

King James IV Lecture

Contemporary Simulation in Dentistry

How real does it have to be?

King James IV
(17 March 1473 – 9 September 1513)

**King of Scotland from 11
June 1488 until his death
(aged 40) at the Battle of
Flodden in 1513**



King James IV

- James IV is generally regarded as the most successful of the [Stewart](#) monarchs. He was responsible for a major expansion of the [Scottish royal navy](#), which included the founding of two royal dockyards and the acquisition or construction of 38 ships, including the [Michael](#), the largest warship of its time.




King James IV – Royal Dentist

- 1503 when the king summoned a ‘barbour’¹ to extract one of his teeth for the sum of 14 shillings (around £450² in today’s money).
- “This noble king, James IV, was well learned in the art of medicine, and also a cunning chirurgenor”
- Founder of this Royal College !

Royal Court during King James IV

James IV's court and royal household were cosmopolitan, containing assorted foreign peoples including French and Italian minstrels as well as hosting a number of Africans.





Learning Outcomes

1. Identify and summarize the **important features** of new technologies used in contemporary simulation
2. **Understand the potential** and some of the limitations of haptically enabled environments for psychomotor skills training
3. Comprehend and **discuss the evidence** available for simulated practice education
4. **How real** does the simulation have to be?

Why is Simulated Practise Important?

“simulation is a necessary component for professional skills acquisition” (Coles, Meglan and John, 2011)

“it is no longer acceptable or appropriate, for students at any level of training to practise new skills on patients, even if they have a patient’s explicit consent” (Aggarwal & Darzi, 2006)”



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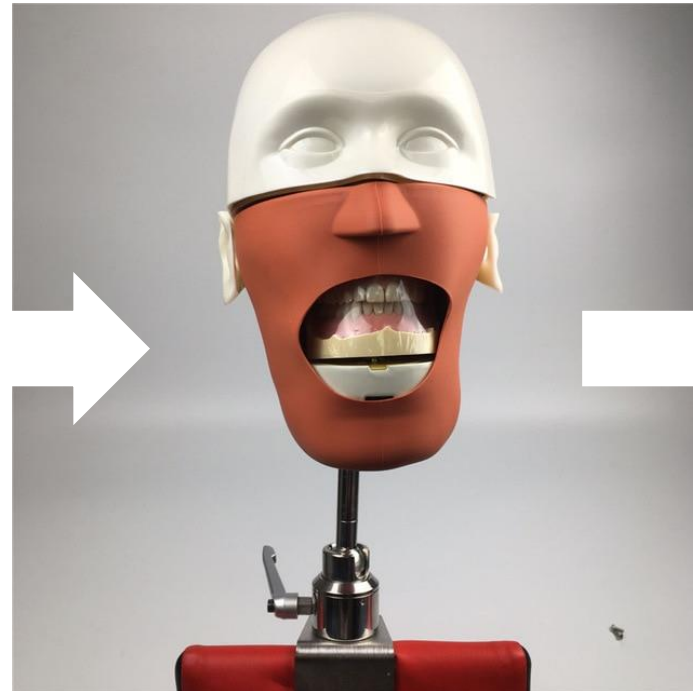
Repetitive Deliberate Practice



A STANDARD **WORKFLOW**



Read the
theory



Practice on
Plastic / extracted teeth



Practice on
patients

Why change current practice?

- Unrelenting pressure to update & reform
- Increasing societal pressures for patient safety
- Patients less willing to be “guinea pigs”
- Ethics about students working on each other
- Fewer suitable patients for students to learn on
- Fewer suitable extracted teeth
- Fewer teachers available
- Our students expect the latest technology



The 6 Schneider fallacies: High Performance Skills acquisition*

- Practice makes perfect
- Must train for the total skill
- Skill learning is intrinsically enjoyable
- Must train for accurate performance
- Initial performance is a good predictor of success
- Once concepts have been learned, proficiency will develop in operational setting

*W Schneider "Training high-performance skills - fallacies and guidelines" Human Factors 27 (3) pp. 285-300 (1985)



Opportunities with haptic technology

For dental students

- *Repeated deliberate practice*
- *Psychomotor skills training*
- *Mirror vision practice*
- *Objective assessment*
- *More independent practice & learning*
- *Peer review & learning*
- *Objective feedback*
- *No plastic or real teeth to find*
- *Case presentation with history, rads etc*
- *No aerosol !*



Opportunities with haptic technology For dental teachers

- *Less tutor time*
- *Able to review procedural stages*
- *Can compare to peers easier*
- *Can monitor student usage*
- *Monitor student progress easier*
- *Objective data*
- *Operative tasks increasing e.g. implants*
- *Remote supervision*
- *No aerosol!!*

Failing to fail!

Assessment and feedback is independent of the teacher

Dixon C. & Roudsari R. Failing to fail phenomena. European Journal of Dental Education 2022 p1-8



Why is there resistance?

“the technology is not there yet”

“if it ain't broke why fix it?”



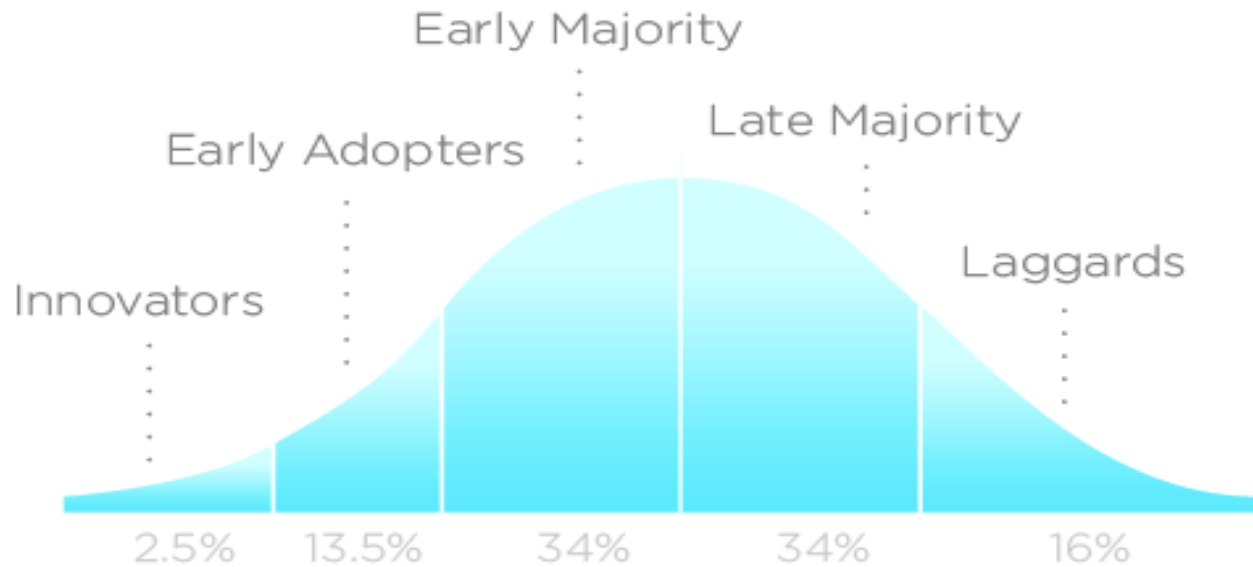
“we will be without a job”





