Journal of Dental Sciences 21 (2026) 501–508

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Original Article

Development and validation of a checklist for evaluating root canal treatment performance in Taiwan

Tien-Hao Chang [a,b], Yong-Chen Huang [c], Shu-Hui Chang [d], Stanley Shih-Li Tsai [e,f], Yi-Ling Tsai [b,g*]

[a] *Department of Dentistry, China Medical University Hsinchu Hospital, Hsinchu, Taiwan*
[b] *School of Dentistry, National Taiwan University, Taipei, Taiwan*
[c] *Department of Statistics and Data Science, College of Science, National University of Singapore, Singapore*
[d] *Institute of Health Data Analytics and Statistics, College of Public Health, National Taiwan University, Taipei, Taiwan*
[e] *College of Medicine, National Taiwan University, Taipei, Taiwan*
[f] *Li Family Clinic, Taipei, Taiwan*
[g] *Department of Dentistry, National Taiwan University Hospital, Taipei, Taiwan*

Received 8 October 2025; Final revision received 28 October 2025
Available online 11 November 2025

KEYWORDS
Checklist;
Clinical competence;
Delphi method;
Endodontic education

Abstract *Background/purpose:* Over the past decade, numerous efforts have been made to develop guidelines for endodontic education; however, there has been no corresponding reform of the assessment scale. This study aimed to adopt an integrative approach to develop a checklist that summarizes the guidelines into key points for evaluating root canal treatment performance.

Materials and methods: We followed the modified Delphi method and employed a five-step process to develop the checklist. Eight experts were recruited to develop the checklist, each with at least 7 years of clinical dentistry experiences, including a minimum 5 years in endodontics, as well as at least 3 years of teaching experience. Inter-rater reliability was assessed by three experts who applied the final item-weighted checklist to evaluate 66 extracted natural teeth operated by students who were about to enter pre-clinical training. Both experts and students were asked to provide feedback regarding the content validity of the checklist.

Results: The careful development process with expert opinions supported the content validity. The final checklist includes 15 key items designed to measure comprehensive root canal treatment skills. The inter-rater reliability ranged from 0.437 to 0.865, indicating

* Corresponding author. Department of Dentistry, National Taiwan University Hospital, No. 1, Chang-Te Street, Taipei 100229, Taiwan.
E-mail address: tyl.endo@gmail.com (Y.-L. Tsai).

https://doi.org/10.1016/j.jds.2025.10.035

acceptable agreement among raters. Both teachers and students confirmed that the items were clear, comprehensible, and relevant, thereby supporting the face validity of the checklist.

Conclusion: This study developed the first qualitative checklist in Taiwan for assessing root canal treatment techniques using a structured approach and the modified Delphi method. The checklist offers teachers a standardized assessment tool and enhances learning efficiency for students.

Introduction

The core competence of undergraduate endodontic education is the transmission of knowledge about endodontics and practical skills required for root canal treatment techniques.[1–3] Over the past 10—20 years, numerous efforts have been made to develop guidelines for endodontic education. In 2013, the European Society of Endodontology updated its guidelines for undergraduate curricula.[1] Additionally, the Association for Dental Education in Europe published guidelines for endodontic education twice, first in 2010 and again in 2017. Moreover, in 2015, the General Dental Council in the UK announced similar guidelines.[2–4] However, there has not been a corresponding reform of the assessment scale.

Presently, the evaluation for endodontic technique is primarily holistic rating, which is based on the overall impression of an expert and is usually efficient.[5] However, using experts to rate performances is costly, and may introduce errors by expert raters.[5] On the contrary, analytic ratings for objective performance assessments, such as rubrics, are typically designed as checklists containing a list of specific clinical behaviors or specific skill steps.[4] Nevertheless, this approach lacks a multi-round, systematic process for establishing expert consensus and is susceptible to the subjective value judgments.

The most popular tool to evaluate the pre-clinical students' performance in root canal treatment skills in most countries in the world is to assess the X-ray images of root canal filling.[6–16] However, it is a pity that some essential steps (for example, the location of access opening, outline form, and removal of pulp roof) cannot be obtained from X-ray images, and it is not easy to integrate those steps into the checklist for evaluating root canal treatment performance. Therefore, it is necessary to develop a new tool other than the X-ray images to assess those essential steps mentioned above in our checklist.

