The potential of a simulated workplace environment for emergency remote teaching

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The COVID-19 pandemic and the South African government's response of a lockdown required the cessation of all clinical training. Virtual environments offered alternative methods of teaching and learning clinical skills in an attempt to mitigate the cancellation of first year students' clinical visits. The research question of how a simulated workplace environment could replace first year students' workplace visits was addressed. A case study at a University of Technology focusing on a radiation therapy program provided an opportunity for academic and clinical lecturers and first year students to consider the qualities of the Virtual Environment for Radiotherapy Training. Findings indicated that the environment could be incorporated into emergency remote teaching to enhance student learning as it provided an engaging, safe, and effective space in which to learn clinical skills. These findings have implications for the design of responsive curricula for the changing higher education and professional landscapes.

Keywords: COVID-19, clinical practice, virtual environment for radiotherapy training, radiation therapy

In radiation therapy practice the disciplinary fields of physics, human biology and computer science inform the understanding of complex biological systems (SAQA, 2018). It is, therefore, essential that undergraduate students learn to apply concepts from these disciplinary fields to a variety of contexts in the work environment. In the South African context, the Bachelor of Science in Radiation Therapy qualification is registered with the South African Qualifications Authority (SAQA) and is regulated by the Health Professions Council of South Africa (HPCSA). These qualifications are required for graduates to be eligible for employment in public or private health settings. In preparing graduates from the program to provide radiation therapy as an integral member of multi-disciplinary teams, opportunities for students to gain clinical practice experience throughout their undergraduate studies is a quality requirement set by SAQA, and is strongly endorsed by the HPCSA. To facilitate the application of theoretical knowledge to practice and the transfer of knowledge to unfamiliar future clinical activities, the Bachelor of Science in Radiation Therapy program is structured so that students are placed in clinical practice on a rotational basis throughout the academic year at all levels of study

Work-integrated learning, including work placements in the form of experience in clinical departments, plays an important role in students' development as health care practitioners (Cunningham et al., 2015; Bharj & Embo, 2018; Zegwaard & Rowe, 2019). Through clinical visits, observations, and the provision of assistance, as appropriate, students in the health sciences are inducted into the practices and values of their chosen professions. Towards the end of 2019, the severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) was first diagnosed, and the Coronavirus Disease 2019 (COVID-19) pandemic impacted South Africa early in the 2020 academic year. The decision to implement a national lockdown was taken to prevent the rapid spread of the disease and allow time to prepare for the anticipated increases in the critical care needs of many patients. All higher education institutions were required to cease face-to-face teaching and migrate to emergency remote modalities which immediately impacted students' work placements because of the need to withdraw them from the clinical platform.

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Like other countries, the national lockdown immediately impacted students' work placements by withdrawing them from the clinical platform. Hospital staff who were overextended in treating severe cases of COVID-19 had little time for inducting and supervising novices. In addition, the increased health risks for students working directly with patients known to be COVID-19 positive was problematic. The cancellation or delay of these students' work placements raised concerns about students being able to meet graduation requirements, and as noted by (Wall, 2020), integrate successfully into the workforce, and reduce the impact on their future career prospects.

The pandemic affected all students in the radiation therapy program but had a particular impact on first year students who were embarking on their studies in radiation therapy without opportunities to access the clinical work environment. Medical Imaging and Oncologic Modalities is a first year subject typically taught at the institution, in which both theoretical and clinical concepts are presented. This subject has been traditionally taught using complementary pedagogical tools such as web-based resources, small group tutorials and practical applications. Instruction is delivered through various systems, including simulated workplace environments, face-to-face lectures, and a ten-week rotation in the workplace. First year students' clinical visits have been shown to provide rich learning opportunities for orientation to practice and for enabling students to better integrate theoretical and practical knowledge (Sachs et al, 2017). In response to the lockdown, the Virtual Environment for Radiotherapy Training (VERT) was considered a viable alternative to students participating in in-person clinical visits. This research study addresses the potential for VERT to mitigate the impact of the cancellation of first year students' clinical visits. The research question that the study posed was:

How could a simulated workplace environment replace/partially replace first year radiation therapy students' clinical outcomes?