Challenges for Universities

Technology adoption life cycle



INNOVATION ADOPTION LIFECYCLE

Roger's Bell Curve

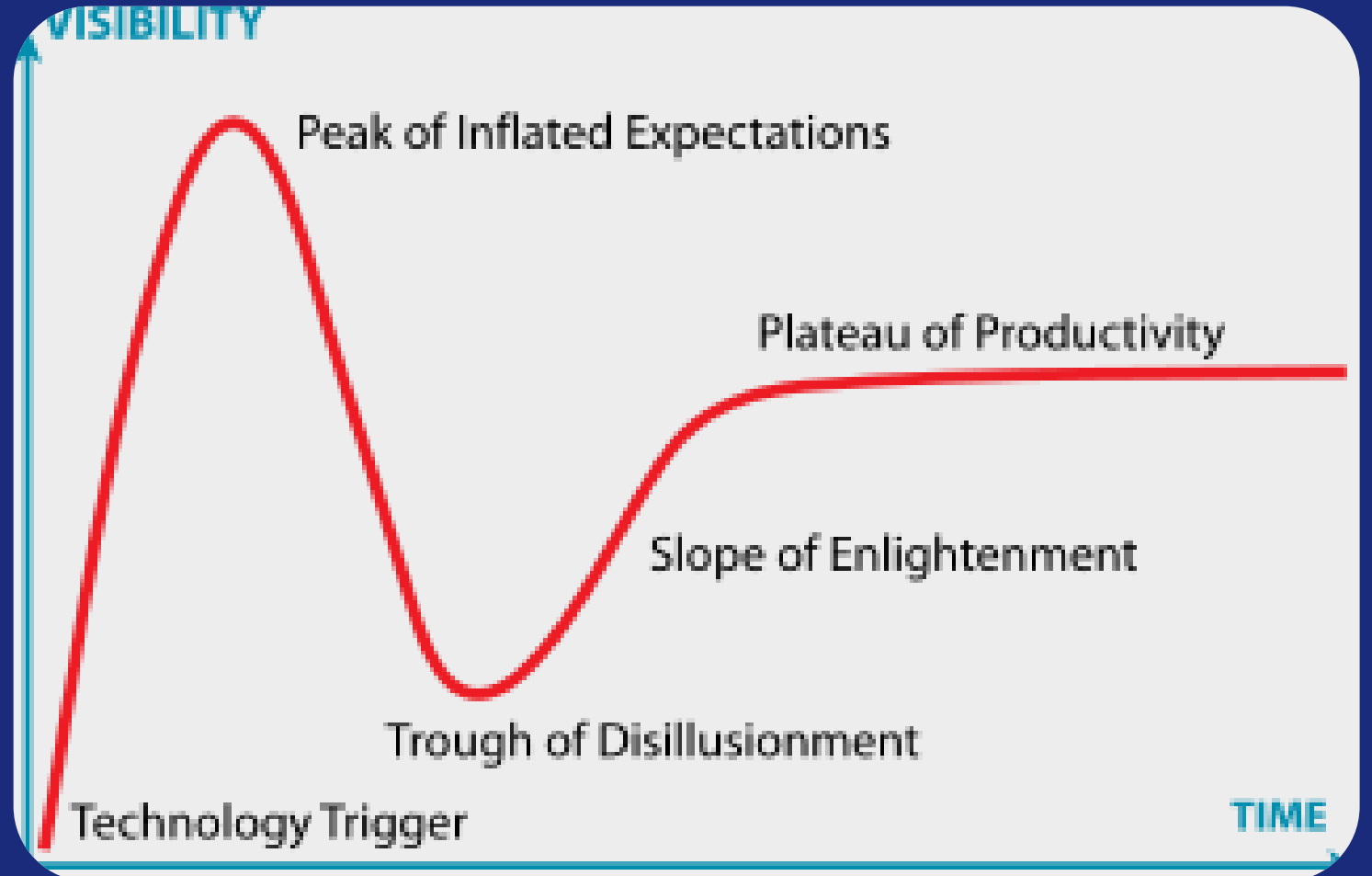
Joe M. Bohlen, George M. Beal &
Everett M. Rogers at
Iowa State University (1957)

INNOVATION ADOPTION LIFECYCLE



Introduction of new technology

Gartner Hype Curve



What is haptics?

- “pertaining to touch” it allows the user to interact and modify virtual objects by providing tactile sensation through forcefeed from the device

Dental tutors teaching students in the traditional phantom head/clinical skills laboratory



A man in a light blue short-sleeved shirt and safety glasses is working on a haptic dental training system. He is focused on a task, possibly assembling or adjusting a component. The system includes a computer monitor, a keyboard, and various cables. The background shows a laboratory or office setting with other people and equipment.

hapTEL

Tse, B., Harwin, W., Barrow, A., Quinn, B., San Diego, J., & Cox, M. (2010). Design and development of a haptic dental training system-hapTEL. *Haptics: Generating and perceiving tangible sensations*, 101-108.

