Science Arena Publications
Specialty Journal of Medical Research and Health Science
ISSN: 2521-3172
Available online at www.sciarena.com
2025, Vol, 10 (1): 77-86

Correlation between Dental Students' Theoretical Knowledge and Clinical Skills Regarding Endodontics: A Retrospective Analysis in REU

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Abstract: *Endodontic outcomes are linked to dental students' ability to apply cognitive information to effective dental procedures. Recent studies show that students undergo rigorous dental training but struggle to apply their classroom gains in clinical practice, raising doubts about the effectiveness of current dental training. This is a retrospective analysis using students' grades and clinical competency in male and female campuses of Riyadh Elm University, Riyadh, KSA. Grades for the included students were retrieved from the administration of REU after the ethical approval. Questions and their responses related to endodontics were included in our study. Grades from the phantom lab and clinics were acquired from the relevant personnel. Students received grades at each step of the endodontic procedure, which were used in our study. Analysis revealed that the students scored significantly higher in the phantom lab and clinical procedures as compared to the theoretical part of endodontics. This trend was similar between males and females, with no significant difference (p-value >.05). Hence, it can be concluded that there is no correlation between students' theoretical knowledge and clinical/practical skills in endodontics. Therefore, the hypothesis is accepted.*

Keywords: *Theoretical dentistry, Dental practice, Dental education, Dental students*

INTRODUCTION

Endodontic outcomes are linked to dental students' ability to apply cognitive information into effective dental procedures [1]. Recent studies show that students undergo rigorous dental training but struggle to apply their classroom gains in clinical practice, raising doubts about the effectiveness of current dental training [2]. Endodontics requires precision adjustments and analytical thought, as well as knowledge of pulpal and periapical pathology, in the technique of root canal treatment. Still, a theoretical perspective indicates that students rarely exhibit confident and competent actions in independent, difficult assignments [3]. Kami [4] noted that theoretical research conducted by students does not necessarily guarantee clinical performance [5]. Students must learn effective image interpretation to integrate diagnostic imaging into their clinical decision-making framework [6, 7]. Moreover, evidence indicates that clinical confidence is inextricably associated with formal mentoring and actual case encounters. Numerous dental students admitted they are still indecisive while dealing with intricate endodontic cases; however, their theoretical knowledge is quite sound [8]. The use

of simulation-based training and practical workshops has been useful to cover a gap between theoretical knowledge and application [9]. Additionally, limited encounters with various cases present a major concern that affects the students and their ability to convert knowledge attained in theory to clinical specialization. Studies show that with increased practical experience, the student does better in endodontic procedures and possesses better problem-solving skills [9, 10].

Rationale of the study

Findings of the study will help in determining the existing gap in the knowledge and practice of endodontic procedures among REU dental students. Exploratory in nature, the study will give insights into the current training models and offer possible solutions for adapting educational techniques for improving their applicability for dental students, affording them better theoretical understanding and physical ability.

Null hypothesis

There is no correlation between dental students' theoretical knowledge and practical skills related to Endodontics.

Aims and objectives

The aim of this study is to determine the correlation between students' theoretical knowledge and clinical skills in endodontics.

Objectives include assessing the predictive validity of a theoretical knowledge assessment on students' practical skills and determining an optimal cutoff value for theoretical knowledge.

Materials and Methods

Study design: A retrospective analysis using students' grades and clinical competency.

Setting: Male and female campuses of Riyadh Elm University, Riyadh, KSA.

Participants: Students from Riyadh Elm University's male and female campuses were included. Students from 2021-2025 who had completed phantom courses in Operative dentistry were included.

Sample size: A convenience sampling technique will be used, and a total of 300 students was employed for this study.

Data sources/measurement

Theoretical knowledge assessment: Grades for the included students were retrieved from the administration of REU after the ethical approval. Questions and their responses related to endodontics were included in our study.

Practical skills assessment: Grades from the phantom lab were acquired from the relevant personnel. Students received grades at each step of the endodontic procedure, which were used in our study.

Statistical analysis: Initially, all the data were entered into an Excel sheet, which was then transferred to SPSS (Statistical Package of Social Sciences) version 22. Descriptive as well as inferential statistics were carried out. Data were tested for normality, and depending on that, mean scores were compared using a t-test. Results were presented in the form of tables and graphs.

Ethical Considerations: This proposal was submitted to the ethical board of REU, and IRB approval was obtained before we initiated the data collection process.