BRIEF OVERVIEW OF THE LITERATURE ON SIMULATED WORKPLACE ENVIRONMENTS

Clinical lecturers, as those responsible for professional education, are faced with a plethora of equipment and software packages designed to teach basic and advanced technical and clinical skills to students (Burch, 2014). Simulated workplace environments (SWEs) are one of the increasingly popular methods for learning such skills. Procedural and situational simulations, as representations of "how-to-do-something" (Alessi & Trollip, 2003, p. 214) are frequently used in health professions education to teach a range of skills to students before they enter clinical practice. The effective use of simulation in professional education is well documented and has decreased clinical training hours in the workplace, leading to more meaningful patient encounters, and reduced pressure on the clinical platform (Bradley, 2006; Gaba, 2004; Good, 2003; Motola et al., 2013).

Thoirs et al. (2011) argue for the use of these environments to substitute clinical days as activities where simulation could be used to focus on clinical or technical competencies. In order to successfully teach and learn such competencies, simulations are potentially useful at the basic university level, that is, first year of study. The following section provides a brief overview of VERT as a suitable simulated workplace environment.

A Virtual Environment for Radiotherapy Training

The Virtual Environment for Radiotherapy Training (VERT) is a high-fidelity simulation hardware and software resource that replicates the expensive radiotherapy treatment machine used in highly pressurized clinical environments (Bridge et al., 2017). The VERT software package includes a three-dimensional (3D) effect that enables a better visual understanding of clinical concepts such as the dose distribution, and consideration for organs at risk and therefore provides for improved understanding of the patient's side effect profile. Through engaging graphics and life size visualizations, the system offers a useful training platform for radiotherapy students, nurses and existing staff. The success of the system is that it creates a sense of belief that the user's interaction with the patient and radiotherapy machine is real (Beavis et al., 2006).

This study explored and matched the abilities of VERT with concepts that first year students should understand and transfer to the clinical setting. Previously, Kirby (2015), reported on how the system had been used to enhance student learning by providing an engaging, safe and effective pre-clinical environment for learning. There is currently no evidence of how the system could effectively replace, or partially replace clinical outcomes for first year students. The following section details the theoretical framework used to understand the various forms of clinical practice.

Theoretical Framework and Translation Device

In actual clinical visits or in simulated clinical environments, it is important to distinguish between different kinds of practice that the students need exposure to. To distinguish between types of practice, 'Legitimation Code Theory' (LCT) (Maton, 2014) was chosen as a theoretical framework for understanding different forms of practical work and their relative complexity. The framework enabled theoretically and research-informed decision making with regard to appropriate forms of simulation and of practical work more generally. One of the LCT tools, namely 'epistemic semantic gravity' (ESG) (Martin et al., 2019) describes the ways in which knowledge and practices relate to specialized contexts, such as a clinical environment. Epistemic semantic gravity can be stronger or weaker along a continuum of strengths (Maton, 2016, p. 242). Stronger epistemic semantic gravity (ESG+) describes knowledge and practices in specialized contexts of use. Weaker epistemic semantic gravity (ESG-) reflects instances where meaning is less dependent on a specialized context of use. An example of weaker epistemic semantic gravity could be general patient care, which traverses many different health science and medical fields of practice. Administering therapeutic radiation doses exemplifies stronger epistemic semantic gravity as it is specific to the field of radiation therapy.

In order to operationalize the theory a 'translation device' (Maton & Chen, 2016, p. 31) is needed to bridge between the high-level concepts of epistemic semantic gravity and its application in clinical practice. The epistemic semantic gravity translation device used in this study was derived from the scope of work of radiation therapists. This scope includes understandings of patient treatment and care in the specialized context of radiation therapy as an ethical position, and in South Africa, a mandated code of conduct for radiation therapists. Epistemic semantic gravity ranges from simplified or basic contexts, such as routine clinical practice and patient care, to the comfort and well-being of the patient during a complicated clinical procedure. In more specialized forms of practice in radiation therapy, the epistemic semantic gravity increases, such as when a radiation therapist sets up the treatment parameters and administers the treatment accurately and safely. Epistemic semantic gravity increases even more in highly complex clinical environments (described as 'advanced clinical practice' in curriculum documents) during simulations and actual clinical experience. Finally, the highest level epistemic semantic gravity refers to the complex tasks of treatment planning, problem solving, attending to novel and complex cases, and developing innovative practices.

