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Development of an online tooth morphology course in response to COVID-19 restrictions

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1 | PROBLEM

Tooth morphology, a foundation of clinical and laboratory dentistry, is traditionally taught using lectures supported by study using extracted teeth, plastic replica, wax or chalk carving, or drawing.[1] The need to review this model has been highlighted recently by pressures that include the difficulty to obtain and retain good quality teaching specimens, and reduction in teaching hours.[1] During academic year 2020–2021, in response to the COVID-19 pandemic and in line with government restriction, our institution curtailed physical presence on campus for staff and students posing additional challenges to the delivery of our tooth morphology course.

The delivery of lectures through recordings uploaded to a virtual learning environment (VLE) or remote lecturing using communication platforms cannot fully alleviate the problem. Learning with models (2D or 3D) is preferable to help integrate knowledge acquired in lectures with the 3D structure and appreciate differences in dental morphology. Flash cards offer a potential solution as they provide multiple views of the same tooth and highlight distinguishing features of the teeth. While some learners easily translate 2D information into 3D representations, others struggle with the process.[2] In addition, assessment of knowledge in 2D is not aligned with its clinical application.

2 | SOLUTION

dvantage of the Canvas VLE available at our institution to develop a self-directed tooth morphology learning environment proposing multiple entry points in 2D or 3D to students. We generated interactive FDI (Fédération Dentaire Internationale, FDI World Dental Federation) grids representing permanent or deciduous dentitions. Each button on the grid was linked to a Canvas VLE page containing either a 2D flashcard or a 3D interactive model for each tooth (Figure 1).

The dental schools at the University of Dundee and the University of Michigan in Ann Arbor both created a series of 3D dental morphology models for permanent or deciduous dentitions available from the SketchFab website. These models were embedded into Canvas pages, allowing students to access the model in situ without access to external sites. Staff-led interactive sessions were held through Microsoft Teams using unlabeled 3D models loaded to Microsoft PowerPoint. These were screen shared to discuss dental features and quiz students. Each week, lecture notes and recordings were made available (see Supporting Information for full description). Assessment was performed through Canvas quizzes using embedded 3D models that students had not previously seen. Each question required learners to correctly identify a 3D tooth model and answer a question regarding the developmental milestones of the tooth.

3 | RESULTS

In response to the problems described above, the solution developed has allowed the continuation of delivery of material for which 3D spatial representation is important. The models were labeled to highlight individual features, providing students with an integrated 3D learning tool that could potentially rival extracted teeth as it offers

