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RESEARCH ARTICLES

Perceived adequacy of preclinical endodontic training and self-reported clinical competence among undergraduate dental students

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ABSTRACT

Aim: To evaluate undergraduate dental students' perceived adequacy of preclinical endodontic training and its association with their perceived competence to perform endodontic treatment according to clinical protocols.

Materials and Methods: This cross-sectional questionnaire-based study included 265 fourth- and fifth-year undergraduate dental students from dental schools in Ankara, Türkiye, who had completed their clinical endodontic training. The questionnaire comprised demographic items and questions with responses recorded on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree) to assess clinical self-competence and the perceived adequacy of preclinical training. Data were analysed using descriptive statistics. Associations between students' perceived clinical competence and the perceived adequacy of preclinical endodontic training were analysed using Pearson's chi-square test, with effect sizes assessed by Cramér's V. A linear-by-linear chi-square test was applied to evaluate ordinal trends. Statistical significance was set at $p < 0.05$.

Results: A total of 265 students participated in the study, comprising 188 (70.9%) females, 72 (27.2%) males, and 5 (1.9%) students who preferred not to disclose their gender. Among them, 115 (43.4%) were fourth-year and 150 (56.6%) were fifth-year students. Students' self-reported clinical competence was significantly associated with the perceived adequacy of preclinical training across all assessed endodontic procedures (Pearson's chi-square test, $p < 0.05$). Effect sizes were predominantly small to moderate. The linear-by-linear chi-square test showed a positive linear trend for most procedures, whereas no significant trend was observed for irrigation or the use of magnification.

Conclusion: Students generally consider their endodontic preclinical education and clinical competence to be adequate. The perceived adequacy of preclinical training was significantly associated with perceived clinical competence and demonstrated a consistent directional trend across the majority of the assessed endodontic procedures.

Keywords: clinical competence, endodontic education, preclinical training, self-efficacy

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INTRODUCTION

Dental education is a complex and dynamic process that integrates theoretical knowledge, practical skills, and professional attitudes to prepare students for clinical practice (1,2). Among the stages of dental training, the transition from preclinical to clinical education is a critical milestone in students' professional development (3). During this period, students move from simulated environments, where they perform procedures on training models or extracted human teeth, to patient-based care. This transition often challenges their technical proficiency, confidence, and communication skills (4). As a result, their level of preparedness for clinical work is a major determinant of the quality and effectiveness of dental education programmes (5).

Preclinical training aims to develop the foundational psychomotor skills and cognitive understanding necessary for clinical competence (6,7). It allows students to become familiar with dental instruments, materials, and procedures before they are exposed to patient care. However, despite the importance of preclinical education, the extent to which it adequately prepares students for clinical situations remains a subject of debate (7,8). Many students experience anxiety and uncertainty when entering clinical courses, suggesting a potential gap between preclinical instruction and real-world clinical demands (9). Understanding how students perceive their preparedness may, therefore, provide valuable insights into the strengths and weaknesses of the educational process.

In contemporary dental education, students' perceptions are increasingly recognised as significant indicators of the quality of the learning experience (3,10). Student-centred approaches value learners' experiences, attitudes, and reflections as important components of meaningful learning (11). By analysing students' self-assessment of their preparedness and self-efficacy, educators can identify potential barriers to learning, optimise teaching methodologies, and improve the overall educational experience.

Self-efficacy, defined as one's belief in their ability to perform specific tasks successfully, plays a significant role in clinical performance, motivation, and persistence (12,13). Consequently, assessing students' self-efficacy and perceived preparedness can serve as an indirect measure of how effectively the curriculum supports the development of clinical competence. Previous studies have explored dental students' perceptions of their preclinical and clinical experiences (14-16). Some have reported that students feel adequately prepared for clinical practice following comprehensive preclinical training (2), whereas others have found that students struggle to adapt to patient treatment due to a lack of confidence or insufficient practice in simulated settings (4). These differences highlight the influence of contextual factors, such as curriculum structure, teaching methods, and institutional resources, on students' educational experiences (10).

Despite this growing body of research, there remains limited evidence regarding how dental students in specific educational settings perceive their transition from preclinical to clinical training (2). In line with this, the preparedness of dental students for clinical procedures has been investigated by several studies using qualitative and various other methodological approaches (5,14-18). However, to the best of our knowledge, the existing literature lacks a study that investigates students' perceptions of their preclinical education retrospectively following the completion of their endodontic training. Retrospective evaluations obtained following clinical experience may provide a more realistic and comprehensive understanding of students' preparedness.

