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‘Making it Real’ – Stimulation in the Simulation Clinic

by

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Abstract

Simulation is increasingly recognised as an integral component of modern health care education, especially for learning irreversible interventional procedures. Dentistry has utilised various types of simulation activities during preclinical education for many years. This article reviews the application of the Simulation Clinic in contemporary dental education at James Cook University's dental school in Australia and offers insight into how 'making it real' can stimulate the successful acquisition of clinical skills.

Introduction

Simulation may be defined as a modelling process that attempts to replicate a particular set of problems or events, that can then be used to help teach someone how to do something. In contemporary health care education, simulation is increasingly employed as a training tool to artificially duplicate the conditions of a specified operative procedure. This has been driven by the patient safety agenda and is especially pertinent for procedures that require irreversible intervention. Early-stage training is thus more safely and more predictably performed in simulation, rather than during real-life clinical scenarios involving patients.

Operative skills training has long been an essential component of preclinical education in Dentistry because dental students, somewhat uniquely in undergraduate education, are required to undertake significant numbers of interventional procedures on many patients during their training to deliver the clinical competency so essential for graduation as an independent dental practitioner. Simulation in Dentistry dates back to the early use of extracted teeth for operative skills training, followed by the introduction of more realistic 'phantom head' or mannequin simulators during the late 19th Century[1,2]. Figure 1 illustrates the contemporary mannequin simulator, as currently utilised in the James Cook University (JCU) Dentistry Simulation Clinic.

Whilst many of us well remember the hours spent as undergraduates in 'operative technique laboratories' undertaking traditional models of didactic instruction, technique demonstration, followed by repeated performance of procedures on artificial plastic teeth assessed and graded by experienced instructors, there have been many significant advances in simulation technology and educational approaches in recent years including, most recently, the use of virtual reality (VR) simulators featuring haptic-enhanced touch and proprioceptive feedback mechanisms[3].

Simulation in Practice

Irrespective of the mode of simulation, the over-arching aim is to effectively 'close the gap' between academic theory and clinical practice. As shown diagrammatically in Figure 2, however, this process is probably best considered as a continuum of educational activities. Seamlessly 'joining the dots' becomes the key priority, with the important interface between pre-clinical subjects and operative skills established in the Simulation Clinic, followed by the important and fundamental transition into 'real-life' clinic activity. The process may be repeated many times, with each additional clinical skill acquisition often associated with an increasing complexity of task. The critical issue driving simulation is the ability of educators to stimulate active, hands-on learning in as realistic an environment as possible.

Table 1 lists a number of specific advantages of simulation during operative skills training which include, in addition to acquiring basic manual dexterity, an introduction to aspects of professionalism in healthcare practice such as appropriate clinic attire, punctuality and time keeping, instruction in basic ergonomic principles, and experience in recording and documenting procedures and maintaining contemporaneous case notes. Anecdotally, students also report growing confidence in their role as young dental practitioners which is especially encouraging.

Of particular relevance during the early stages of simulation instruction are the ergonomic approaches to optimise appropriate use of instruments and dental handpieces, facilitate effective handling of the dental mirror, and the development of finger rests to enhance stability during intra-oral operations. Additional, useful skills to acquire include the correct selection and application of extraction forceps and suturing techniques for oral surgery.

Whilst this all helps to instil the fundamental operative skills necessary for clinical dental practice, there are a number of challenges in delivering effective Simulation Clinic teaching, as summarized in Table 2. Perhaps the most significant of these relate to ensuring appropriate student engagement with the Simulation Clinic activities and the encouragement of individual students to take ownership for their work and learning. Indeed, these are essential prerequisites for successful simulation and educational progress.

There are also a number of additional factors that may influence the overall success of operative skills training. As highlighted in Table 3, one of the most important determinants of successful skill acquisition is timely and appropriate feedback on individual performance by experienced instructors, as well as good timetabling management in teaching sessions and ensuring a supporting and proactive learning environment. There is no substitute for experienced and enthusiastic clinical teachers[4].