In medical education research, the Delphi method and the nominal group technique are commonly used for expert consensus.[15,16] The Delphi method gathers experts' opinions anonymously in multiple rounds, allowing for a collective decision-making process that incorporates both quantitative and qualitative properties. This approach builds consensus based on the experts' expertise and experiences, ensuring content validity.[14,17] However, traditional implementation can be limited by factors such as manpower and resources. To address these challenges, some studies have introduced the "modified Delphi method," which simplifies the questionnaire process while maintaining the essential benefits of the original method.[18]

Developing a qualified evaluation checklist should be based on a structured procedure and a systematic approach to reduce evaluation biases and increase reliability among different evaluators. Those quality evaluation checklists can precisely reflect the clinicians' performance.[4] In the current literature review,[17–19] most checklists used in root canal treatment are based on the early literature and scholars' consensus. However, to the best of our knowledge, there is no pre-clinical root canal treatment checklist for a similar developmental process.

This study aimed to use a structured and systematic approach, alongside the modified Delphi method, to develop an integrative checklist that summarizes the guidelines into key points for the primary root canal treatment process. We suppose that this checklist will effectively assess the performance of these techniques, provide teachers with a consistent evaluation framework, and ultimately enhance learning efficiency for students.

Materials and methods

This study was approved by the Research Ethics Committee of the National Taiwan University Hospital, Taipei City, Taiwan (IRB NO. 20200501RINA).

Participants

Eight experts (3 males and 5 females), aged 30—50 years, were recruited in this study from the National Taiwan University Hospital to develop the checklist for evaluating root canal treatment performance. All experts had at least 7 years of clinical dentistry experiences, including a minimum of 5 years in endodontics, and at least 3 years of teaching experience and familiarity with clinical endodontic assessments. To examine inter-rater reliability and face validity, 66 fifth-year undergraduate students who were about to enter pre-clinical training were recruited to prepare extracted natural teeth, and their performances were evaluated by three experts using the final version of the checklist.

Development process

We referred to the framework for checklist development proposed by Schmutz et al.[19] to adapt the five steps for evaluating root canal treatment performance. The modified Delphi method was applied during the development process as follows (Fig. 1):

Step 1: Development of a draft checklist

In the first step, three experienced endodontists developed a draft checklist based on multiple guidelines, textbooks, and recommendations,[1,6–8,20–22] as well as their own clinical experience.

Step 2: Modified Delphi review rounds

A modified Delphi process was conducted in three rounds of questionnaires administered via anonymous emails to five experts who were not involved in the draft development in Step 1.

First round: initial development

In the first round, the five experts were asked to provide their opinions on item "reservation", "deletion", and "amendment" as well as suggestions for revision. Then, the percentages of each response category were calculated, and the expert feedback was analyzed and summarized as additions or deletions for consideration in the next round. Items with $\geq$ 85 % agreement on "reservation" and " amendment " items are above 85 %, the item will be retained for the next round.[9–11]

