

# Evaluating the Impact of Preclinical and Clinical Exposure to the Pediatric Pulpotomy Procedure on Confidence Among Senior Dental Students: An Analytical Survey Study

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**Purpose:** This study evaluated senior dental students' confidence in their knowledge and clinical skills in performing pulpotomy procedures on primary molars based on the number of procedures performed on pediatric patients and/or extracted primary teeth.

**Methods:** An electronic survey was validated and modified from the National League of Nursing (NLN) questionnaire and was used to assess the student's satisfaction with past learning and self-confidence in performing pulpotomy on pediatric patients and primary extracted teeth. The questionnaire comprised 29 questions across six sections outlining various clinical experience and knowledge acquisition aspects. The target sample was senior dental students enrolled at a governmental dental school during the 2023–2024 academic year, which were 369 students who were recruited for this study. The association between knowledge and clinical experience of performing pulpotomies and self-confidence was analyzed using a chi-square test. The association between knowledge and practical/clinical experience and the competency grade was performed using an independent sample *t*-test and ANOVA ( $\alpha = 0.05$ ).

**Results:** Of the targeted subjects, 215 responded to the questionnaire, yielding a response rate of 66.3%. A significant association was found between the number of procedures performed on pediatric patients and students' confidence levels ( $p < 0.001$ ), as well as between competency grades and confidence levels ( $p < 0.001$ ). In contrast, the number of times they practiced pulpotomy on extracted teeth did not significantly affect their confidence level ( $p = 0.381$ ). No significant association existed between knowledge scores and confidence levels ( $p = 0.869$ ). Those who reported better learning experiences were more likely to report higher confidence levels ( $p < 0.001$ ).

**Conclusion:** The number of pulpotomy procedures performed on pediatric patients significantly impacted students' confidence levels, while knowledge scores showed no correlation with confidence. A positive relationship between competency grades and confidence. These findings underscore the importance of practical training in enhancing both clinical skills and confidence in performing clinical procedures.

**Keywords:** dentistry, dental procedures, confidence, dental interns, clinical experience, theoretical knowledge, pediatric dentistry

## Introduction

Dentistry is a distinctive health occupation that harmoniously integrates artistic and scientific elements in delivering patient health care.<sup>1</sup> Dentists must possess diverse expertise, including knowledge of science and medicine, social intelligence, and artistic skills.<sup>1</sup> In their multifaceted role, dentists face critical challenges in managing and preventing dental caries.

Dental caries is the most prevalent oral disease worldwide. It is commonly seen in daily dental practice and is a major cause of oral pain in children.<sup>2,3</sup> It dramatically affects their well-being and quality of life, including social, functional, and emotional aspects.<sup>4</sup> As a multifactorial and dynamic disease, dental caries begins with surface demineralization of the dental hard tissues,<sup>5,6</sup> progresses to cavitation and pulp involvement if untreated, and<sup>7</sup> can result in pain, swelling, and systemic symptoms.<sup>7</sup>

Pulpal therapy, including pulpotomy and pulpectomy, was developed to prevent the progression of dental caries and preserve tooth structure.<sup>8,9</sup> Pulpotomy is performed after pulp exposure due to caries or trauma and involves removing the coronal pulp, managing bleeding, and applying medicaments like mineral trioxide aggregate (MTA) or formocresol.<sup>9</sup> The treated tooth is then sealed with a stainless-steel crown to prevent reinfection.<sup>9</sup> The American Academy of Pediatric Dentistry recommends pulpotomy as the preferred treatment for pulpally involved but symptom-free primary molars to maintain them until normal exfoliation.<sup>9</sup> This underscores the importance of comprehensive clinical skills in dental education.

The high prevalence of untreated dental disease in children underscores the critical need for general dentists to address this issue, beginning with the foundational education of dental students in pediatric dentistry.<sup>10,11</sup> Despite this, research shows that dental students often engage in fewer restorative procedures, extractions, and pulp therapies, placing more emphasis on preventive care.<sup>11–13</sup> This deficit in hands-on experience with specific treatments can adversely affect students' confidence in clinical practice.<sup>14</sup> A recent systematic review revealed that the prevalence of dental caries among children in Saudi Arabia aged 5–7 years and 12–15 years were 84% and 72%, respectively, further emphasizing the urgency of equipping future dentists with the necessary skills to manage such widespread oral health issues.<sup>15</sup> A study from the University of Jordan highlights a strong correlation between academic achievement and clinical performance,<sup>16,17</sup> yet practical performance depends on more than intellectual abilities; it also requires social intelligence and personal attributes, which are critical for developing cognitive and psychomotor skills.<sup>16–18</sup>

Practical courses in dental curricula are intentionally designed to complement theoretical components, ensuring students acquire essential knowledge and procedural steps for various dental treatments.<sup>16,19</sup> Clinical training, particularly in pediatric dentistry, is critical. This is vital in giving students the hands-on experience needed for competence.<sup>19</sup> However, transitioning from theory to practice presents challenges, as factors such as patient cooperation can impact students' performance and confidence, affecting their ability to deliver optimal care.<sup>20</sup> The dental program at King Abdulaziz University in Jeddah, Saudi Arabia, is a six-year program that exemplifies integrating theory and practice. Students are first exposed to lectures on pulpotomy in their fifth year, followed by preclinical lab sessions where they practice the procedure on extracted teeth to familiarize themselves with the steps. However, the pulpotomy procedure on pediatric patients in the fifth year is optional. In the sixth year of the program, it is mandatory for students to perform the pulpotomy procedure on pediatric patients in the clinic. In Saudi Arabia, the high prevalence of dental caries often necessitates pulpotomy procedures to preserve the teeth of pediatric patients. To ensure graduates are competent in managing such cases, the dental program requires sixth-year students to perform the pulpotomy procedure successfully on pediatric patients as part of their clinical training to fulfill the program's graduation requirements.