Acquisition of Clinical Skills and Competence

In relation to clinical skill acquisition, it is recognized that skills may be considered as either 'hard', primarily psychomotor required to master safe operative interventions, or 'soft' cognitive and behavioural skills that support diagnostic reasoning, communication, professionalism and teamworking; these are summarized in Table 4.

Simulation teaching has traditionally concentrated on 'hard' skill acquisition, with courses in communication skills, professionalism and ethics often delivered didactically during the early years of dental education. Modern health care practitioners, of course, require a complex and wide-ranging skill set for contemporary practice and the ability to introduce and refine 'soft' skills in the simulated environment via clinical problem solving and discussion of case-based scenarios undoubtedly strengthens the educational continuum and adds relevance to simulation training.

George Miller's pyramidal model of the 1990's highlighted a progressive development of clinical competence from the initial acquisition of knowledge through the application of that knowledge, demonstrable competence in clinical skills and ultimately reliable and consistent performance in clinical practice. The reality, of course, is that true clinical competence relies very heavily upon the cognitive processes that underpin diagnosis, treatment planning and patient management. Introducing these skills early during simulation offers substantive opportunities to stimulate and engage young practitioners in a more holistic manner[5].

Ultimately, to achieve clinical competency a dental practitioner must possesses all the necessary knowledge, experience, critical-thinking, problem solving skills, professionalism and ethical values, in addition to basic operative skill, to ensure patient well-being and to deliver efficacious oral health care[6].

Achieving Clinical Excellence in Education

As explored in a recent FDJ article, contemporary dental education requires a student-centred, competence-based learning approach to facilitate the production of our next generation of clinician scientists, critical thinkers, oral health team leaders and life-long learners. Early exposure to operative skills acquisition, appropriate quality assurance of educational processes, effective clinical supervisor training, and very precise assessment methods aligned and comprehensively mapped to specialist-led learning outcomes are all essential prerequisites for successful learning and teaching and, thereby, the delivery of clinical excellence[7].

In addition, stimulating proactive student participation, encouraging self-reflectance on performance, and identifying individual learning goals at each stage of the curriculum help to optimally engage students in their education. The appropriate use of IT and patient management software also assists students in contemporaneous case note recording and in delivering timely and accurate formative and summative assessment of both simulated and 'real-life' clinical performance.

James Cook University Simulation Clinic

JCU established a new, regional dental school in Cairns in North Queensland in 2009, with a specific remit to enhance Tropical and Indigenous oral health in underserved populations. JCU Dentistry is thus committed to increasing the education, distribution and delivery of integrated health care to local communities. The overall aim of the 5-year BDS programme is to develop well-qualified, experienced, and confident dental graduates capable of independent practice who possess both the knowledge and the practical skills to deliver comprehensive dental health care in a variety of settings, especially for rural and remote communities. Whilst Years 1 to 4 are based in Cairns, the final 'capstone' year of the programme provides comprehensive oral health care experience in a series of regional and remote clinical outplacements[8].

The Dentistry teaching buildings at the Cairns campus are fortunate to include a state-of-the-art, 80-chair Dental Simulation Clinic located immediately adjacent to the JCU Dental out-patient clinic. Specifically tailored as a 'clinic' rather than a 'laboratory', the Simulation Clinic is designed to reproduce as accurately as possible the organisation, instrumentation, infection prevention and control protocols, and standards of professionalism as applied within the JCU Dental Clinic itself.

A simulation teaching session in progress is illustrated in Figure 2, and the compulsory Simulation Clinic teaching syllabus and associated competencies for all teaching semesters during Years 1 to 4 of the BDS programme are listed in Table 5. For each teaching session, students are provided with detailed criteria for each exercise, listing the specific tasks to be completed and subsequently assessed by their Simulation Clinic tutor.