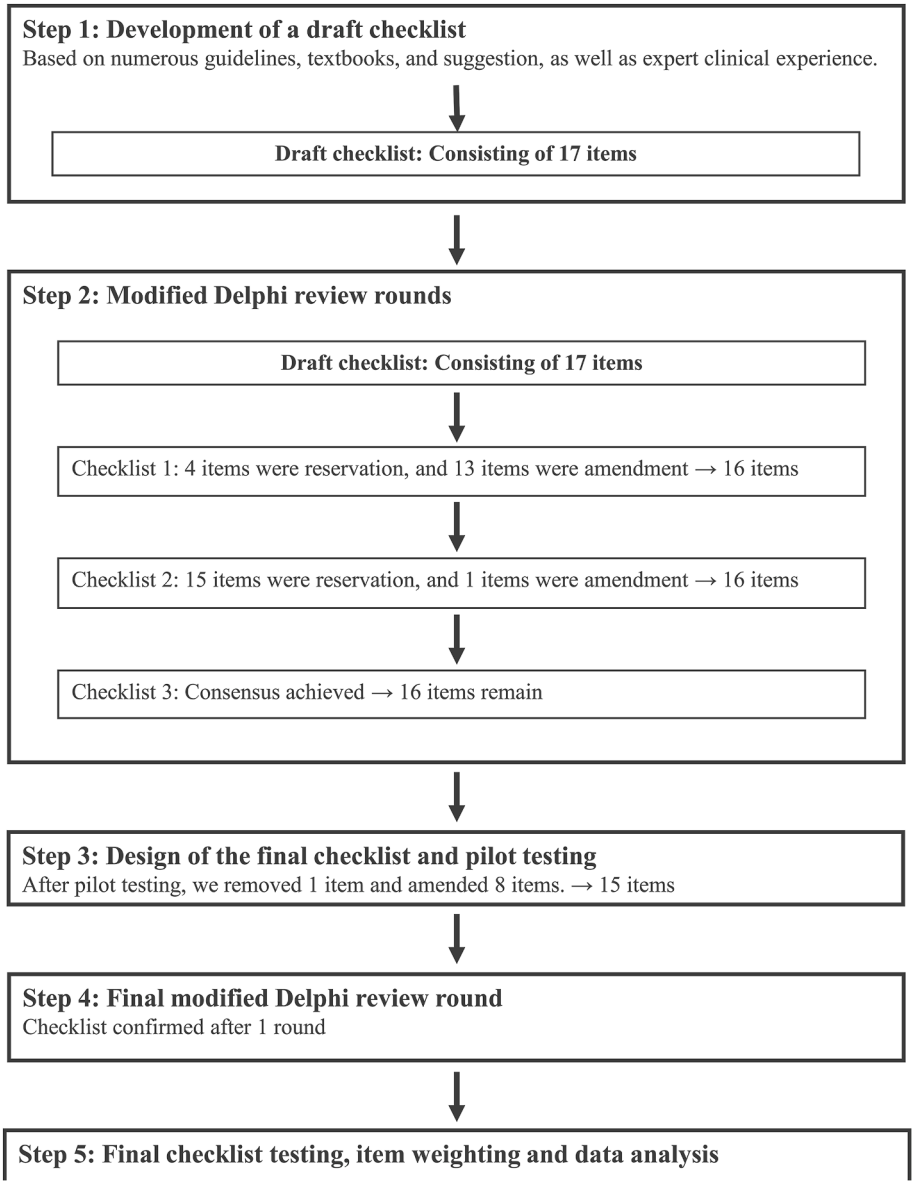

Figure 1 Five steps to developing a checklist for evaluating the root canal treatment performance.

Second round and third round: content validity and stability

To examine the content validity of the checklist, five experts were asked to rate their level of agreement with the revised questionnaire using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).[12] They were also invited to provide free-text comments. Consensus was defined a priori as the mean (M) Likert score ≥ 4, a standard deviation (SD) ≤ 1, and quartile deviation (Q) ≤ 0.6.[12] Items were also considered to have reached consensus if $Q > 0.6$ but decrease in the third round. The Wilcoxon signed-rank test was applied to assess the stability of expert ratings between the second and third rounds, with a non-significant *p*-value indicating stability and consensus among the experts.

Step 3: Design the final checklist and pilot testing

In the third step, three experts pilot-tested the checklist by evaluating six extracted natural teeth and their corresponding X-rays. During the evaluation, experts were invited to provide free-text comments on the items. Based on their feedback, unclear and ambiguous items and descriptions were revised.

Step 4: Final modified Delphi review round

In step 4, the revised checklist developed in Step 3 was sent anonymously to the five experts recruited in Step 2. The criteria for reaching consensus were the same as those applied in the second and third rounds of Step 2. As in previous rounds, experts were also invited to suggest amendments if any items contained inappropriate wording or descriptions.

Step 5: Final checklist testing, item weighting, and psychometric analysis

Three experts applied the checklist developed in Step 4 to evaluate 66 extracted natural teeth operated by fifth-year undergraduate students who were about to enter preclinical training. The weight assigned to each item was determined through expert discussion. Inter-rater reliability was examined using Kendall's W coefficient based on the 66 sets of ratings from the three experts, with values above 0.3, 0.5, and 0.7 interpreted as weak, moderate, and strong agreement, respectively.[23] To assess face validity, both experts and students were asked whether the items were clear and understandable, and whether they adequately reflected the intended skills and procedures.