Professor B. E. A. Quinn

Virtual reality simulation in dentistry

Nissin Simodont Dental Trainer



Colored 3D models of teeth based on CT-scans

VirtEasy by HRV Simulation



SIMtoCARE



Mixed Reality Simulator
















Procedures and Courses

20:07 Thu 26 Aug SIMtoCARE

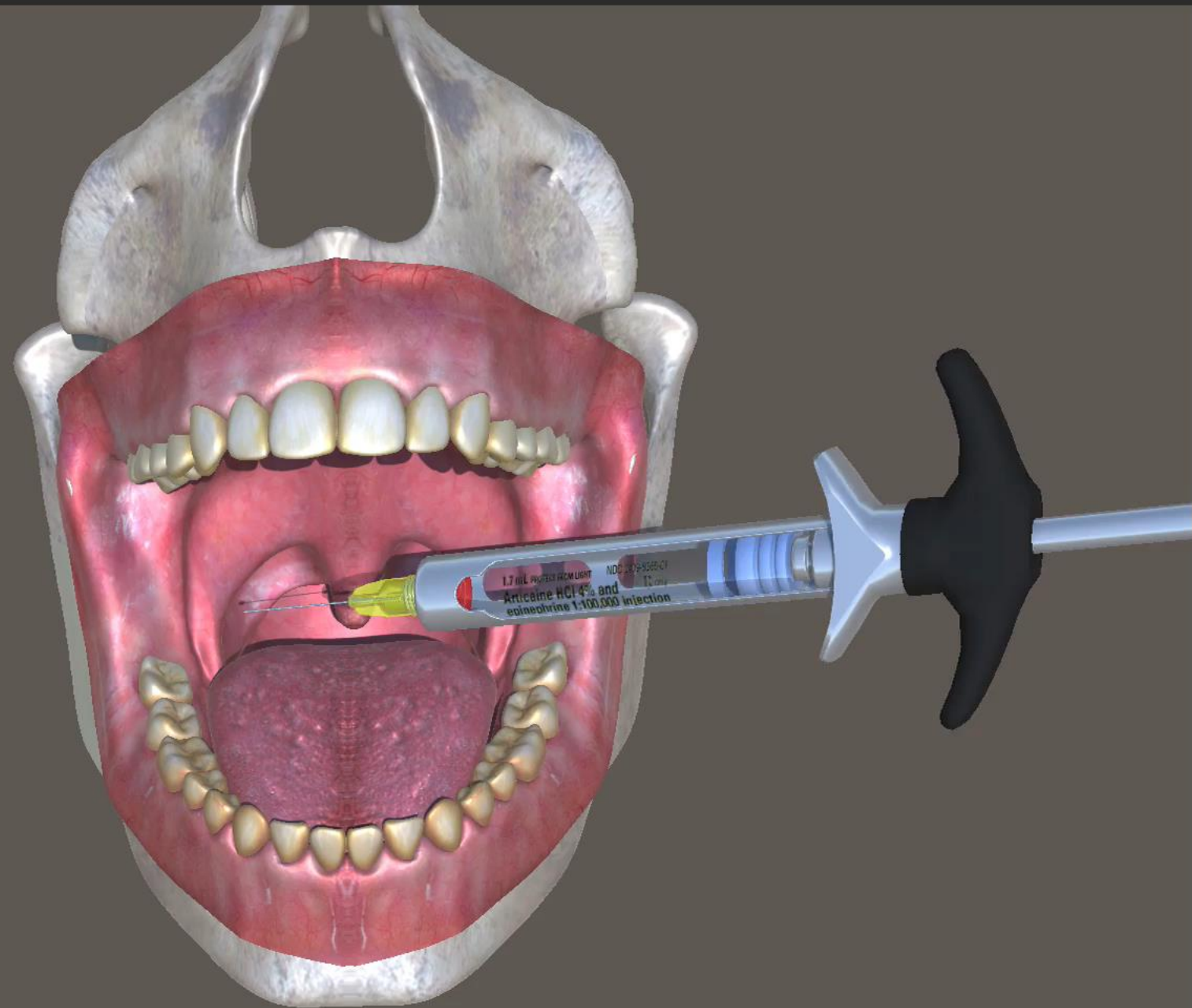
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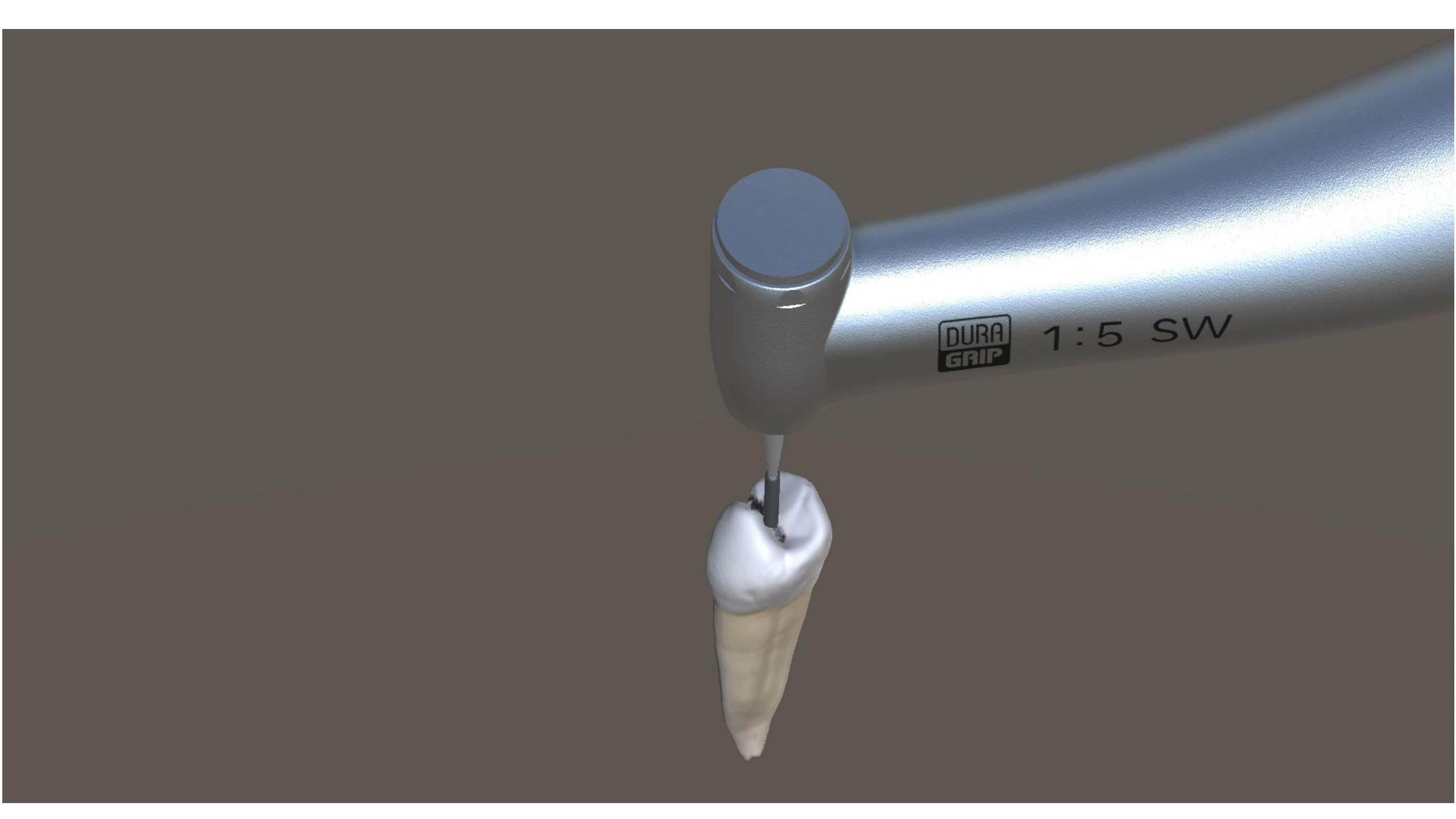
PROCEDURES

Courses

-  **Manual dexterity**
Cases: 31
-  **Operative dentistry**
Cases: 17
-  **Prosthodontics**
Cases: 18
-  **Endodontics**
Cases: 6
-  **Implantology**
Cases: 8
-  **Pedodontics**
Cases: 4
-  **Periodontics**
Cases: 2
-  **Anesthesia**
Cases: 1
-  **Anatomy & charting**
Cases: 12
-  **Problem based**
Cases: 2
-  **My Scans / Patient specific**
All your patient scans

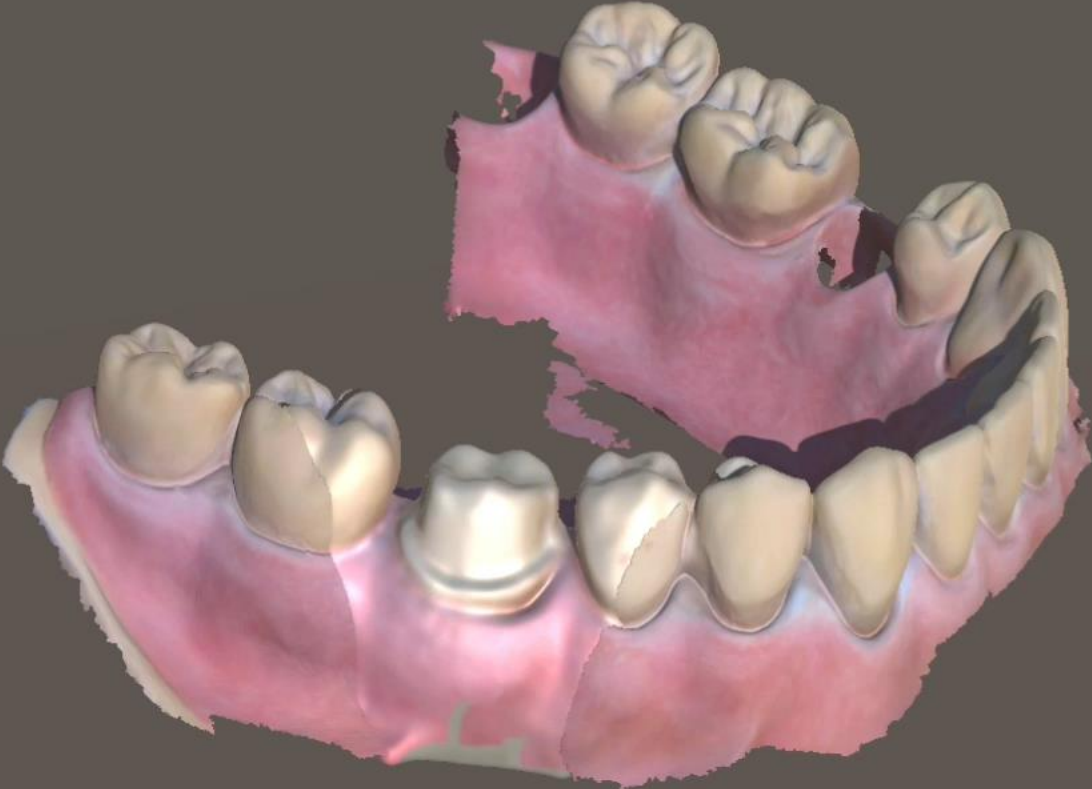
- Dental Anatomy & Charting
- Paedodontics
- Dental Anesthesia
(in progress)
- Periodontics (in progress)

