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High Technology, High Touch: Implementing Virtual Reality Education and Ensuring the Elements of Humanism are Not Forgotten

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Abstract

Virtual Reality (VR) technology is being utilized increasingly in medical and healthcare education. It now complements face-to-face and other blended learning experiences. The offer of virtual "tours" through realistically created scenarios or narratives, set in intensive care units, emergency resuscitation rooms and operating theatres has become very attractive and appealing to learners. At the same time, ensuring accurate content, facts, proper standardizations and validation is also crucial. Healthcare subject matter experts are now working closely with technology experts, game developers, animators and data analytics specialists to produce VR, AR (augmented reality) and even eXtended Reality (XR) simulation and games for medical learners across the spectrum; from undergraduate to faculty development and continuing education.

The safe, controlled and immersive environment of VR learning enables deliberate repetitive practice for doctors, nurses and allied health personnel. With clearly defined, intended learning objectives, practically any range of scenarios can be created in VR today. Institutions and departments planning to undertake VR or technology enhanced learning (TEL) training programmes must ensure they conduct adequate needs assessments, compare the existing range of educational tools and select what meets their learners' needs. High technology does not equate to better learning outcomes. What is more important is the learning goals are met, the platform has high buy-in and acceptance and is also reasonably costed. Finally, as healthcare is a 'high tech, high touch' industry, the elements of humanism must never be forgotten in planning and implementing these training sessions and programmes.

Introduction

The Lancet Global Commissioner for the Education of Healthcare Professionals for the 21st century, in 2010, commented that, "The effect of e-learning is likely to be revolutionary, although how precisely it will revamp professional education remains unknown". **(**1**)** Now, ten years later, the potential for e-learning across various disciplines has expanded and pushed the traditional boundaries. Rapid technological advances are now shaping healthcare provision globally. **(**2-4**)**

The Covid 19 pandemic has given technology enhanced learning **(**TEL**)** a big push forward. Disruption to clinical postings, tremendous reduction in face-to-face teaching, alterations in the way assessments and examinations are conducted and the reduction in dedicated training time, especially for frontline healthcare providers became the norm for the last three years. The fact that learning and training must go on despite all the pressures of providing clinical service had led teachers and faculty to explore new ways of delivering knowledge and skills to medical students, residents in training, medical officers and for faculty development. With this, technology has been given a boost. This has also created a paradigm shift in medical education. **(**4-6**)** In coming up with new modules in TEL, issues such as maintenance of competence, adaptability of learners, upscaling and maintaining cognitive and procedural skills as well as psychological safety are all important considerations. The mantra of "learning, unlearning and relearning" has become very applicable.**(**5,6**)**

In many institutions during the early days of the Covid 19 pandemic, there were many challenges and roadblocks in the implementation of TEL. Criticisms such as the lack of "touch and feel" **(**the tactile elements of skills and procedural training**)**, lack of realism, insufficient expertise who were trained in this area, high cost of investment, as well as the lack of confidence in such facilitation amongst the faculty, were frequently heard. **(**4,5**)** Thus, besides the challenge of thinking of suitable TEL methodologies in teaching and training, the issue of mindset and buy-in was also to be managed, with these new educational strategies.

Now, three years into the pandemic, TEL is more widely used. Publications to support its use has sky-rocketed and it is being adopted across many levels of training. **(**6-17**)** A high level of interest has been generated, and more educational and innovation grants have become available for piloting such methodologies. Whichever method is utilized, the adoption of educational techniques must be learner-centric and principle-based, and also have the ease of training delivery by the educators borne in mind. The learning goals and outcomes measures are also very crucial and must be considered early so as to be mainstreamed appropriately. Finally, it must be realized that technology alone cannot transform

medical education. The human elements **(**learners, educators, faculty, patients and the community**)** must be taken into account and be integrated as relevant.