Table 1 is a translation device developed for this study. It provides numerical values (1 – 4) to assess the level of epistemic semantic gravity and enables simulated clinical practice events to be plotted. The resultant profile makes visible the extent to which students are able to simulate the full range of practice. While the full range of epistemic semantic gravity is desirable, at the first year level, it might be expected that the focus would be on the lower levels of epistemic semantic gravity.

TABLE 1: Translation device developed for this study to assess epistemic semantic gravity range and type of clinical practice.

Unit of analysis	Epistemic Semantic Gravity Range	Epistemic Semantic Gravity Codes	Numeric value	Descriptors
	Stronger	ESG++	4	Planning/problem solving
Clinical practice	↑	ESG+	3	Advanced clinical practice
	↓	ESG-	2	Specialized treatment
	Weaker	ESG--	1	General patient care

METHODS

The exploratory nature of the research question warranted the use of a qualitative research design and methodology. A case study at a University of Technology focusing on one program, the Bachelor of Science in Radiation Therapy, provided an opportunity for academic and clinical lecturers and first year students to engage in dialogue to consider how VERT could assist first year students to learn clinical skills.

Participants

The qualitative nature of the question required the responses of deliberately selected groups of participants who reflected particular features, i.e., novice entry-level students who need to learn clinical skills, expert academic lecturers teaching concepts in the classroom and the clinical lecturers involved with student training in the workplace. For this reason, a single stage, purposive sample of all registered first-year students as well as academic and clinical lecturers involved in teaching and learning the subject called Medical Imaging and Oncology were approached to answer the research question.

All participants for the study were recruited by electronic mail via the head of department, this was to eliminate possible, but unintentional coercion, recruitment and participation bias.

Data Collection

Semi-structured individual interviews (Cousin, 2009) were conducted with three academic staff members as content experts who teach the subject, to ascertain their understanding of how students acquire clinical competence in VERT. These interviews ranged in length from 45 – 75 minutes. Each interview started with the question "What is your experience of teaching clinical concepts in VERT?" Examples of follow up questions included, "Is there anything in VERT that you found beneficial for application in clinical practice? Please elaborate."

Two semi-structured focus group interviews were conducted with seven first-year students to identify clinical concepts learnt during sessions in VERT. Focus group interviews gave participants the opportunity to self-correct and collectively verify the abilities of the SWE. The focus group sessions lasted for about 45 minutes and focus group questions guiding the discussion of the group, included "How could the sessions in VERT help students to apply concepts in the clinical department? What about those sessions helped/did not help to apply clinical concepts?"

Two semi-structured focus group interviews were conducted with the clinical lecturers responsible for student training at the two tertiary hospitals accredited to offer workplace based learning. At Site A, seven clinical lecturers participated and at Site B, there were eight participants in the focus group. Similar to the focus groups with the students, focus groups with the clinical lecturers lasted about 60 minutes in length. Each focus group started with the question "What is your experience of VERT?" Follow up questions included, "How could the sessions in VERT help/not help students to apply concepts in the clinical department?"

Data Analysis

Individual interviews with academic staff and focus groups with students and clinical educators were transcribed using standard transcribing methods (Edwards & Lampert, 2014). 'Member checks' (Savin-Baden & Howell-Major, 2013, p. 477) were undertaken and the transcriptions were cleaned and revised before analysis. A two-step process of coding the data was undertaken, following the verification of transcripts by both interviewers and interviewees. Initially in vivo coding was applied, following Saldaña's (2013) first cycle coding methods, which entailed extracting keywords from the participants' quotations. The second cycle of coding reframed the in vivo keywords in terms of the four levels and categories of epistemic semantic gravity, which explained the data with reference to the theoretical framework in greater detail. Thereafter, an empirical thematic analysis was conducted that included data generated from all transcribed audio recordings. Data quality was ensured by participants verifying the transcribed audio recordings of the interviews and inter-rater reliability of the findings by the three authors.

