

# Introducing a Comprehensive Care Model in Clinical Undergraduate Dental Education at Liaquat University of Medical and Health Sciences Jamshoro: A Comparative Assessment of Undergraduates' Self-Perceived Preparedness

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## Abstract

**Background:** We hypothesized that comprehensive care clinic exposed students report higher self-perceived preparedness in both procedural and professional domains of the Dental Undergraduates Preparedness Assessment Scale (DU-PAS) than students in fragmented clinical postings.

**Materials and Methods:** Quantitative, cross-sectional, multi-institutional comparative design at Institute of Dentistry, Liaquat University of Medical and Health Sciences. Final year Bachelor of Dental Surgery (BDS) students from four dental colleges in Pakistan were recruited using convenience sampling, including one institution (LUMHS) that implemented an integrative CCC rotation and compared with students from three institutions with conventional, discipline-based clinical rotations. Preparedness was assessed using the validated DU-PAS instrument. Scores were compared using Kruskal–Wallis and Dunn's tests.

**Results:** A total of 166 students participated. LUMHS students had the highest mean ranks in radiographic prescription ( $p=0.005$ ), periodontal treatment ( $p=0.013$ ), caries management ( $p=0.011$ ), and multidisciplinary treatment planning ( $p=0.004$ ). They had the lowest mean ranks in single-rooted ( $p=0.031$ ) and multi-rooted endodontics ( $p=0.001$ ) and crowns ( $p=0.006$ ). Six of 26 professionalism and communication items differed significantly, all highest at LUMHS. Part A scores did not differ across institutions ( $p=0.165$ ); Part B ( $p=0.020$ ) and total scores ( $p=0.023$ ) did, with LUMHS highest.

**Conclusion:** A CCC rotation was associated with higher self-perceived preparedness in selected items, and with lower self-perceived preparedness in endodontics and crowns. Because only one institution offered the CCC, institutional differences may explain part of these results. Further longitudinal and multi-center studies are recommended to determine the long-term educational impact of comprehensive care models within diverse dental training environments.

**Keywords:** Clinical Competence; Competency-Based Education; Comprehensive Dental Care; Education, Dental; Pakistan; Students, Dental

## Introduction

Dental education is increasingly shifting toward approaches that promote integrated learning, critical thinking, and evidence-based decision-making.<sup>1–3</sup> Traditional department-based rotations provide isolated procedures and quota-driven requirements, resulting in fragmented clinical experiences that leave many graduates underprepared for multidisciplinary treatment planning and independent clinical practice as a general dental practitioner.<sup>4–8</sup>

The Comprehensive Care Clinic (CCC) model offers an alternative by enabling students to manage patients holistically, coordinate interdisciplinary treatment plans, and deliver care from diagnosis through completion by a single clinician.<sup>9,10</sup> Early studies suggest that such models enhance clinical confidence and promote patient-centered decision-making,<sup>11</sup> but evidence from low-resource contexts such as Pakistan remains limited.<sup>12,13</sup> These settings face unique barriers, including constrained infrastructure, variable faculty expertise, and reliance on traditional teaching models.<sup>14</sup>

To address these challenges, Liaquat University of Medical & Health Sciences (LUMHS) introduced a CCC posting for final-year BDS students to promote continuity of care, strengthen interdisciplinary planning, and enhance workplace-based learning. This model integrates core principles of competency-based education and aims

planning, and enhance workplace-based learning. This model integrates core principles of competency-based education and aims to provide a more coherent, realistic clinical learning experience. Because few multi-institutional comparative data are available in Pakistan, this study aimed to evaluate whether final-year students who completed a CCC rotation reported higher self-perceived preparedness than peers trained in conventional departmental rotations. We hypothesized that CCC-exposed students would score significantly higher in both procedural and professional domains of the Dental Undergraduates Preparedness Assessment Scale (DU-PAS).

## Materials and Methods

This study used a cross-sectional, comparative design with a naturally occurring exposure group. Final-year Bachelor of Dental Surgery (BDS) students from four Pakistani dental colleges completed the DU-PAS. Self-reported preparedness scores were compared across institutions to evaluate the association between exposure to a CCC rotation and perceived readiness for independent practice. The CCC posting ran at LUMHS from January to December 2024, and DU-PAS responses from the four institutions were collected online between <sup>21</sup> October and <sup>15</sup> November 2024.

Advanced Studies and Research Board of LUMHS approved the study vide Doc# LUMHS/REG/ACD/17159/62. All participants received an electronic information sheet and provided informed consent via a checkbox on the first page of the online questionnaire. Participation was voluntary, confidential, and had no impact on academic evaluation or clinical rotations. No incentives were offered. Permission to collect data at the three comparison institutions was arranged within each institution by its faculty collaborator, who is a co-author and who distributed the survey link; these institutions did not issue separate approval letters.

All final-year BDS students enrolled during the 2023–2024 academic year at the participating institutions were eligible. Exclusion criteria were incomplete clinical rotations or duplicate/partially completed questionnaires. Participants from three comparison institutions (Bibi Aseefa Dental College [BADC], Muhammad Medical & Dental College [MMDC], and Watim Dental

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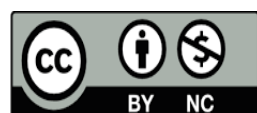
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College [WDC]) were recruited through their faculty collaborators. Gender was recorded in the questionnaire.