All the statistical analyses were conducted using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Statistical significance was determined using a two-sided α level of 0.05.

Results

Characteristics of experts

The invited eight experts had extensive clinical education experience, with a mean of 12 years of clinical dental practice (standard deviation [SD] = 5.1) and 10.5 years of clinical teaching experience in endodontics (SD = 5.6).

Step 1: Development of a draft checklist

Three experts developed a draft checklist by summarizing the guidelines and literature review, which consists of 17 potential items.

Step 2: Modified Delphi review rounds

Delphi rounds and checklist changes. During the first round, 4 items were reserved, and 13 items were amended. The questionnaire was amended to 16 items in the second round, based on the results of the first round. After the second round, 13 items achieved a high level of consensus among experts. The mean range is 3.8—5.0, with an overall mean of 4.64. In the third round, the five experts reached consensus on all the items. The mean range is 4.2—5.0, with an overall mean of 4.89.

Following the Wilcoxon signed-rank test, 16 items were found to be statistically insignificant with *p*-values ranging from 0.157 to 1.000, which confirmed the stability and content validity between the second and third rounds. After three review rounds of step 2, the checklist contained 16 items.

Step 3: Design the final checklist and pilot testing

After pilot testing, we removed 1 item and amended 8 items with unclear descriptions. At this step, we identified 15 items as an appropriate checklist for evaluating root canal treatment performance.

Step 4: Final modified Delphi review round

All five experts agreed with all the amendments made in step 3. The mean range is 4.6—5.0, the overall mean is 4.86, and the quartile deviation of all items is less than 0.6.

Step 5: Final checklist testing, item weighting, and psychometric analysis

The final root canal treatment assessment form finally concludes with the identification of 15 items that cover all steps of endodontic treatment. These include 3 items for access opening, 3 items for root canal debridement, including early coronal enlargement and cleaning and shaping, 3 items for root canal filling, and 6 items for procedure errors. Each item is accompanied by an explicit description and assigned weighting (Table 1).

In terms of psychometric properties, inter-rater reliability was statistically significant for all items, with most coefficients ranging between 0.5 and 0.7, four items exceeding 0.7, and two items near 0.5, indicating moderate to high agreement among the raters (Table 2). In addition, both experts and students reported that the items were clear, comprehensible, and relevant, thereby supporting the satisfactory face validity of the checklist.

Discussion

To our knowledge, this is the first study to develop a checklist for students to assess root canal treatment

Table 1 Checklist for evaluating root canal treatment performance.

Expert:_____ Student ID:_____ Tooth No.:_____

(1) Please write NA if it cannot be evaluated. (2) Some items only have a binary rating scale. (3) Mishap in root canal treatment: please circle present or absent.

Item			Object of assessment	Instructions	Performance				Comment
Access opening	1	Location, outline form	Tooth	It is necessary to remove the old fillings and caries first, and then judge by the remaining structure. Evaluation: Appropriateness of the location and outline form. Achieved (2): Both are suitable. Partially achieved (1): One of them does not match. Not achieved (0): Two do not match. 【Location】 Represents the position of entry, fully, partially, or without deviation from the referenced anatomy, with no missing root canals. 【Outline form】 The outline form is complete, partial, or error-free.	Not achieved	Partially achieved	Achieved	NA	
	2	Tooth structure preservation		It is necessary to remove the old fillings and caries first, and then judge by the remaining structure. Achieved (2): The walls of the pulp chamber are properly prepared, and the floor of the pulp chamber is intact without damage. Partially achieved (1): Insufficient preparing of the pulp chamber wall; or excessive preparation of the pulp chamber wall or floor, but not exceeding 1/2 thickness. Not achieved (0): The pulp chamber wall or floor is over-prepared by more than 1/2 thickness.	Not achieved	Partially achieved	Achieved	NA	
	3	Remove pulp roof		Use a hook probe. Achieved (2): The roof of the pulp chamber and the pulp horn were completely removed, and the probe did not sink in. Partially achieved (1): On one or more pulp chamber walls or roofs, the probe hooks unevenly but does not sink. Not achieved (0): The probe is deeply recessed in one or more of the pulp chamber walls or roofs.	Not achieved	Partially achieved	Achieved	NA	
Early coronal enlargement	4	Coronal enlargement	RCF X-ray	Achieved (2): Straight line access from the orifice to the portion of the 1/2 root canal Partially achieved (1): Excessive removal of dentine or no straight-line access from the orifice to the portion of the 1/2 root canal Not achieved (0): Any perforations have occurred in this area.	Not achieved	Partially achieved	Achieved	NA	
Cleaning and shaping	5	Working length determination	X-ray with a file	According to the tooth position, if there is no suitable X-ray film for interpretation, it will be classified as "Not achieved". Achieved (2): The distance between the file tip and the root apex is within 0.5–1 mm.	Not achieved		Achieved	NA	