Results and Discussion

The aim of this study was to assess the relationship between knowledge and skill of dental students in endodontics at Riyadh Elm University. The results were analyzed for 300 students using SPSS version 22, and the result was presented by using a bar chart and tabulation. The results obtained demonstrated that students'

P/CL performance was relatively higher than theory/ lecture scores. This was done in order to determine if any trends or effects existed between gender and between academic levels. The features of each of the visuals, as well as the data they contain, are clarified below.

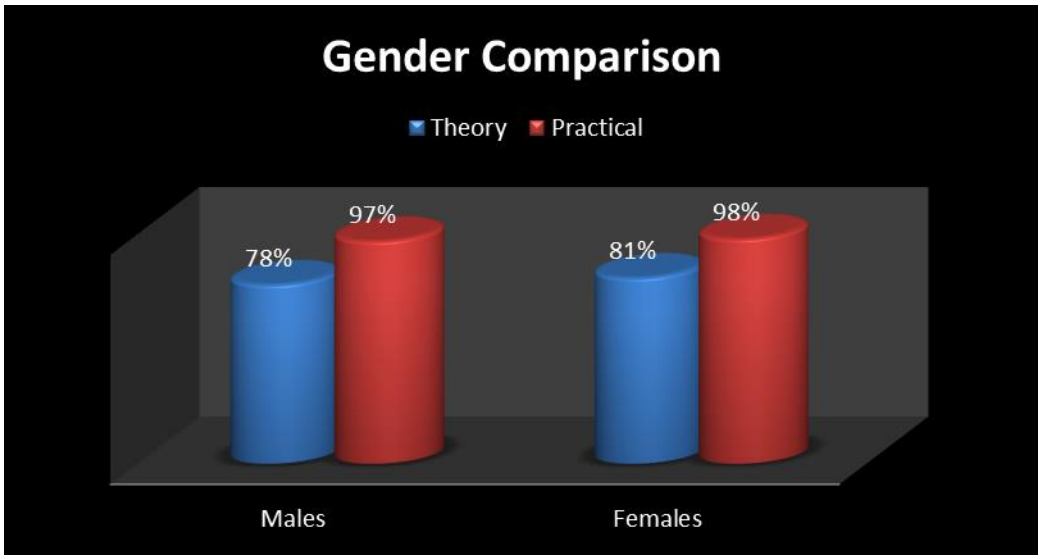

Figure 1. Comparison of Theoretical and Practical/Clinical Grades Between Male and Female Students ($p > 0.05$)

Table 1 illustrates the comparison of the mean of theoretical and Clinical performance of male and female dental students. It was found that the males had exercised an average of 78% in theoretical examinations and 97% in practical tests. In the theory part, the female students scored 81% while they scored 98% when it came to clinical exams. From the scores recorded, the authors observed that the TWO samples of male and female students had performed better in the practical procedures; however, analyzing the outcome, it was noted that gender did not significantly influence the performance of the students because $p > 0.05$. This means that gender is not an issue when it comes to the difference between theoretical and clinical skills. Men get an equal benefit from the practical lessons, as women are also challenged in the theoretical aspects of their learning. The improvement in the clinical tasks means that the practical training environment of REU is efficient. Theoretical concerns could originate from comparable variation in the learning approaches among the learners or test-taking stress. A task that is practical might come with matching visuals and motion, therefore enhancing the grasping ability. This equal passing secures consistent training between the male and female and therefore validates the existence of standard training. This is an assertion that points towards the fact that instructional methods are satisfactorily applied and effective between the two campuses. It also supports the argument that gender does not affect the level of match between the acquired content knowledge and requirements for an occupationally qualified candidate. This figure also supports other studies done on performance, which show that training models affect performance in dental education more than demographic characteristics. All in all, the visual validates how practical fluency is higher than formal correctness among both male and female participants.