According to Maton and Chen (2016), qualitative analysis using LCT involves movement between abstract theory and concrete data in iterative cycles in order to gain theoretical understanding without losing track of the empirical findings. The third stage of analysis therefore went beyond the emergent themes and applied the translation device (Table 1) to define more precisely the patterns emerging from the data.

Ethical Considerations

The head of the department where the program was offered granted permission for the researchers to interview students and staff members. Ethical clearance was obtained from the Faculty Research Ethics Committee at the University of Technology as the research site.

In hearing all participant voices, the researchers ensured that the participants were protected. The risk of emotional distress during interviews was minimized by informing participants not to answer any questions with which they were not comfortable. All participants signed a letter acknowledging informed consent and indicating voluntary participation, prior to engaging in the research study. Site and participant confidentiality were ensured by assigning an alphabetical identifier to each site (e.g., Site A, B or C) and a numerical identifier to each participant (e.g., Lecturer 1 or Student 1). No direct identifiers or links to sites and participants were retained. Table 2 is a summary of the research design used in this study.

TABLE 2: Summary of research design.

Research question	Source(s) of data	Data collection method	Unit of analysis	Analytical method
How could a simulated workplace environment replace/partially replace first year radiation therapy students' clinical outcomes?	Three academic lecturers	Semi-structured individual interviews	Qualities of VERT to enable competent practice	In vivo coding and ESG categories
	Seven first year students	Semi-structured student focus group interviews	Clinical concepts learnt in VERT	
	Fifteen clinical lecturers	Semi-structured clinical lecturers focus group interviews	Qualities of VERT to enable competent practice	

FINDINGS

Table 3 is a summary of the two-step data coding and analysis process. Three overall themes emerged from the keyword exercise to address the research question of how VERT, as a simulated workplace environment, replaced or partially replaced first year radiation therapy students' clinical outcomes. These themes included how the concepts underpinning clinical practice were taught using VERT, the influence of VERT on students' self-confidence in clinical practice, and clinical educators' understanding and perceptions of VERT for use in developing clinical competence. Each theme is presented in turn.

Concepts Underpinning Clinical Practice

The lecturers interviewed used VERT to shift between theory and practice by making visible the structures and processes that are not possible to observe during busy work placements, as explained by the academic lecturer: "VERT is Virtual Environment for Radiation Therapy Training. So … I use the Linac [a medical device used for external beam radiation treatment] in a virtual space to teach them [the students] concepts of set up and principles of Radiation Therapy" (Lecturer 1).

Through repetitive practice students were able to cement fundamental clinical concepts. VERT provided an opportunity to demonstrate radiotherapy practice without having to take students into the clinical setting

The following section as an example of an exercise available in VERT to instruct students on the implications of certain radiation dosages on targeted organs. In Figure 1 below, a screenshot from the system used at the research site, the radiation beam as shown in VERT penetrates a tumor in the prostate gland (area marked in red). The beam also effects the surrounding normal tissue (the bladder situated anteriorly and the rectum posteriorly to the prostate). In this illustration the stronger epistemic semantic gravity of the specialized field of practice (ESG2) is apparent. The legend/key is presented on the right side of the image that indicates the dose delivered in centigray (cGy). This information provides students with accurate information on the actual dose delivered to the patient in one radiation beam.

TABLE 3: Example of data coding and analysis.

Participant	Transcription	In vivo code	ESG
Academic lecturer	I'm definitely teaching theory with practice. It's using practical things in your hands, holding it, touching it, feeling it, watching where the shifts are, watching where the movements are going, how these concepts are coming into play, seeing okay, maybe no, that's not what needs to happen. I must move it maybe the other way. That practice they don't necessarily get when they come into the clinical department. So it's nice for them to have that space to understand the concepts that way when they come to department it's a little bit clearer for them.	…teaching theory with practice… …practice they don't get in clinical department…a bit clearer	ESG2 ESG1
First year student	Actually working with the machine, being able to use the controls and also position the patient, actually seeing the patient … so in a way it's like realistic but you just not at the hospital. So you also get the feel of what the radiographers are doing.	…working with the machine…realistic, you just not at the hospital…	ESG3 ESG2
Clinical lecturer	I'm sure it does help because if I remember as a first year, I was terrified of a hand control. Didn't want to touch it … I will touch the patient, you control the machine. But if you have VERT before you even come here you're like okay this, I know this thing. I can move this button and you know	…terrified of hand control I will touch the patient… I know this thing…	ESG1 ESG1 ESG1