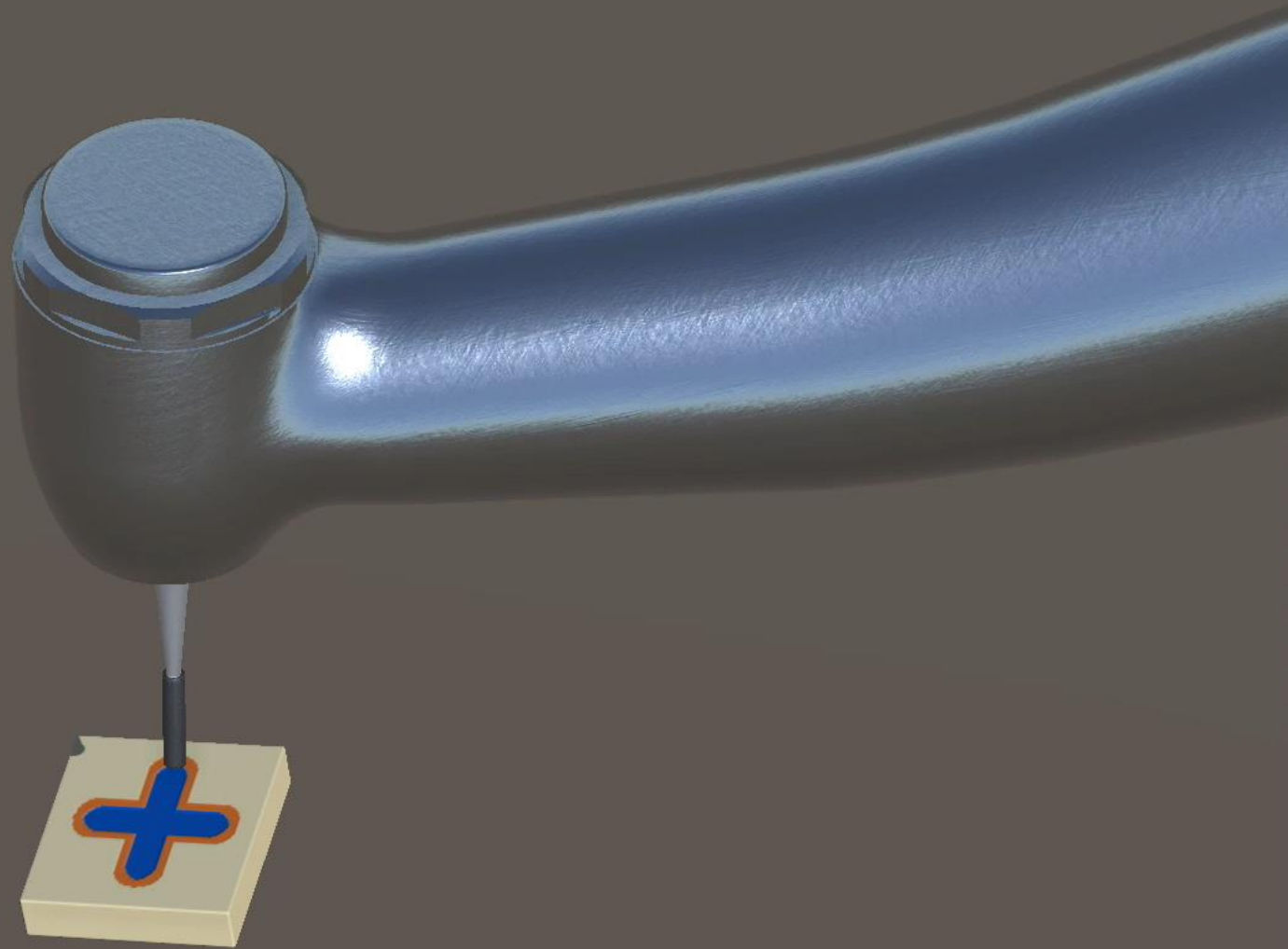




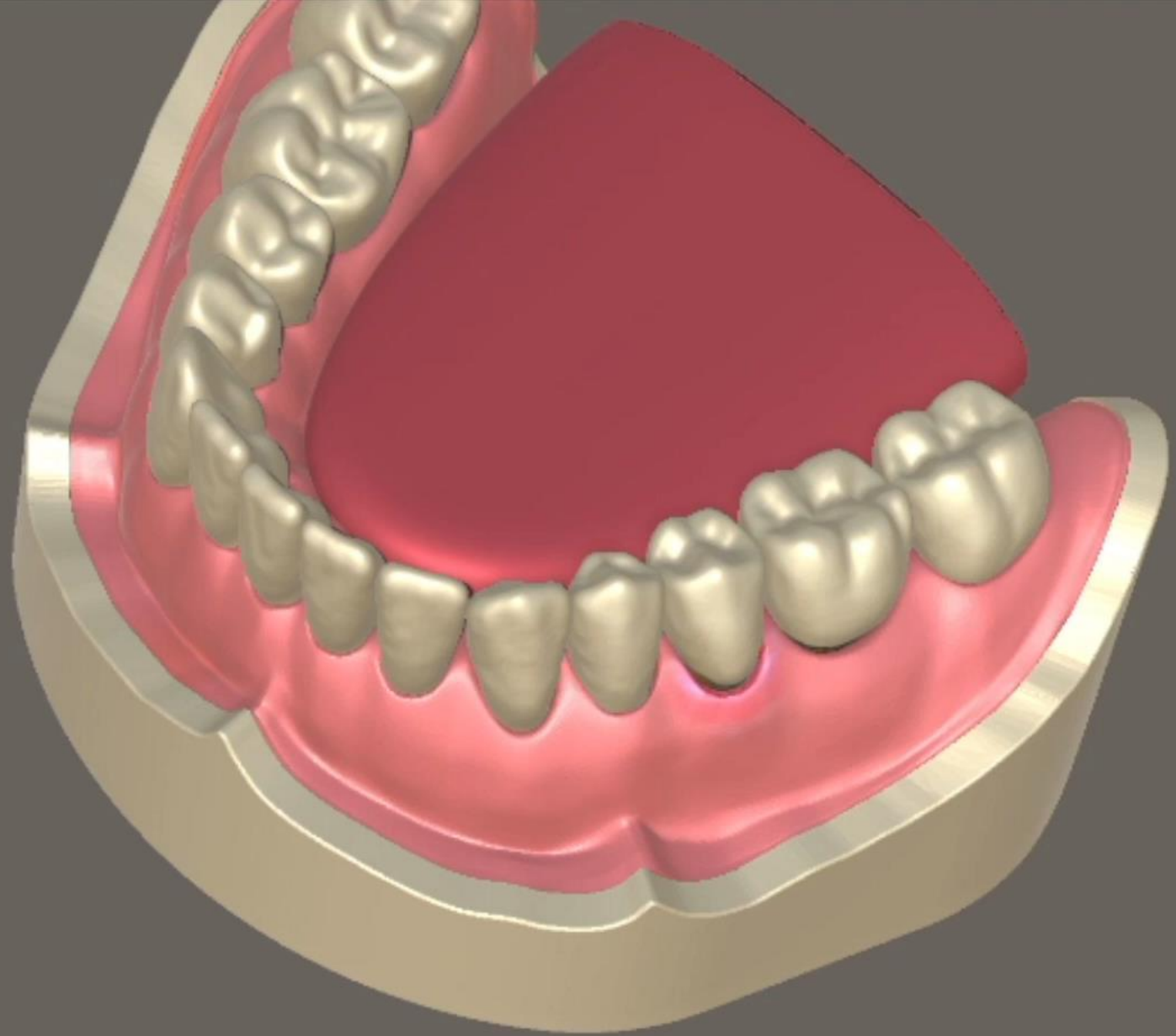
DURA
GRIP

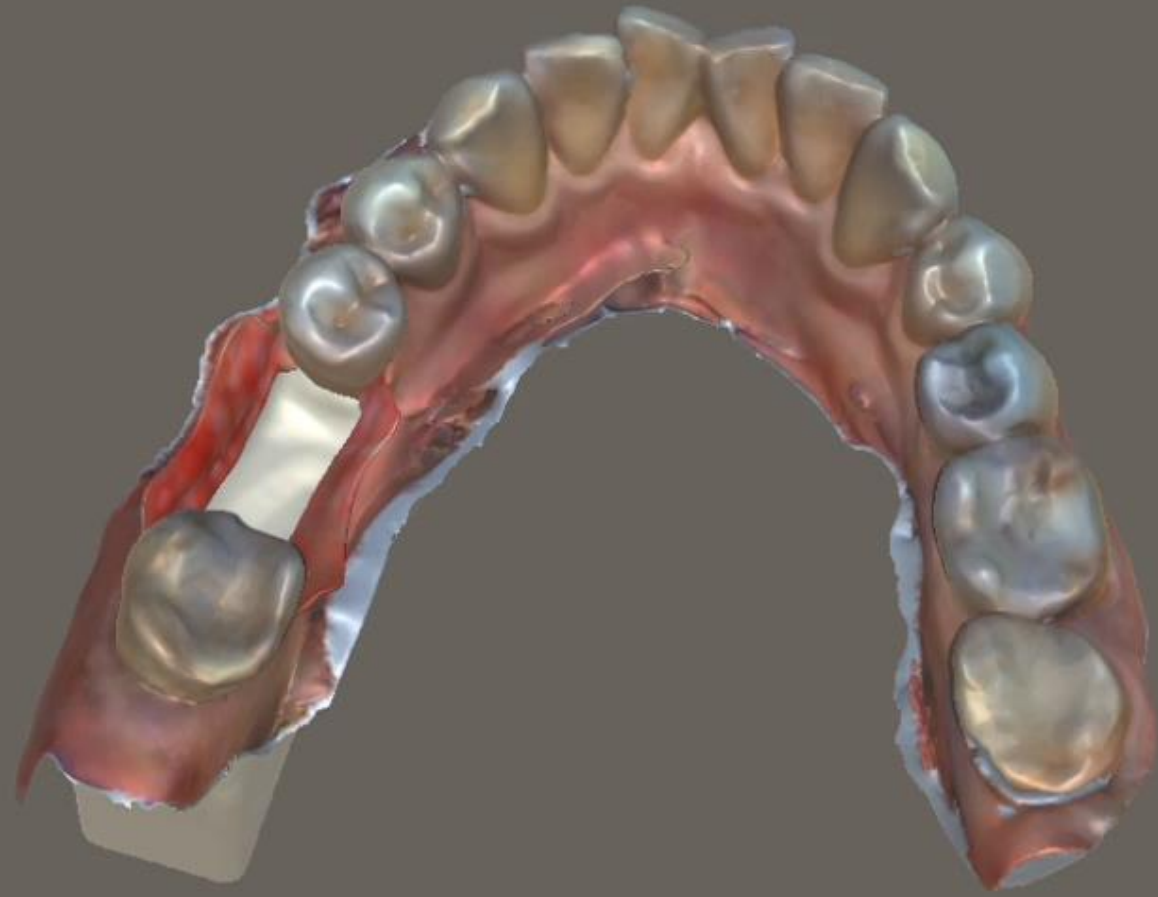
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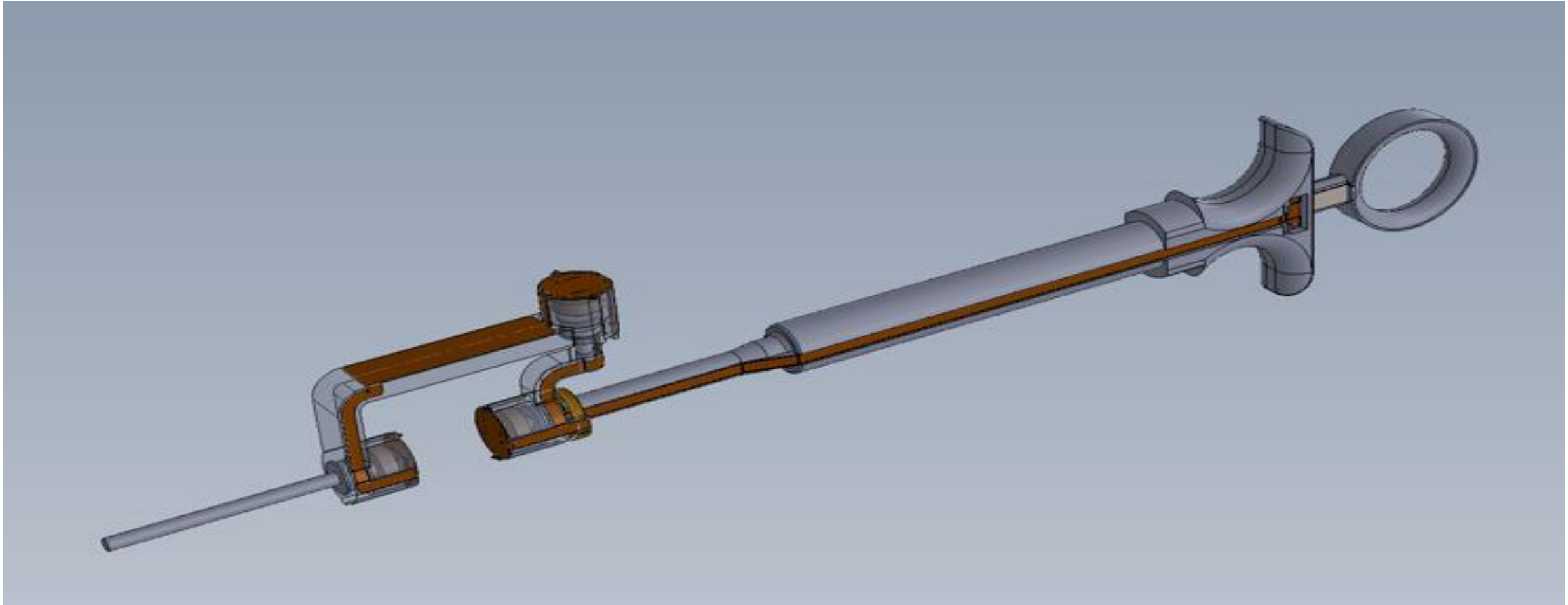




Forsslund Dental Simulator for third molar surgical extractions



injections



Giving an injection - Simuteach

Oculus Rift
Glasses





Simu
Team
Professor B. J. A. Quinn
Touch • Teach • Solve





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Are the skills transferable?