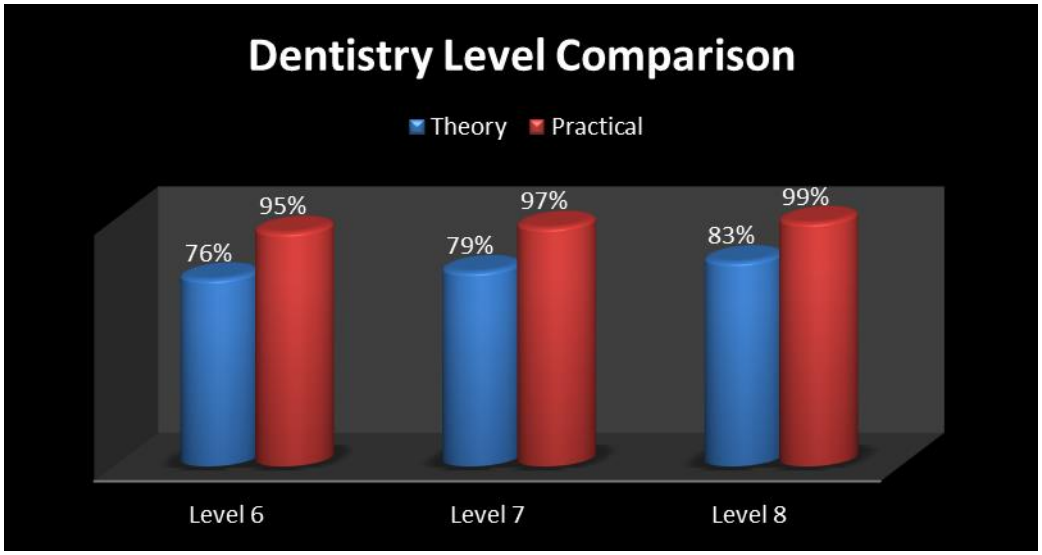

Figure 2. Comparison of Theoretical and Practical/Clinical Grades Among Students at Various Academic Levels ($p > 0.05$)

The performance of students for the achievement of theoretical and practical tasks is also shown in **Figure 2** at levels 6, 7, and 8. In theory, the students at Level 6 had an average of 76, while in clinicals, their averages were 95. The results show that the level 7 students rose slightly to 79 percent, as well as 97 percent, on the theory and practice performances. At Level 8, the average scores were 83 % in theory and a satisfactory 99% in the clinical aspect. Based on the findings, the theoretical and clinical grades have improved across the levels, but not significantly so, since the p-value is greater than 0.05. This is an implication of that, which means that academic progression may not be useful for a more practical convergence of theory and skill. Some of the new century skills remain in a condition where the hands-on skills are advancing, while the growth in theoretical knowledge does not exhibit a corresponding proportionality. It is evident that, in defining the success of teaching techniques through practices, practical grades are higher than theoretical ones. Based on the arguments above, it is evident that clinical experience and lab exposure yield better results for the students. This evidence confirms the fact that students gain a better understanding when participating in procedures as opposed to passive learning. Within this respect, it implies that in order to make a forceful point during discussions, the knowledge taught in a classroom must be blended with cases. However, the results indicate that there is still a gap in instructional strategy that cannot be erased by level-based growth. Performance could be due to practice, the use of feedback, and evaluation during the conduct of the simulation. Nevertheless, general notions may require a more real-life style of teaching. In the given graphic, it is clear that practical competence improves with the level, while theoretical improvement is considerably slower. Therefore, the theory-practice integration is a phenomenon that should be discussed at all levels.

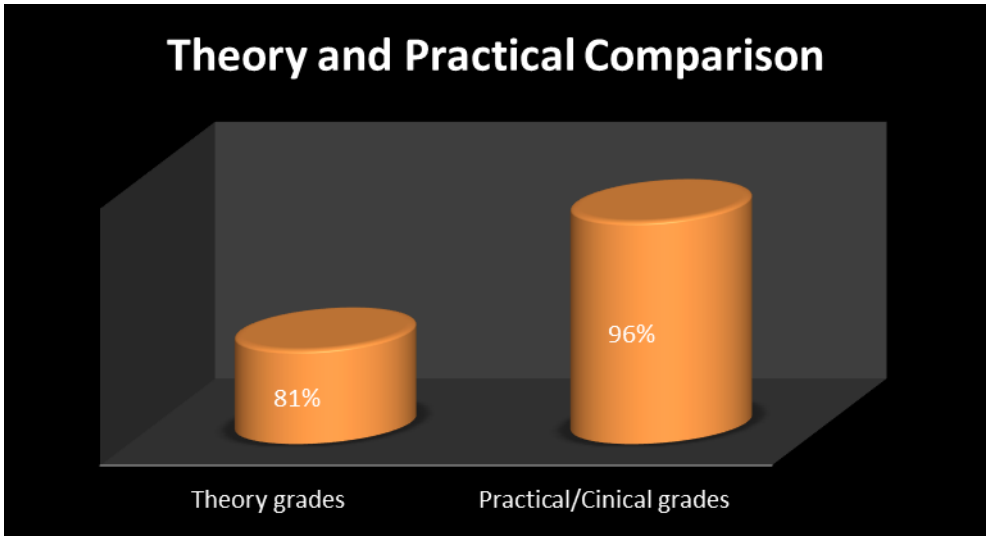

Figure 3. Comparison of Theoretical and Practical/Clinical Grades Among All Students ($p < 0.05$)