Consultants supervising each step evaluate and assess the procedure using a validated rubric. As part of the training, the consultant provides detailed feedback following the procedure, discussing the student's performance and highlighting areas of strength and areas that need improvement. This structured approach ensures students are equipped with the theoretical knowledge and practical experience to perform procedures independently, aligning with the standards emphasized by the United Kingdom General Dental Council (GDC), which stresses that new graduates should possess sufficient theoretical knowledge to perform procedures independently.<sup>21</sup> Graduate students are expected to have theoretical knowledge paired with limited experiential practice, ensuring they are familiar with the procedures and have acquired an essential basic understanding of them.<sup>21</sup> Students can undertake a clinical competency examination following initial clinical exposure to pulpotomy procedures. However, the mandatory nature of the competency can sometimes pressure students into attempting the exam before they feel adequately prepared or confident in their abilities.

Confidence is a crucial component of any teaching program that aims to deliver effective patient care.<sup>22</sup> Self-confidence in performing dental procedures is an essential educational outcome.<sup>23</sup> The literature indicates a complex relationship between dental students' confidence and their performance in clinical procedures. While some studies found a positive correlation between self-confidence and clinical performance,<sup>24,25</sup> others reported no significant correlation. A study in the United Kingdom found that limited clinical exposure results in a lack of confidence in performing specific treatments.<sup>12</sup> Moreover, student performance, ability to execute tasks, and confidence are closely linked to their education quality.<sup>26</sup> Curriculum changes and outreach programs have improved students' confidence levels.<sup>27</sup> Students generally feel more confident in basic procedures like direct restorations and simple endodontic treatments and less confident in

complex procedures such as indirect restorations and managing patients with special needs.<sup>22,28</sup> The literature suggests fostering supportive learning environments, integrating self-assessment into curricula, and providing adequate clinical exposure to enhance student confidence.<sup>29,30</sup> Another study showed that dental students exhibited high self-confidence in light-curing procedures, but their theoretical knowledge was not retained. This suggests that practical training effectively builds confidence, which is essential for clinical performance. However, to ensure comprehensive competency in patient care, it is crucial to reinforce theoretical understanding alongside practical skills, fostering a supportive learning environment that enhances confidence and knowledge.<sup>31</sup>

The COVID-19 pandemic substantially impacted dental healthcare systems globally, particularly affecting dental education and clinical training.<sup>32</sup> A key consequence was the reduction in parents bringing their children to dental schools, driven by concerns about virus transmission during aerosol-generating procedures.<sup>33,34</sup> This decline in patient attendance limited dental students' clinical exposure, preventing them from performing essential procedures such as preventive and restorative treatments.<sup>35</sup> Consequently, there were concerns about the long-term effects on students' clinical competence and training.<sup>36</sup> To address this, dental schools adapted by allowing students to perform certain procedures on natural or typodont teeth in the absence of patients.<sup>36</sup> Furthermore, securing cooperative or suitable patients for the procedure presents a challenge for some students, prompting them to practice on extracted teeth as an alternative.

Undergraduate training for performing pulpotomy procedures on pediatric patients includes theoretical learning, pre-clinical practice on extracted or plastic teeth under supervision, and clinical practice on patients in a hospital setting.<sup>22,37</sup> Proper training and confidence play a crucial role in the effectiveness of dental care provided to pediatric patients with diverse clinical conditions.<sup>38</sup> The existing literature fails to provide sufficient evidence regarding the frequency of clinical exposure to the pulpotomy procedure, the level of knowledge, and the learning experience impact on confidence and proficiency level in executing the pulpotomy procedure. Therefore, this study aims to assess senior dental students' confidence in their knowledge and clinical skills in performing pulpotomy procedures on primary molars. Specifically, it will examine how the number of pulpotomy procedures performed on pediatric patients and/or extracted primary teeth in the final two years of their dental education correlates with their self-reported confidence.

The null hypothesis is that there is no significant relationship between the number of pulpotomy procedures performed by senior dental students on pediatric patients and/or extracted primary teeth, their knowledge of the procedure, and their confidence in performing it.

## Materials and Methods

Ethical approval was obtained from the Research Ethical Committee at King Abdulaziz University Faculty of Dentistry (KAUFD) (approval no. 198–11-23). The inclusion criteria for this study encompassed senior dental students enrolled at KAUFD during the 2022–2023 and 2023–2024 academic years, those who had started their internship year, and recent graduates who had completed the sixth year of the dental program, respectively, totaling to 369 students. The exclusion criteria involved those enrolled in years preceding or following the specified academic period and those not wishing to participate in the study.