Flight simulator studies

Laparoscopy studies

Dental studies

Where is the evidence?



hapTEL Interdisciplinary team

Prof. Margaret Cox (Director, KCL)

Prof. Nairn Wilson (User-Group Coordinator, KCL)

Dr. Jonathan P. San Diego (Project Manager, KCL)

Dr. Barry Quinn ((Lead Clinician, KCL)

King's College Staff and Post-graduate students

Prof. Stephen Dunne, Prof. Tim Newton, Dr. Jon Hindmarsh,
Prof. Mark Woolford, Prof. Brian Millar, Dr. Brett Robinson,
Prof. Avijit Banerjee, Mr. Joe Harper, Mr. Lewis Hyland, Ms Tracy-Ann Green, Mr.
Arash Shahriari Rad and
Mrs. Clarabella Gray

University of Reading - Cybernetics team

Prof. William Harwin, Dr. Alistair Barrow and Mr. Brian Tse.

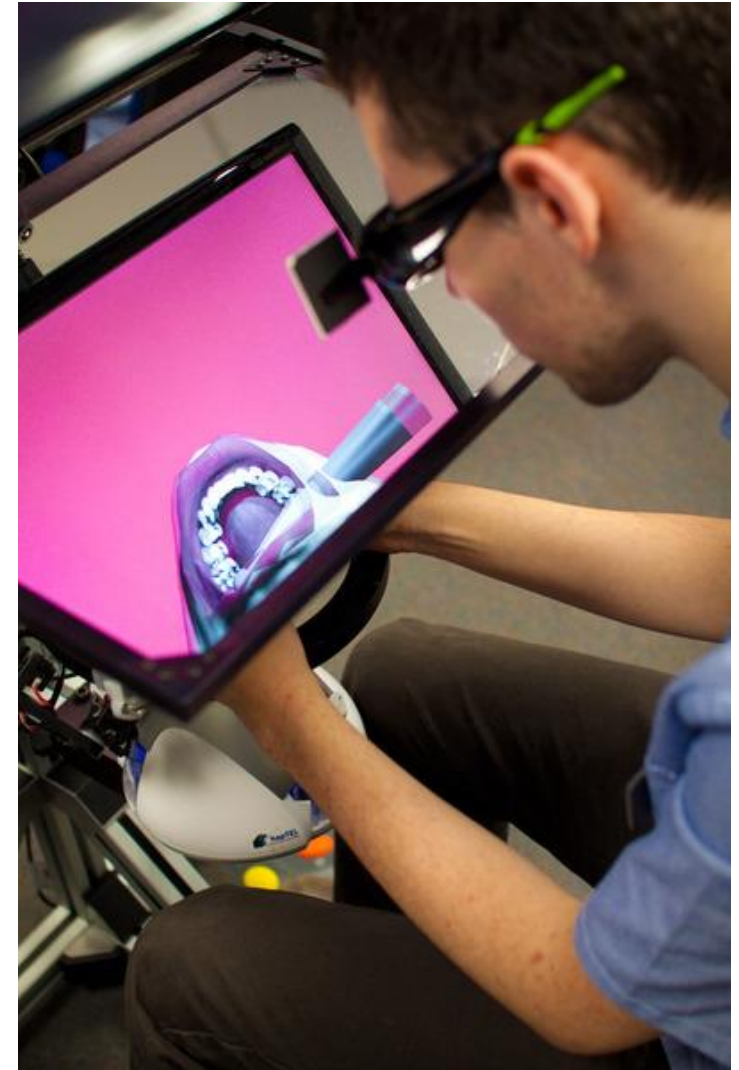
Consultants

Mr. Bruce Elson - Engineering

Prof. Patricia Reynolds – Flexible learning in Dentistry

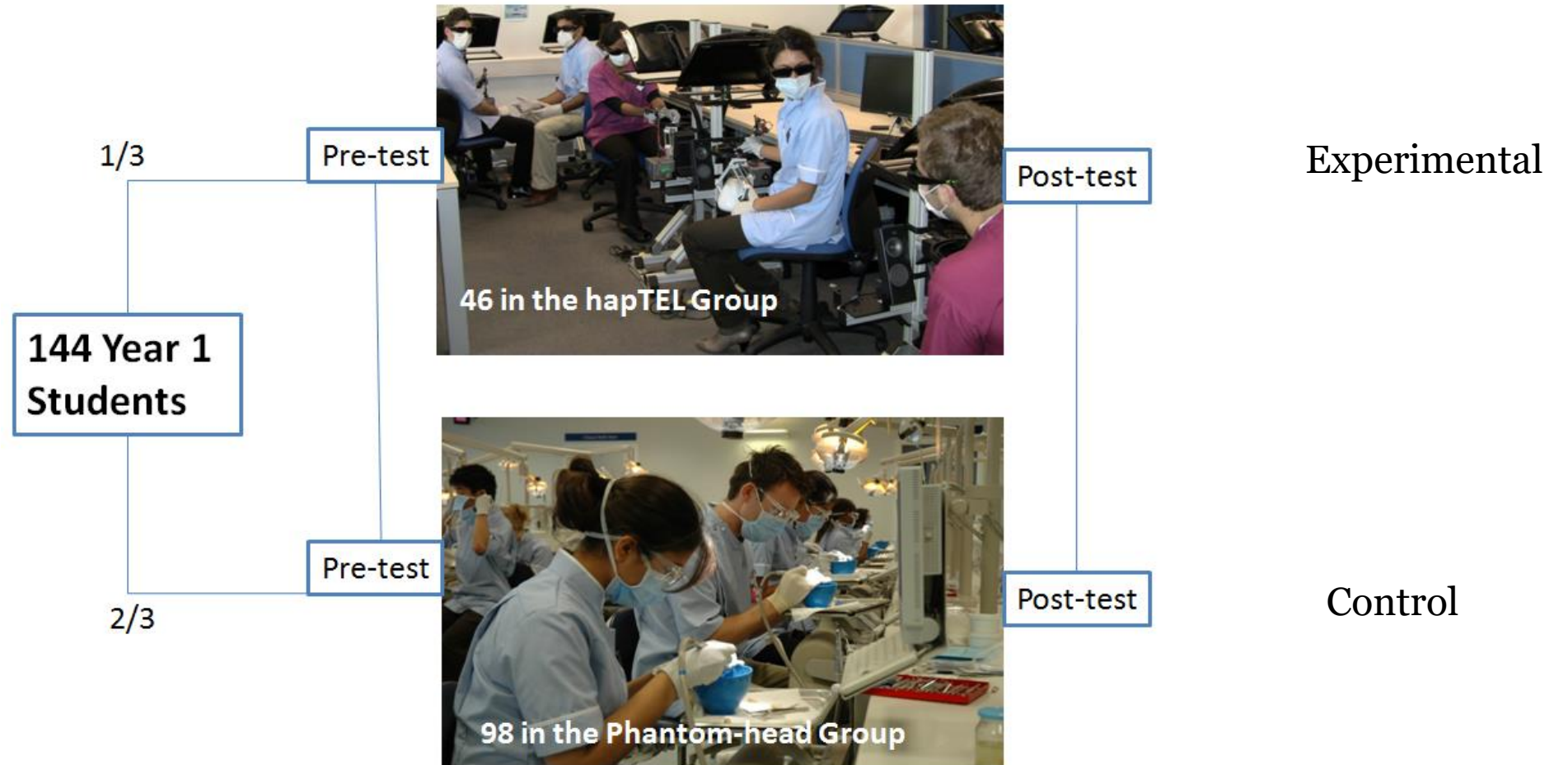
Null Hypothesis for PhD

“There is no difference between haptically (HEVRS) and traditionally (phantom head) trained dental students for occlusal cavity preparations in a Frasaco plastic analogue lower left first permanent molar”