The CCC at LUMHS is a capstone clinical posting based on competency-based education and workplace-based learning principles. Final-year BDS students manage <sup>4-5</sup> multi-disciplinary patient cases from diagnosis to completion under direct faculty supervision. Students conduct diagnostic workups, develop interdisciplinary treatment plans, perform procedures within the scope of general practice, and coordinate referrals when specialist care is required. Learning activities include supervised clinics, structured formative feedback, workplace-based assessments, and rotating administrative/clinical responsibilities within small teams.<sup>15,16</sup> The CCC is one of six sequential eight-week clinical modules in the final year (Oral Surgery, Operative Dentistry and Endodontics, Pediatric Dentistry, Orthodontics, Prosthodontics and the CCC), and student groups reach it at different points in the year. The patients assigned to each student need a combination of preventive, restorative, endodontic, periodontal and radiographic care. Students work in teams of four to five and rotate through four roles: team leader, clinician, outpatient manager and radiology officer. Each week, one Operative Dentistry and Endodontics faculty member and one Oral and Maxillofacial Surgery faculty member supervise the triage of incoming patients into single-problem and multi-problem cases. Students receive feedback on every patient encounter and complete a weekly treatment-planning exercise. Cases that need specialist intervention are referred to postgraduate clinics, where the student manages the referral, keeps the records and observes the specialist procedure. Instructor calibration was undertaken prior to implementation to standardize expectations. A detailed description of the CCC workflow, team-based roles, feedback structure, and the final posting assessment proforma is provided in Supplementary File <sup>1</sup>.

A final posting assessment proforma (Supplementary File <sup>2</sup>) was used for instructor-led formative assessment. Prior to implementation, all instructors participated in calibration sessions to harmonize rubric interpretation. Instructor scores were used for individualized feedback and educational guidance only and were not included in the comparative analyses based on DU-PAS.

The primary outcome was self-perceived preparedness measured by the DU-PAS, a validated instrument assessing clinical procedures (Part A, <sup>24</sup> items) and professional/communication competencies (Part B, <sup>26</sup> items). The <sup>50</sup> items were used in English with their original wording; no item was reworded, added or removed. Part A items were answered, "No experience", "With help" or "On my own", and Part B items "No experience", "Mostly" or "Always"; responses were scored <sup>0</sup>, <sup>1</sup> and <sup>2</sup>, respectively. Item scores were summed to give a Part A score (0–48), a Part B score (0–52) and a total score (0–100), with higher scores indicating greater self-perceived preparedness.<sup>17,18</sup> A brief face-and-content review of the DU-PAS and the study's structured feedback form was conducted by was not validated again in this sample; internal consistency in this sample was Cronbach's  $\alpha = 0.87$  for Part A and  $0.92$  for Part B.

Data were collected using an online questionnaire (Microsoft Forms). Responses were anonymous, and all 166 submissions were complete. Data were analyzed using SPSS version <sup>26</sup>. Descriptive statistics summarized participant characteristics and DU-PAS item scores. Normality was assessed via the Shapiro–Wilk test; because item scores violated normality, between-group comparisons used three senior faculty members at LUMHS; the feedback form was pilot tested with a small group of final-year students to confirm clarity and acceptability. Because the DU-PAS was not modified, the published evidence for its validity was relied on and the instrument non-parametric methods. Overall differences across the four institutions were tested with the Kruskal–Wallis H test. Where significant, pairwise post-hoc comparisons were performed using Dunn's test with Bonferroni adjustment for the six pairwise comparisons. Part A, Part B and total scores were the main comparisons. The <sup>50</sup> item-level comparisons were exploratory and were not adjusted for the number of items tested; as a sensitivity check, item p-values were also judged against a Bonferroni threshold of  $p < 0.001$  ( $0.05/50$ ). were not adjusted for the number of items tested;

as a sensitivity check, item p-values were also judged against a Bonferroni threshold of  $p < 0.001$  ( $0.05/50$ ). Effect size was expressed as epsilon-squared,  $\epsilon^2 = H/(N - 1)$ . Gender distribution was compared across institutions with the chi-square test. Dunn's tests, effect sizes, domain scores and Cronbach's  $\alpha$  were computed in Python <sup>3,13</sup> with SciPy <sup>1,17</sup>. All tests were two-tailed with  $\alpha = 0.05$ .

## Results

In total, 166 students completed the DU-PAS (LUMHS <sup>53</sup>, MMDC <sup>28</sup>, BADC <sup>42</sup> and WDC <sup>43</sup>); 113 (68.1%) were women, and gender distribution did not differ significantly across institutions ( $p = 0.117$ ; Table <sup>1</sup>). Separately, <sup>63</sup> LUMHS students completed the CCC feedback form at the end of their rotation; their responses are summarized in the rest of this paragraph and in Figure <sup>1</sup> and are not part of the DU-PAS comparison. LUMHS students rated the overall educational experience as "Excellent." Clinical skill development, patient management, and critical thinking were consistently reported as "Effective" or "Very Effective," with students highlighting improvements in treatment planning, patient communication, and clinical decision-making. LUMHS respondents felt "very supported" by instructors and mentors, and constructive feedback on performance was frequently provided, with responses indicating that feedback was "always" or "frequently." The most frequently reported areas of improvement in LUMHS respondents include treatment planning and sequencing, clinical decision-making and problem-solving, and patient communication and rapport building. Other areas of development include case documentation, self-evaluation, professionalism, and time management. (Figure <sup>1</sup>)

Part A, Part B and total DU-PAS scores are shown in Table <sup>1</sup>. Part A scores did not differ across institutions. Part B scores differed, but no pairwise comparison remained significant after Bonferroni adjustment. Total scores also differed; in pairwise comparisons, only the difference between LUMHS and WDC was significant.

Table <sup>2</sup> compares self-perceived preparedness for clinical procedures (Part A) across the four institutions. Eight of the <sup>24</sup> items differed significantly. LUMHS students had the highest mean ranks for prescribing appropriate dental radiographs ( $p = 0.005$ ), formulating a comprehensive treatment plan ( $p = 0.004$ ), performing nonsurgical periodontal treatment ( $p = 0.013$ ) and removing dental caries ( $p = 0.011$ ). LUMHS students had the lowest mean ranks for endodontic treatment of single-rooted teeth ( $p = 0.031$ ), endodontic treatment of multi-rooted teeth ( $p = 0.001$ ) and providing crowns ( $p = 0.006$ ); MMDC students had the highest mean ranks for these three items and for assessing orthodontic treatment needs ( $p = 0.005$ ). The remaining <sup>16</sup> items did not differ significantly.