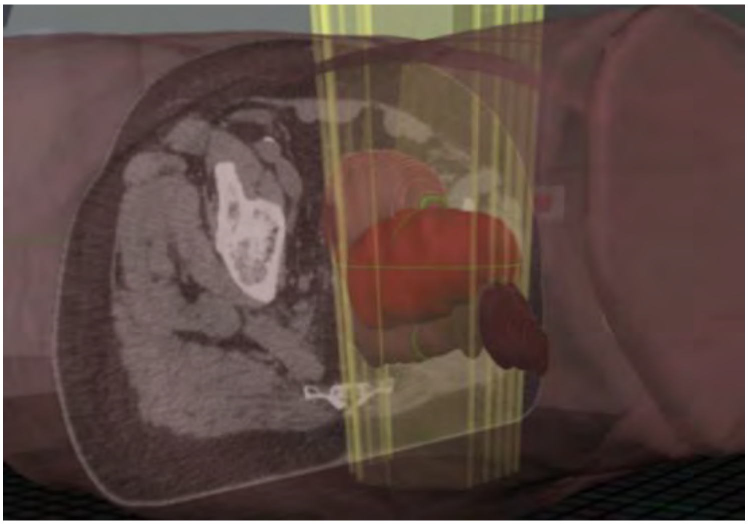
According to the academic lecturers interviewed, VERT enabled students to see the ionizing radiation that is present but invisible during real-world clinical practice. The ability to see the effect of the radiation dose on an organ at risk introduces the safe use of radiation from the outset of the course. Students could also see the effect on the internal organs of what seemed like a small misalignment on the virtual patient's 'skin'.

An academic lecturer reported how VERT allowed her to teach theory and practice together:

> I'm definitely teaching theory with practice. It's using practical things in your hands, holding it, touching it, feeling it, watching where the shifts are, watching where the movements are going, how these concepts are coming into play, seeing okay, maybe no, that's not what needs to happen. I must move it maybe the other way. That practice they don't necessarily get when they

> come into the clinical department. So it's nice for them to have that space to understand the concepts that way when they come to department it's a little bit clearer for them (Lecturer 1).

FIGURE 1: The immersive affordance of VERT: Seeing the ionizing radiation dose.



She further explained how this was done without sending students to the workplace.

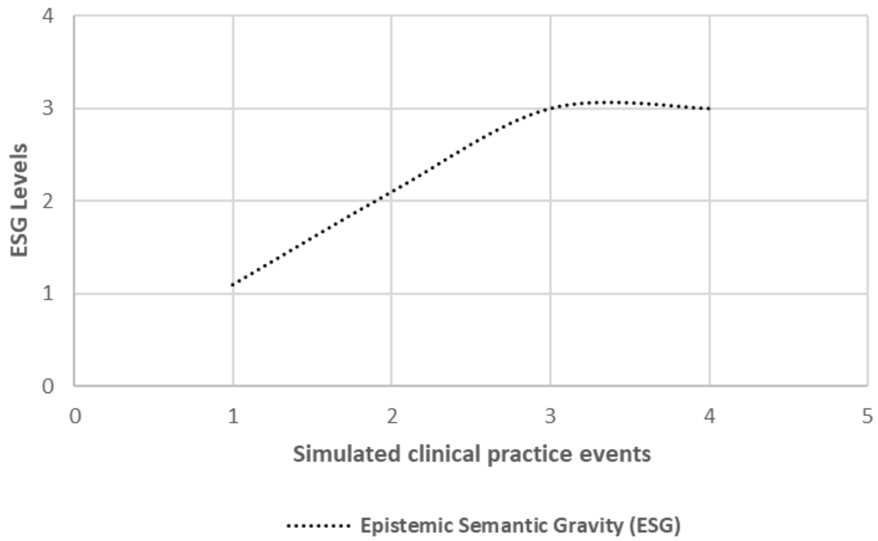
> VERT allows me the space to be able to teach them [students] the concepts without taking them out of the clinical. So it's really helpful to have that hands-on, otherwise I would have had to bring the students to the department to teach, to the clinical department to teach that. So now I can do it while I'm busy teaching the concepts. So it's not a matter of teaching it now and then coming to do it in the department a few weeks later. We can teach it and then practice it in the same space so that that idea sort of is given some sort of foundation in their brains (Lecturer 1).