hapTEL Simulator

Study Design



Clinical Tasks



Practice Task 1

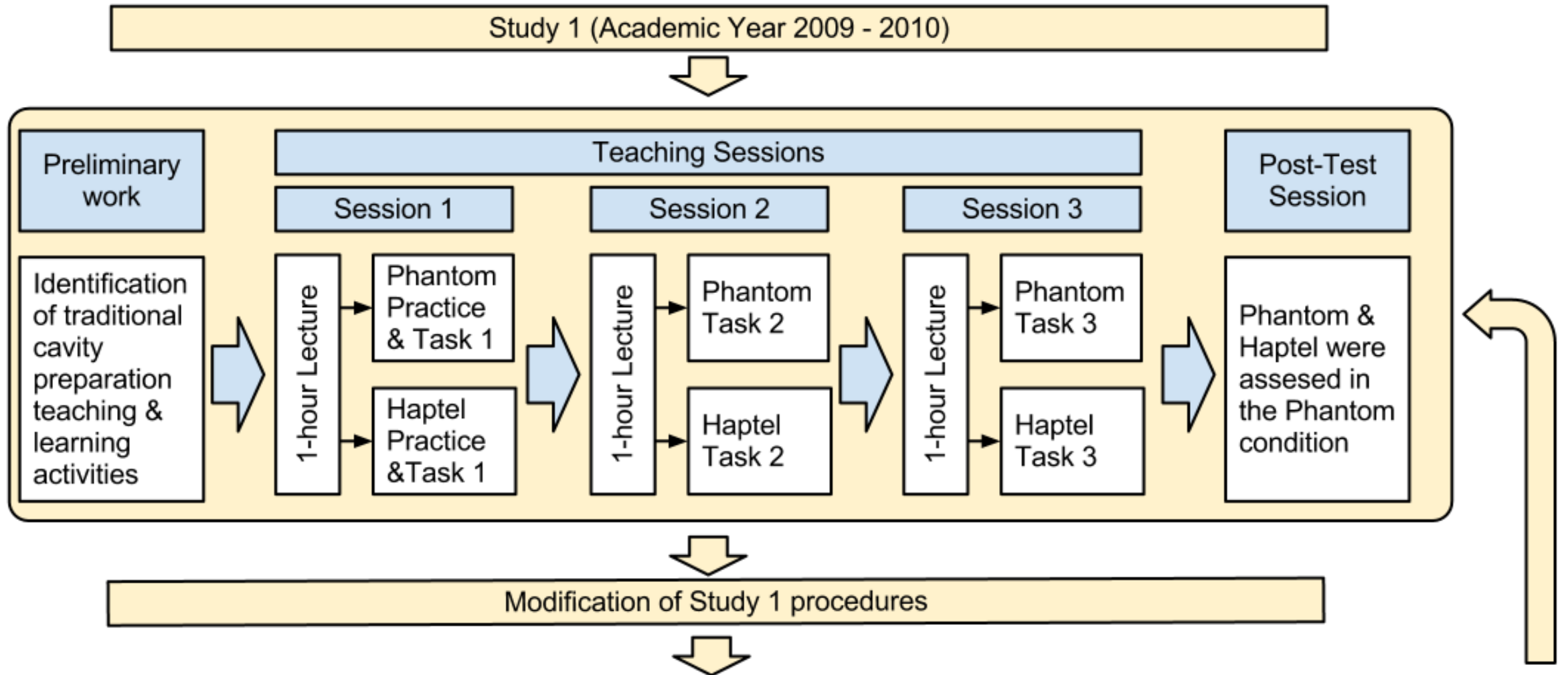
Practice Task 2

Practice Task 3

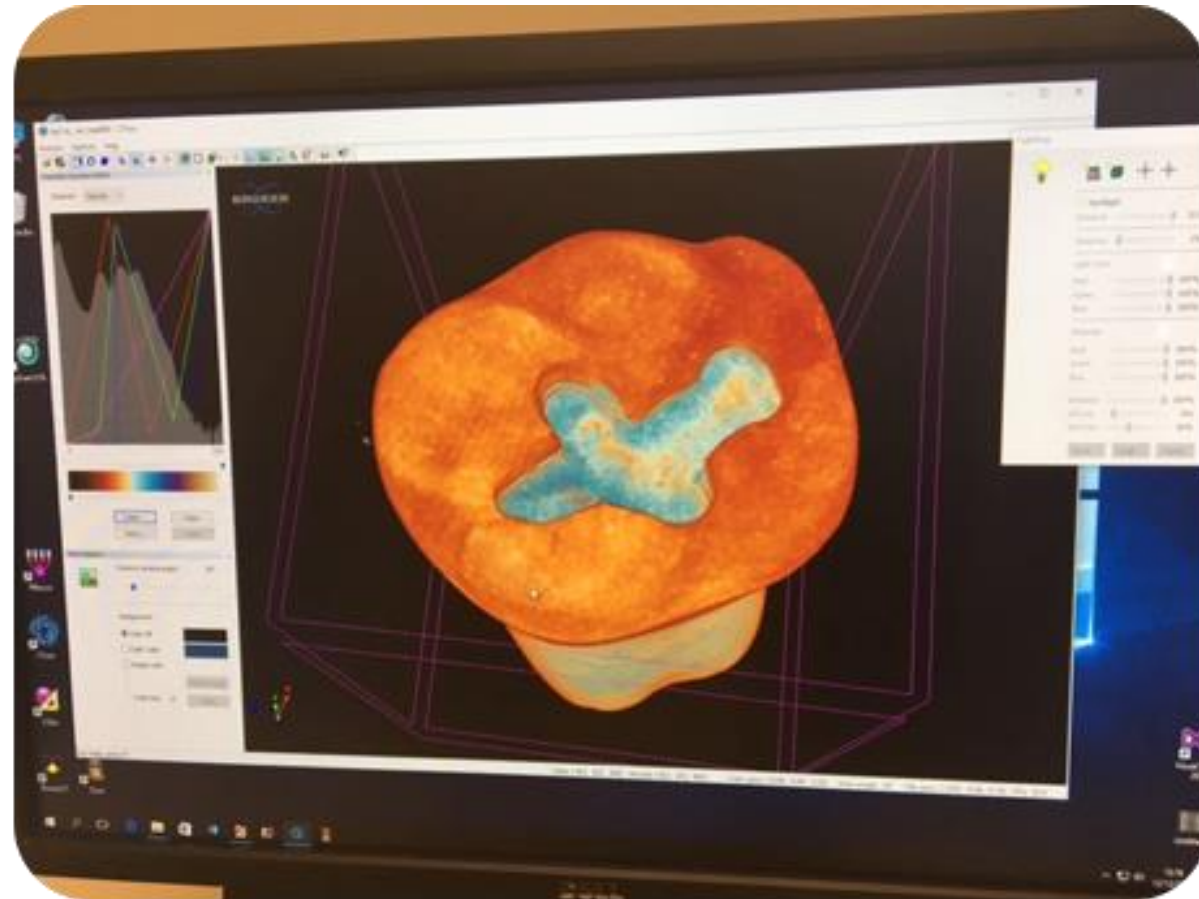
Assessment

Top view and the schematic cross section of the plastic teeth

Learning Activities



Colour Enhanced 3D image of MicroCT



Results



The **haptically trained** students had **performed as well** as the traditional phantom head trained students