Virtual Reality (VR) Training

Today, one of the TEL methods adopted is the use of VR. VR learning and training has come a long way especially in the last decade. It has now reached a point where it has been shown to improve learning outcomes **(**3,7,12**)**

VR refers to the use of computer applications or computer-generated environment that enables learners to experience immersive 3-dimensional **(**3D**)** visual or audio simulation. Learners will be immersed in a 3D world, interact with virtual objects or persons and be actively involved in exploring the virtual environment as they negotiate a scenario/ narrative created to meet certain learning objectives. VR learning is especially well received by the younger generation of learners. It has indeed enabled the 'learning anywhere, learning anytime' concept. It utilizes the principles of adult learning or andragogy: autonomous, self-directed, self-initiated, goal driven and taps on the internal motivations of learners. The deliberate repetitive practice VR training offers will help learners gain proficiency and mastery, even with the lack in actual clinical cases. **(**10,11,14,18**)**

VR offers immersive, experiential learning; learners learn through experiencing the subject matter first hand. It can be used for skills development as well as inculcating cognitive capabilities. **(**Photo 1**)** Team skills via group or multi-player activities are also possible. Learners can gain confidence, familiarization and get to practice real world scenarios such as those encountered in the emergency department, operating theatres, intensive care units and others. These scenarios are recreated in a virtual, simulated environment, using the state-of-the-art VR technology. This way, VR learning can foster imagination and creativity as well as enable some degree of flexibility in an active learning environment. VR simulation is today accepted as an important component of alternative teaching technique or a teaching reform, where the potential for learners to benefit from independent and self-directed learning is tremendous. **(**2,3, 14-16**)**

Photo 1: Virtual Scenario with a learner assessing a patient in a simulated environment

VR education and training is usually part of a bigger picture or educational masterplan for institutions. This would encompass virtual environment representation for education, virtual simulations inter-phased with virtual encounters, real world encounters or environments, as well as integration of hybrid education models which incorporate VR components. VR simulation training can also now be used to evoke standardized computer-based assessment. This capability enables a new range of proficiencies, which may have been difficult to assess via traditional means, to be assessed. For example, it is now possible to record the motion of simulated surgical instruments and equipment, measure the steadiness of the operators'/ learners' hands and detect any contact with adjacent skin or anatomical structures. Learning using VR can also be staged and phased, where more advanced skills are built upon the background of basics ones. Through simulation practices and these technologically enhanced learning capabilities, we are moving from the historical mantra of, "see one, do one, teach one" to "see one, simulate many, do a few competently and teach everyone" **(**12, 17-20**)**

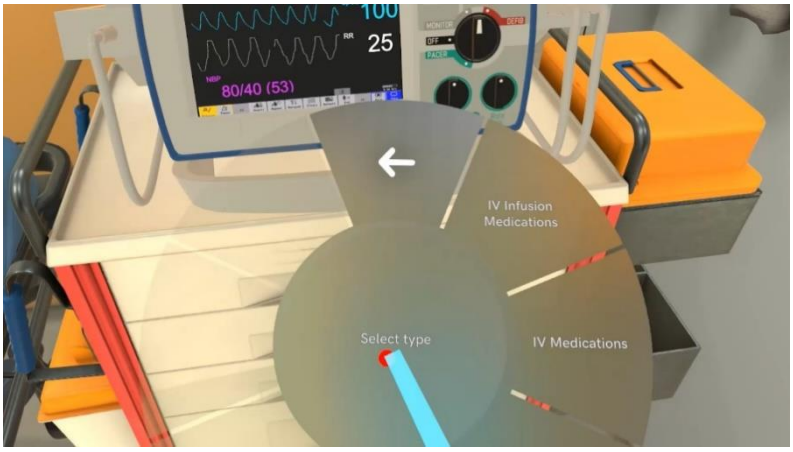

Photo 2: Various choices for the learner to select for each assessment point

Interactivity is one of the key features in VR simulation training. It helps to enhance the learner experience as well as the fidelity. These interactions are between the learner and the virtual simulated characters, the virtual environment as well as the virtual equipment/ instruments. In very advanced cases, the VR learning experience can include tactile experience, which utilizes interactive tissue models which are haptic rendering. In the latest VR simulations, leaners can even be given the freedom to perform simulated interventions utilizing different techniques and approaches. This is very useful and also helps to increase the acceptance of VR as it progresses towards adaptive application for higher level decision-making, just like the encounters in real world patients. **(**20**) (**Photo 2, Photo 3**)**

