

THE IMPACT OF ARTIFICIAL INTELLIGENCE ASSISTANCE ON THE DIAGNOSTIC DECISIONS OF DENTAL STUDENTS IN CARIES DETECTION

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Abstract. *The integration of Artificial Intelligence (AI) into dental diagnostics has emerged as a transformative development in dental education. This study investigates the impact of AI assistance on the clinical and radiographic diagnostic decisions of dental students during dental caries detection. While traditional training relies heavily on visual-tactile metrics and conventional radiographic interpretation, AI systems utilizing Convolutional Neural Networks (CNNs) offer a standardized, data-driven second opinion. Current literature suggests that AI assistance substantially improves students' diagnostic accuracy and sensitivity, particularly in identifying early enamel and proximal carious lesions. Furthermore, AI tools reduce diagnostic time and enhance student confidence. However, concerns regarding automation bias, potential false positives, and a deficiency in structured curricula persist. This paper outlines the mechanisms, educational benefits, limitations, and future outlook of implementing AI in dental diagnostics training.*

1. Introduction

Dental caries remains one of the most prevalent chronic conditions globally. Early and accurate detection is essential for executing minimally invasive therapies. Traditionally, undergraduate dental students develop diagnostic skills through clinical observation and manual interpretation of bitewing, periapical, and panoramic radiographs. However, this pedagogical methodology often exhibits substantial inter-observer and intra-observer variability due to differing experience levels and the qualitative nature of human visual interpretation.

In recent years, **Artificial Intelligence (AI)** and deep learning models have evolved to match or sometimes exceed human capabilities in medical imaging classification. In operative dentistry, AI software functions as an adjunctive decision-support mechanism. Understanding the explicit influence of AI assistance on dental students' diagnostic choices is vital for reforming dental school curricula and safeguarding patient outcomes.

2. Methodological Integration of AI in Dental Education

AI systems designed for caries detection primarily employ deep learning models, specifically **Convolutional Neural Networks (CNNs)** and architectures like **U-Net**. These systems analyze digital imaging formats—such as bitewing radiographs and intraoral photographs—to segment and classify carious lesions based on radiolucency and surface alterations.

In educational simulation settings, students are typically introduced to a dual-phase diagnostic sequence:

1. **Conventional Phase:** Students independently analyze clinical data or radiographs without computer assistance.
2. **AI-Assisted Phase:** Students review the same data alongside AI-generated bounding boxes, annotations, or heatmaps highlighting potential pathological areas.

3. Impact on Diagnostic Parameters

Research data evaluating AI software (e.g., Overjet Caries Assist, Diagnocat) consistently indicates measurable behavioral and quantitative shifts in student performances:

3.1. Sensitivity, Specificity, and Overall Accuracy

Undergraduate dental students frequently underdiagnose early-stage or proximal enamel caries because of overlapping anatomical structures or subtle radiolucency. AI assistance corrects this deficiency by significantly increasing student diagnostic **sensitivity**.

- According to recent metrics, student diagnostic accuracy can jump from approximately **0.91 to 0.96**, with sensitivity metrics climbing steeply (e.g., from 0.35 to 0.67) when aided by automated annotations.
- First-year (D1) and third-year (D3) dental students demonstrate overall diagnostic improvements ranging between **43% and 46%** post-AI training implementation.

3.2. Efficiency and Time Management

Manual radiographic mapping is time-consuming for novices. Eye-tracking trials demonstrate that AI annotations optimize cognitive processing by directing a student's gaze to affected zones quicker. Consequently, the mean diagnostic timeline drops noticeably (e.g., from **67.89 seconds down to 53.92 seconds** per radiograph), decreasing extraneous cognitive fatigue.

3.3. Student Confidence levels

The diagnostic uncertainty typical of junior dental students often causes delayed decision-making or improper patient management proposals. Receiving immediate validation from an objective AI utility substantially increases students' subjective confidence markers across all lesion types (enamel, dentin, and pulp-involved caries).

4. Comparative Overview: AI-Assisted vs. Conventional Student Diagnosis

The table below summarizes the shift in key metrics observed when dental students utilize AI tools versus traditional approaches:

Diagnostic Metric	Conventional Student Performance	AI-Assisted Student Performance	Clinical Significance
Sensitivity	Low to Moderate (frequent missing of early enamel/proximal lesions)	High (substantial inflation of early detection rates)	Prevents untreated progression of caries.
Specificity	High (conservative approach to sound surfaces)	Variable (potential for a 5%–7% rise in false positives)	Risks unnecessary restorative interventions if blindly trusted.
Average Interpretation Speed	Slow and erratic gaze distribution	Fast and targeted visual processing	Maximizes workflow efficiency in clinical setups.
Inter-Operator Variability	High (varying based on individual student competence)	Low (standardized diagnostic baseline)	Ensures consistency in institutional treatment planning.

5. Challenges and Educational Risks

Despite clear benefits, integrating AI into the clinical decisions of dental students introduces critical pedagogical risks:

- **Automation Bias:** Novice operators risk developing an over-reliance on technology. Students might overlook lesions that the AI fails to highlight (false negatives) or fail to scrutinize the system's errors.

- **Overtreatment Risk:** Early AI models can trigger a **5% to 7% false positive rate (FPR)** on sound surfaces. If a student blindly follows a false positive mark, it can lead to irreversible, unnecessary removal of sound enamel structure.

- **Curricular Deficiencies:** Survey data shows that while over **89%** of dental students acknowledge that AI sharpens their diagnostic capacity, less than **17%** feel their current university curriculum provides adequate preparation for navigating AI ecosystems safely.

6. Conclusion

Artificial Intelligence functions as a powerful diagnostic catalyst in dental education. It significantly enhances dental students' diagnostic sensitivity, spatial visualization of caries, interpretation speed, and clinical confidence. However, AI must be positioned strictly as an **adjunctive screening aid** rather than a definitive diagnostic tool. Institutional academic frameworks must develop structured training modules that teach students to think critically, mitigate automation bias, and blend AI findings with traditional tactile and patient-specific risk profiles.

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