(*continued on next page*)

Table 1 (*continued*)

Expert:_____ Student ID:_____ Tooth No.:_____

(1) Please write NA if it cannot be evaluated. (2) Some items only have a binary rating scale. (3) Mishap in root canal treatment: please circle present or absent.

Item			Object of assessment	Instructions	Performance		Comment
				Not achieved (0): The distance between the file tip and the root apex is more than 0.5—1 mm; that is, the file is too short or over the root apex.			
	6	Master cone selection	X-ray with master gutta-percha cone	Check the master cone X-ray film and compare it with the working length X-ray film. According to the tooth position, if there is no suitable X-ray film for interpretation, it will be classified as "Not achieved". Achieved (2): the distance between the master cone and the root apex is within 0.5—1 mm, and the master cone has no gap or bends at the root apex. Not achieved (0): The distance between the master cone and the root apex is more than 0.5—1 mm, and the master cone has a gap or bends at the root apex.	Not achieved	Achieved NA	
Obturation	7	Length	RCF X-ray	Choose X-rays suitable for evaluation according to the tooth position; if there is no suitable X-ray for interpretation, it will be classified as "Not achieved". Achieved (2): The distance between the tip of the root canal filling and the root apex within 0～2 mm Not achieved (0): The distance between the tip of the root canal filling and the apex of the root is more than 0～2 mm; that is, it is too short or over the apical foramen.	Not achieved	Achieved NA	
	8	Dentistry		Choose X-rays suitable for evaluation according to the tooth position; if there is no suitable X-ray for interpretation, it will be classified as "Not achieved". In any part of the root canal, there are the following: Achieved (2): No voids and air bubbles in the root canal filling, or between the root canal filling and the root canal wall. Not achieved (0): Severe voids or air bubbles in the root canal filling or between the root canal filling and the root canal wall.	Not achieved	Achieved NA	
	9	Taper		Choose X-rays suitable for evaluation according to the tooth position; if there is no suitable X-ray for interpretation, it will be classified as "Not achieved". Achieved (2): A continuous taper is achieved from the orifice to the root apex, and there is no uneven root canal wall preparation. Not achieved (0): There is no continuous taper from the orifice to the root apex, or there is severe uneven root canal wall preparation.	Not achieved	Achieved NA	
Mishaps	10	Ledge	RCF X-ray	Absent (2): None Present (0): It was identified when the root filling was at least 1 mm shorter than the initial working length or (and?) deviated from the original curvature canal shape.	Present	Absent NA	

11	Zipping	Absent (2): None Present (0): It was identified when the apical termination of the filled canal appeared as an elliptical shape transported to the outer wall and occurs around the working length	Present	Absent	NA
12	Furcation perforation	Absent (2): None Present (0): It was identified when the extrusion of filling material through the furcation area was detected in multirooted teeth.	Present	Absent	NA
13	Striping perforation	Absent (2): None Present (0): It was identified when the extrusion of the material was detected on the lateral (interior) wall of the root of any tooth.	Present	Absent	NA
14	Apical perforation	Absent (2): None Present (0): It was identified when the apical termination of the filled canal was different from the original canal terminus, or when the filling material was extruded through the apical foramen.	Present	Absent	NA
15	Separated instrument	Absent (2): None Present (0): It was identified through observation of the radiograph and according to the radiopacity between the filling material and the separated instrument	Present	Absent	NA

RCF: root canal filling, NA: not available.

techniques using the modified Delphi method. These five steps include drafting an assessment form based on summarized guidelines and literature, refining it through expert consensus, conducting a pilot test for further revisions, confirming agreement on the revised form, and assigning importance weights to each item before applying the finalized checklist in practical evaluations. The final version consists of 15 assessment items with explicit corresponding descriptions and weightings. Through the modified Delphi method, the checklist provides strong content validity, ensuring that the items adequately reflect the intended construct.[14] Furthermore, the results showed acceptable inter-rater reliability and face validity, indicating that the checklist possesses satisfactory psychometric properties. These findings suggest that the checklist provides a structured, reliable, and valid tool for evaluating root canal treatment performance.