Table <sup>3</sup> compares self-perceived preparedness in professional and communication items (Part B). Six of the <sup>26</sup> items differed significantly, and LUMHS students had the highest mean rank for each: referring patients with suspected oral cancer ( $p = 0.014$ ), referring patients with complex treatment needs ( $p = 0.014$ ), reflecting on clinical practice to address learning needs ( $p = 0.001$ ), giving patients opportunities to express their expectations of treatment ( $p < 0.001$ ), motivating patients towards self-care ( $p = 0.005$ ) and asking a supervisor or colleague for help ( $p = 0.015$ ). The remaining <sup>20</sup> items did not differ significantly.

Effect sizes and Dunn's pairwise comparisons for the <sup>14</sup> items that differed significantly are given in Table <sup>4</sup>. Epsilon-squared ranged from  $0.05$  to  $0.11$ . In pairwise comparisons, LUMHS students rated themselves higher than WDC students

for prescribing radiographs, comprehensive treatment planning, caries removal and both referral items, and lower than MMDC students for endodontic treatment of multi-rooted teeth and for crowns. For endodontic treatment of single-rooted teeth, no pairwise comparison remained

significant. Three items remained significant at the Bonferroni threshold for <sup>50</sup> tests ( $p < 0.001$ ): endodontic treatment of multi-rooted teeth, reflecting on clinical practice, and giving patients opportunities to express their expectations.

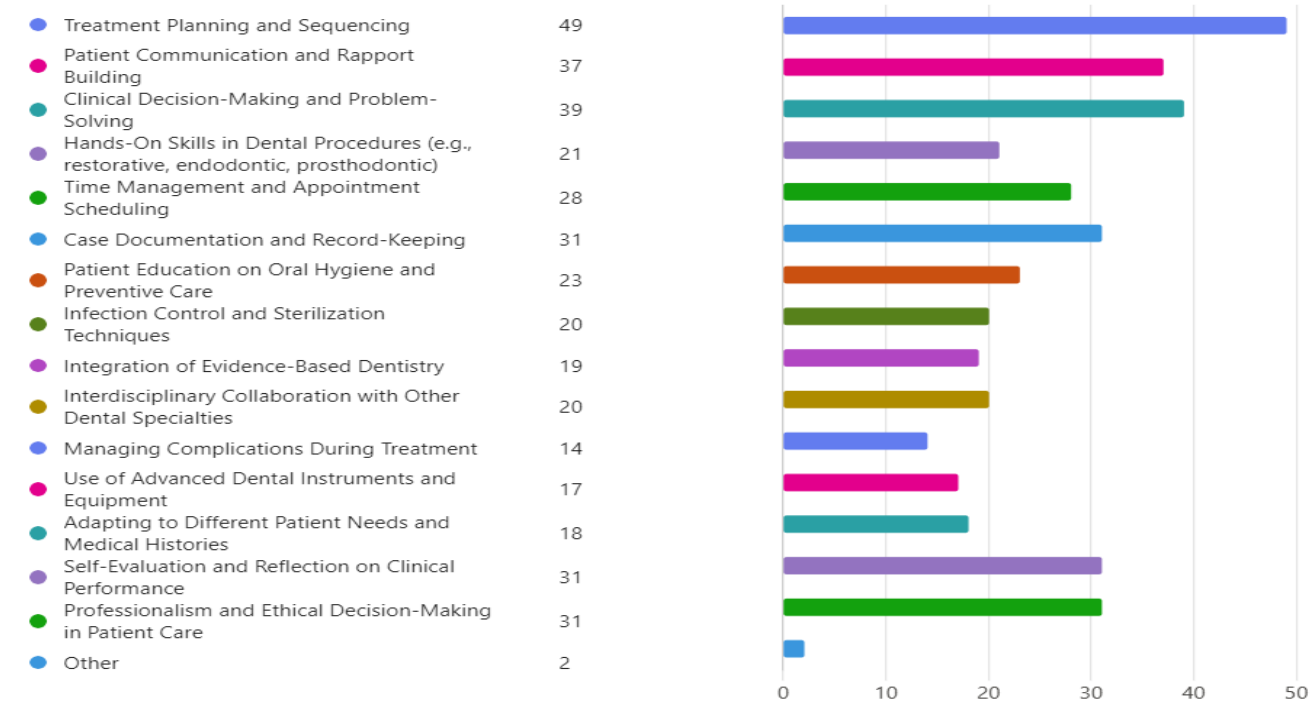


**Figure 1.** Bar chart illustrating the specific skills and knowledge areas improved during the comprehensive care clinic rotation by final-year BDS students at LUMHS (n = 63 respondents; each student could select more than one area).