An electronic questionnaire was created using Google Forms (Google Forms, a free online survey tool, is a product developed and maintained by Google LLC, headquartered in Mountain View, California, USA). Informed consent was obtained from all senior students prior to their participation in the survey, with participation confirmed by students completing and submitting the survey after agreeing to the consent statement. The survey was designed to maintain confidentiality, ensuring no questions or collected data could identify participants. Each student was assigned a unique code solely for correlation purposes. This approach preserved participant anonymity while ensuring convenience, data security, and voluntary participation.

The electronic survey, modified from the National League of Nursing (NLN) questionnaire, was used for data collection to assess the student's satisfaction with past learning and self-confidence in performing pulpotomy on pediatric patients and primary extracted teeth.<sup>39</sup> The modifications to the questionnaire were designed to adapt the original nursing-related questions to be specific to pulpotomy procedures, ensuring relevance and accuracy in the context of dental education. After modifying the survey instrument, a comprehensive content validation process ensued, followed

by face and content validation by performing a pilot study. The final version of the questionnaire, which incorporated all necessary modifications, comprised 29 questions across six distinct sections outlining various aspects of clinical experience and knowledge acquisition. Section 1 focused on gathering demographic data (4 questions), categorizing senior dental students into categories based on their practical/clinical experience levels practicing pulpotomies extraorally on extracted primary molars and on pediatric patients in undergraduate education over the past two years. The student experience groups were divided as follows: low performance (0–1), medium performance (2), and high performance ( $\geq 3$ ) of pulpotomy procedures. Section 2 (10 questions) delved into assessing self-reported level of satisfaction with clinical learning experiences. The provided data presents the feedback and perceptions of dental students regarding the teaching methods, materials, and instructors' effectiveness in educating them about pulpotomies on primary molars. The responses were collected using a Likert scale, with options ranging from "strongly disagree" to "strongly agree" for statements related to the helpfulness, effectiveness, motivation, and suitability of both teaching methods and materials. Section 3 (8 questions) aimed to evaluate self-confidence in executing pulpotomy procedures on pediatric patients. Students were asked about their confidence in performing pulpotomies, receiving critical instructions, and retaining and utilizing the skills they learned and theoretical knowledge of pulpotomy. Section 4 (3 questions) incorporated three questions of this nature. Furthermore, Section 5 (3 questions) was dedicated to inquiries regarding the reception of supplementary information on pulpotomy and identifying sources through which senior dental students acquired such knowledge. Finally, Section 6 (1 question) offered an optional open-ended segment, allowing senior dental students to provide qualitative insights and reflections on their learning encounters and levels of self-assurance, [Appendix 1](#). Data was collected over three months. The survey was distributed to the target dental students through a quick response code (QR code) generated explicitly for this purpose.

The competency grades for each student's pulpotomy procedures during the dental program were collected with proper authorization from the relevant official channels. To maintain confidentiality, each student was assigned the same unique code as in the survey, and all identifying information, such as names, was removed. The correct answers to the three knowledge questions were summed up as the knowledge score, and the responses to the learning experience questions were summed up to create a learning experience score. The number of pulpotomy procedures performed on pediatric patients and those carried out on extracted teeth were combined with knowledge and learning experience scores to evaluate their overall association with confidence levels. Additionally, the combined effect of these variables on competency scores was analyzed to assess their impact on student performance.

Data were analyzed using SPSS version 20.0 (IBC SPSS Statistics for Windows, Armonk, NY, USA). No sample size calculations were made because all target subjects were invited to participate. The confidence level in performing pulpotomies responses was categorized as 1) Confident, 2) Partially confident, and 3) Not confident. Later, the second and third categories were combined because very few respondents answered that they were not confident. The chi-square test evaluated the association between knowledge and practical/clinical experience of performing pulpotomies and self-confidence. Data normality was assessed by visual inspection of the Q-Q plots. Independent sample *t*-test and ANOVA were used to compare the competency grades by level of knowledge, practical/clinical experience, and confidence ( $\alpha = 0.05$ ).

## Results

Of all the targeted subjects ( $n=369$ ), 215 responded to the questionnaire, yielding a response rate of 66.3%. About half of the respondents were males (47.9%). [Table 1](#) illustrates the educational hands-on experience the participants had with practicing the pulpotomy procedure extra orally on primary extracted molars and performing the pulpotomy on patients during their undergraduate education. Regarding practicing pulpotomy on primary extracted teeth, about half of the participants never (16.3%) or only once (35.3%) practiced pulpotomy on extracted teeth. In comparison, 20.5% practiced two times, and 27.9% practiced three times or more. When asked about the number of pulpotomies they performed on pediatric patients, 38.1% performed it once only, 24.2% performed it twice, and 37.7% performed it three times or more. When the participants were asked questions to explore their knowledge about the correct method of performing pulpotomies, most answered them correctly. More than one-third of the participants stated that their source of knowledge about the pulpotomy procedure was lectures (39.1%) and social media (36.7%). Only 19.5% reported their source of knowledge to be articles, and 11.6% reported books ([Table 2](#)).