In **Figure 3** below, a composite of all the students' average theory and practical/clinical marks has also been provided. The theoretical pass mean score was 81, while the practical scores had a slightly higher mean of 96%. In addition, it was identified that the difference of 15% between the two groups is statistically meaningful with $p < 0.05$. This means that the difference cannot be attributed to sampling or random occurrence of variation and is definitely present across the sample. Students' performance has remained higher in clinical tasks than in the theoretical tests and assignments. The result dispels the hypothesis of the existence of a close relationship between theoretical knowledge and realistic performance. It also depicts the success of this learning in the REU dental program. The high returns for clinical employment suggest that the facilities for simulation, educational staff, and practical experience are enhancing skill acquisition. At the same time, theoretical measurements are more inclined to examination-cramping methods of memorization and recall, which are highly ineffective from a real-life outlook. The results reveal a distorted process of transferring knowledge from the sphere of learning to its practical application. The gap may also be a result of students feeling more comfortable when carrying out procedures than being tested on academic content. This means that the differences have stressed the relevance of including clinical scenarios in the curriculum. This figure suggests that what is currently being practiced in regard to teaching and learning may be more helpful in the act of transmitting skills than the transfer of knowledge. Thus, the research promotes educational change that incorporates theoretical practices with more student participation. This way, it will be possible to narrow the performance gap between how theoretical content is delivered to the students. In general, **Figure 3** supports the study's conclusion both visually and statistically.

Table 1. Sample of Theoretical and Practical/Clinical Grades

No.	Theoretical Grades	Practical/Clinical grades	p-value
1	77%	98%	.000
2	75%	97%	.000
3	82%	100%	.000
4	81%	100%	.000
5	79%	97%	.000
6	80%	96%	.000
7	81%	95%	.000

The following **Table 1** shows the real scores of seven students regarding their theoretical and clinical evaluation. The theoretical scores are 75-82% and the practical/ clinical scores are 95-100%. The theoretical part of Self-Assessment Student 1's score was 77%, and the practical part, which was the clinical practice, he scored 98%. Among all the students, Student 3 was the best performing student, whose average theoretical performance was calculated as 82 percent, and had the best clinical work score of 100 percent. Clinical results were also higher than the theoretical results in all learners enrolled in the course. The range of the percentage difference was rather small, between 14% and 23% which implies that there was a predictable gap. In the same manner as the other statistics, the data trends are similar to the common overall trends. This led to the affirmation of the present model, indicating that practical ability is more robust than theoretical correctness. They may explain how students retain and apply the tactile skills in a better way by having lab repetition or hands-on experience. It is also possible to note that the presented table proves the more comprehensive conclusion of the study directly and concretely. This demonstrates how the real level of students contributes to the idea of reconsidering the education system. It also attests to the general reliability of the overall sample data due to consistency in the results obtained. This micro-level is useful to show more of the real-world impact of the displayed averages. These are some reasons that support the argument that better strategies are needed in theoretical instruction, as shown in **Table 1**. From the above results, it can be concluded that increasing the teaching effectiveness of the current model, while theory teaching could benefit from applied teaching methods. The flows present in the evaluation reinforce the findings made previously with regard to the theory-practice gap, which is observed in all the other sections of the study.

Overall summary of findings

The present work aimed to understand the link between knowledge and competence of DE students of Riyadh Elm University (REU). The findings showed that there was a significant and statistically significant difference between clinical and theoretical mean values; the clinical averages were 96 % and the theoretical 81%. The difference, as apparent from the above results, marks 15% which advocates more importance of the skills over conventional classroom teaching. From the gathered information, it can be inferred that although students receive a great extent of confidence and competency in the clinical field, advancements in this particular area do not originate from bookish or theoretical knowledge. This is consistent with the study's hypothesis that theoretical incomparability does not equal clinical competency. Thus, the work is consequential to educators and administrators as it points to an educational discrepancy that impacts professional preparedness [6, 11]. Further, it brings into question the decision-making capacity of students at the cognitive level, particularly in clinical cases. For this reason, the related clinical scores may also be a sign of clinical performance meaning, over practice and supervision, as opposed to understanding of concepts. This point to the need to have an educational model that integrates knowledge with reasoning in a clinical way to bring about a holistic development in students [12].