In the past, numerous guidelines have provided detailed descriptions of root canal treatment but lacked corresponding scoring standards. To address this gap, our study incorporated the insights of eight experts with extensive clinical and teaching experience in endodontics to translate the root canal treatment process into key assessment items. Through a structured and systematic development process, we developed the first comprehensive checklist in a step-by-step manner, resulting in the first qualitative assessment form for this procedure. Our checklist offers several advantages: it provides clear scoring criteria, ensures consistent scoring standards across teachers, and adopts a user-friendly format that saves time. Because assessments are conducted on an item-by-item basis, the checklist enables students to identify the root causes of their problems, and allows teachers to provide timely and constructive feedback to preclinical students on the root canal treatment technique. In addition to serving as a learning performance evaluation tool, the checklist can also shorten the exploratory period of student learning and enhance learning efficiency.

Some caution is warranted when interpreting the results. First, only fifth-year undergraduate students were recruited to prepare extracted natural teeth in this study. To improve sample representativeness, future research could include students at different levels and use various types of teeth. Nevertheless, the checklist was developed based on established root canal treatment guidelines rather than tailored to a specific student group, suggesting that it should be applicable across different student cohorts and educational settings. Second, only cross-sectional data were collected to examine inter-rater reliability. Future studies may include longitudinal samples to assess test–retest reliability. Third, internal consistency was not examined, as it is inconsistent with the formative nature of the measure.[24] As recommended by MacKenzie et al.,[25] we instead assessed inter-rater reliability and found acceptable reliability for the proposed checklist.

This study developed the first qualitative checklist of endodontic education in Taiwan. This checklist is applied to pre-clinical education in our study. It is worthy to further study in the future whether this root canal treatment checklist can be used in different stages of endodontic training.

In conclusion, this study developed the first qualitative checklist in Taiwan for assessing root canal treatment

Table 2 Inter-rater reliability for each item.

No.	Item	Kendall's W[a]
c1	Access open: location, outline form	0.509
c2	Access open: tooth structure preservation	0.437
c3	Access open: remove pulp roof	0.598
c4	Coronal enlargement: According to anatomy	0.592
c5	Working length determination	0.632
c6	Master cone selection	0.865
c7	RCF: Length	0.774
c8	RCF: Dentistry	0.778
c9	RCF: Taper	0.727
c10	Ledge	0.664
c11	Zipping	0.479
c12	Furcation perforation	0.667
c13	Striping perforation	0.667
c14	Apical perforation	0.512
c15	Separated instrument	0.667

RCF: root canal filling.
[a] Kendall's coefficient of concordance.

techniques using a structured approach and the modified Delphi method. The final version, comprising 15 weighted items with explicit criteria, demonstrated strong content validity as well as acceptable inter-rater reliability and face validity. It provides standardized scoring, supports consistent evaluation, and facilitates constructive feedback to improve student learning. While this study has certain limitations, the checklist is grounded in established guidelines and shows promise for application across different stages of endodontic training.

Declaration of competing interest

All contributing authors declare no conflicts of interest.

Acknowledgments

This study was supported by MOE Teaching Practice Research Program, Ministry of Education, Taiwan (PMN1122083), and grants from the Professor Hsueh-Wan Kwan Faculty Development Foundation, National Taiwan University Dental School Alumni Association, Taiwan. We thank the participating experts and the National Taiwan University Hospital, Department of Dentistry, for their valuable resources support.

