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ISSN: 2663-9491 e-ISSN: 2789-6897

ORIGINAL ARTICLE

Enhancing Oral Histology Competency Through Laboratory- Based Education – A Study Among 1st Phase Undergraduate BDS Students at Sapporo Dental College and Hospital, Bangladesh

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Received: 23 Feb 2026
Accepted: 25 Feb 2026
Published Online: 27 Feb 2026

Published by:
Gopalganj Medical College, Gopalganj, Bangladesh

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DOI: 10.5281/zenodo.18799095

ABSTRACT

Background: *Oral histology is one of the foundational subject in dental education. Traditional lecture-based methods may not adequately engage students or support the development of competencies. Laboratory-Based Education (LBE) offers hands-on learning, critical thinking, and enhanced retention. This study evaluated the effectiveness of LBE in improving oral histology competency among first-phase BDS students in Bangladesh. This study aimed to assess the impact of LBE on academic performance and student perceptions of oral histology.* ***Methods & Materials:*** *A quasi-experimental study was conducted among 69 first-phase Bachelor of Dental Surgery (BDS) students at Sapporo Dental College and Hospital, Dhaka, Bangladesh, from September 2024–August 2025. Students completed pre- and post-tests (MCQs and SAQs) before and after the structured laboratory sessions. Perceptions were gathered using Likert-scale questionnaires and open-ended feedback. Data were analyzed using SPSS v25.0 with paired t-tests, confidence intervals, and Cohen's d values. The qualitative data were subjected to thematic analysis.* ***Results:*** *Mean pre-test scores (47.8 ± 9.4) improved significantly in the post-test (68.3 ± 8.7), with a mean difference of 20.5 (95% CI: 18.2–22.8, $p < 0.001$; Cohen's $d = 2.26$). Over 90% of the students reported improved understanding, engagement, and critical thinking. The thematic analysis highlighted enhanced visualization, peer learning, and better exam preparation as key benefits.* ***Conclusion:*** *LBE significantly enhanced oral histology competency and was strongly endorsed by the students. The findings support the integration of structured laboratory sessions into the Bangladeshi BDS curriculum to align with global standards and improve competency-based training.*

Keywords: *Oral histology, Laboratory-based education, Bachelor of Dental Surgery*

(The Insight 2026; 9(1): 47-50)

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INTRODUCTION

Oral histology constitutes a fundamental pillar of dental education, functioning as a vital link between foundational biomedical sciences and clinical disciplines. It enables students to comprehend the microscopic architecture and functional characteristics of oral tissues, thereby establishing a scientific basis for precise diagnosis and effective treatment planning in subsequent clinical practice [1]. Traditionally, the subject has been taught predominantly through lecture-based methods supplemented with microscopy demonstrations. While these approaches facilitate coverage of theoretical content, they often fail to foster critical thinking, long-term retention or application of knowledge in practical contexts [2,3].

Globally, dental education has undergone a paradigm shift from teacher-centered instruction toward competency-based and student-centered models. These approaches emphasize active learning, engagement, and problem-solving over passive information delivery [4]. Regarding this, laboratory-based education (LBE) has gained prominence as an effective pedagogy for subjects like histology. LBE enables students to actively observe, analyze and interpret histological slides, thereby enhancing comprehension and practical competency [5,6].

Evidence indicates that LBE significantly improves academic outcomes in oral histology. Studies have shown that students exposed to structured microscopy sessions achieve higher performance and greater confidence compared to those relying solely on lectures [7]. Research comparing virtual and real microscopy further highlights that while both approaches improve learning outcomes, hands-on laboratory experiences provide deeper understanding and skill development [8].

In addition to measurable academic gains, LBE exerts a positive influence on student perceptions and engagement. Findings suggest that microscopy-based sessions not only yield higher assessment scores but also enhance satisfaction with the learning process [9]. Moreover, interactive and laboratory-focused teaching strategies have been shown to promote motivation, teamwork, and critical thinking, all of which are essential competencies in modern dental education [10].

Beyond student perceptions, curriculum-based investigations point to the need for reform in oral histology teaching. Research conducted in Saudi dental schools identified gaps in curriculum design and gender-specific participation, underscoring the importance of innovative methods like LBE for inclusivity and effectiveness [11]. Similarly, the integration of traditional and e-learning methods in histopathology courses has been reported to improve learning outcomes by accommodating diverse learning preferences [6].

In South Asia, persistent challenges such as large class sizes, limited resources, and reliance on didactic instruction continue to hinder effective oral histology education [12]. In Bangladesh, the traditional curriculum remains in practice, providing limited scope for experiential learning in preclinical subjects such as oral histology. The implementation and effectiveness of LBE in dental colleges throughout the country have not been adequately explored through empirical research, even though digital and blended instructional strategies have gained increasing attention in other academic fields.

The demand for competency-based training in Bangladesh is pressing, as dental graduates are increasingly expected to meet international standards. Structured LBE offers the potential to address deficits in knowledge application, practical skills and critical thinking. However, there is a noticeable gap in the literature that has to be thoroughly examined because there is still a dearth of actual data from the local context.