'Hands-on' operative and clinical experience are thus emphasized from the very first year of the BDS course, with Year 1 and 2 students timetabled to the Simulation Clinic for 1 session each week, and required to demonstrate increasing professionalism and progressive acquisition of dental practice skills. Fundamental to successful progression through the BDS course, therefore, is the ability to achieve competency in a series of formally assessed operative procedures. Selected from the Simulation Clinic syllabus and judged to be representative of the key operative skills at each stage of the programme, these are important 'pass/fail' assessments (with remediation sessions and one supplementary re-sit examination available to unsuccessful candidates). An example of the assessment rubric for the Class V Composite Restoration Assessment in Year 2 is shown in Table 6. The competency assessment process can be quite demanding for some students, especially during the two non-clinical years of the course, and students may require access to both practical and pastoral support to address difficulties and failure[9].

Having successfully passed 6 formal competency assessments during Years 1 and 2, students progress to clinical Years 3 and 4. Although now possessing a basic range of operative skills, students are specifically counselled that Simulation Clinic sessions remain important to help them maintain and then enhance their skill level to deliver more complex interventions. Complementing their 5 regular JCU Dental clinical treatment sessions each week, Year 3 and 4 students are additionally timetabled to 1 or 2 Simulation Clinic sessions. The fundamental principle is that basic operative skill acquisition must be achieved and demonstrated during simulation sessions before undertaking that treatment on patients. Making Simulation Clinic sessions as real as possible, therefore, remains key to effectively stimulating the learning process especially during the years when students are increasingly gaining confidence by treating their own patients in the clinic.

Prior to embarking on their Year 5 clinical placements, JCU dental students will have undergone 4 years of Simulation Clinic teaching, learned techniques required for over 40 operative interventions of varying complexity and demonstrated competency in 10 formal skills assessments; Table 5.

How Real Can it Get?

To make things truly real within the Simulation Clinic, it is important that teaching activities are not perceived, especially by experienced clinical students, to be poor imitations of clinic activities or as taking place in a particularly artificial environment. Many of these issues have been addressed at JCU by ensuring senior specialist clinicians' input into the design of teaching programmes, standardizing operative interventions, ensuring consistency in instrumentation and, wherever possible, adopting a 'specialist-team' approach to teaching continuity by timetabling the same Simulation Clinic teachers and supervisors that students will ultimately seek tuition from in the JCU Dental Clinic. Aligning academic teaching as seamlessly as possible with subsequent clinical practice is thus an important objective.

Increasingly, we are developing the use of computer software in simulation, especially for early year students, to gain experience of documenting operative procedures and completing contemporaneous case note records, and to facilitate students completing self-reflective logbooks of their activities and performance. This substantially aids in the subsequent transition into the clinic; Figure 2.

In the future we plan to invest further in our application of technology to deliver a suite of pre-sessional instruction videos using on-line resources, supplement timetabled training opportunities with increased and more flexible access to VR simulators, utilize digital intra-oral cameras to visualize the detail of 'real-time' tooth preparation and to create visual archival records for teaching and assessment. An increased use of portable tablet devices will enhance assessment and feedback, and facilitate more detailed and contemporaneous self-reflective practice.

We believe that enhancing basic operative skills training with appropriately tailored opportunities to undertake oral diagnostic reasoning, clinical problem solving, case-based discussion and review of treatment outcomes should strongly enhance the efficacy and clinical relevance of our simulation teaching and to truly 'make it real' in the Simulation Clinic.

Conclusions

Modern dental education balances an expanding scientific knowledge base with effective preparation of new graduates for safe and, ultimately, independent clinical practice. Simulation in Dentistry remains essential to enhance patient safety during the teaching of irreversible operative interventions. It is likely that the future will see developments within the science of simulation involving artificial intelligence, big data, computing and deep learning. Whether this technology will ever reduce the requirement for dental care to be delivered to patients attending university teaching clinics remains speculative. Whilst the authors of this paper believe there is no replacement for 'real-life' clinical experience, a structured approach to 'making it real' in the Simulation Clinic delivers significant opportunities to enhance the effective acquisition of 'hard' and 'soft' clinical skills.

