on the 2013 examination).

Of course we only have Y scores for the 2012 candidates, and X scores for the 2013 candidates, but if all candidates had taken both examinations, the equating formula for mapping scores from 2013 to 2012 would be:

$$Y' = \frac{sd(X_T)}{sd(Y_T)} (X - mean(X_T) + mean(Y_T)) \quad (3)$$

where:

- $sd(Y_T)$ is the standard deviation of Y scores for the total sample,
- $sd(X_T)$ is the standard deviation of X scores for the total sample,
- $mean(Y_T)$ is the mean Y score for the total sample,
- $mean(X_T)$ is the mean X score for the total sample.

In terms of equation 1,

$$b = \frac{sd(X_T)}{sd(Y_T)} \quad \text{and} \quad a = mean(Y_T) - b(mean(X_T)) \quad (4)$$

The four values required for equation (3) are estimated using the common portions of the exams. The procedure, referred to in the literature as 'common item linear equating,' will be presented below. In this case the equating (common) portion of the examination forms part of the total score. The procedure is identical for situations in which the equating part of the examination is treated as a separate entity.

Equating Formulas – Common Item Equating

The actual procedure begins with the calculation of two scores in each of the two samples:

Y_1 = the score for 2001 candidates on the entire examination (300 items)

V_1 = the score for 2001 candidates on the common portion (110 items)

X_2 = the score for 2002 candidates on the entire examination (300 items)

V_2 = the score for 2002 candidates on the common portion (110 items).

To find the values needed for equation 3, four intermediate statistics must be estimated:

$$\text{var}(Y_T) = .5 \text{var}(Y_1) + .5 \text{var}(Y_2) + .25[\text{mean}(Y_1) - \text{mean}(Y_2)]^2 \quad (5)$$

$$\text{var}(X_T) = .5 \text{var}(X_1) + .5 \text{var}(X_2) + .25[\text{mean}(X_1) - \text{mean}(X_2)]^2 \quad (6)$$

$$\text{mean}(Y_T) = .5\text{mean}(Y_1) + .5(\text{mean}(Y_2)) \quad (7)$$

$$\text{mean}(X_T) = .5\text{mean}(X_1) + .5\text{mean}(X_2) \quad (8)$$

Four of the values that appear in equations 5 through 8 must be estimated under the assumption that the regression slopes of Y_1 on V_1 in Group 1 and X_2 on V_2 in Group 2 are the same. The four estimates are:

$$\text{var}(Y_2) = \text{var}(Y_1) - \left\{ \frac{\text{cov}(Y_1, V_1)}{\text{var}(V_1)} \right\}^2 [\text{var}(V_1) - \text{var}(V_2)] \quad (9)$$

$$\text{var}(X_1) = \text{var}(X_2) + \left\{ \frac{\text{cov}(X_2, V_2)}{\text{var}(V_2)} \right\}^2 [\text{var}(V_1) - \text{var}(V_2)] \quad (10)$$

$$\text{mean}(Y_2) = \text{mean}(Y_1) - \frac{\text{cov}(Y_1, V_1)}{\text{var}(V_1)} [\text{mean}(V_1) - \text{mean}(V_2)] \quad (11)$$

$$\text{mean}(X_1) = \text{mean}(X_2) + \frac{\text{cov}(X_2, V_2)}{\text{var}(V_2)} [\text{mean}(V_1) - \text{mean}(V_2)] \quad (12)$$

Calculation of the Equating Expressions:

Step 1. From the data, calculate the following values:

- (a) Group 1 (2012): means and standard deviations of Y and V, also the covariance between Y and V.
- (b) Group 2 (2013): Means and standard deviations of X and V, also the covariance between X and V.

Step 2. Substitute the values from Step 1 into equations (9) through (12).

Step 3. Substitute the values from Steps 1 and 2 into equations (5) through (8).

Step 4. Substitute the results of Step 3 into equations (3) and (4).

References

Angoff, W.H. (1971). Scales, norms, and equivalent scores. In R.L. Thorndike (Ed.), *Educational measurement* (2nd ed., 508-600). Washington DC: American Council on Education.