Therefore, this study aimed to assess students' clinical self-competence and the perceived adequacy of preclinical training in endodontic procedures. The null hypothesis of this study (H0) is that there is no significant difference between students' levels of clinical self-competence and their perceptions of the adequacy of preclinical training in endodontic procedures.

MATERIALS AND METHODS

Ethical approval and sample size calculation

This study was conducted with the approval of the Ethics Committee for Non-Clinical Scientific Studies, Faculty of Dentistry, Ankara University (Approval No: 53/2024, dated 06 May 2024). The sample size was calculated based on a type I error (α) of 0.05, an effect size (d) of 0.2, and a statistical power (1–α) of 0.90. According to these parameters, the minimum required sample size to achieve 90% power was determined to be 265 participants.

Participants and administration of the questionnaire

A total of 265 fourth- and fifth-year undergraduate students from dental schools in Ankara who had completed their clinical endodontic training participated in the study during the 2024–2025 academic year. The original questionnaire developed by Baaij and Özok (14) was utilised as a framework, with its main structure preserved to allow comparisons with future studies. The questions related to root canal treatment were subsequently revised to align with the specific aims of the present study, resulting in a questionnaire utilising a Likert scale to cover different stages of endodontic treatment. This draft was comprehensively reviewed by faculty members with prior experience in questionnaire-based research and finalised according to their feedback.

The final version of the questionnaire was converted into an online format using Google Forms (Google LLC, Mountain View, CA, USA) and disseminated via WhatsApp groups routinely used by students for communication. The questionnaire link was shared repeatedly throughout the data collection period to ensure that all eligible students had the opportunity to participate. At the beginning of the questionnaire, detailed information was provided regarding the study's purpose, structure, and participation requirements. Anonymity was ensured, and no identifying information was recorded. Participation was voluntary, and students could proceed only after confirming their informed consent.

The questionnaire consisted of two sections: (1) demographic information and (2) a three-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree) designed to assess students' clinical self-competence and their perceived adequacy of preclinical training in endodontic procedures.

Statistical analysis

The data were analysed using the SPSS 22.0 statistical software package (IBM Corp., Armonk, NY, USA). Descriptive statistical methods were employed for data evaluation, with results presented as frequencies and percentages. Associations between categorical variables were examined using the Pearson's chi-square test, with effect sizes assessed by Cramér's V. Given the ordinal structure of the Likert-scale data, the association between perceived clinical competence and the perceived adequacy of preclinical training was analysed using linear-by-linear chi-square tests in 3 × 3 contingency tables. The level of significance was set at $p < 0.05$.

RESULTS

Demographic characteristics

Table 1 presents the demographic characteristics and self-reported endodontic treatment experience of the participants. A total of 265 undergraduate dental students participated in the study. Of these, 188 (70.9%) were female, 72 (27.2%) were male, and 5 (1.9%) preferred not to disclose their gender. Regarding academic year, 115 (43.4%) participants were fourth-year students and 150 (56.6%) were fifth-year students.

During preclinical training, most students reported performing 0–5 root canal treatments on anterior teeth (34.7%), followed by 5–10 (32.8%), 10–15 (20.4%), 15–20 (9.1%), and >20 (3.0%). Similarly, for posterior teeth, 33.2% of students performed 0–5 root canal treatments, followed by 31.3% (5–10), 26.0% (10–15), 5.0% (15–20), and 4.5% (>20).

Table 1. Demographic characteristics and self-reported endodontic treatment experience of the participants

Characteristics	Category	n	%
Gender	Female	188	70.9
	Male	72	27.2
	Prefer not to say	5	1.9
	Total	265	100.0
Academic year	Fourth Year	115	43.4
	Fifth Year	150	56.6
	Total	265	100.0
Number of Root Canal Treatments in Anterior Teeth	0–5	92	34.7
	5–10	87	32.8
	10–15	54	20.4
	15–20	24	9.1
	>20	8	3.0
	Total	265	100.0
Number of Root Canal Treatments in Posterior Teeth	0–5	88	33.2
	5–10	83	31.3
	10–15	69	26.0
	15–20	13	5.0
	>20	12	4.5
	Total	265	100.0

Association between perceptions of the adequacy of preclinical training and perceived clinical competence

Table 2 presents the associations between students' self-reported clinical competence and the perceived adequacy of preclinical training across endodontic procedures. Across all assessed endodontic procedures, students' self-reported clinical competence showed statistically significant associations with their perceived adequacy of preclinical training (Pearson's chi-square tests, $p < 0.05$). The strength of the associations was predominantly in the small-to-moderate range, based on Cramér's V effect size values. Linear-by-linear chi-square tests demonstrated a significant positive linear trend for most procedures. In contrast, no significant linear trend was identified for either irrigation or magnification ($p > 0.05$).