Photo 3: Learner accessing the patient virtually

There are many differences in learning using VR, versus the traditional way of learning. These differences are noted in the areas of 'patient' exposure/ scenario creation, achieving competencies, costs incurred, the learning process, nurturing clinical reasoning as well as facilitation and execution of lessons. Some of these are reflected in Table 1.

	Real World Training	**Virtual World Training**
Case Scenario	Learning from and managing as patients present or are encountered	Scenarios/ narratives are prepared and written prior, in order to plan and develop the appropriate characters in the immersive environment. These may be based on faculty's prior experiences and encounters
Handling Errors/ Attaining Competency	Cost of errors or ignorance can be high, resulting in morbidity or mortality to patients	The safe immersive environment allows for some mistakes and errors to be made and corrected. This does not harm actual patients. The repetitive, deliberate practice allows learners to try again and again until competency or mastery is attained
Financials and Costs	No extra cost, except for faculty time and effort in supervision. Patients will present with certain symptomatology and learners will manage, often guided by faculty	Currently, involves cost investments such as software development, procurement of goggles and development of suitable facilities.

Patient/ Scenario Flow	Case load can be very heavy specially in busy departments, with high turnover of patients. Common cases are encountered more frequently. Speed and familiarity is linked to experience and seniority.	Scenarios are handled usually one at a time. Some may find the "lag phase" too slow, especially with more experienced learners. They would have to follow all the steps in a systematic way and not be able to take short-cuts or skip steps.
Encounters and Narratives	Opportunistic, in terms of what types of cases/ patients will present. Depends on "what comes through the doors" and the frequency as well. Thus exposure can be haphazard which also makes the skills acquisition less organized and more reactive.	Scenarios can be repeated as needed until familiarity is achieved. Scenario planning can be done for: a. Commonly encountered 'bread and butter' cases or b. Rare cases, whereby practice is useful to upkeep knowledge and skills
Processes	Cases are 'naturally' presenting or coming to the hospitals/ clinics. The learning is more straightforward	There is a need to call for tender, using educational/ innovation grants. Appointment of game developer, animator, technical experts etc. Development takes time and can be labour intensive, going through all the relevant stages up to the beta testing stage
Orientation and Familiarization	Everyone is familiar with the process and steps of delivery of patient care. No running –in period needed as it is known and well accepted	Orientation will be required, familiarization with equipment, techniques and set-up are necessary. Some may encounter VR motion sickness, giddiness, disorientation etc
Adoption and Practice	The experience of traditional medical care and practice is known, whereby supervision is provided on the job and in a face-to-face fashion	May require time to get buy-in and change mindsets beyond the early adopters. Others may need more help in training and adoption

Table 1: Differences in Learning Using VR versus that of the Traditional Face-to-Face Encounter with Patients

Implementation of VR Educational Programme

When considering whether to embark on VR or TEL training for your department or institution, several factors must be taken into account and weighted appropriately. Firstly, knowing whether it is an institution wide or just a departmental initiative will be useful as it can affect funding/ financing and policies for utilization. Where it fits into the overall training framework and masterplan must also be clearly delineated. Setting up a committee or taskforce to lead focused group discussions for feedback is useful. Engagement and adequate communications to create awareness, understanding and buy-in should be planned from the start. It is also necessary to bear in mind the organizational and training culture. Engagement with subject matter and technical experts will be helpful. Professionals from various specialties should also provide their inputs on where VR/ TEL can be embedded in the curriculum of each discipline as well as in inter-professional collaborative practice training. If formally

included in the curriculum, charting and planning the learning outcomes, milestones and goals are necessary and should be done early. Here is also where pedagogy and andragogy considerations must be borne in mind. **(**20-22**) (**Fig 1**)**