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TABLES

Table 1: Benefits of Simulation in Operative Skills Acquisition

- Introduction to Professionalism in Practice
- Skill Acquisition in Advance of Patient Exposure
- Repeated Practice to Establish and Refine Skills
- Enhance Ergonomic Awareness
- Flexible Training Experience
- Opportunity to Deliver Standardized Feedback
- Facilitate Smooth Transition to Clinic Environment
- Gain Experience in Documenting Procedures & Clinical Care

Table 2: Challenges in the Simulation Clinic Environment

- Ensuring Student Engagement & Active Participation
- Students taking ownership of work
- Effective utilization of time
- Limitations in Use of Plastic rather than Natural Teeth
- Professionalism – Punctuality & Dress Code
- Curriculum Design & Timetabling
- Requirement for Student Supervision
- Feedback often Limited to Discussing Final Result
- Cost of Equipment Maintenance, Disposable Items & Materials

Table 3: Factors Influencing Operative Skills Training

- Complexity of Task
- Amount of Practice
- Quality of Supervision & Feedback
- Time Management
- Proactive Learning Environment

Table 4: Hard & Soft Clinical Skills

Hard Skills	Operative / Psychomotor
Soft Skills	Diagnostic Reasoning Clinical Decision Making Treatment Planning Communication Professionalism Teamwork

Table 5: The JCU Model - Simulation Clinic Teaching & Competencies for the BDS Programme

Year	Semester	Teaching Activities	*Competency Assessment*
1	**1**	Introduction to Simulation Clinic Infection Control & PPE Instruments & Sharps Ergonomics in Practice	*None*
	2	Class I Cavity Preparation for Amalgam & Composite Restorations Pit & Fissure Sealants	*Class I Cavity Preparation for Amalgam & Composite Restorations* *Pit & Fissure Sealants*
2	**1**	Class II Cavity Preparation & Composite Restoration Class V Cavity Preparation & Composite Restoration Temporary Restorations Atraumatic Restorative Treatment Rubber Dam Techniques Indirect Pulp Capping Fissure Sealant Application Topical Fluoride application	*Class II Cavity Preparation & Composite Restoration* *Class V Cavity Preparation & Composite Restoration*
	2	Alginate Impression Taking (Edentulous & Dentate Jaws) Class III Composite Restoration Class IV Composite Restoration Complex Resin Restoration Introduction to Periodontics	*Class III Composite Restoration* *Class IV Composite Restoration*
3	**1**	Adjacent Class II Restorations Exodontia Anterior & Premolar Teeth Endodontics Periodontics Pulpotomy & Stainless Steel Crowns Strip Crowns	*Endodontics Logbook*
	2	Splinting Traumatised Teeth Anterior Crown Preparation & Temporisation Posterior Crown Preparation & Temporisation Gold Crown Preparation Molar Endodontics	*Anterior Crown Preparation & Temporisation*
4	**1**	Canine Crown Preparation & Temporisation Posterior Crown Preparation & Temporisation Ceramic Only Preparation & Temporisation Exodontia Suturing	*Posterior Crown Preparation & Temporisation* *Suturing*
	2	Bridge Preparation Fibre Reinforced / Maryland / Cantilever Bridges Direct & Indirect Veneers	*None*