DISCUSSION

According to the guidelines published by the European Society of Endodontology (ESE) and the Association for Dental Education in Europe (ADEE), dental students are expected to graduate with the skills required to perform root canal treatment on uncomplicated anterior and posterior teeth (1,2). Achieving this graduation outcome may be particularly challenging in endodontics (19), as procedures in this field are often perceived by students as more difficult than those in periodontology and restorative dentistry (20). This perception arises from the variable and intricate structure of the root canal system and the clinically demanding, high-precision stages of endodontic treatment (21,22).

Furthermore, stress experienced by students during undergraduate endodontic education is a significant concern (23). Students' levels of stress and confidence are shaped by various factors, including the patient, the type of clinical procedure, the instructor, the teaching method, the clinical organisation, and the individual characteristics of the student (24). These factors may directly influence self-confidence, motivation, and clinical performance (25). Therefore, it is crucial to regularly evaluate whether the endodontic curriculum adequately meets students' educational needs in this area.

Within the educational process, both a supportive learning environment and the student's sense of confidence are of great importance (26,27). This context highlights that performing root canal treatment on a patient is a key experience that elevates a student from merely being skilful to becoming a confident clinician (15). Experience can enhance an individual's perception of confidence, while confidence may, in turn, facilitate the acquisition of further experience (28). Confidence is not a trait that can be directly measured; however, students' reported perceived competence in a specific area can serve as an indicator of their level of preparedness in that domain (29). Although actual ability does not always match perceived ability (9), the results of this study suggest that students' perceived competence may support the quality of the clinical experiences they acquire in the future.

Table 2. Association between students' self-reported clinical competence and perceived adequacy of preclinical training across endodontic procedures

Perceived preclinical training adequacy statement		**Clinical competence statement**								**p†**	**p‡**
		I feel competent at performing access cavity preparation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that access cavity preparation was adequately taught during my preclinical training.	Disagree	20	37	11	20,8	23	14,6	54	20,4	< 0.001	< 0.001
	Neutral	15	27,8	26	49,1	42	26,5	83	31,3		
	Agree	19	35,2	16	30,1	93	58,9	128	48,3		
	Total	54	100	53	100	158	100	265	100		
		I feel competent at performing rubber dam isolation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that rubber dam isolation was adequately taught during my preclinical training.	Disagree	14	51,9	17	27	55	31,4	86	32,5	< 0.001	0.017
	Neutral	5	18,5	29	46	36	20,6	70	26,4		
	Agree	8	29,6	17	27	84	48	109	41,1		
	Total	27	100	63	100	175	100	265	100		
		I feel competent at determining the working length according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that working length determination was adequately taught during my preclinical training.	Disagree	5	35,7	9	13,8	20	10,8	34	12,8	< 0.001	< 0.001
	Neutral	2	14,3	38	58,5	35	18,8	75	28,3		
	Agree	7	50	18	27,7	131	70,4	156	58,9		
	Total	14	100	65	100	186	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Table 2. Continued

Perceived preclinical training adequacy statement		Clinical competence statement								p†	p‡
		I feel competent at preparing root canals according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that root canal preparation was adequately taught during my preclinical training.	Disagree	4	36,4	10	16,7	20	10,3	34	12,8	< 0.001	< 0.001
	Neutral	3	27,2	40	66,6	41	21,1	84	31,7		
	Agree	4	36,4	10	16,7	133	68,6	147	55,5		
	Total	11	100	60	100	194	100	265	100		
		I feel competent at performing irrigation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that irrigation procedures were adequately taught during my preclinical training.	Disagree	3	25	11	21,6	42	20,8	56	21,1	0.005	0.068
	Neutral	4	33,3	29	56,8	62	30,7	95	35,8		
	Agree	5	41,7	11	21,6	98	48,5	114	43,1		
	Total	12	100	51	100	202	100	265	100		
		I feel competent at placing calcium hydroxide according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the placement of calcium hydroxide was adequately taught during my preclinical training.	Disagree	21	65,6	27	30	36	25,2	84	31,7	< 0.001	< 0.001
	Neutral	4	12,5	50	55,6	28	19,6	82	30,9		
	Agree	7	21,9	13	14,4	79	55,2	99	37,4		
	Total	32	100	90	100	143	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Table 2. Continued