In technology adoption, there is always a need to look at the end-users. Considerations such as digital literacy, willingness to adopt will affect training decisions. The availability of expertise in the institution and partners will also help to decide on champions, trainers and persons who can conduct training for the staff. A learner-centric approach is necessary, thus ensuring their involvement at every stage is a must, right up the alpha testing phase before moving on to the beta testing/ implementation and pilot phases. When doing this across the institution, bearing in mind the diffusion of innovation model is helpful. 'Diffusion', in this context, is the social process in response to the new learning technology or innovation. In general, according to Dearing JW et al, learners and staff can be segmented accordingly as: **(**21**)**

Innovators: approximately 2%-5%

Early adopter: 13.5%

Early majority: 34%

Late majority: 34%

Laggards: 16%

Thus, in designing ad delivery, the above has to be taken into the calculation of implementation and buy-in time. Factors such as whether the training and resources will be managed centrally, such as in a simulation facility.**(**Photo 4**)** Infrastructure cost, layout, number of rooms, configuration with haptic capabilities, staffing and work processes for learners who want to make bookings of these facilities are all important. Not forgetting the ease of wi-fi and internet availability as well as trained faculty/ staff to help with trouble shooting must be incorporated. **(**22-24**) (**Fig 1**)**

Fig 1: Elements and Domains to Consider when Embarking on Virtual Reality Education and Training

Photo 4: Dedicated place for VR training and debrief

Other Considerations in VR Training

The value in VR is in the immersive component which provides experiential learning. Its provides a sense of presence for learners and it attempts to match access to clinical experience in an easier or simpler format. Once the learners put on their head-sets, they are completely immersed in the virtual environment created for them. VR is also dynamic, interactive and adaptive. Scenarios can be designed to replicate human interactions. The focus can be customized accordingly such as on decision making, clinical reasoning or critical thinking. eXtended Reality **(**XR**)** technology which includes both VR and AR **(**augmented reality**)** has now been able to create new human-computer interfaces that approximates natural human movements, interaction and experience. Many more programmes are now being adapted to enable these features. **(**24, 25**)** This is quite different when compared with a 360 degree video, which tends to be largely passive and does not allow realistic interactions. With 360 degrees video,the disconnect between the learners' movement in the real world and their lack of movement in the virtual world can lead to giddiness, nausea and often, disorientation. VR also enables mobile learning, with psychological safety and the experience can be enjoyable. There is also the potential for gamification of the VR applications. Good engagement, enabling autonomous learning and the requirement of only small spaces are other positive points for VR learning. **(**25-27**)**

VR on the other hand, may not be able to teach techniques such as abdominal palpation. Even in some more complex procedural skills, the 'touch and feel' may be lacking with VR training. Even in communications training such as breaking bad news, it still lags behind in terms of the complexities

of language processing and facial expressions recognition. However, if XR is utilized, most of these challenges can be overcome to a certain extend, short of having the actual patient in front of learners. Newer XR devices can enhance learners' experiences through capabilities such as stereoscopic 3D displays, motion tracking, haptic feedback, natural human-based user interfaces **(**UI**)** and so on. Head mounted displays can now include organic light emitting diode displays which allow excellent response times, colour quality, field of view and image resolution in a relatively light weight package. **(**20, 25, 26**)**

For debriefing, once the scenarios are completed, this can be done virtually, with automatically generated feedback on performance. Debriefing can also be done by a faculty after the learners compete the scenario in face-to-face fashion. For multi-player scenarios, again debriefing can be done virtually upon completion or be conducted in the traditional face-to-face way. **(**Photo 5**)** Debriefing is central to the learning process and must certainly be thought of when the VR scenario is first being conceptualized and planned. Adding this in at the last minute will make it difficult for the game developer and outcomes may not be optimal.