**Table 1** Numbers of Pulpotomies Practiced and/or Performed per Student

| Question                                                                                                                                 | Categories | n (%)     |
|------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------|
| How many times did you practice pulpotomies extraorally on extracted primary molars in the undergraduate education (fifth or sixth year) | 0          | 35 (16.3) |
|                                                                                                                                          | 1          | 76 (35.3) |
|                                                                                                                                          | 2          | 44 (20.5) |
|                                                                                                                                          | 3 or more  | 60 (27.9) |
| How many pulpotomies on primary molars you performed in the undergraduate education (fifth or sixth year) on pediatric patient           | 0 or 1     | 82 (38.1) |
|                                                                                                                                          | 2          | 52 (24.2) |
|                                                                                                                                          | 3 or more  | 81 (37.7) |

**Table 2** Knowledge About the Pulpotomy Procedure and Exposure to Educational Material Among Participants

| Question                                                                                                                                                                  | Options                                       | n (%)      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------|
| In the pulpotomy procedure for primary molars, which type of bur is recommended for the removal of the coronal pulp chamber?                                              | Low speed round bur*                          | 165 (76.7) |
|                                                                                                                                                                           | High speed round bur                          | 37 (17.2)  |
|                                                                                                                                                                           | High speed fissure bur                        | 2 (0.9)    |
|                                                                                                                                                                           | Low speed fissure bur                         | 3 (1.4)    |
|                                                                                                                                                                           | High speed 330 bur                            | 8 (3.7)    |
| For how long should formocresol be applied during a pulpotomy procedure?                                                                                                  | 5 minutes*                                    | 184 (85.6) |
|                                                                                                                                                                           | 5 seconds                                     | 15 (7.0)   |
|                                                                                                                                                                           | 15 seconds                                    | 15 (7.0)   |
|                                                                                                                                                                           | 10 minutes                                    | 1 (0.5)    |
| What is the indication for pulpotomy treatment in primary molars?                                                                                                         | Carious exposure in vital asymptomatic tooth* | 189 (87.9) |
|                                                                                                                                                                           | Pulp necrosis                                 | 12 (5.6)   |
|                                                                                                                                                                           | Tooth almost exfoliating                      | 3 (1.4)    |
|                                                                                                                                                                           | Non-restorable tooth                          | 1 (0.5)    |
|                                                                                                                                                                           | Presence of swelling or fistula               | 10 (4.7)   |
| Have you been exposed to any educational material regarding pulpotomy in primary molars in the past two years other than the lecture taken in your fifth-year curriculum? | Books                                         | 25 (11.6)  |
|                                                                                                                                                                           | Lectures                                      | 84 (39.1)  |
|                                                                                                                                                                           | Scientific articles                           | 42 (19.5)  |
|                                                                                                                                                                           | Conferences                                   | 14 (6.5)   |
|                                                                                                                                                                           | Workshops                                     | 20 (9.3)   |
|                                                                                                                                                                           | Social media                                  | 79 (36.7)  |
|                                                                                                                                                                           | Other                                         | 8 (3.7)    |

**Notes:** \* Asterisks represent the correct answer. ©Copyright, National League for Nursing, 2022.

When the participants were asked about their learning experience with pulpotomy procedures during their undergraduate education, the majority agreed or strongly agreed that the teaching methods and teaching materials were helpful, effective, motivating, and suitable to how they learn. Most also reported that their instructors used helpful resources and gave valuable feedback. Most participants expressed confidence that their undergraduate learning experiences had adequately prepared them to perform pulpotomies in their future practice, enhancing their overall confidence in the procedure (Table 3).

The participants were asked about their current confidence level when performing pulpotomies on pediatric patients, and 58.1% reported that they were confident. In comparison, 41.9% said they were partially or not confident. Table 4 assesses the effects of different elements of the educational experience on the current confidence in performing pulpotomy. Performing higher numbers of pulpotomies on pediatric patients was significantly associated with an increase in the reported confidence level ( $p < 0.001$ ). In contrast, the number of times they practiced pulpotomy on extracted teeth did not significantly affect the confidence level ( $p = 0.381$ ). When the correct answers to the three knowledge questions were summed up as the knowledge score, it was not associated with the confidence level. Also, when responses to the learning experience questions were summed up to create a learning experience score, those who reported higher learning experiences were more likely to report higher confidence levels ( $p < 0.001$ ). When the knowledge and learning experience scores were combined, the combined score was also associated with the confidence level, where higher scores were associated with higher confidence levels, and vice versa ( $p < 0.001$ ).

The effects of different elements of the educational experience on the student's competency grades were also assessed in Table 5. The participants' grades increased with increasing pulpotomies performed on pediatric patients ( $p < 0.001$ ) and with increased confidence ( $p < 0.001$ ). However, the grades improved with a lower number of practiced pulpotomies on extracted teeth ( $p < 0.001$ ), lower learning experience scores ( $p < 0.001$ ), and lower combined scores ( $p < 0.001$ ).