**Table 1.** Gender and DU-PAS scores of final-year dental students by institution

| Characteristic                          | LUMHS<br>(n=53) | MMDC<br>(n=28)      | BADC<br>(n=42)    | WDC<br>(n=43) | All<br>(N=166)    | Test;<br>p-value             | $\epsilon^2$ |
|-----------------------------------------|-----------------|---------------------|-------------------|---------------|-------------------|------------------------------|--------------|
| Women, n (%)                            | 37 (69.8)       | 19 (67.9)           | 23 (54.8)         | 34 (79.1)     | 113 (68.1)        | $\chi^2=5.89$ ;<br>$p=0.117$ | –            |
| Men, n (%)                              | 16 (30.2)       | 9 (32.1)            | 19 (45.2)         | 9 (20.9)      | 53 (31.9)         |                              |              |
| Part A score<br>(0–48),<br>median (IQR) | 33<br>(29–37)   | 34<br>(26.2–36.5)   | 31.5<br>(26.5–38) | 27<br>(24–36) | 32<br>(25.8–36.2) | H=5.09;<br>$p=0.165$         | 0.03         |
| Part A score<br>(0–48),<br>mean (SD)    | 32.6 (6.5)      | 31.0 (9.3)          | 30.8 (8.0)        | 29.8 (7.4)    | 31.2 (7.6)        |                              |              |
| Part B score<br>(0–52),<br>median (IQR) | 35<br>(29–41)   | 29.5<br>(23.2–37.5) | 29.5<br>(24–37)   | 28<br>(25–36) | 31<br>(26–39)     | H=9.88;<br>$p=0.020$         | 0.06         |
| Part B score<br>(0–52),<br>mean (SD)    | 35.2 (8.1)      | 29.9 (10.3)         | 30.6 (9.7)        | 30.9 (8.5)    | 32.0 (9.2)        |                              |              |
| Total score (0–100),<br>median (IQR)    | 65<br>(59–76.5) | 64.5<br>(50–71.8)   | 62<br>(49.8–71.5) | 59<br>(50–72) | 62.5<br>(52.8–74) | H=9.51;<br>$p=0.023$         | 0.06         |
| Total score (0–100),<br>mean (SD)       | 67.8 (12.3)     | 60.9 (17.6)         | 61.4 (13.8)       | 60.7 (13.5)   | 63.2 (14.2)       |                              |              |

Scores are sums of item scores (0 = no experience; 1 = with help [Part A] or mostly [Part B]; 2 = on my own [Part A] or always [Part B]); higher scores indicate greater self-perceived preparedness. IQR = interquartile range; SD = standard deviation;  $\chi^2$  = chi-square test (df = 3); H = Kruskal–Wallis test (df = 3);  $\epsilon^2$  = epsilon-squared. p-values in bold are below 0.05.

**Table 2. Comparison of self-perceived preparedness for clinical procedures (DU-PAS Part A) among final-year dental students across institutions**

| Question                                                                                                 | Dental Institute | N   | Mean Rank | P-Value |
|----------------------------------------------------------------------------------------------------------|------------------|-----|-----------|---------|
| I am able to obtain a complete medical history from my patients                                          | LUMHS            | 53  | 89.72     | 0.244   |
|                                                                                                          | MMDC             | 28  | 76.38     |         |
|                                                                                                          | BADC             | 42  | 79.82     |         |
|                                                                                                          | WDC              | 43  | 84.07     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to undertake a comprehensive, clinical oral examination                                        | LUMHS            | 53  | 83.70     | 0.581   |
|                                                                                                          | MMDC             | 28  | 75.89     |         |
|                                                                                                          | BADC             | 42  | 82.67     |         |
|                                                                                                          | WDC              | 43  | 89.02     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to prescribe appropriate dental radiographs                                                    | LUMHS            | 53  | 96.17     | 0.005   |
|                                                                                                          | MMDC             | 28  | 78.86     |         |
|                                                                                                          | BADC             | 42  | 88.14     |         |
|                                                                                                          | WDC              | 43  | 66.37     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to undertake periapical radiographs                                                            | LUMHS            | 53  | 94.53     | 0.169   |
|                                                                                                          | MMDC             | 28  | 80.66     |         |
|                                                                                                          | BADC             | 42  | 79.69     |         |
|                                                                                                          | WDC              | 43  | 75.48     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to undertake bitewing radiographs                                                              | LUMHS            | 53  | 85.36     | 0.288   |
|                                                                                                          | MMDC             | 28  | 95.46     |         |
|                                                                                                          | BADC             | 42  | 81.48     |         |
|                                                                                                          | WDC              | 43  | 75.40     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to interpret common findings on dental radiographs                                             | LUMHS            | 53  | 89.42     | 0.358   |
|                                                                                                          | MMDC             | 28  | 82.52     |         |
|                                                                                                          | BADC             | 42  | 85.95     |         |
|                                                                                                          | WDC              | 43  | 74.45     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to assess the treatment needs of patients requiring orthodontics                               | LUMHS            | 53  | 85.26     | 0.005   |
|                                                                                                          | MMDC             | 28  | 95.48     |         |
|                                                                                                          | BADC             | 42  | 65.17     |         |
|                                                                                                          | WDC              | 43  | 91.43     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to formulate a comprehensive treatment plan which addresses all treatment needs of my patients | LUMHS            | 53  | 99.97     | 0.004   |
|                                                                                                          | MMDC             | 28  | 78.39     |         |
|                                                                                                          | BADC             | 42  | 76.00     |         |
|                                                                                                          | WDC              | 43  | 73.85     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to provide a range of treatment options to my patients based on their individual circumstances | LUMHS            | 53  | 91.61     | 0.294   |
|                                                                                                          | MMDC             | 28  | 77.34     |         |
|                                                                                                          | BADC             | 42  | 84.42     |         |
|                                                                                                          | WDC              | 43  | 76.62     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to explain the merits and demerits of various treatment options to my patients                 | LUMHS            | 53  | 93.59     | 0.143   |
|                                                                                                          | MMDC             | 28  | 72.32     |         |
|                                                                                                          | BADC             | 42  | 83.39     |         |
|                                                                                                          | WDC              | 43  | 78.44     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to obtain a valid consent from my patients prior to undertaking any treatment.                 | LUMHS            | 53  | 90.00     | 0.078   |
|                                                                                                          | MMDC             | 28  | 67.96     |         |
|                                                                                                          | BADC             | 42  | 80.57     |         |
|                                                                                                          | WDC              | 43  | 88.47     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to carry out patients' treatment sessions in an appropriate order                              | LUMHS            | 53  | 87.25     | 0.892   |
|                                                                                                          | MMDC             | 28  | 82.43     |         |
|                                                                                                          | BADC             | 42  | 81.50     |         |
|                                                                                                          | WDC              | 43  | 81.53     |         |
|                                                                                                          | Total            | 166 |           |         |
| I am able to prescribe                                                                                   | LUMHS            | 53  | 85.42     | 0.911   |