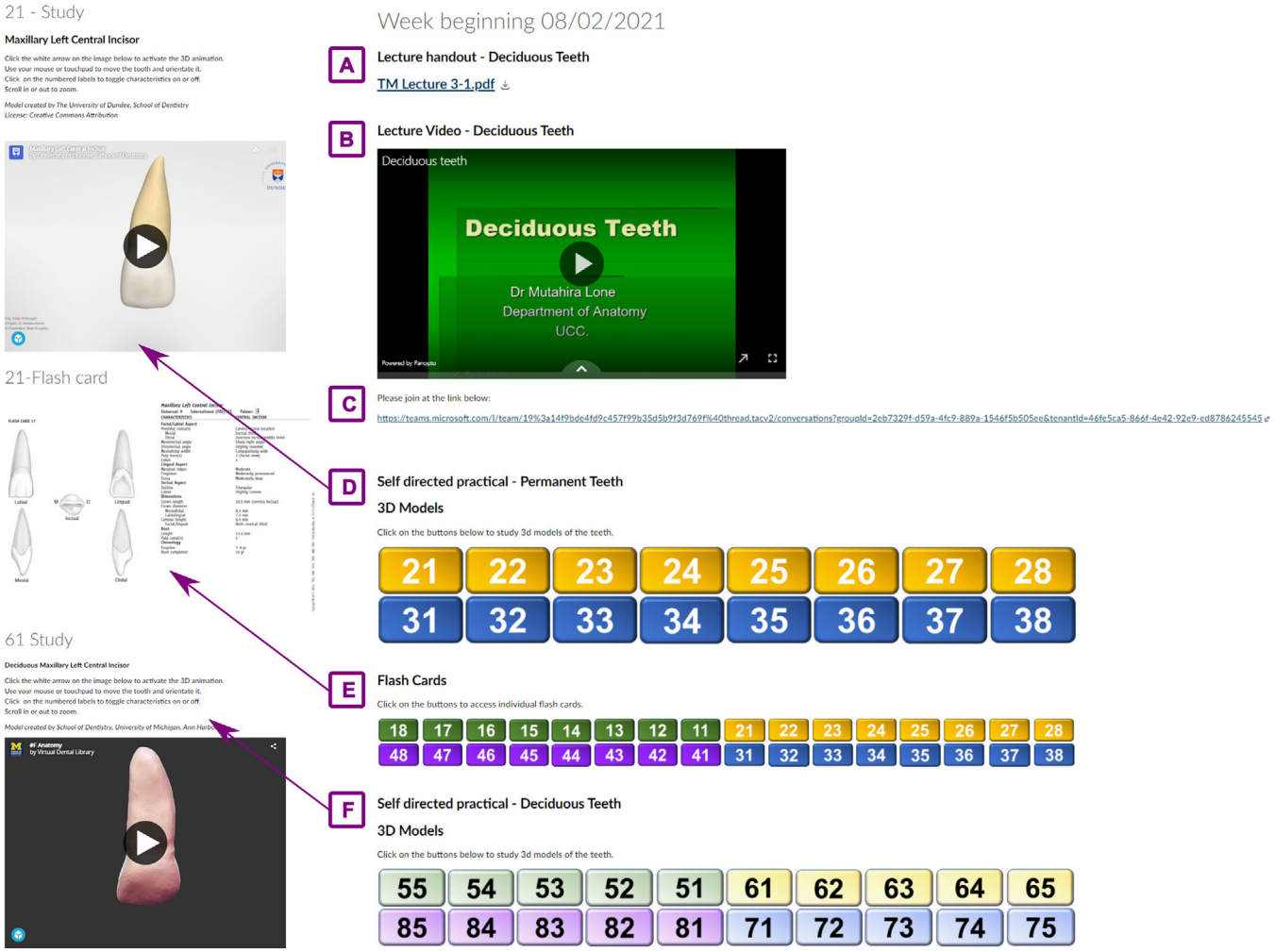

FIGURE 1 Canvas LMS page displaying multiple entry points to the material. For the selected week, students are presented with (A) lecture notes, (B) lecture video recording, (C) a link to the weekly live session, (D) an FDI grid (left side) linking to 3D models for permanent dentition (University of Dundee SketchFab models), (E) an FDI grid linking to flash cards for permanent dentition,[4] (F) an FDI grid linking to 3D models (University of Michigan SketchFab models) for the deciduous dentition. The panels on the left display the linked pages. While lecture notes and recordings were released in a timetabled fashion, students had continued access to previous material and learning tools, allowing self-pacing of learning

immediate feedback on feature identification. Examination results for the 2021 cohort (68.7 ± 1.8%) are in line with the average results of the cohorts from 2016 to 2019 (71.5 ± 1.2%, $p = 0.237$ Student's *t*-test).

The use of 2D and 3D approaches combined with lecture recording, notes, and live sessions for discussions with instant feedback allowed us to cater to different learning modes, and diverse schedules, and gave control to learners, in line with the principles of the Universal Design for Learning.[3] While more research will be needed to investigate if students can translate virtual 3D learning to the identification of extracted teeth and if this can be implemented as a replacement for in-person teaching, we believe that this approach offers a strong alternative for students that prefer a self-paced learning environment to directed education.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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