**Table 3** The Satisfaction With Past Learning and Self-Confidence About Pulpotomy Questions and Responses

| <b>Satisfaction with Past Learning</b>                                                                                                         |                          |                 |                  |              |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------|------------------|--------------|-----------------------|
| <b>The Teaching Methods used When Teaching Me about Pulpotomy on Primary Molars</b>                                                            | <b>Strongly Disagree</b> | <b>Disagree</b> | <b>Undecided</b> | <b>Agree</b> | <b>Strongly Agree</b> |
| Helpful                                                                                                                                        | 10 (4.7)                 | 4 (1.9)         | 14 (6.5)         | 67 (31.2)    | 120 (55.8)            |
| Effective                                                                                                                                      | 10 (4.7)                 | 8 (3.7)         | 15 (7.0)         | 76 (35.3)    | 106 (49.3)            |
| Motivating                                                                                                                                     | 11 (5.1)                 | 14 (6.5)        | 33 (15.3)        | 59 (27.4)    | 98 (45.6)             |
| Suitable to the way I learn                                                                                                                    | 11 (5.1)                 | 13 (6.0)        | 19 (8.8)         | 71 (33.0)    | 101 (47.0)            |
| <b>The teaching materials used (Plastic teeth and extracted teeth in the preclinical lab course) to teach me how to do pulpotomy correctly</b> | <b>Strongly disagree</b> | <b>Disagree</b> | <b>Undecided</b> | <b>Agree</b> | <b>Strongly agree</b> |
| Helpful                                                                                                                                        | 8 (3.7)                  | 13 (6.0)        | 19 (8.8)         | 66 (30.7)    | 109 (50.7)            |
| Effective                                                                                                                                      | 9 (4.2)                  | 15 (7.0)        | 19 (8.8)         | 70 (32.6)    | 102 (47.4)            |
| Motivating                                                                                                                                     | 11 (5.1)                 | 17 (7.9)        | 26 (12.1)        | 61 (28.4)    | 100 (46.5)            |
| Suitable to the way I learn                                                                                                                    | 12 (5.6)                 | 13 (6.0)        | 18 (8.4)         | 70 (32.6)    | 102 (47.4)            |
| <b>The instructors who taught (teach) you about pulpotomy on primary molars</b>                                                                | <b>Strongly disagree</b> | <b>Disagree</b> | <b>Undecided</b> | <b>Agree</b> | <b>Strongly agree</b> |
| Used helpful resources to teach me                                                                                                             | 10 (4.7)                 | 3 (1.4)         | 11 (5.1)         | 72 (33.5)    | 119 (55.3)            |
| Gave me useful feedback                                                                                                                        | 12 (5.6)                 | 5 (2.3)         | 22 (10.2)        | 53 (24.7)    | 123 (57.2)            |

(Continued)



**Table 3** (Continued).

| <b>Self-confidence</b>                                                                               |                          |                 |                  |              |                       |
|------------------------------------------------------------------------------------------------------|--------------------------|-----------------|------------------|--------------|-----------------------|
| <b>Regarding performing pulpotomy in primary molars, I am confident that</b>                         | <b>Strongly disagree</b> | <b>Disagree</b> | <b>Undecided</b> | <b>Agree</b> | <b>Strongly agree</b> |
| I was comfortable using preclinical simulation activities (pulpotomy on plastic and extracted teeth) | 8 (3.7)                  | 11 (5.1)        | 18 (8.4)         | 61 (28.4)    | 117 (54.4)            |
| My instructors gave me useful feedback after the exercise                                            | 8 (3.7)                  | 5 (2.3)         | 22 (10.2)        | 62 (28.8)    | 118 (54.9)            |
| I have mastered the content that my instructors taught me                                            | 7 (3.3)                  | 11 (5.1)        | 32 (14.9)        | 77 (35.8)    | 88 (40.9)             |
| I obtained the required knowledge                                                                    | 6 (2.8)                  | 6 (2.8)         | 32 (14.9)        | 77 (35.8)    | 88 (40.9)             |
| I have developed the required skills                                                                 | 6 (2.8)                  | 11 (5.1)        | 27 (12.6)        | 84 (39.1)    | 87 (40.5)             |
| I received critical instructions necessary for me in the clinic                                      | 6 (2.8)                  | 9 (4.2)         | 29 (13.5)        | 73 (34.0)    | 98 (45.6)             |
| I remember now (in internship year) what I was taught two years ago (in fifth year)]                 | 9 (4.2)                  | 11 (5.1)        | 26 (12.1)        | 74 (34.4)    | 95 (44.2)             |
| I use now (internship year) the skills that I learned two years ago (in fifth year)                  | 8 (3.7)                  | 8 (3.7)         | 29 (13.5)        | 63 (29.3)    | 107 (49.8)            |

**Table 4** Effect of Number of Pulpotomies Performed on Patients, Knowledge, and Learning Experience on the Confidence Level of Performing Pulpotomy

| <b>Question</b>                                                     | <b>Categories</b> | <b>Confident</b> | <b>Partially or not Confident</b> | <b>p-value</b> |
|---------------------------------------------------------------------|-------------------|------------------|-----------------------------------|----------------|
| Number of pulpotomies performed on patients in fifth and sixth year | 0 or 1            | 31 (37.8)        | 51 (62.2)                         | <0.001*        |
|                                                                     | 2                 | 29 (55.8)        | 23 (44.2)                         |                |
|                                                                     | 3 or more         | 65 (80.2)        | 16 (19.8)                         |                |
| Number of times practiced pulpotomy on extracted teeth              | 0                 | 25 (71.4)        | 10 (28.6)                         | 0.381          |
|                                                                     | 1                 | 42 (55.3)        | 34 (44.7)                         |                |
|                                                                     | 2                 | 25 (56.8)        | 19 (43.2)                         |                |
|                                                                     | 3 or more         | 33 (55.0)        | 27 (45.0)                         |                |
| Knowledge score                                                     | 0–2 (low)         | 50 (58.8)        | 35 (41.2)                         | 0.869          |
|                                                                     | 3 (high)          | 75 (47.7)        | 55 (42.3)                         |                |
| Learning experience score                                           | 5–70              | 24 (40.0)        | 36 (60.0)                         | <0.001*        |
|                                                                     | 71–80             | 35 (54.7)        | 29 (45.3)                         |                |
|                                                                     | 81–90             | 66 (72.5)        | 25 (27.5)                         |                |
| All (combined)                                                      | 5–78              | 26 (36.1)        | 46 (63.9)                         | <0.001*        |
|                                                                     | 79–92             | 42 (60.0)        | 28 (40.0)                         |                |
|                                                                     | 93–105            | 57 (78.1)        | 16 (21.9)                         |                |