Table 6: The Class V Composite Restoration Assessment Rubric*

	Pass (P)	Borderline (B)	Unsatisfactory (U)	Mark
Contour of Restoration	Followed the natural surface contour of the cervical area of the treated tooth.	Under- or over-contoured by <0.5mm	Under- or over-contoured by >0.5	
Margins	Junction of restoration and tooth not detectable by probe.	Junction of restoration/tooth slightly detectable by probe	Deficiency or void at margins >0.5mm wide	
Surface of Restoration	1. Free of flash and voids 2. Smooth	Some minor polishing required	Gross roughness (requiring replacement of restoration)	
Other Considerations	1. No excessive removal of tooth structure 2. No iatrogenic damage to adjacent teeth and gingiva	Cavity over-extended by less than 1mm or minor damage to gingiva	Cavity over-extended by more than 1mm in any dimension or major damage to gingiva	
Rubber Dam Application and Moisture Control	Rubber dam is applied without trauma to the surrounding hard and soft tissues. The rubber dam should be kept DRY when placing composite.	Dam or frame needs adjustment for access, safety, moisture control and/or patient comfort	Rubber dam not placed	
OVERALL				
The following issues will result in an immediate failure in the exam: ☐ Significant damage to adjacent tooth structure which requires a filling ☐ Wrong tooth or surface prepared ☐ Significant overhang or deficiency of composite restoration which will lead to recurrent caries or periodontal disease				

**An Unsatisfactory awarded in any category, or more than one Borderline, results in a FAIL for the Competency Assessment.*

FIGURES

Figure 1: Contemporary mannequin as utilised in the JCU Dentistry Simulation Clinic

Figure 2: Joining the Dots in Dental Education

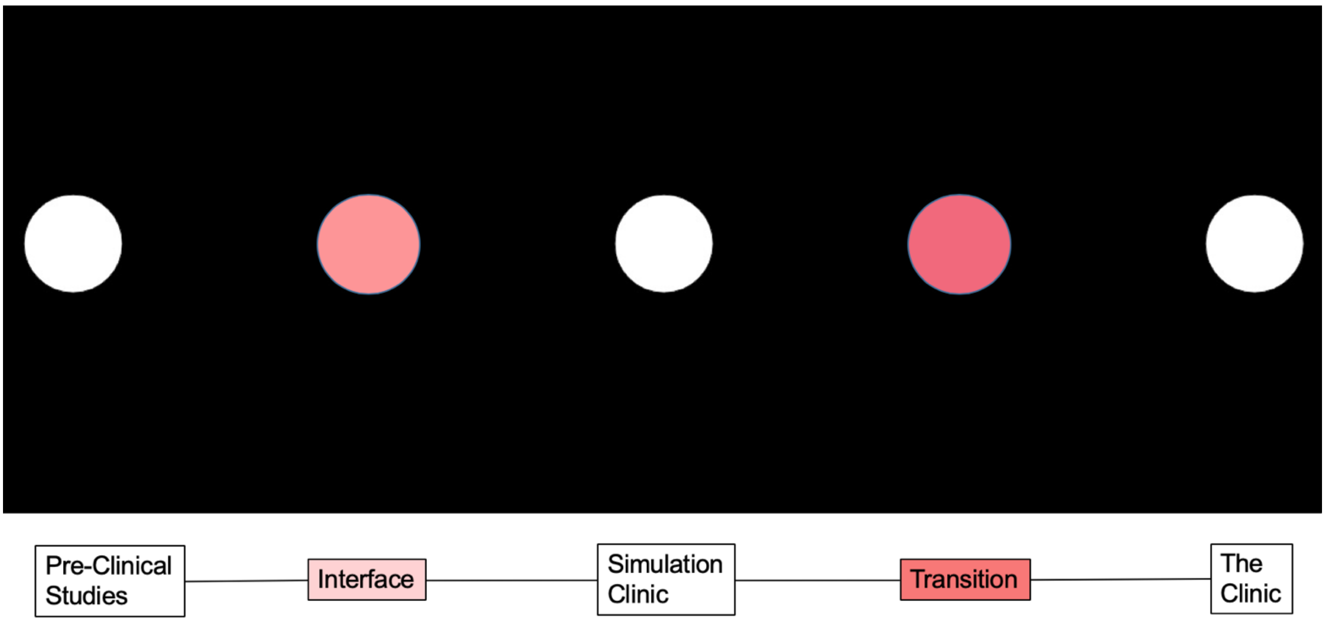

Figure 3: A teaching session in progress within the JCU Dentistry Simulation Clinic