Another example of VERT creating an effective learning opportunity concerns the concept of the ionization – a fundamental clinical concept at first year level. The simulation created by VERT proved particularly beneficial according to Lecturer 1:

> I wish that all of the disciplines could have something like VERT to teach with. I just think it helps make the penny drop … you know because you talk about it and you question them and you have this whole interaction and then say, "Okay, so now show me."

Figure 2 is an epistemic semantic profile of teaching ionization using VERT. The dotted line represents the clinical environment and the inevitable rise in the epistemic semantic gravity as this concept is applied to the practice of radiation therapy. VERT demonstrates the complex ionization concept through multiple learning events that reinforce the concept avoiding a 'once off' learning event, common in the classroom. The gradual rise towards a plateau in the profile demonstrates how repetitive exposure to the virtual representation in VERT strengthens their epistemic semantic gravity scores. A plateau is reached as the higher epistemic semantic gravity levels are only possible when the concept is applied in actual clinical practice where students interact with real patients.

FIGURE 2: The resultant profile for teaching a clinical concept using VERT



It should be noted that in preparing students for the clinical environment a chance that lower epistemic semantic gravity has not be learned is possible. This was confirmed by this first year student who commented that:

> Actually working with the machine, being able to use the controls and also position the patient, actually seeing the patient … so in a way it's like realistic but you just not at the hospital. So you also get the feel of what the radiographers are doing (First Year Student 7).

Lecturers reported that while the virtual learning environment was a good initiative, it had disadvantages. Technology is often seen as a barrier to teaching and learning abstract concepts. In this regard it is important to note that the software was not designed with the intention to visualize complex and complicated concepts, but rather "…very simple concepts" (Beavis et al., 2006; Bridge et al., 2007). Academic and clinical lecturers were of the opinion that technology could hide important principles. Students are subsequently not exposed to the entire process and lose out on fundamental concepts. Lecturer 2 commented:

> And sometimes the basics get lost in the technology …the interface or the software sort of hides the equations and the concept behind everything … what is happening behind then the technological side of it sort of hides it

Confidence Building

In addition to learning fundamental clinical concepts, the virtual treatment also built students' confidence for their first clinical placements:

> For me, when I first saw the VERT, I was like, okay, this can actually you know, help me prepare myself for what to expect in the clinical department … and not being totally stressed out when you go into the room for the first time" (First Year Student 3).

The students did not discount the importance of the 'real' clinical environment for learning, as the following first year pointed out:

> When you're at Clinicals, you just always learn more. But VERT has, with the immobilization devices, with positioning, it helped us all with that, with what we saw at Clinicals. It's just you will always learn more at Clinicals, the practical work and everything (First Year Student 7).

While learning in the virtual environment, or on a laptop, was helpful in enabling students to 'see the invisible'; it is important that students use this environment as a support to their understanding of the complex and abstract concept of ionizing radiation. An important aspect of the ease of repetition in the virtual environment was the confidence that it gave to students: "But you just feel more confident after working on the VERT and then you come in real life and you also have to all these things. It just makes it easier. You're not so scared" (First Year Student 1).

A clinical lecturer recalled and reflected on her terrifying first experience in the workplace:

> I'm sure it does help because if I remember as a first year, I was terrified of a hand control. Didn't want to touch it … I will touch the patient, you control the machine. But if you have VERT before you even come here you're like okay this, I know this thing. I can move this button and you know (Clinical Lecturer 2).