**Notes:** Chi-square test. \*Statistically significant ( $p < 0.05$ ).

**Table 5** Effect of Number of Pulpotomies Performed on Patients, Knowledge, Learning Experience, and Confidence on the Pulpotomy Competency Grade (Out of 10)

| Parameter                                                           | Score                    | n   | Mean $\pm$ SD    | p-value  |
|---------------------------------------------------------------------|--------------------------|-----|------------------|----------|
| Number of pulpotomies performed on patients in fifth and sixth year | 0 or 1                   | 82  | 7.2 $\pm$ 1.2 a  | <0.001*‡ |
|                                                                     | 2                        | 52  | 8.6 $\pm$ 0.9 b  |          |
|                                                                     | 3 or more                | 81  | 9.1 $\pm$ 0.9 c  |          |
| Number of times practiced pulpotomy on extracted teeth              | 0                        | 35  | 9.1 $\pm$ 0.8 a  | <0.001*‡ |
|                                                                     | 1                        | 76  | 8.3 $\pm$ 1.2 b  |          |
|                                                                     | 2                        | 44  | 7.9 $\pm$ 1.3 b  |          |
|                                                                     | 3 or more                | 60  | 7.9 $\pm$ 1.6 b  |          |
| Knowledge score                                                     | 0–2 (low)                | 85  | 8.1 $\pm$ 1.5    | 0.122†   |
|                                                                     | 3 (high)                 | 130 | 8.4 $\pm$ 1.2    |          |
| Learning experience score                                           | 5–70                     | 60  | 8.5 $\pm$ 1.1 a  | 0.006*‡  |
|                                                                     | 71–80                    | 64  | 8.5 $\pm$ 1.2 a  |          |
|                                                                     | 81–90                    | 91  | 7.9 $\pm$ 1.5 b  |          |
| Combined score (All)                                                | 5–78                     | 72  | 8.5 $\pm$ 1.1 a  | 0.014*‡  |
|                                                                     | 79–92                    | 70  | 8.4 $\pm$ 1.3 ab |          |
|                                                                     | 93–105                   | 73  | 7.9 $\pm$ 1.5 b  |          |
| Confidence level                                                    | Partial or not Confident | 90  | 7.9 $\pm$ 1.3    | <0.001*† |
|                                                                     | Confident                | 125 | 8.5 $\pm$ 1.3    |          |

**Notes:** †Independent sample t-test. ‡ANOVA. \*Statistically significant ( $p < 0.05$ ). The significant differences are among each category (parameter). Means that have different alphabetical letters within the same parameter are statistically different from each other at  $p < 0.05$  using Tukey post hoc test.

## Discussion

The survey used in this study included questions aimed at measuring knowledge, practical/clinical experience (expressed by the frequency of performed pulpotomy procedures), and learning experience. This approach recognizes that a combination of theoretical learning and practical experience is crucial for students to gain both the scientific foundation and the hands-on expertise necessary for their future careers in dentistry.<sup>40,41</sup>

The survey explores how different clinical experiences might influence the confidence levels of senior dental students from KAUFU. This rigorous delineation ensured the study's focus remained exclusively on the targeted cohort within the designated time frame, enhancing the research's coherence and academic integrity. Furthermore, this research provides valuable insights into the readiness of senior students to carry out specific pediatric dental procedures. The survey used a combination of open-ended and closed-ended questions. This structured approach aims to comprehensively capture senior dental students' perspectives and experiences. In addition, it collected qualitative and quantitative data and provided a comprehensive view of the senior dental students' experiences with the pulpotomy procedure over the past two years. When we asked senior dental students, it was clear that the transition from preclinical to clinical setting needed a step in between, more hands-on practice with their instructor as one-to-one for first exposure to the procedure in the clinic.

The null hypothesis was partially rejected because a positive relationship was identified between the frequency of pulpotomy procedures performed on pediatric patients and students' confidence levels, with increased clinical experience correlating with greater confidence. However, no significant relationship was observed between practice on extracted primary teeth and confidence levels, nor between theoretical knowledge scores and confidence. This indicates that hands-



on clinical experience is more impactful than preclinical practice or knowledge alone. Notably, students with higher confidence in performing pulpotomies also achieved higher competency grades.

The survey results indicated that senior dental students prefer lectures as their primary source of acquiring knowledge on pulpotomy, followed by social media, scientific articles, books, workshops, and, lastly, conferences. These findings demonstrate the growing role of digital resources in medical education. This finding matched the results of Oakley et al in 2012, Garrido et al in 2022, and Al-Obaidi in 2024.<sup>42-44</sup> Furthermore, this distribution reveals that senior dental students adopt a multifaceted approach to augmenting their understanding of pulpotomy procedures, integrating traditional academic resources, experiential learning, and contemporary digital platforms.