|                                                                                  |       |     |        |       |
|----------------------------------------------------------------------------------|-------|-----|--------|-------|
| drugs to my patients appropriately                                               | MMDC  | 28  | 82.59  |       |
|                                                                                  | BADC  | 42  | 85.13  |       |
|                                                                                  | WDC   | 43  | 80.13  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to administer inferior dental nerve blocks effectively                 | LUMHS | 53  | 87.93  | 0.345 |
|                                                                                  | MMDC  | 28  | 79.07  |       |
|                                                                                  | BADC  | 42  | 87.69  |       |
|                                                                                  | WDC   | 43  | 76.83  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to perform nonsurgical periodontal treatment using appropriate methods | LUMHS | 53  | 97.67  | 0.013 |
|                                                                                  | MMDC  | 28  | 71.02  |       |
|                                                                                  | BADC  | 42  | 78.01  |       |
|                                                                                  | WDC   | 43  | 79.52  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to remove dental caries effectively                                    | LUMHS | 53  | 96.96  | 0.011 |
|                                                                                  | MMDC  | 28  | 81.13  |       |
|                                                                                  | BADC  | 42  | 82.96  |       |
|                                                                                  | WDC   | 43  | 68.98  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to restore teeth with tooth colored fillings appropriately             | LUMHS | 53  | 93.86  | 0.052 |
|                                                                                  | MMDC  | 28  | 82.04  |       |
|                                                                                  | BADC  | 42  | 85.73  |       |
|                                                                                  | WDC   | 43  | 69.51  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to restore teeth with amalgam fillings appropriately                   | LUMHS | 53  | 91.40  | 0.296 |
|                                                                                  | MMDC  | 28  | 86.75  |       |
|                                                                                  | BADC  | 42  | 75.95  |       |
|                                                                                  | WDC   | 43  | 79.02  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to perform endodontic treatment on single rooted teeth appropriately   | LUMHS | 53  | 74.41  | 0.031 |
|                                                                                  | MMDC  | 28  | 96.14  |       |
|                                                                                  | BADC  | 42  | 95.36  |       |
|                                                                                  | WDC   | 43  | 74.90  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to perform endodontic treatment on multi rooted teeth appropriately    | LUMHS | 53  | 66.14  | 0.001 |
|                                                                                  | MMDC  | 28  | 104.43 |       |
|                                                                                  | BADC  | 42  | 94.24  |       |
|                                                                                  | WDC   | 43  | 80.78  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to provide crowns using principles of tooth preservation               | LUMHS | 53  | 74.13  | 0.006 |
|                                                                                  | MMDC  | 28  | 107.80 |       |
|                                                                                  | BADC  | 42  | 83.99  |       |
|                                                                                  | WDC   | 43  | 78.74  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to provide mechanically sound partial dentures                         | LUMHS | 53  | 84.42  | 0.634 |
|                                                                                  | MMDC  | 28  | 73.66  |       |
|                                                                                  | BADC  | 42  | 86.15  |       |
|                                                                                  | WDC   | 43  | 86.17  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to provide mechanically sound full dentures                            | LUMHS | 53  | 71.92  | 0.136 |
|                                                                                  | MMDC  | 28  | 88.25  |       |
|                                                                                  | BADC  | 42  | 88.52  |       |
|                                                                                  | WDC   | 43  | 89.78  |       |
|                                                                                  | Total | 166 |        |       |
| I am able to undertake nonsurgical tooth extractions appropriately               | LUMHS | 53  | 94.31  | 0.094 |
|                                                                                  | MMDC  | 28  | 75.18  |       |
|                                                                                  | BADC  | 42  | 80.12  |       |
|                                                                                  | WDC   | 43  | 78.90  |       |
|                                                                                  | Total | 166 |        |       |

**Table 3. Comparison of self-perceived preparedness in professional and communication items (DU-PAS Part B) among final-year dental students across institutions**