The present study was designed to evaluate the effectiveness of laboratory-based education (LBE) in enhancing oral histology competency among 1st phase undergraduate Bachelor of Dental Surgery (BDS) students at Sapporo Dental College and Hospital, Bangladesh. Specifically, it seeks to compare pre- and post-intervention academic performance, examine student perceptions of LBE and analyze qualitative feedback to generate insights into its broader applicability in the Bangladeshi context.

METHODS & MATERIALS

This quasi-experimental study was conducted at Sapporo Dental College and Hospital, Dhaka, Bangladesh, over a period of one year (September 2024–August 2025). A total of 69 first-phase BDS students were enrolled in the study.

Selection Criteria:

Inclusion criteria:

- Students are currently enrolled in the 1st phase BDS program.
- Willing to participate and provide written informed consent.

Exclusion criteria:

- Students are absent for more than 25% of sessions.
- Those unwilling to provide feedback or incomplete data.

Data Collection and Study Procedure: The study was conducted following the Declaration of Helsinki (1975), as revised in 2013. Ethical approval was obtained from Ethical Review Committee of Sapporo Dental College & Hospital (Approval No. 2024/05; Approval Date: September 1, 2024), and informed consent was obtained from all participants before data collection. Participants were selected using purposive sampling technique. Data collection involved both quantitative and qualitative approaches. At the beginning of the intervention, the students completed a pre-test comprising multiple-choice questions (MCQs) and short-answer questions (SAQs) covering oral histology concepts. Structured laboratory-based education (LBE) sessions were conducted over 6–8 weeks. This included slide observation using light microscopy, labelling exercises, small group discussions, and instructor-guided demonstrations. After completion, students undertook a post-test using a format similar to the pre-test. Additionally, a structured questionnaire using a five-point Likert scale was administered to assess students' perceptions of the LBE, along with open-ended questions for qualitative feedback.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Descriptive statistics (mean, standard deviation, percentages) were used to summarize baseline and feedback data. Pre- and post-test scores were compared using a paired t-test. A 95% confidence interval (CI) for the mean difference was calculated, and Cohen's d was used to measure effect size. The significance level was set at $p < 0.05$. Qualitative data from open-ended responses were subjected to thematic analysis to identify key themes.

RESULTS

Table I describes the baseline characteristics of the participants. The majority of students (78.26%) were female, while 21.74% were male. Most students (76.81%) were in the 20–21 years age group, and only 23.19% were aged 22 years or older.

Table – I: Demographic Characteristics of Participants (*n*=69)

Variable		Frequency (n)	Percentage (%)
Age Group (years)			
	20–21	53	76.81
	≥22	16	23.19
Gender	Male	15	21.74
	Female	54	78.26

Table II presents the comparison of pre- and post-test scores. The mean pre-test score was 47.8 ± 9.4, which increased significantly to 68.3 ± 8.7 after the intervention. The mean improvement was 20.5 points, with a 95% CI of 18.2–22.8. The difference was highly significant ($p < 0.001$), and the effect size (Cohen's d = 2.26) indicates a large educational impact.

ISSN: 2663-9491 e-ISSN: 2789-6897

Table – II: Comparison of Pre- and Post-Test Scores

Assessment	Mean ± SD	Median (IQR)	95% CI	Effect Size (Cohen's d)	p-value
Pre-test Score	47.8 ± 9.4	48 (42–55)	18.2 – 22.8	2.26 (large)	<0.001
Post-test Score	68.3 ± 8.7	69 (62–74)			

Table III shows student perceptions of laboratory-based education. Over 90% of students either agreed or strongly agreed that LBE improved their understanding of oral histology, enhanced engagement, and increased the applicability of microscopy. Importantly, 94.2% of students recommended including more laboratory-based sessions in the curriculum.

Table – III: Student Feedback on Laboratory-Based Education (Likert Scale, *n*=69)

Item	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)
LBE improved understanding of oral histology	55.1	36.2	8.7	0
Sessions increased engagement & interest	47.8	40.6	11.6	0
Practical microscopy enhanced application	52.2	39.1	8.7	0
Group discussions encouraged critical thinking	43.5	44.9	11.6	0
Recommend integrating more LBE in curriculum	58	36.2	5.8	0

Table IV summarizes the thematic analysis of open-ended responses. Four themes were identified: enhanced visualization through microscopy, the value of peer learning, improved exam preparation, and a desire for more frequent laboratory-based sessions. Enhanced visualization was the most frequently reported theme (n = 41).

Table – IV: Thematic Analysis of Student Feedback

Theme	Representative Student Quotes (summarized)	Frequency (%)
Enhanced Visualization	"Microscopy made structures clearer than lectures alone."	41 (59.4)
Peer-Learning Value	"Group work improved confidence in slide identification."	28 (40.6)
Improved Exam Preparation	"Post-test questions were easier after lab sessions."	35 (50.7)
Desire for More Sessions	"Need more frequent LBE to reinforce concepts."	32 (46.4)

DISCUSSION

The present study evaluated the impact of Laboratory-Based Education (LBE) on oral histology competency among 1st phase BDS students of Sapporo Dental College, Dhaka, Bangladesh. The results demonstrated a statistically significant improvement in post-test scores, with a large effect size, alongside overwhelmingly positive student perceptions. These findings align with a growing body of evidence highlighting the role of laboratory-based and active learning approaches in dental education.

