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Educational Note

Enhancing conceptual knowledge: an approach to using Virtual Environment for Radiotherapy Training in the classroom

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Abstract

This report discusses the approach to teaching undergraduate radiation therapy students in New Zealand using the Virtual Environment for the Radiotherapy Training (VERT) system. In conjunction with VERT being used to teach clinical skills, integration of conceptual knowledge occurs across all 3 years of the programme; this report gives examples of how this is achieved in practice.

Keywords: conceptual knowledge; education; radiation therapy; VERT

The Department of Radiation Therapy at the University of Otago, Wellington (UOW), is New Zealand's national provider of radiation therapy education. Students gain a Bachelor of Radiation Therapy (BRT) following completion of a 3-year undergraduate programme and are eligible for registration on completion. The programme encompasses all aspects of radiation therapy treatment and dosimetric planning. The first year of the degree is primarily academic, whereas the second and third years consist of one academic semester and a second on clinical placement at one of nine centres across the country. UOW acquired the immersive Virtual Environment for the Radiotherapy Training (VERT) system in January 2013.

VERT is specialised software designed for training radiation therapy staff, allowing the realism of a linear accelerator with 3D visualisation. This virtual reality benefits training as clinical skills can be practiced without patients in a safe environment with greater variety than what might be achievable in a clinical setting and decreased accompanying costs. A range of linear accelerator manufacturers and models are available replicating what users can experience in the clinical environment. The VERT set up at UOW incorporates a large screen in a blackened room mimicking the treatment room bunker; the software creates a life-size patient positioned on a linear accelerator, virtual light imitates the radiation beam allowing visualisation of the treatment area. Cross-sectional anatomy allows the user to view inside the patient showing the target area as well as organs at risk (OAR); dose modelling is also possible adding to the experience. Virtual Presenter functionality enables screen shots of VERT to be captured; this can be incorporated into subsequent presentations, lectures and practical demonstrations.[1]

Much of the focus of VERT research has been regarding the development of psychomotor

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skills within a virtual simulation environment, alleviating some of the time pressures and quality issues previously experienced by undergraduate students within a clinical setting.[2–5] Although these are important skills to develop and become competent in, New Zealand students spend significant periods of time in the clinical environment during their second and third years where continued exposure allows these skills to be mastered. Although UOW continues to utilise VERT to develop clinical skills proficiency, our focus has been to integrate VERT across our curriculum. Modern radiation therapy techniques are becoming increasingly complex, presenting challenges on how best to address these in the classroom. UOW academic staff determined that VERT should be used in conjunction with traditional teaching methods, to address the conceptual knowledge underpinning radiation therapy. The aim is to enhance the student learning experience as more complex ideas are discussed; visualisation using VERT helps consolidate key points of interest. The following examples illustrate the UOW approach.

Basic clinical skills including machine and pendant operation are introduced in semester one of the first year before a short clinical placement. These take the form of one on one or small group sessions over 1–2 hours, with discussions focussing on the principles and concepts of simple techniques. Motor skills are continually developed and consolidated in both second and third years of the programme (e.g., mastering appositional electron set ups). The obvious benefit is that along with practical skills, conceptual understanding and knowledge of electron dosimetry can be addressed in a safe environment, free from clinical time pressures.

The anatomy and imaging paper is a subject taught across the first year of the BRT programme. The paper is designed to encourage the student practitioner to apply anatomical knowledge to the clinical contexts as early as possible by interrelating anatomical and imaging concepts in parallel. UOW's installation of a fully functional planning system had been used for some time to both teach and assess students' proficiency in identifying anatomy on images. VERT has proven to be a useful tool to enhance the delivery of the paper. Datasets with volumetric contouring of anatomical structures come to life in the context of the full size screen and visualisation of the patient relative to treatment equipment. VERT specific tools, such as setting structure transparency levels, have enabled the demonstration of internal structures with visual reference to surface anatomy. For many students, building a 3D understanding of human anatomy is a challenge and VERT provides another way to facilitate the transition from representative 2D diagrams in reference books and computerised tomography datasets to real-world understanding of patients' internal anatomy.

European Society of Radiotherapy and Oncology guidelines suggest that all radiation therapists as a minimum are able to interpret and evaluate a treatment plan.[6] As such first year students are introduced to treatment planning in the second semester. Within this subject students generate and critique a range of 3D conformal treatment plans. Key concepts include anatomy, beam arrangement, modulated treatment delivery, inverse planning, tumour and target volume coverage/conformity, OAR sparing, integral/peripheral dose and dose volume histogram evaluation. Using VERT during a planning class allows students to visualise, for example, how the anatomy and imaging component of the degree fits into the treatment planning context.

Spatial awareness and the ability to mentally visualise in a 3D perspective is a skill that students take time to develop. Using VERT alongside a planning system, a basic concept such as how to choose an appropriate beam arrangement can be introduced based on the size, shape and location of the target volume, while also considering the surrounding anatomy and OARs. This approach offers another way in which students can appreciate the relative position of OARs, and how treatment field placement can influence overall dose coverage to the target and OARs. In addition, their ability to visualise in three dimensions and consider the limitations of treatment machines can be developed, something not always possible with a planning system.[7] Utilising VERT in conjunction with a planning system occurs in classes across all 3-year groups as the treatment sites being planned increase in complexity.

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Students gain experience of intensity-modulated radiation therapy and volumetric-modulated radiation therapy before embarking on their second year clinical placements. VERT is utilised in this context to demonstrate the increasing complexity of radiation therapy techniques by supporting didactic teaching with visualisation of modelled dose distributions. Thus, permitting demonstration and discussion around the technical differences of a modulated technique compared with a 3D conformal technique. A novel workaround has been developed to allow the interactive comparison of multiple plans. The aim is to aid student understanding of conceptual underpinnings, as well as the transfer of this knowledge to clinical practice. Using the Virtual Presenter, a structured teaching module has been created that delivers the content described above over a 1-hour session. Formal evaluation of the module has taken place and publications reporting on the process are pending.[8]

VERT has also been used in the teaching of oncology papers that explore, among other things, how cancers occurring in specific body sites are managed. Again the aim is to enhance conceptual understanding through visualisation. This is particularly useful in discussions involving highly complex techniques taught in the third year such as craniospinal treatment. VERT can model the dose distribution and demonstrate the complexities of the technique highlighting, for example, junction position, field placement/shielding to OAR and segmentation on a level previously not possible in a classroom setting. Using VERT to support the teaching around specific tumour sites has facilitated the application of core academic content to the clinical environment, thus strengthening links between academic and clinical learning.

The introduction of VERT has not changed the curriculum taught at UOW but has enhanced it allowing staff to demonstrate complex ideas and techniques with technology that is comparable with the clinical environment. Teaching practical skills and integrating VERT into subjects (e.g., anatomy and imaging, planning and oncology papers) in various ways across the curriculum provide examples of how UOW has implemented VERT.

Staff experience and student feedback suggests that students enjoy and draw benefit from the visual and interactive nature of VERT.[7,8] There is an associated increase in staff workload to incorporate VERT teaching and create lesson plans, however, all UOW staff utilise VERT in classes across the curriculum and are enthusiastic about the benefits it brings to the BRT programme; this is evidenced by a number of papers and publications pending. The opportunity to acquire and develop clinical skills in a safe environment enhances student ability to perform assessable tasks in demanding radiation therapy environments. Combined with traditional teaching methods, VERT supports the learning of conceptual knowledge underpinning radiation therapy leading to an enriched student learning experience.

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Conflicts of Interest

None.

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