The 'Tangible World' and the 'Techno-Thing'

Some of the clinical educators did not know what VERT was, but were keen to learn more about the virtual platform: "… explain to [us] this VERT, what do they actually do? What do they physically do with the machines? How does it work?" (Clinical Lecturer 1). However, others had a concern that a simulated workplace environment would never replace learning in the clinical setting:

> We're still living in a very tangible world. If that is what we only did, VERT and we treated our patients like that but we're not doing it. We come into a solid world on this side and you're teaching them something that's a techno-thing. They're being taught a techno-procedure or set up, whatever and now they have to translate into a real life patient here. That's your acid test. Do they actually know how they will be able to do it? That is what the problem is here (Clinical Lecturer 1).

It was also noted that VERT could not replace the clinical competence needed at higher levels of study, but met the requirements expected of first year students during the first term of study, as noted by the clinical lecturer:

> I think in the department we have a lot of advanced techniques. We are very pressurized. I still feel that you can sufficiently equip a student to be ready for the real-world environment, maybe not with the advanced techniques but I still believe that you can be a student that walks out here and tomorrow if I have a plan for you to do, you will do it, you will do it if I train you properly, if I spend time with you (Clinical Lecturer 4).

In summary, a trend that emerged from the data was how the use of VERT explained the logic of practice effectively. VERT was successfully used to demonstrate fundamental concepts that were particularly critical for competent radiation therapy practice at first year level.

DISCUSSION

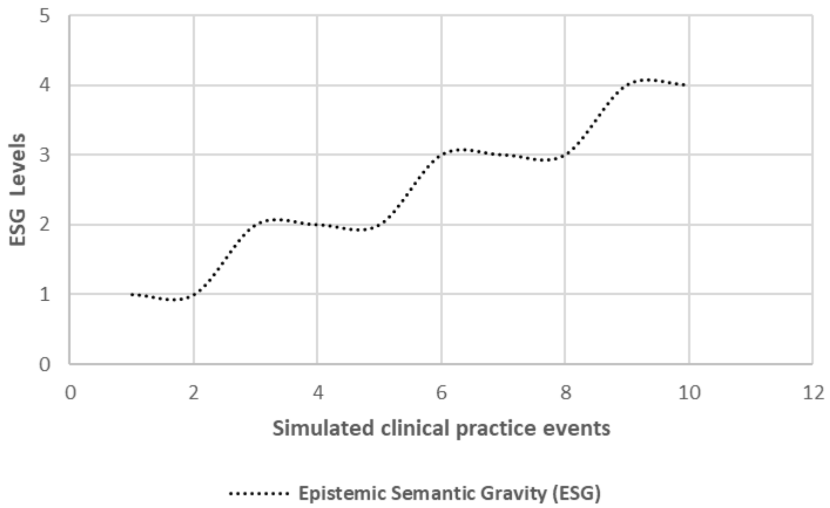
This study contributed to our understanding of how a simulated workplace environment replaced or partially replaced first year students' visits to the workplace. These simulated exercises could serve as alternative teaching activities during the COVID-19 pandemic.

In this study, it was found that the COVID-19 pandemic delayed first year students' placement in the workplace, and a virtual environment was introduced without compromising the acquisition of fundamental clinical skills. Similarly, Osterhölm et al. (2010) previously reported that students experienced their training as less pressured when they learned in a 'patient free' environment. Osterhölm et al. (2010) also noted that the students' understanding of the clinical techniques improved when they could 'see' inside the patient and understand the dose in relation to the three dimensional representation of the anatomy of the patient.

As the research will provide feedback into curricular and pedagogical arrangements, the findings hold potential benefits for undergraduate radiation therapy students, as well as for students in other professional fields that are facing difficulties in attaining field centric experiences. It was therefore important that the researchers drew on students' feedback and suggestions to help them (researchers) understand how clinical competence was acquired in the simulated workplace environment. It was equally important to elicit information from the academic and clinical lecturers for triangulation of the student data. Thus, hearing all voices on how VERT could replace or partially replace the clinical environment was an important ethical aspect considered for the benefit of all participants.