Academic level and gender-based trends

Further, comparing the scores obtained by the learners at different levels of education and by gender also gives evidence of a similar split between the theoretical and clinical test results. The course outcomes evaluated from Level 6 students showed 76% in theory, whereas in the clinical area, 95% was recorded for the Level 6 group; for Level 8, 83% in theory and 99% in the clinical area were achieved. This means that while both competencies increase with academic levels, the difference between them remains stable, constant, and 'unsatisfactory' as evidenced in **Figure 1**. Similarly, regarding the differences in gender, there was a minimal difference, where the male students, on average, scored 78% in theory and 97% in practice, while the female students recorded 81% and 98%. These differences were not significant; thus, the theory-practice gap cannot be attributed to gender or level, but it is probably an education system issue that needs to be addressed. It suggests that the current practices of teaching do not progress enough to ensure that there is development of the theories in parallel to clinical skills training. The lack of variation in one subgroup does not elicit the idea that the

curriculum design fails due to individual differences in students. Therefore, academic progression does not give the solution to this issue. Curriculum strategies at all levels require change so that there is the integration of knowledge and skills [7].

Alignment with existing literature

The results of the present study corroborate the studies carried out in dental education in other countries. Alajlan *et al.* (2022) also stated that one participant confessed to feeling more at ease and comfortable when practicing procedures [1], but could not defend their decisions in the same theoretical manner. Jamshidy *et al.* (2023) also attested to the fact that students believed that a lot of theoretical training was not relevant and applicable in the outside world [10]. Some of the important observations to be made when making decisions in a clinical environment are dependent on experiences and advice from seniors rather than theory, as noted by Keel (2023). In the same way [9], Sever (2024) noted the same idea that theoretical proficiency does not equate to clinical proficiency and skills during pressured circumstances and or difficult cases [3]. The evidence obtained from REU supports the general findings gathered from the international literature, two beginnings to make people understand that the theory-practice gap phenomenon is not exclusive to their countries. It is a common problem in dental institutions all over the world. This increases the reliability of the findings of the current study as well. It also supports the plea for the integration of changes in the understanding of the subject, as well as the confidence in the process. This is a pattern that can be identified at the international level, prompting institutions to support the development of such strategies that can help to ensure that contents delivered in the academic institution are well coordinated with the requirements of the clinical facilities.

Need for curriculum reevaluation

This is definitely another clear indication that in this study, the theory-practice divide has not shifted at all, and that a reform of the curriculum is necessary. Lecture, memorizing, and textual approaches, as well as using textbooks and paper-and-pencil tests, are insufficient in the development of the intellectual foundation required to succeed in clinical practice. It is apparent that the type of learning that students have is active through simulation and practical examinations, but the theoretical part of the learning process remains more passive and distant. This disconnection implies that students are able to go through certain activities and accomplish them without appreciating the rationale behind such activities. Thus, the curriculum design process should adapt the clinical context to the theoretical teaching approach. This may include case-based discussions where the facilitator discusses certain topics in a tutorial or lectures, flipped classrooms, and the practice of related material. Integration of theory with clinical situations will enable the student to see the concept and apply it in clinical practice. Furthermore, integrating clinical competencies with other diagnostic reasoning assignments helps in knowledge enhancement. If not all areas are integrated, then theoretical learning can be transformed from meaningful material with an emphasis on its treatment throughout the academic year and even throughout one's education, into material intended for preparation for a particular exam. New skills need to be supported by the curriculum; no longer is the curriculum capable of maintaining mechanical reproduction.

Promoting and expanding the utilization of the Place-Based Education methodology

It is therefore clear that the qualitative aspect of the REU dental program, experiential learning, is another strength based on the good clinical scores at all levels. Phantom lab training or simulation, patient-based teaching, and supervised clinical sessions provide some of the best times for students to develop practical skills, confidence, and efficiency. However, they have to be utilized as vehicles for theory reinforcement as well. It is paramount for the students to think: while doing, they need to explain why a certain diagnosis fits; they need to know the other diagnoses that were not entertained; and the theoretical rationales for the decisions made. This can be done by the faculty, forcing the students to reflect on procedures through asking questions. It is recommended that debriefings follow the clinical part, wherein students justify their decisions based on academic knowledge. Furthermore, including reflective questions or concept mapping before or after a clinical

activity can provide an application of theoretical underpinning to practical skills where required. Taking from the context of the evaluation of learning, it therefore implies that learning should be both procedurally and cognitively experiential. When integrated with structured reflection, it can provide the link between the "doing" and the "knowing" that will complement the clinical development of judgment.