One of the study's main objectives was to examine the relationship between the number of pulpotomies performed by senior dental students over the past two years and their confidence levels. This analysis is crucial for understanding how the frequency of performing pulpotomies influences students' confidence and proficiency. The finding that senior dental students with more hands-on experience in the pulpotomy procedure on pediatric patients tend to exhibit higher confidence supports the idea that students need to complete a specific number of procedures to be confident in performing the procedure independently. Our results match the results of Hattar et al.<sup>22</sup>

The study results highlight the significant impact of learning experiences on senior dental students' confidence levels, aligning with findings by Hossain et al in 2023 and Thompson Stone et al in 2017.<sup>19,45</sup> This consistency across studies reinforces the notion that diverse and hands-on educational strategies are universally essential for building competence and self-assurance in dental education. Similarly, this evidence emphasizes the critical role of hands-on experience in building confidence among dental students, as highlighted by Hattar et al, who concluded that extensive experience with restorative procedures contributed to high confidence levels. However, the study also revealed a lack of confidence in other types of procedures, primarily due to limited experience.<sup>22</sup> Together, these findings underline the importance of comprehensive and varied practical experiences in fostering confidence and competence in dental students.

Dental education aims to effectively transfer learning experience through knowledge from lectures or laboratory practice to clinical practice. The primary objective of dental educators is to ensure that newly graduated individuals have the essential skills and confidence required for the commencement of their professional journeys. Our findings show that students with more practice have more confidence to carry out pulpotomy procedures, which matches results from multiple studies in the literature. For example, a 2020 study revealed that insufficient practice or experience can hinder the integration of knowledge and skills, thereby hindering knowledge transfer to clinical practice. More dental training and practice can help to improve this transfer. Furthermore, the study included dental education, which can be enhanced by integrating theoretical knowledge with practical application via stimulation or direct experience with actual patients.<sup>46</sup>

However, our results revealed no significant relationship between knowledge scores and confidence levels. This finding contrasts with the conclusions of Katowa-Mukwato et al 2014, which identified a positive correlation between knowledge and self-perceived competence.<sup>47</sup> They suggested that enhanced knowledge could strengthen self-concept regarding skills, subsequently improving performance. These discrepancies underscore the complex interplay between knowledge, practice, and confidence in dental education. Moreover, our findings suggest that students' confidence is multifactorial, with no single factor serving as a definitive predictor, highlighting the need for a comprehensive approach to fostering confidence in dental training.

The confidence levels of dental students naturally would vary. A literature review reveals limited research explicitly exploring students' confidence in different dental procedures.<sup>22</sup> Most studies tend to focus on confidence in general dental practices.<sup>23</sup> Research in Saudi Arabia has shown that there have been some efforts to study dental education and dental students' confidence levels.<sup>48</sup> A few studies found that dental students were confident in simple dental procedures and that this confidence grew through practical experience and assisted sessions. However, students needed more confidence when faced with more complex tasks, such as surgical extractions or veneers.<sup>22,48</sup> The data found in our study emphasize the importance of effective teaching methods, appropriate instructional materials, and supportive faculty in fostering confidence and competence among senior dental students when performing pulpotomy procedures. These findings are consistent with those reported in the paper by Meisha, D. E. et al.<sup>24</sup>

Our findings indicate that the frequency of pulpotomies carried out on pediatric patients or extracted teeth significantly influenced competency scores. More pulpotomy procedures were performed on patients, resulting in higher

competency grades. On the other hand, the more frequently the procedure was carried out on extracted teeth, the lower the competency grade was. These findings make sense since performing pulpotomy procedures on extracted teeth does not emulate the actual conditions where the competency assessment is exclusively carried out intra-orally on pediatric patients. This finding does not align with the results reported by Ragsdale JW, who found no correlation between performance and competency grades and stated that other factors may contribute to and affect the competency grades, which need to be explored.<sup>49</sup> The findings may be attributed to different study samples, where Ragsdale JW et al study was carried out on third-year medical students.

Results show no relationship between the frequency of clinical experience in performing pulpotomy procedures, knowledge, and clinical competency scores. This may be explained by the fact that some students may be knowledgeable but not necessarily skilled in performing the procedure. The findings match those of Liaw et al, which suggest that clinical experience alone is not a reliable indicator of a student's knowledge or competency scores related to the procedure.<sup>50</sup> A study found a moderate to weak positive correlation between dental students' didactic and psychomotor performance, with the strength of the correlation varying by course. Specifically, the study examined performance in dental anatomy and preclinical operative courses.<sup>51</sup>

Senior students have provided valuable feedback regarding their training experience, expressing a need for increased practical exposure before transitioning to clinical settings. Specifically, they have emphasized the importance of hands-on practice on plastic teeth or extracted specimens to facilitate memorizing procedural steps and materials. Moreover, they highlighted the significance of enhanced supervision, advocating for more personalized mentorship arrangements such as one-to-one interactions between students and supervisors. Furthermore, senior students have expressed a desire for continuity in their learning experiences, noting a preference for having the same supervisor in laboratory settings and clinical rotations. This continuity fosters familiarity and instruction consistency, enhancing the learning process. Additionally, senior students have underscored the pivotal role of actual patient encounters in building confidence and refining clinical skills. However, they regret the limited availability of suitable cases for hands-on practice, which challenges their skill development. Factors beyond where knowledge shapes the intricate nature of confidence. The data suggests that learning experiences—such as practical training, workshops, and other educational activities—can have a significant impact on enhancing confidence among senior dental students, and these findings align with those reported in the articles by Sjöström M et al and Elliott E et al.<sup>52,53</sup>

All previous results indicate that while knowledge is a crucial component of dental education, hands-on experience, and varied learning opportunities play a critical role in fostering confidence. This comprehensive approach helps senior dental students feel more confident in their skills, leading to better clinical outcomes and a smoother transition into professional practice.

