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Promoting dental students' understanding of dental materials: A case study of dental materials laboratory education in Taiwan

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Driven by the rapid development of digital dental technologies, the field of dentistry is undergoing a dramatic transformation.[1] This shift presents a unique challenge for dental educators, particularly in Taiwan, where traditional methods often emphasize technical proficiency over theoretical understanding.[2] While Taiwanese dental students typically demonstrate strong manual skills, they often struggle with the abstract scientific principles of materials science, a core component of preclinical dental education. This gap is increasingly problematic as the industry moves from conventional techniques to complex digital workflows.[3] Traditionally, dental laboratory education has focused on manual skills such as wax carving, investing, and metal casting. While these dental techniques remain valuable, they are steadily being replaced by digital alternatives like intraoral scanning, computer-aided design/computer-aided manufacturing (CAD/CAM), and three-dimensional (3D) printing.[4] These tools streamline the fabrication process and reduce the need for specialized equipment and large spaces. As a result, even smaller dental clinics can now establish compact, in-house digital laboratories, fundamentally changing daily dental practice pattern.

This dental technological evolution directly impacts the roles of the dental technicians and the clinicians. As one senior certified dental technician in Taiwan noted that the clinicians now expected to be familiar with both conventional and digital approaches.[5] This requires understanding the advantages and limitations of different fabrication processes, materials, and outcomes. The dental students must critically evaluate traditional and digital systems and make informed decisions based on both technical skill and scientific knowledge. To meet these changing needs, Taiwanese dental students should be trained with advanced dental technologies as early as possible. Early exposure builds not only technical competence but also adaptability and confidence in navigating digital workflows.

We redesigned a second-year laboratory course into an 18-week program emphasizing hands-on application and clinical relevance. It included four modules: (1) impression-taking with alginate and intraoral scanners, (2) wax-up and crown preparation, (3) metal casting and cementation, and (4) manipulation of resin-based materials (Table 1). A key feature was the direct comparison between traditional and digital methods, allowing dental students to observe differences in accuracy, efficiency, material handling, and failure points firsthand. To support analytical development, standard lab reports were replaced with structured worksheets featuring guided reflection questions. These helped dental students to link practical observations with scientific principles. For example, comparing the accuracy of intraoral scans to that of conventional impressions or

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Table 1 The course topic and outline for the course entitled "dental materials laboratory education".

Weeks	Course topic	Course outline
1	Course introduction and lab safety guidelines	Overview of course structure, safety protocols, and lab usage policies
2	Traditional and digital impression techniques 1 — Alginate impression (half arch)	Introduction to traditional impression techniques using alginate; hands-on practice with half-arch impressions
3	Traditional and digital impression techniques 2 — Digital scan (half arch)	Training in digital impression methods using intraoral scanners; comparison with traditional techniques
4	Traditional and digital impression techniques 3 — Digital scan (full arch)	Full arch scanning using digital equipment and emphasizing accuracy and workflow differences
5	Traditional and digital impression techniques 4 — Crown preparation and comparison	Clinical procedures for crown preparation using traditional techniques; comparison with digital crown workflows
6	Traditional and digital impression techniques 5 — Crown preparation and comparison	Advanced practice in crown preparation and evaluation of restoration fit between digital and traditional methods
7	Midterm report	Presentation and discussion of students' progress, findings, and reflections on completed modules
8	Wax pattern carving	Hands-on wax carving to create tooth models; focus on anatomical accuracy and material handling
9	Investing	Introduction to investment procedures for metal casting; focus on precision and technique
10	Metal casting and polishing I	Casting of dental alloys and initial polishing; comparison of metal properties and casting challenges
11	Metal casting and polishing II	Final polishing of metal restorations and quality assessment of surface finish and adaptation
12	Dental cements I	Overview of dental cements, types, properties, and clinical application scenarios
13	Dental cements II	Advanced work with dental cements; troubleshooting, finishing, and clinical considerations
14	Self-curing resin I	Introduction to self-curing resin materials; manipulation techniques and setting behaviors
15	Self-curing resin II	Advanced work with self-curing resins; troubleshooting, finishing, and clinical considerations
16	Final report and discussion	Submission and discussion of final laboratory reports; peer feedback and instructor evaluations
17	Flexible learning and feedback I	Provide students who do not perform well with opportunities to review and wrap-up their final report
18	Flexible learning and feedback II	Continuation of course wrap-up projects

analyzing how errors in a manual wax-up affected material performance. Completing these while procedures were fresh reinforced clinical understanding and materials science concepts. As shown here, a blended learning approach that combined visual demonstrations, online tutorials, and group discussions to support dental students' strengths in hands-on tasks while enhancing reasoning skills (Table 1).

In summary, this redesigned course prepared dental students for a rapidly evolving clinical environment. The goal was not to produce researchers, but was thoughtful to let the future clinicians who could navigate both traditional and digital workflows and make sound decisions based on technical and scientific understanding. This model bridges the gap between global dental technological trends and the specific learning needs of dental students in Taiwan, emphasizing the importance of early training in digital dentistry. Furthermore, the changes brought about by the digital transformation of dentistry have a significant impact on improving the quality of dental care. By integrating the concepts of digital dentistry into undergraduate dental materials laboratory education, we hope that the curriculum innovation may facilitate closer collaboration between the dentists and the dental technicians in the future, allowing them to jointly discuss and formulate the fabrication of dental restorations, thereby improving the quality of dental care and demonstrating the collaboration in practicing the precision medicine and the whole-patient care.[5]

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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