Study limitations

Nevertheless, this study has some limitations, which are discussed below, although such limitations are not unique to this research. However, the following are the main methodological limitations that could have influenced the study findings to some extent: First, the study was conducted in only one institution, Riyadh Elm University, and thus the findings might not be generalizable to other institutions. The delivery mode of education, the resources to be used, and the target student populations may vary in other universities. Secondly, the given analysis considered only endodontics, thereby excluding the possibilities of having the findings relevant to other fields of dentistry, for example, prosthodontics or periodontology. Also, focusing simply on the grades as a measure of accomplishment will allow for attributes such as critical thinking, ethical judgment, and communication skills. The main drawback of this assessment method includes: There is no direct feedback from the students. It would have been more beneficial to include the views of the students or the faculty members through interviews or questionnaires. At last, it is outlined that the study is cross-sectional and does not enable us to track the subjects over a period of time. Nonetheless, the gathered data can be seen as sufficient to carry on the further investigations gracefully. The way forward for filling such gaps in the future is for research in dental education effectiveness to be more profound.

Suggestions for future research

Thus, it is necessary to expand in both scope and method the future investigations of the theory-practice relationship in the context of dental education. It might be effective to use both quantitative analysis of students' academic performance and results of qualitative research in the form of interviews or focus groups. The study of students from their academic years up to the clinical phase would help in establishing when the disparity occurs. They could also involve multiple institutions so as to develop benchmarking against different models of delivery systems. There is a need to build new knowledge regarding teaching methods such as flipped classrooms, interprofessional collaboration, and learning portfolios. It would be helpful to review factors such as exam stress and perceived capability levels, as they may create unanticipated obstacles in theory and practice. Moreover, adding more than one dental field of study to the curriculum evaluation would provide a more detailed view of performance. Such lines of investigation could greatly inform future curriculum development and lead to research-backed educational policies across dental schools.

Practical recommendations for educational reform

According to the results of this study, several practicable alterations are suggested to enhance the students' approach to THEORETICAL: Clinical competencies balance. First of all, curriculum designers should always connect the theoretical information introduced to the learners with the clinical realities. One way to enhance this integration may be to co-teach these two program components with both academic and clinical faculty. Mileages from assessment should move away from rote knowledge toward components such as OSCEs, case-based questions, and the native oral defense of clinical circumstances. To complement this, purposeful and meaningful reflective chores should be adopted with a view to enhancing reflective acknowledgment of the main reason as to why they did what they did. Mentors in clinical practice should encourage students to justify the reasons for their actions towards patients from time to time. Other approaches, such as integrated approaches or putting theory into practice, also help in increased depth of learning. Assessment feedback should not only be based on the performance criteria linked to measurable performance indicators, but also on the subject matter knowledge. In addition, it would also be appropriate to emphasize that in order to hold successful faculty development programs, educators need to be prepared in the principles of integrative teaching strategies. Such

changes can help in developing graduates who have procedural training as well as the theoretical understanding that facilitates analytical clinical reasoning [13].

Conclusion

This research work assessed the relationship between the theoretical mastery and clinical performance of dental students of Riyadh Elm University, and found that there is a consistent and statistically significant improvement between these two areas of performance. A significant difference in performance levels was observed between the practical and theoretical assessment scores, with the gap widening from lower to higher academic years. There was no significant gender variation, indicating that the issue is structural rather than individual. In line with prior research, the findings suggest that there is a requirement for a new educational system that is in sync with bookish knowledge as well as practical knowledge. The current appointment training environment is therefore satisfactory at generating procedural confidence, while theoretical learning is shipped out and lacks a practice context. To this end, it is recommended that an integrative mode of teaching be adopted, including case-based learning, reflective practice, and applied assessments that bridge the gap between theory and practice. Doing so would not only allow them to acquire knowledge but also improve their diagnostic thinking and judgment in practical contexts. Therefore, connecting theory with practice would eventually lead to the development of highly competent and productive dentists capable of delivering safe, ethical, and evidence-based care.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: This study received an ethical approval # FUGRP/2025/413/1254/1136 (Riyadh Elm University).

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