| Question                                                                                      | Dental Institute | N   | Mean Rank | P Value | Question                                                                                    | Dental Institute | N   | Mean Rank | P Value |
|-----------------------------------------------------------------------------------------------|------------------|-----|-----------|---------|---------------------------------------------------------------------------------------------|------------------|-----|-----------|---------|
| I feel confident referring patients with suspected oral cancer                                | LUMHS            | 53  | 99.80     | 0.014   | barriers to effective communication with patients appropriately                             | MMDC             | 28  | 75.18     | 0.155   |
|                                                                                               | MMDC             | 28  | 79.11     |         |                                                                                             | BADC             | 42  | 73.38     |         |
|                                                                                               | BADC             | 42  | 76.10     |         |                                                                                             | WDC              | 43  | 90.70     |         |
|                                                                                               | WDC              | 43  | 73.50     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 89.16     |         |
| I am confident to evaluate new dental materials and products using an evidence-based approach | LUMHS            | 53  | 86.33     | 0.896   | I restrict my relations with my patients to a professional level                            | MMDC             | 28  | 68.71     | 0.163   |
|                                                                                               | MMDC             | 28  | 81.43     |         |                                                                                             | BADC             | 42  | 80.69     |         |
|                                                                                               | BADC             | 42  | 79.98     |         |                                                                                             | WDC              | 43  | 88.90     |         |
|                                                                                               | WDC              | 43  | 84.80     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 93.42     |         |
| I am confident to interpret the results of research which may influence my practice           | LUMHS            | 53  | 81.87     | 0.970   | I feel I can manage people's expectations of their treatment                                | MMDC             | 28  | 75.64     | 0.146   |
|                                                                                               | MMDC             | 28  | 84.21     |         |                                                                                             | BADC             | 42  | 79.24     |         |
|                                                                                               | BADC             | 42  | 86.10     |         |                                                                                             | WDC              | 43  | 80.55     |         |
|                                                                                               | WDC              | 43  | 82.51     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 93.92     |         |
| I feel able to raise concerns about inappropriate behavior of my colleagues                   | LUMHS            | 53  | 79.08     | 0.820   | I recognize my personal limitations in clinical practice                                    | MMDC             | 28  | 76.43     | 0.001   |
|                                                                                               | MMDC             | 28  | 87.93     |         |                                                                                             | BADC             | 42  | 82.98     |         |
|                                                                                               | BADC             | 42  | 85.17     |         |                                                                                             | WDC              | 43  | 75.78     |         |
|                                                                                               | WDC              | 43  | 84.43     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 98.71     |         |
| I use an evidence-informed approach in my clinical practice                                   | LUMHS            | 53  | 86.72     | 0.690   | I reflect on my clinical practice in order to address my learning needs                     | MMDC             | 28  | 58.04     | <0.001  |
|                                                                                               | MMDC             | 28  | 85.91     |         |                                                                                             | BADC             | 42  | 82.95     |         |
|                                                                                               | BADC             | 42  | 84.71     |         |                                                                                             | WDC              | 43  | 81.87     |         |
|                                                                                               | WDC              | 43  | 76.78     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 104.18    |         |
| I am able to manage the behavior of children to enable appropriate dental treatment           | LUMHS            | 53  | 92.84     | 0.230   | I provide opportunities for my patients to express their expectations from dental treatment | MMDC             | 28  | 70.86     | 0.005   |
|                                                                                               | MMDC             | 28  | 84.11     |         |                                                                                             | BADC             | 42  | 73.45     |         |
|                                                                                               | BADC             | 42  | 75.86     |         |                                                                                             | WDC              | 43  | 76.06     |         |
|                                                                                               | WDC              | 43  | 79.06     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 100.50    |         |
| I have sufficient knowledge of scientific principles which underpin my dental practice        | LUMHS            | 53  | 85.53     | 0.613   | I feel able to motivate my patients to encourage self-care for their dental needs           | MMDC             | 28  | 72.77     | 0.015   |
|                                                                                               | MMDC             | 28  | 75.80     |         |                                                                                             | BADC             | 42  | 78.10     |         |
|                                                                                               | BADC             | 42  | 88.65     |         |                                                                                             | WDC              | 43  | 74.81     |         |
|                                                                                               | WDC              | 43  | 80.98     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 96.46     |         |
| I maintain accurate records of my clinical notes                                              | LUMHS            | 53  | 86.24     | 0.943   | I feel comfortable asking for help from supervisor or colleague if needed                   | MMDC             | 28  | 85.89     | 0.124   |
|                                                                                               | MMDC             | 28  | 81.43     |         |                                                                                             | BADC             | 42  | 69.05     |         |
|                                                                                               | BADC             | 42  | 81.43     |         |                                                                                             | WDC              | 43  | 80.08     |         |
|                                                                                               | WDC              | 43  | 83.50     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 92.50     |         |
| I feel confident to communicate potential risks of operative procedures to patients           | LUMHS            | 53  | 93.67     | 0.144   | I take responsibility for my continuing professional development                            | MMDC             | 28  | 70.11     | 0.295   |
|                                                                                               | MMDC             | 28  | 71.91     |         |                                                                                             | BADC             | 42  | 79.82     |         |
|                                                                                               | BADC             | 42  | 82.94     |         |                                                                                             | WDC              | 43  | 84.72     |         |
|                                                                                               | WDC              | 43  | 79.06     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 91.83     |         |
| I feel confident managing anxious patients with appropriate behavioral techniques             | LUMHS            | 53  | 95.59     | 0.069   | I feel I can manage to communicate effectively with my patients                             | MMDC             | 28  | 79.91     | 0.204   |
|                                                                                               | MMDC             | 28  | 72.79     |         |                                                                                             | BADC             | 42  | 83.27     |         |
|                                                                                               | BADC             | 42  | 80.04     |         |                                                                                             | WDC              | 43  | 75.79     |         |
|                                                                                               | WDC              | 43  | 78.95     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 93.28     |         |
| I am aware of my legal responsibilities as a dental professional                              | LUMHS            | 53  | 92.66     | 0.143   | I feel confident to communicate appropriately with my colleagues                            | MMDC             | 28  | 82.02     | 0.411   |
|                                                                                               | MMDC             | 28  | 81.61     |         |                                                                                             | BADC             | 42  | 79.77     |         |
|                                                                                               | BADC             | 42  | 84.45     |         |                                                                                             | WDC              | 43  | 76.05     |         |
|                                                                                               | WDC              | 43  | 72.51     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 91.35     |         |
| I am able to refer patients with complex treatment needs appropriately                        | LUMHS            | 53  | 96.69     | 0.014   | I am able to fulfill my responsibilities as an effective member of the dental team          | MMDC             | 28  | 78.52     | 0.205   |
|                                                                                               | MMDC             | 28  | 83.64     |         |                                                                                             | BADC             | 42  | 78.32     |         |
|                                                                                               | BADC             | 42  | 83.06     |         |                                                                                             | WDC              | 43  | 82.13     |         |
|                                                                                               | WDC              | 43  | 67.58     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 89.01     |         |
| I am able to work within the constraints of clinical appointment schedules                    | LUMHS            | 53  | 89.27     | 0.694   | I take appropriate measures to protect patient confidentiality                              | MMDC             | 28  | 81.57     |         |
|                                                                                               | MMDC             | 28  | 81.30     |         |                                                                                             | BADC             | 42  | 72.38     |         |
|                                                                                               | BADC             | 42  | 80.31     |         |                                                                                             | WDC              | 43  | 88.83     |         |
|                                                                                               | WDC              | 43  | 80.93     |         |                                                                                             | Total            | 166 |           |         |
|                                                                                               | Total            | 166 |           |         |                                                                                             | LUMHS            | 53  | 90.08     |         |
| I feel confident to address                                                                   | LUMHS            | 53  | 90.08     | 0.095   |                                                                                             |                  |     |           |         |