Perceived preclinical training adequacy statement		**Clinical competence statement**								**p†**	**p‡**
		I feel competent at performing root canal obturation according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that obturation techniques were adequately taught during my preclinical training.	Disagree	37	78,7	37	36,3	25	21,6	99	37,4	< 0.001	< 0.001
	Neutral	7	14,9	49	48	28	24,1	84	31,7		
	Agree	3	6,4	16	15,7	63	54,3	82	30,9		
	Total	47	100	102	100	116	100	265	100		
		I feel competent at managing intraoperative complications according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the management of procedural complications was adequately taught during my preclinical training.	Disagree	40	80	39	38,6	35	30,7	114	43	< 0.001	< 0.001
	Neutral	6	12	46	45,6	23	20,2	75	28,3		
	Agree	4	8	16	15,8	56	49,1	76	28,7		
	Total	50	100	101	100	114	100	265	100		
		I feel competent at using dental loupes according to the clinical protocol.									
		Disagree		Neutral		Agree		Total			
		n	%	n	%	n	%	n	%		
I believe that the use of dental loupes was adequately taught during my preclinical training.	Disagree	5	35,7	17	25,8	66	35,7	88	33,2	< 0.001	0.113
	Neutral	6	42,9	36	54,5	34	18,4	76	28,7		
	Agree	3	21,4	13	19,7	85	45,9	101	38,1		
	Total	14	100	66	100	185	100	265	100		

†: Pearson's chi-square test. ‡: Linear-by-linear chi-square test.
p values < 0.001 are reported as p < 0.001.
Values are presented as n (%). Each statement was rated on a 3-point Likert scale (1 = Disagree, 2 = Neutral, 3 = Agree)

Feedback is an essential component of the educational assessment and evaluation process. When used effectively, it can enhance the quality of the course and support student development (19,30), as well as help identify which aspects of the educational experience students value most (31). Previous research indicates that regularly gathering students' evaluations and feedback is highly important for identifying issues and implementing changes to improve the educational programmes (10,22). These evaluations may help identify strategies to enhance endodontic education and may also contribute to improving other related courses (30). Nevertheless, students' perspectives are often not sufficiently considered when planning the future of dental education (32).

In the present study, students generally considered themselves clinically competent in most endodontic procedures and perceived their preclinical education as adequate for clinical practice. A lack of confidence in new graduates may lead to excessive dependence on supervision, thereby slowing their professional development. Conversely, an inflated sense of confidence may compromise patient safety by encouraging attempts at procedures that exceed their capabilities (1). Therefore, it is essential that individuals recognise their actual level of competence realistically and develop a level of confidence that is aligned with it (9).

Baaij et al. reported that students with low self-efficacy before graduation showed a more pronounced improvement thereafter, whereas those with higher self-efficacy referred patients for endodontic surgery more frequently (16). Therefore, self-efficacy appears to be a dynamic concept that markedly influences both clinical decision-making and post-graduation development (16). Although the students in this study reported high levels of perceived competence, their evaluations were largely based on simple and uncomplicated cases. When they encounter more challenging real-life patient scenarios after graduation, their perceptions of their own competence may, therefore, change (33). In addition, levels of self-confidence may be influenced by individual personality traits and personal views and may not always accurately reflect true competence. This situation may even, at times, be interpreted as an indication of unconscious incompetence (3). Even in the presence of these limitations, the results of this study provide a meaningful contribution to understanding how their education influences the way students assess their own abilities.

According to the ESE guidelines, no recommendation is made regarding the number of root canal treatments an undergraduate dental student should perform before graduation (2). Self-efficacy has been defined as a feeling of competence and confidence, expressed as self-assurance in one's ability to perform specific tasks successfully (15). Students' self-efficacy was influenced mostly by their clinical experience when performing root canal treatment. It seems that the more root canal treatments students perform on patients, the greater their self-efficacy is at graduation (15). Baaij et al. further reported that, to increase self-efficacy, students should perform as many root canal treatments as possible, and that the number of treatments performed under the supervision of an endodontist influences students' self-efficacy and perceived level of competence (14). On this basis, it might be recommended that, before graduation, students should perform at least three root canal treatments on patients, preferably under the supervision of an endodontist (14). In the present study, more than half of the students had performed at least five root canal treatments. This suggests that their high perceived competence may be linked to having gained sufficient practical experience through an adequate number of clinical cases.