Wu and Chiang reported similar improvements when students engaged in structured microscopy sessions, concluding that laboratory learning fosters both performance and confidence in histological interpretation [7]. Their findings mirror our observation that post-test scores improved by more than 20 points, indicating substantial knowledge gain. Similarly, Chang et al. found that while both virtual and traditional microscopy improved learning outcomes, real microscopy provided superior opportunities for visual-spatial understanding and diagnostic competency [8].

From a pedagogical perspective, LBE not only improved test performance but also enhanced engagement. Ali and Syed observed that Bangladeshi dental students perceived laboratory strategies as more effective for conceptual clarity compared to lectures alone [2]. Our findings extend this by showing that more than 90% of students endorsed LBE as an effective and engaging method. Fernandes et al. also highlighted that student exposed to microscopy-based sessions scored higher on assessments and expressed greater satisfaction [9].

The thematic analysis in our study revealed that students particularly valued enhanced visualization, peer learning, and exam preparation. These insights are supported by Qing et al., who demonstrated that virtual microscopy improved visualization and self-paced learning, though many students still preferred conventional slide observation [13]. Similarly, Radwan et al. noted that interactive approaches encouraged teamwork and problem-solving, elements that our students recognized in their feedback [10]. Together, these findings emphasize that LBE has cognitive, affective, and social learning benefits.

In the South Asian context, where dental education often relies heavily on didactic lectures, the integration of LBE represents a significant step toward competency-based training. Alotaibi and AlQahtani reported that Saudi students preferred light microscopy, as it provided tactile engagement and fostered concentration, a sentiment echoed by Bangladeshi students in this study [12]. Johnson et al. also highlighted that active learning strategies in histology were linked with more effective study habits and deeper retention, underscoring the need for curricular reform [14].

The large effect size (Cohen's d = 2.26) observed in our study indicates that LBE produced not only statistically significant but also educationally meaningful improvements. Comparable studies, such as Chiang et al., have shown that assessment formats incorporating laboratory content significantly influenced student performance, underscoring the robustness of laboratory engagement as a teaching tool[15].

It is worth noting that while virtual microscopy and digital platforms are becoming popular globally, resource constraints in Bangladesh make real microscopy sessions more feasible in the near term. However, MacPherson and Brueckner suggested that blended models combining digital and traditional approaches could further strengthen histology learning [16]. For

institutions in Bangladesh, this implies that future integration of affordable digital platforms alongside conventional microscopy could increase flexibility and accessibility, particularly for revision and independent study.

The findings of this study add a growing evidence base indicating that LBE should be prioritized in preclinical dental curricula. In Bangladesh, where many students transition directly from higher secondary education, active laboratory-based strategies are especially important for bridging the gap between theoretical learning and practical application. Moreover, given the rising demand for graduates with global competencies, embedding LBE within the BDS curriculum would align local education with international standards.

The overwhelmingly positive feedback from students in this study also carries implications for curriculum planners. Students expressed a strong preference for more frequent and structured LBE sessions, suggesting that curricular reforms emphasizing hands-on learning would not only improve outcomes but also be well-received by learners. This aligns with international calls to integrate competency-based teaching methods across the dental curriculum.

In summary, this study confirms the effectiveness of laboratory-based education in improving oral histology competency among Bangladeshi dental students. The results demonstrate substantial knowledge gain, a large effect size, and overwhelmingly positive student perceptions. By bridging theoretical knowledge and practical skills, it provides a foundation for developing globally competent dental graduates prepared for the complexities of modern practice.

LIMITATIONS

This study was limited by its single-center design, relatively small sample size, and reliance on short-term assessments. Longitudinal studies across multiple institutions are needed to confirm the generalizability and sustainability of the outcomes. Additionally, resource limitations restrict the exploration of digital or hybrid microscopy approaches, which may enhance flexibility.

CONCLUSION

Laboratory-based education significantly improved oral histology competency among first-phase BDS students in Bangladesh. Students achieved higher post-test scores with a large effect size and reported positive perceptions of laboratory learning. Analysis revealed enhanced visualization, peer learning, and better exam preparation as key benefits. These findings confirm LBE is an effective teaching approach that should be integrated into preclinical dental education. Adoption could align Bangladeshi curricula with international standards, better preparing students for clinical applications in dentistry.

DATA AVAILABILITY STATEMENT

All the data related to this study is included in this article.

FUNDING

Self.

ACKNOWLEDGEMENT

Faculty members & Oral Histopathology Laboratory Stuffs of the Oral Pathology & Periodontology Department of Sapporo Dental College & Hospital.

ETHICAL APPROVAL

This study was approved by the Ethical Review Committee of Sapporo Dental College & Hospital.

CONFLICTS OF INTEREST

There were no conflicts of interest.

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