Thus, VR training is not here to replace expert educators and other forms of blended learning. It serves to supplement the existing list of available techniques and tools in medical education.

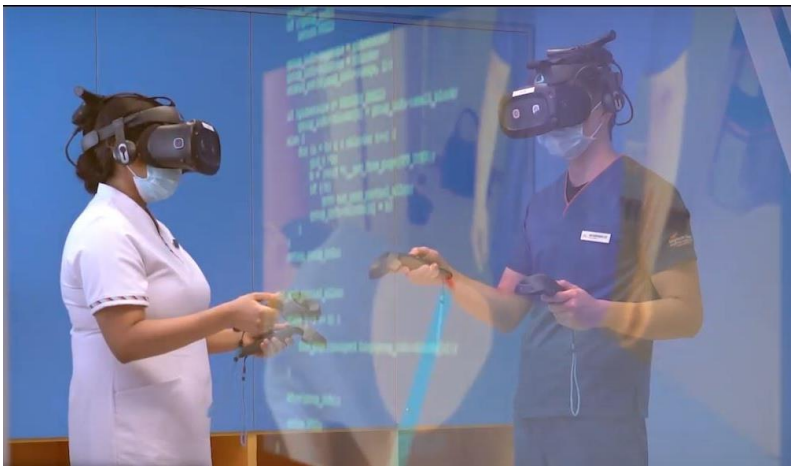

Photo 5: Enhancing teamwork with multi-playerplayer games

Enhancing Elements of Humanism in VR Education

The practice of Medicine is today very clearly a high touch and high technology industry. Especially post Covid 19 pandemic, the use and adoption of technology in healthcare has grown exponentially. However, one must not forget the essential component of human touch and humanism; thus the 'high touch' description. Therefore, even as TEL, VR and other technology make major strides in healthcare, these elements must not be forgotten. In all training utilizing technology, ensuring the presence of these elements must be mainstreamed. Some practical examples would include:

- Using realistic human scenarios that would be encountered in the real world. These narratives can have a powerful impact on learners
- Customization of audio used in these training can add to the humanistic experience. This can also be suited to the different culture and language. For example, the use of Asian voices in suitable countries
- The human engagement of learners can also take place during pre-briefing when they are told of the setting and experience they are about to embark on. These are usually interactive and learners will know their faculty are available.
- In some VR training, the debriefing can be conducted face-to-face after completion of the scenario and this allows for more "humanistic" discussions. **(**Photo 6**)**
- After simulation, faculty can meet up with learners to share on the transference of their VR or simulated experience to the real world setting. **(**Photo 6**)**
- The use of hybrid simulation has also enabled more human elements to be incorporated , for example transitioning between the VR application and a standardized patient or actor who has been briefed .
- With the advancing of technology and capabilities, the avatars and characters used in VR and TEL training are very human-like these days. This can further help learners with the element of realism.

Photo 6: Faculty discussing a scenario with the learners

Conclusion: The Future of VR and Technology Enhanced Learning

The use of VR, AR and XR have certainly enabled innovations in the medical learning environment. With newer developments and increasing fidelity as well as realism, it is all done in the hope that learners can gain and maintain proficiency and the ability to retain knowledge is better, given the experiential, immersive exposure. **(**28**)** All these technologies, embodying simulation and leveraging on immersive visualizations as well as the ability to capture personalized analytics are really the beginning of more to come. VR will continue to help healthcare staff build up their mastery through real life scenarios as it gains widespread dissemination and utilization. The ability for self directed, remote learning which offers flexibility, and is environmentally friendly is very attractive. Of course the issues of connectivity and access must also be addressed. Faculty, game developers and institutions engaged in this type of learning and training must ensure proper validation, reproducibility as well as standardization, as much as possible as healthcare subject matter experts partner with 'tech-know-hows' in this pursuit.

Finally, it is necessary to bear in mind that technology alone cannot transform medical education and that, not one type of technology will fit everyone.

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