References

1. De Moor R, Hulsmann M, Kirkevang LL, Tanalp J, Whitworth J. Undergraduate curriculum guidelines for endodontology. *Int Endod J* 2013;46:1105—14.
2. Field JC, Walmsley AD, Paganelli C, et al. The graduating European dentist: contemporaneous methods of teaching, learning and assessment in dental undergraduate education. *Eur J Dent Educ* 2017;21(Suppl 1):28—35.
3. Cowpe J, Plasschaert A, Harzer W, Vinkka-Puhakka H, Walmsley AD. Profile and competences for the graduating European dentist - update 2009. *Eur J Dent Educ* 2010;14:193—202.
4. General Dental Council. *Preparing for practice: dental team learning outcomes for registration. Revised 2015*. London: General Dental Council; 2015. Available from: https://www.gdc-uk.org/docs/default-source/education-documents/preparing-for-practice-(revised-2015).pdf.
5. Slater SC, Boulet JR. Predicting holistic ratings of written performance assessments from analytic scoring. *Adv Health Sci Educ Theory Pract* 2001;6:103—19.
6. Rotstein I, Ingle JI. Ingle's endodontics. In: *7th ed. Raleigh: PMPH USA*; 2019.
7. Torabinejad M, Fouad AF, Shabahang S, eds. *Endodontics: principles and practice*, 6th ed. St. Louis: Elsevier, 2020.
8. Berman LH, Hargreaves KM, eds. *Cohen's pathways of the pulp*, 12th ed. St. Louis: Elsevier, 2020.
9. Wu ML, Tu CT. *SPSS and the application and analysis of statistics*, 2nd ed. Taipei: Wu-Nan Book Inc., 2006:23—4.
10. Stewart D, Gibson-Smith K, MacLure K, et al. A modified Delphi study to determine the level of consensus across the European Union on the structures, processes and desired outcomes of the management of polypharmacy in older people. *PLoS One* 2017;12:e0188348.
11. Heiko A. Consensus measurement in Delphi studies: review and implications for future quality assurance. *Technol Forecast Soc Change* 2012;79:1525—36.
12. Schneider PJ, Evaniew N, McKay P, Ghert M. Moving forward through consensus: a modified Delphi approach to determine the top research priorities in orthopaedic oncology. *Clin Orthop Relat Res* 2017;475:3044—55.
13. Holden MC, Wedman JF. Future issues of computer-mediated communication: the results of a Delphi study. *Educ Technol Res Dev* 1993;41:5—24.
14. Keeney S, Hasson F, McKenna HP. *The Delphi technique in nursing and health research*. Chichester: Wiley-Blackwell, 2011.
15. Tsai SS, Chang SC, Ho MJ. Defining the core competencies of medical humanities education through the nominal group technique. *J Med Educ* 2008;12:70—6.
16. Humphrey-Murto S, Varpio L, Gonsalves C, Wood TJ. Using consensus group methods such as Delphi and nominal group in medical education research. *Med Teach* 2017;39:14—9.
17. Rankin G, Rushton A, Olver P, Moore A. Chartered Society of Physiotherapy's identification of national research priorities for physiotherapy using a modified Delphi technique. *Physiotherapy* 2012;98:260—72.
18. Murry JW Jr, Hammons JO. Delphi: a versatile methodology for conducting qualitative research. *Rev High Educ* 1995;18:423—36.
19. Schmutz J, Eppich WJ, Hoffmann F, Heimberg E, Manser T. Five steps to develop checklists for evaluating clinical performance: an integrative approach. *Acad Med* 2014;89:996—1005.
20. European Society of Endodontology. Quality guidelines for endodontic treatment: consensus report of the European Society of endodontology. *Int Endod J* 2006;39:921—30.
21. Tsai SSL, Sar JIC, Chang JZC, Yu SH, Lai EHH, Lin CP. Dental education development reflection from an objective structured clinical examination. *J Dent Sci* 2015;10:248—52.
22. Lai EHH, Chang JZ, Wang CY, Cheng YC, Tsai SL. Summative objective structured clinical examination as a reference of learners' needs before entering internship. *J Dent Sci* 2018;13:350—3.
23. Schmidt RC. Managing Delphi surveys using nonparametric statistical techniques. *Decis Sci J* 1997;28:763—74.
24. DeVellis RF, Thorpe CT. *Scale development: theory and applications*, 5th ed. Thousand Oaks: SAGE Publications, 2022.
25. MacKenzie SB, Podsakoff PM, Jarvis CB. The problem of measurement model misspecification in behavioral and organizational research and some recommended solutions. *J Appl Psychol* 2005;90:710—30.