**Table 4. Effect sizes and Dunn's pairwise comparisons for the 14 DU-PAS items that differed significantly across institutions**

| DU-PAS item                                                                                              | H     | p-value          | $\epsilon^2$ | Pairwise differences (adjusted p)                               |
|----------------------------------------------------------------------------------------------------------|-------|------------------|--------------|-----------------------------------------------------------------|
| <b>Part A: clinical procedures</b>                                                                       |       |                  |              |                                                                 |
| I am able to prescribe appropriate dental radiographs                                                    | 12.96 | <b>0.005</b>     | 0.08         | LUMHS > WDC (0.003)                                             |
| I am able to assess the treatment needs of patients requiring orthodontics                               | 12.89 | <b>0.005</b>     | 0.08         | MMDC > BADC (0.013); WDC > BADC (0.016)                         |
| I am able to formulate a comprehensive treatment plan which addresses all treatment needs of my patients | 13.08 | <b>0.004</b>     | 0.08         | LUMHS > BADC (0.025); LUMHS > WDC (0.010)                       |
| I am able to perform nonsurgical periodontal treatment using appropriate methods                         | 10.77 | <b>0.013</b>     | 0.07         | LUMHS > MMDC (0.024)                                            |
| I am able to remove dental caries effectively                                                            | 11.24 | <b>0.011</b>     | 0.07         | LUMHS > WDC (0.005)                                             |
| I am able to perform endodontic treatment on single rooted teeth appropriately                           | 8.90  | <b>0.031</b>     | 0.05         | None                                                            |
| I am able to perform endodontic treatment on multi rooted teeth appropriately                            | 17.26 | <b>0.001</b>     | 0.10         | MMDC > LUMHS (0.001); BADC > LUMHS (0.012)                      |
| I am able to provide crowns using principles of tooth preservation                                       | 12.33 | <b>0.006</b>     | 0.07         | MMDC > LUMHS (0.004); MMDC > WDC (0.029)                        |
| <b>Part B: professional and communication items</b>                                                      |       |                  |              |                                                                 |
| I feel confident referring patients with suspected oral cancer                                           | 10.65 | <b>0.014</b>     | 0.06         | LUMHS > WDC (0.025)                                             |
| I am able to refer patients with complex treatment needs appropriately                                   | 10.66 | <b>0.014</b>     | 0.06         | LUMHS > WDC (0.007)                                             |
| I reflect on my clinical practice in order to address my learning needs                                  | 16.54 | <b>0.001</b>     | 0.10         | LUMHS > MMDC (<0.001)                                           |
| I provide opportunities for my patients to express their expectations from dental treatment              | 17.92 | <b>&lt;0.001</b> | 0.11         | LUMHS > MMDC (0.006); LUMHS > BADC (0.004); LUMHS > WDC (0.010) |
| I feel able to motivate my patients to encourage self-care for their dental needs                        | 12.64 | <b>0.005</b>     | 0.08         | LUMHS > MMDC (0.032); LUMHS > WDC (0.020)                       |
| I feel comfortable asking for help from supervisor or colleague if needed                                | 10.43 | <b>0.015</b>     | 0.06         | LUMHS > BADC (0.009)                                            |

H = Kruskal–Wallis statistic (df = 3);  $\epsilon^2$  = epsilon-squared, H/(N – 1). Pairwise differences are those with a Bonferroni-adjusted p below 0.05 in Dunn's test; "A > B" means that institution A had the higher mean rank. LUMHS = Liaquat University of Medical and Health Sciences; MMDC = Muhammad Medical and Dental College; BADC = Bibi Aseefa Dental College; WDC = Watim Dental College.

## Discussion

This cross-sectional study examined final-year dental students' self-reported preparedness using the DU-PAS instrument and found that students who completed a CCC rotation at LUMHS reported higher self-perceived preparedness on several clinically oriented items compared with peers in institutions using conventional departmental rotations. At item level, LUMHS students rated themselves highest for radiographic prescription, nonsurgical periodontal treatment, caries removal and comprehensive treatment planning, and lowest for endodontic treatment and crown provision. At domain level, Part A scores did not differ across institutions, while Part B and total scores were highest at LUMHS. The hypothesis that CCC-exposed students would score higher in both domains was therefore only partly supported. These findings suggest that educational environments that integrate continuity of care, structured formative feedback, and interdisciplinary decision-making may be associated with greater confidence in selected procedural domains. However, because the study is cross-sectional and self-reported, the differences observed are associations and cannot be attributed to the CCC model.

Our findings are consistent with earlier reports indicating that workplace-based learning (WBL) experiences and competency-based education (CBE) frameworks can enhance students'

application of clinical knowledge and integration of skills across disciplines.<sup>19,20</sup> Programs that emphasize longitudinal case management, faculty mentorship, and iterative feedback have been associated with improved diagnostic reasoning and more coordinated treatment planning.<sup>21</sup> In the present study, LUMHS students reported higher ranks on items involving radiographic prescription, nonsurgical periodontal therapy, and formulation of comprehensive treatment plans. These areas align closely with domains emphasized during CCC rotations and may explain why these items showed more pronounced differences. The magnitude of differences should, however, be interpreted cautiously.

LUMHS students rated themselves lowest for endodontic treatment of single-rooted and multi-rooted teeth and for providing crowns; for multi-rooted endodontics and crowns they rated themselves significantly lower than MMDC students. In the CCC, cases that need specialist intervention are referred to postgraduate clinics, where the student manages the referral and observes the procedure (Supplementary File 1). CCC students therefore complete fewer complex endodontic and crown procedures themselves, which may explain their lower self-perceived preparedness for these procedures. This explanation was not tested in the present study. It suggests that a comprehensive care rotation should protect a minimum number of hands-on endodontic and crown cases for each student.