Based on the study finding, the following approach of how VERT, as a simulated workplace environment, could be used to support students' learning of clinical practice when in-person clinical visits are not feasible (Figure 3). When plotting the acquisition of clinical competence across simulated clinical practice, Figure 3 demonstrates how the epistemic semantic gravity was strengthened as the complexity of the context of clinical practice was introduced. Upward and downward shifts in the epistemic semantic gravity (ESG1 – ESG4) were demonstrated by the use of VERT due to the virtual clinical context and the presence of a virtual patient simulating advanced practice. The upward shift towards the highest level of epistemic semantic gravity (ESG4) was particularly noticeable when VERT elicited application of fundamental clinical concepts beyond the first year curriculum. Both academic and clinical lecturers recognized the effect on first year students' ability. For the academic lecturers it was where repetition and practice, explaining and re-explaining dominated classroom discourse, while for the clinical lecturers it was students operating in a 'robotic' manner, rather than being engaged in reflective practice.

FIGURE 3: The epistemic semantic gravity profile of using VERT.



CONCLUSION

The contribution to knowledge that this study makes is a reconceptualization of the use of simulated workplace environments. Using LCT's epistemic semantic gravity, the findings offer a coherent account of the knowledge structures of first year students acquiring clinical competence in VERT.. The translation device assists in demonstrating how introducing VERT as a pedagogical approach early in the curriculum, favorably strengthens the epistemic semantic gravity that will further strengthen when placing students in clinical practice at a later time, such as when the pandemic allows the return to work placements.

Lecturers using VERT as a key pedagogy, can strengthen the epistemic semantic gravity that is crucial in transferring the knowledge learned in the simulated workplace environment to the clinical workplace. This environment plays an important role in teaching and learning fundamental concepts and their successful transfer to radiation therapy practice. By using specific features in VERT (such as the virtual patient on a simulated treatment machine) to teach a fundamental clinical concept such as ionization further strengthened the epistemic semantic gravity.

The contribution this study makes to educational practice is to make the 'rules of the game' more explicit (Maton, 2016); that is, the study reveals the advantages of VERT. The study also offers opportunities for curriculum development and review by providing curriculum developers with the tools to identify and understand clinical concepts that can be learnt in the simulated workplace environment at first year level. The findings have implications for clinical lecturers (and other professional lecturers) in understanding and valuing simulation as alternative methods to clinical placements. Clinical educators cautioned that engaged and reflective practice is more than 'pressing the buttons'; and that the problem is not 'book knowledge'; but rather applying the 'book knowledge' competently to the clinical context.

In addition to its knowledge contribution and contribution to the education of radiation therapists when students are unable to access the clinical sites, the study also makes a contribution to radiation therapy practice. The findings relate many of the inconsistencies and errors in unsafe practice to misunderstandings of how those concepts that underpin practice, are acquired through simulated practice. This is clearly the case with regard to understanding the isocenter (the arbitrary point in space where radiation beams intersect) and being able to locate its position accurately for the safe and effective treatment of the patient. The stronger epistemic semantic gravity (ESG2) of specialized practice increases the level of challenge in terms of specialized equipment, virtual patients who have internal organs that need to be protected, and a tumor that requires treatment.

In conclusion, the simulated workplace environment offers a partial replacement for first year radiation therapy students' clinical outcomes. During the COVID-19 pandemic first year students can be kept off the clinical platform and still meet the clinical outcomes. However, students will need to return to clinical placements when safe as critical learning takes place in the real-world environments. Bozkurt and Sharma (2020) note that emergency remote teaching is a temporary solution to an immediate problem, so when the 'problem' of no access to the clinical platform due to COVID-19 abates, the lessons learnt could be further explored in curriculum development. The role of the simulated workplace environment needs further investigation as clinical practice has become increasingly complex and highly computerized and there may be a role in higher levels to provide some competencies through simulated environments. The translation device shows that a high level of competent professional practice is underpinned by high levels of epistemic semantic gravity. These findings have implications for designing responsive curricula in which academic and clinical lecturers unpack simulated workplace learning to respond to the rapidly changing higher education and professional landscapes.

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