Our findings found that there is a positive relationship between competency grades and senior dental students' confidence levels. Research suggests a complex relationship between clinical competency and student confidence in dental education. Community-based clinical training has increased dental students' confidence in treating pediatric patients, particularly for procedures like sealant placement and local anesthesia administration.<sup>38</sup> Final-year dental students generally report higher confidence in performing simple procedures than more complex ones.<sup>48</sup> While students with higher grade point averages (GPAs) demonstrated increased confidence in some procedures, such as oral hygiene instructions, fissure sealants, and preventive resin restorations. This correlation was inconsistent across all dental tasks.<sup>28</sup>

Integrating advanced diagnostic tools and mobile health applications (MHAs) can enhance senior dental students' confidence in performing different procedures on pediatric patients. Kaya et al 2022 demonstrated the potential of convolutional neural networks (CNNs) for automated detection and numbering of primary and permanent teeth in pediatric dental radiographs, achieving high precision. Incorporating such technology into dental education could streamline diagnostics, allowing students to focus on clinical procedures and improve their competence in pediatric dental care.<sup>54</sup> Similarly, Pascadopoli et al 2023 highlighted the effectiveness of MHAs in improving oral hygiene among children, reducing dental plaque, and alleviating dental anxiety.<sup>55</sup> Integrating MHAs during lectures and preclinical training could provide students with valuable resources for patient management and procedural techniques, thereby enhancing their confidence and readiness for clinical practice.

## Clinical Implications

The findings highlight the critical role of hands-on clinical experience in developing confidence among senior dental students for performing pulpotomy procedures, particularly on live pediatric patients. Clinical training programs should, therefore, emphasize increased exposure to real-life patient cases under guided supervision. The study also revealed that clinical experience on extracted primary teeth, regardless of frequency, does not compare to the experience gained from working on pediatric patients and does not positively impact students' confidence levels. This underscores the importance of prioritizing patient-centered training over simulated practice on extracted teeth. Structured opportunities for students to perform pulpotomies in diverse clinical scenarios, combined with supportive mentorship and constructive feedback, can refine procedural skills and build confidence, ultimately leading to better patient outcomes in pediatric dentistry.

## Academic Importance

From an academic perspective, the study underscores the necessity of aligning preclinical and clinical education to bridge gaps in skill development and self-confidence. The lack of a significant relationship between knowledge scores and confidence levels indicates that theoretical knowledge alone does not adequately prepare students for clinical practice. Moreover, the limited impact of practice on extracted teeth highlights the need for educational frameworks to focus on real patient-based training. Dental education curricula should integrate practical, scenario-based learning with traditional didactic approaches, ensuring students gain the confidence required for real-world applications. Revising assessment metrics to evaluate theoretical knowledge, clinical competency, and confidence is essential for fostering student readiness.

By addressing these clinical and academic priorities, dental education programs can better equip future practitioners with the confidence and competence needed to provide high-quality care, ensuring a smooth transition from training to independent practice.

This study's key strength lies in its novel approach, as no prior research in the current literature has investigated the complex relationship between the number and frequency of performed pulpotomy procedures (whether on pediatric patients or extracted teeth), learning experiences, and knowledge on confidence levels and competency scores. However, a limitation of the study is that it was conducted at a single university, which may restrict the generalizability of the findings. Future research could achieve broader and more robust results, including multicenter studies involving diverse educational settings.

## Conclusion

The confidence level of senior dental students was significantly influenced by the number of pulpotomy procedures performed, especially on pediatric patients rather than extracted primary molar teeth. Additionally, positive learning experiences were found to enhance confidence levels. However, there was no significant relationship between knowledge scores and confidence levels. These findings emphasize the need for an educational framework that prioritizes practical training, personalized mentorship, and a smooth transition from pre-clinical to clinical settings. By addressing these elements, dental education can ensure the comprehensive development of student's skills and confidence in performing essential procedures like pulpotomy. This approach strengthens training strategies and highlights the ongoing importance of skill development initiatives to ensure the readiness and confidence of future dental professionals.

## Abbreviations

MTA, mineral trioxide aggregate; KAUFU, King Abdulaziz University Faculty of Dentistry; NLN, National League of Nursing. QR code, quick response code. GPAs, grade point average. MHAs, mobile health applications. CNN, Convolutional neural network.

## Acknowledgments

The authors would like to thank the senior dental students of the KAUFU for participating in the research study. They would also like to express sincere gratitude to Dr. Afnan O. Al-Zain for her assistance with different parts of the project and Dr. Osama Felemban for his invaluable assistance with the statistical analysis for this study. Their expertise and support greatly contributed to the successful completion of this research.

## Funding

There is no funding to report.

## Disclosure

The authors declare no conflicts of interest in this work.

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