An association was observed between perceived clinical competence and perceived adequacy of preclinical education, with a consistent directional trend across most procedures. Accordingly, students who perceive preclinical education as more adequate also tend to perceive higher levels of clinical competence. However, these findings should not be interpreted as evidence of a cause-and-effect relationship whereby preclinical education directly enhances clinical competence. Rather, the results reflect a consistent and directional covariation in students' self-reported perceptions, indicating that preclinical and clinical educational experiences are evaluated within a holistic framework. In this context, students appear to view preclinical education and clinical competence not as separate

domains, but as interrelated components of a coherent learning experience. According to the most recently published guidelines of the British Endodontic Society Teachers of Endodontology Group, it is recommended that the use of dental loupes should be integrated into endodontic clinical skills training and the performance of endodontic treatment within the undergraduate curriculum (34). In this study, no linear trend was identified for dental loupes. These results suggest that the use of dental loupes may be closely associated not only with technical proficiency but also with factors such as individual habits, ergonomic comfort, visual adaptation, and instructor encouragement. Students may have perceived the use of dental loupes not as a natural extension of their clinical competence, but rather as an auxiliary tool dependent on personal preference or external conditions. This inconsistency may also be explained by the fact that preclinical exercises do not fully reflect real clinical conditions, where patient positioning and dynamic movement make magnification more difficult to master than on a mannequin. In addition, this result highlights the importance of not only emphasising basic teaching steps but also incorporating modern endodontic approaches and technologies into undergraduate endodontic education more effectively. Similarly, for irrigation, the absence of a significant linear trend may be related to the fact that this procedure is generally performed in a more standardised and protocol-based manner in the clinical setting. Students may perceive irrigation as a routine procedure in which the selected irrigant is applied at a predetermined volume and duration, rather than as an individual technical skill. Therefore, even if the overall perception of clinical competence increases, self-evaluations related to irrigation may not reflect this increase in a linear manner. In addition, the fact that the clinical success of irrigation is not directly observable in the short term may have led students to rate their perceived competence at this stage at similar levels. These findings indicate that some endodontic procedures are perceived as being shaped by experiences influenced by individual preferences and contextual factors, rather than by a linear progression of learning or competence.

A primary limitation of this study is that the data are based on students' self-reports, which are inherently subjective and may not fully represent actual clinical competence. Consequently, it is not possible to establish a causal relationship between preclinical training and clinical performance. The findings may also have been influenced by contextual factors such as the timing of data collection, assessment-related pressure, or variations in teaching approaches. Moreover, although the study was conducted across dental schools in Ankara, its restriction to a single city limits the generalizability of the results to other educational contexts. Although the quantitative survey data provide useful insights, they may not capture the deeper factors shaping students' perceptions. Future research would therefore benefit from incorporating qualitative interviews and more objective and structured competence assessment tools, such as Objective Structured Clinical Examinations (OSCEs), to provide a more reliable evaluation of students' clinical preparedness.

CONCLUSION

Based on descriptive statistics, the findings indicate that students reported moderate-to-high levels of perceived competence across most endodontic procedures and generally viewed their preclinical education as supportive of clinical practice. Perceived adequacy of preclinical training was associated with perceived clinical competence across all assessed endodontic procedures, and a significant linear trend was additionally observed for most procedures, except for irrigation and magnification. However, these perceptions may be influenced by individual personality traits, and self-perceived competence may not always accurately reflect true clinical ability. Further studies are needed to determine the extent to which students' perceived levels of competence genuinely reflect their actual clinical performance.

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Ethical approval

This study has been approved by the Ethics Committee for Non-Clinical Scientific Studies, Faculty of Dentistry, Ankara University (approval date 06/05/2024, number 53/2024). Written informed consent was obtained from the participants.

Author contribution

Concept: EOT; Design: EOT; Data Collection or Processing: ŞY, FNC, ZT, SU; Analysis or Interpretation: EOT; Literature Search: EOT, CY; Writing: EOT, CY; Critical Review and Supervision: EOT, CY. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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