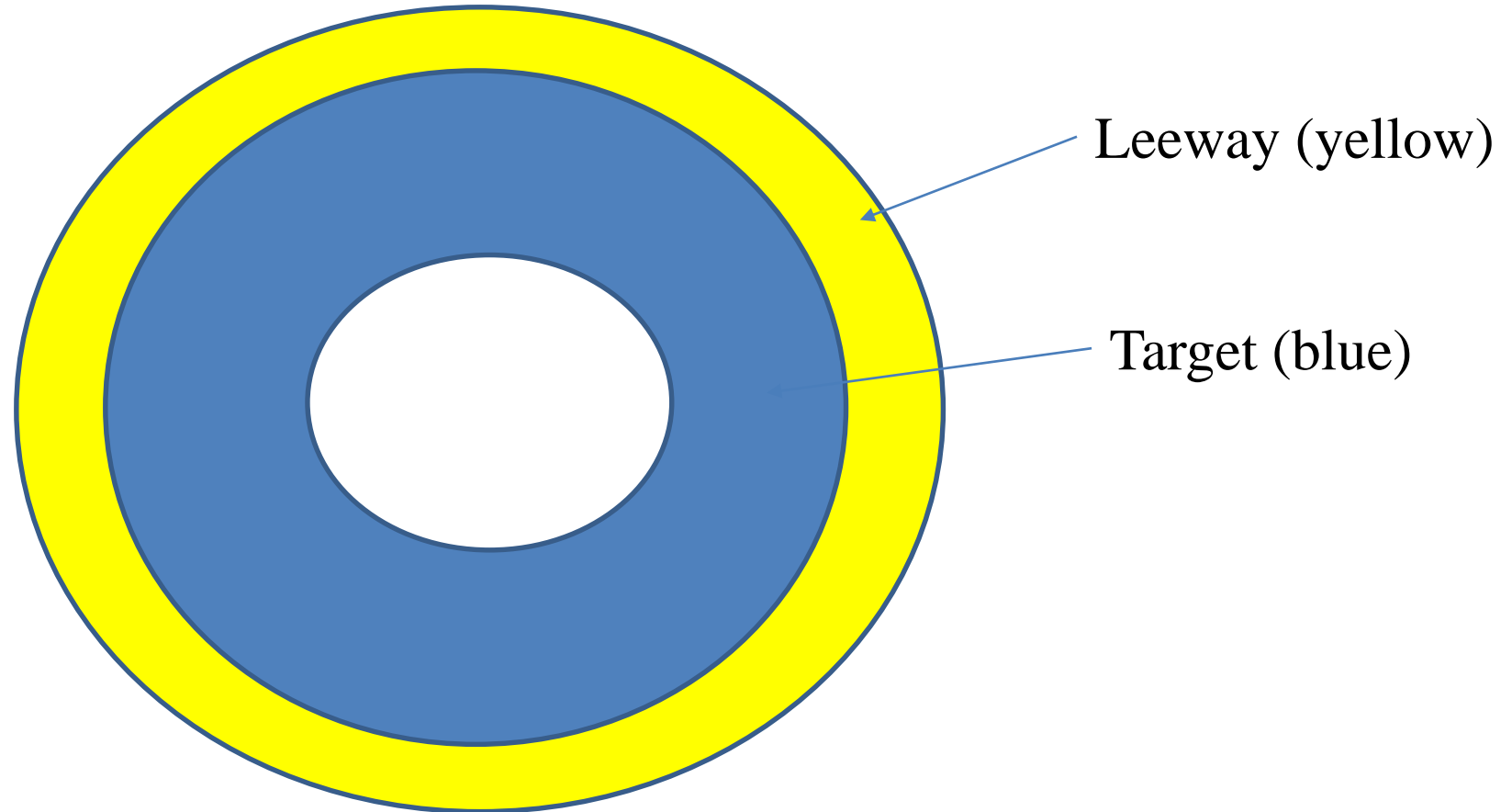


The **skills were transferable** from the hapTEL to the phantom head simulator



Micro-CT imaging was a novel method to assess the volumetric and surface roughness of the student's performance in the plastic teeth

Donut task psychomotor task





Methods

- Non-interventional, retrospective study (no ethical approval required)
- Data was collected for performing the same psychomotor task (donut) in two year cohorts, year 3 (n=99), year 5 (n= 136)
- The students were instructed to remove the blue colour of the donut (in 3D with volume), try to avoid the leeway (yellow/orange) and not to touch the base white material.
- **“Goals set for Mastery”**
- $\geq 96\%$ target removal (blue)
- $\leq 7\%$ leeway removal (yellow/orange)
- $\leq 1\%$ base (white)

- Students were asked to submit their best attempt, with no limits on the number of attempts



Results

In year 3 NO students fulfilled all 3 parameters set of $\geq 96\%$ target, $\leq 7\%$ leeway and $< 1\%$ base

In year 5 47.8% met all three criteria

- Both cohorts improved their psychomotor skills with practice
- The year 5 students, had significantly better results than year 3 dental students, illustrating that the two additional years clinical practice had made a difference in psychomotor skills.
- The objectiveness of the results provided by the simulator has been useful providing feedback that a teacher could not to the same degree of accuracy
- The simulator allowed students guided self-regulated practice

Hololens for immersive environments



So how real does the simulation have to be?

Dental Simulators: How Realistic Are They?

- Grayden S et al 2014 IADR
 - Haptic Simulation Pilot Study of Tactile Feedback Satisfaction by Faculty. Significant number of outliers.
- Quinn et al 2013
 - How Real does the Simulation have to be?
- Johnson L et al 2012 IADR
 - VR carious lesions more realist than plastic analogue teeth but instruments need further development.

Confounders in Published Dental Simulation Research

- Different tasks being performed make comparison between studies difficult;
- Ethical constraints were given as the main reason for not being able to offer a true randomised experimental-control group study;
- Early-adopters of new technologies are usually enthusiasts and are potentially biased in their reporting of results;
- Enthusiastic teachers may get better results.

The Future?

- *Artificial Intelligence*
- *Be able to ask questions*
- *Take a history*
- *Palpate lymph nodes/TMJ*
- *Periodontal probing*
- *Diagnoses*
- *Orthodontics, visualise tooth movement*
- *Time lapse tooth eruption*
- *Matrix band placement*
- *Restore teeth*

The companies want university partners to develop tasks & provide evidence

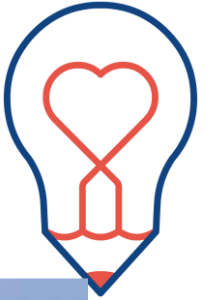


Questions?



References

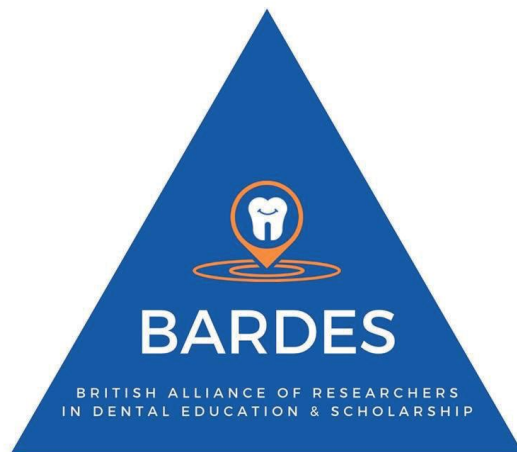
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British Alliance for Researchers in Dental Education & Scholarship

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FOR TOMORROW'S
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