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Alrio Chaves Fernandes
Undergraduate Dental Student,
KLE VK Institute of Dental
Sciences, Belagavi, Karnataka,
India

Dr. Chetan Belaldavar
Department of Oral & Maxillofacial
Pathology & Oral Microbiology,
[KLE VK Institute of Dental
Sciences, Belagavi / K.A.H.E.R
University, Belagavi, Karnataka,
India

Dr. Anand Badavannavar
Department of Oral & Maxillofacial
Pathology & Oral Microbiology,
[KLE VK Institute of Dental
Sciences, Belagavi / K.A.H.E.R
University, Belagavi, Karnataka,
India

Dr. David Albert Coutinho
Department of Oral & Maxillofacial
Pathology & Oral Microbiology,
[KLE VK Institute of Dental
Sciences, Belagavi / K.A.H.E.R
University, Belagavi, Karnataka,
India

Dr. Pushpak Shah
Department of Oral & Maxillofacial
Pathology & Oral Microbiology,
[KLE VK Institute of Dental
Sciences, Belagavi / K.A.H.E.R
University, Belagavi, Karnataka,
India

Dr. Deepa Mane
Department of Oral & Maxillofacial
Pathology & Oral Microbiology,
[KLE VK Institute of Dental
Sciences, Belagavi / K.A.H.E.R
University, Belagavi, Karnataka,
India

Corresponding Author:
Alrio Chaves Fernandes
Undergraduate Dental Student,
KLE VK Institute of Dental
Sciences, Belagavi, Karnataka,
India

Carve. Me: A Structured Digital Framework for Standardized Evaluation of Wax Tooth Carvings in Dental Education

Alrio Chaves Fernandes, Chetan Belaldavar, Anand Badavannavar, David Albert Coutinho, Pushpak Shah and Deepa Mane

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Abstract

Wax tooth carving is a fundamental component of preclinical dental education, aimed at developing students' understanding of tooth morphology and manual dexterity. Conventionally, the evaluation of wax carvings relies on visual inspection by faculty members, making the process subjective and examiner dependent. Such assessment methods often lead to inter-examiner variability, limited scalability, and delayed feedback.

To address these challenges, the present study introduces Carve. Me, a structured digital framework designed to standardize the evaluation of wax tooth carvings. The system enables dental students to upload images of their carvings in five standardized views—labial, lingual, mesial, distal, and occlusal—after selecting the appropriate tooth number or type. Rule-based validation logic ensures completeness of submissions and penalizes incorrect tooth-type uploads. Provisional scores are assigned to each view, promoting fairness and consistency in assessment.

The framework is compatible with the Windows platform and can function offline, making it suitable for institutional use. Although the current version does not incorporate trained artificial intelligence models, the system provides a scalable foundation for future integration of deep learning-based automated evaluation. Carve. Me demonstrates potential to reduce evaluator bias, improve consistency, and encourage student self-assessment in preclinical dental training.

Keywords: Wax tooth carving, dental education, digital assessment, standardized evaluation, preclinical dentistry

Introduction

Wax carving exercises play a crucial role in preclinical dental education by enhancing students, spatial perception, understanding of dental anatomy and psychomotor skills^[4]. Accurate reproduction of tooth morphology is essential for the development of clinical competence in restorative dentistry and prosthodontics^[5]. Traditionally, wax carvings are assessed by faculty members through direct visual comparison with ideal models or extracted teeth often supported by physical rubrics or verbal feedback^[6].

Despite its widespread use, conventional assessment methods are limited by subjectivity and examiner variability^[7]. Differences in experience and interpretation among evaluators can lead to inconsistent grading, which may affect student learning outcomes and perceived fairness^[8]. Additionally, the growing number of dental students has increased faculty workload, making individualized and timely feedback difficult to provide^[9]. Existing methods also lack mechanisms to verify whether students have submitted the correct tooth type, further compromising assessment reliability.

Recent advances in digital dentistry and educational technology have highlighted the potential of structured digital tools to improve objectivity and efficiency in assessment^[10]. The present study proposes Carve. Me, a digital framework aimed at standardizing wax tooth carving evaluation by enforcing structured submissions, basic validation, and rule-based scoring.

Materials and Methods

System Architecture and Platform

Carve.Me was developed as a standalone digital application compatible with Windows-based systems. The framework was designed for use in dental laboratories, classrooms and examination settings, with offline functionality to ensure accessibility in institutional environments^[11].

Submission Workflow

Upon launching the application, users are required to select the tooth number or tooth type from a predefined dropdown menu based on standard dental notation. Following selection, the system mandates the upload of five images corresponding to standardized anatomical views: labial, lingual, mesial, distal, and occlusal. Each image slot accepts only one image, with options for deletion and re-upload prior to final submission.

All images are automatically resized to 224 × 224 pixels to ensure uniformity and compatibility with future machine learning pipelines. The system validates image count and prevents duplication of views.

Validation and Scoring Criteria

The current version of Carve.Me employs rule-based validation logic rather than trained artificial intelligence models. The framework checks whether the uploaded images correspond to the selected tooth type using predefined criteria. If an incorrect tooth type is detected, the corresponding image is assigned a score of zero.

Valid submissions receive provisional scores ranging from 2 to 5 for each view, based on predefined parameters related to anatomical form, symmetry and surface finish. The total score is capped at 23 out of 25, with exceptional work flagged for faculty review.

Results

Implementation of the Carve. Me framework ensured complete and standardized submission of wax carving images across all users. The system successfully prevented incomplete uploads and incorrect view submissions. Rule-based scoring provided baseline evaluation for all valid entries, reducing the likelihood of extreme grading discrepancies.

Faculty feedback indicated a reduction in time spent on preliminary screening, while students reported improved clarity regarding submission requirements and assessment expectations. The structured workflow facilitated consistent documentation and digital record-keeping of student work.

Discussion

The findings suggest that structured digital frameworks such as Carve.Me can address several limitations of traditional wax carving assessment. By enforcing standardized views and tooth-type selection, the system minimizes common student errors and promotes procedural discipline. Rule-based scoring introduces transparency and repeatability, which are essential for fair assessment^[12].

Unlike existing digital tools that focus primarily on visualization, simulation, or CAD-based restorations, Carve.Me emphasizes assessment workflow and validation. Although the absence of trained AI models is a limitation, the structured dataset generated by the framework provides a strong foundation for future development of convolutional neural network-based automated evaluation systems^[13]. Similar digital assessment approaches in medical and dental

education have demonstrated improved reliability and reduced examiner bias when compared with conventional subjective grading methods^[14]. Moreover, structured digital feedback has been shown to enhance learner engagement and self-directed improvement, particularly in skill-based training environments^[15]. Offline-capable systems such as Carve. Me are especially valuable in resource-limited institutional settings where consistent internet access may not be guaranteed^[11]. Future validation studies involving inter-rater comparison and student performance outcomes will be essential to establish the educational impact and reliability of the framework^[16].

Conclusion

Carve.Me represents a novel and practical digital framework for the standardized evaluation of wax tooth carvings in dental education. The system improves consistency, reduces examiner bias, and supports student self-assessment through structured submissions and rule-based scoring. While not fully automated, the framework is scalable and ready for future integration of artificial intelligence-driven assessment tools.

Currently we have also filed for an IP (Copyright) for the same software with the Registrar of Copyrights (India).

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Conflict of Interest

Not available

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