In Part B, six of the <sup>26</sup> items differed significantly, and LUMHS students had the highest mean rank for each: referral of suspected oral cancer, referral of patients with complex needs, reflection on practice, giving patients opportunities to express their expectations, motivating patients towards self-care and asking for help. The other items, including documentation, legal responsibilities and communication with patients and colleagues, did not differ significantly between institutions. This may reflect high baseline self-rating across all groups, creating ceiling effects that limit the sensitivity of self-report instruments in capturing incremental growth in non-procedural behaviors. Similar ceiling effects have been observed in professionalism that occur implicitly through routine patient professionalism that occur implicitly through routine patient documented in other DU-PAS-based studies in the region, discrete, observable tasks. Future evaluations should incorporate complementary objective measures such as blinded OSCE ratings, standardized workplace-based assessment tools, and structured clinical observation rubrics to triangulate and validate self-perceived preparedness.

Institutional differences observed in this study highlight broader systemic factors influencing student preparedness. LUMHS benefits from a more established academic structure that includes specialist departments, a dedicated skills laboratory, and an operational CCC where students can manage interdisciplinary cases with supervision. In contrast, the comparison institutions have younger faculties, fewer postgraduate programs, and discipline-based clinical rotations. These characteristics were not measured in this study, but differences between the institutions in resources, clinical exposure, faculty support and learning environment may explain some or all of the differences in self-perceived preparedness reported here. The groups were not matched or adjusted for prior academic performance or faculty-to-student ratio, and other contextual variables such as institutional culture, clinic workflow, and extracurricular training opportunities may also affect preparedness scores. These inherent differences reinforce the importance of contextualizing CCC outcomes within each institution's resources, infrastructure, and faculty development capacity.

Despite these contextual limitations, the CCC model offers potentially valuable strategies for enhancing competency-based dental education in resource-limited settings. By encouraging students to manage cases longitudinally, coordinate referrals, and collaborate across disciplines, the model is designed to build skills aligned with contemporary expectations of patient-centered and team-based care.<sup>24</sup> Structured formative feedback, which is a core component of WBL, also supports reflective practice and continuous improvement and these attributes are critical for early-career dentists facing increasing technological, diagnostic, and procedural complexity.<sup>25,26</sup> The CCC structure may therefore be worth piloting and evaluating in other institutions that plan to move from procedural quotas to more holistic measures of competence; its feasibility and scalability were not assessed in this study.

A notable strength of this study is its multi-institutional design, which allows comparison across varied educational contexts. The use of a validated preparedness instrument also strengthens credibility. Instructor calibration in the CCC setting further ensured consistent formative assessment practices during rotations, though these instructor-derived ratings were not analyzed comparatively. Nonetheless, this study has important limitations. Preparedness was measured through self-report and may not reflect actual clinical competence, particularly because students knew their responses contributed to a research study. Differential response rates may selection introduce bias if students who felt more confident were

particularly in domains where students perceive themselves as performing adequately even if objective assessments suggest room for growth.<sup>22,23</sup> It is also possible that the DU-PAS instrument, while validated, is less sensitive to subtle or short-term changes in comparison institutions. Age, pre-clinical academic performance and other baseline characteristics were not collected, and the comparisons were not adjusted for them. The <sup>50</sup> item-level comparisons were not adjusted for multiple testing, and only three items remained significant at a Bonferroni threshold. At LUMHS, the survey was distributed by the study team, which includes faculty who teach in the CCC, and this may have encouraged favourable self-ratings. The DU-PAS measures self-perceived preparedness, not observed clinical performance, and it was not validated again in this sample. interactions rather than through more likely to participate.<sup>27</sup> The cross-sectional design prevents causal inference, and the sample is drawn exclusively from Pakistani institutions, limiting generalizability to other educational systems. The CCC was offered at only one institution, so its effect cannot be separated from other differences between LUMHS and the Future work should integrate objective measures of competence and evaluate long-term outcomes to determine whether self-reported preparedness translates into improved professional performance. Longitudinal studies following graduates into internship or early clinical practice would provide insight into the durability of benefits associated with CCC-like rotations. Randomized or stepped-wedge implementation trials across multiple institutions, although logistically challenging, would allow more rigorous causal evaluation of comprehensive care models by controlling for known and unknown confounders. Further research should also explore how CCC components can be standardized while remaining adaptable to local resource constraints and curricular structures.

The policy implications of these findings are noteworthy but should be interpreted cautiously. While the observed differences suggest that integrative capstones may be associated with higher self-perceived preparedness, large-scale mandates are premature. Rather than recommending universal implementation, accrediting bodies and institutional leaders may consider supporting targeted pilots of CCC-style rotations, investing in faculty development programs, and allocating resources to strengthen interdisciplinary clinical environments. Such measured approaches would allow evidence-informed scaling of CCC elements while ensuring alignment with local capacity.

## Conclusion

This multi-institutional study found that students completing a CCC rotation reported higher self-perceived preparedness in radiographic assessment, nonsurgical periodontal care, caries management, and comprehensive treatment planning, and lower self-perceived preparedness in endodontic treatment and crown provision. These findings suggest that integrative, continuity-of-care experiences within competency-based frameworks may be associated with greater confidence in selected procedural domains. Six of the <sup>26</sup> professionalism and communication items and the Part B and total scores also favoured LUMHS, while Part A scores did not differ. Because the CCC was offered at only one institution, these differences cannot be separated from differences between the institutions. Further longitudinal and multi-center research is warranted to evaluate the long-term impact of CCC-style models across diverse dental education settings.

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1. **Feroze Ali Kalhor:** Conception; study design; funding/resources; data collection and/or processing; analysis and/or interpretation; literature review; manuscript writing; and critical review.
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