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RECEIVED 29 April 2023

ACCEPTED 14 September 2023

PUBLISHED 03 October 2023

## CITATION

Botha BS, Hugo-van Dyk L and  
Nyoni CN (2023) Simulating infection  
prevention and control through virtual reality: a  
vehicle for equity, diversity, and inclusivity in  
Africa.  
*Front. Educ.* 8:1214321.  
doi: 10.3389/feduc.2023.1214321

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# Simulating infection prevention and control through virtual reality: a vehicle for equity, diversity, and inclusivity in Africa

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Endemics in Africa are prominent, especially in countries with low income and inadequate infection prevention and control (IPC) measures. Additionally, poorly trained nurses negatively influence infection-related indicators, and these nurses may require re-training. Re-training is expensive, and due to limited resources, healthcare institutions in Africa may not have the opportunity for their nurses to be re-trained in a critical competence such as IPC. Simulation-based education, including virtual reality (VR), has shown numerous benefits in acquiring critical thinking, communication, and clinical skills. However, VR has been reserved for healthcare education in the global north. Also, no educational programmes currently exist that harness the power of VR in a low-resource context such as Africa. We argue that VR is a possible low-cost simulation modality that can create standardised training resulting in equitable, diverse, and inclusive IPC education for nursing students. However due to a lack of technological training and ongoing support, low to middle-income countries often end up failing to implement the interventions over a longer term than the initial investment. Authors like Hofstede identified dimensions causing problems between various cultures, which might restrict the implementation of newer technologies in a diverse, equitable, and inclusive manner. The design and implementation of an educational innovation must address and integrate the cultural dimensions of the targeted context. Embracing, understanding, and respecting the variations in local culture within African universities is essential to inclusive and diverse education practices and the subsequent designing and implementation of educational innovation such as VR.

## KEYWORDS

virtual reality simulation, infection prevention and control, EDI, equity, diversity, inclusivity

## 1. Introduction

The burden of Africa's endemic diseases is the largest in the world, with infectious diseases contributing the most. Yearly, infectious diseases account for more than 227 million years of life lost with an annual loss in productivity of more than 800 billion United States Dollars ([World Health Organization, 2019](https://www.who.int/news-room/fact-sheets/detail/infectious-diseases)). Outbreak prone diseases are becoming increasingly devastating and of the ten million deaths that occur per year, the majority are in Africa ([World Health Organization, 2019](https://www.who.int/news-room/fact-sheets/detail/infectious-diseases); [Kumar et al., 2020](https://www.who.int/news-room/fact-sheets/detail/infectious-diseases)). The healthcare system including the health workforce

is often unprepared and under-resourced to positively influence infection prevention and control.

The health workforce must be competent in infection prevention and control. However, practice suggests that healthcare workers must be constantly trained and re-trained regarding infection prevention and control (Qureshi et al., 2022). Training and re-training of the health workforce requires resources including trainers, time out of work and financial investments which are often not available in many African settings. Evidently, during the COVID-19 pandemic, health ministries in collaboration with educational institutions and partner organisations conducted country wide training and re-training of the health workforce regarding infection prevention and control. The trainings were reported as once-off institution-based occasions with limited chances for practice and competence development (Tsiouris et al., 2022). In addition, the training programmes varied across institutions and there is a scant literature reflecting on the impact of such training on the health workforce in Africa.

Nurses are the largest healthcare worker group comprising up to 66% of the health workforce [World Health Organization (WHO), 2021] and nursing education institutions are a pipeline for future competent nurses that positively influence the infection indicators in Africa. Healthcare simulation and clinical skills teaching are often presented through institution-based laboratories which are not uniformly resourced across nursing education institutions. The unequal distribution of resources for skills training, logistical issues related to institution-based training, limited human resources for training and the penetration of the digital platforms and connectivity within the continent call for alternative and inclusive educational approaches for learning and teaching infection prevention and control in Africa. In this paper, we propose an innovative and inclusive simulation modality for learning and teaching infection prevention and control focusing on nursing students in Africa.

## 2. Africa and nursing education

Infectious diseases are a threat to Africa's developmental goals. In the aspirational vision 2063, the African Union argues for a well-educated citizenry underpinned by science, technology, and innovation for healthy and well-nourished people (African Union, 2021). The development of health has a significant impact on the social security and economic activities of countries across the African region. A myriad of interventions focused on tackling infectious diseases have been implemented in the continent and the education of nursing students to competently engage infectious diseases is an example of such intervention (Nyaruba et al., 2022). However, educational interventions often land in dissimilar contexts in Africa.

The context of education and professional practice have profound effects on the quality of educational outcomes. Africa, a continent of 54 countries, is an example of a plural socio-cultural and educational context interwoven with historical legacies of colonialism, inequality, and barriers to access social services (Shackleton and Gwedla, 2021). Additionally, resources and investments focused on nursing education and practice are inadequate. Ideally, countries must have sufficient nursing education institutions that positively influence the healthcare labour workforce towards universal health coverage (Cometto et al., 2020). However, Africa is imbued with a sub-optimal distribution of nursing education institutions and poor quality and quantity of nurse educators with a direct impact on the quality and quantity of the

human resources for health. For example, Malawi and Zambia are reportedly operating with less than half of their targeted numbers of nurse educators, with most of them not having a qualification in nursing education (Middleton et al., 2014). Education is a basic human right, while higher education, within the context of nursing, is a privilege to individuals based on multiple factors including availability and capacity of nursing education institutions.

## 3. Simulation-based: equity, diversity, and inclusivity

Simulation-based education is an educational strategy that replaces or amplifies real experiences with guided practices (Gaba, 2004). Ideally, simulation is meant to replicate aspects of the real world in a manner that allows students to be immersed in their learning environment. Technology does not necessarily define simulation, but the focus should be on educational approaches grounded in established learning theories (Jeffries et al., 2015). Advancements in student clinical knowledge, skills acquisition, communication, and critical thinking have been reported as the benefits of simulation-based education in healthcare sciences. These positive outcomes related to simulation-based education are reported predominantly in the global north, as Hallinger and Wang (2020) detail the low utilisation and uptake of simulation-based education in low-and middle-income countries.

Computerised mannikins are a key feature in some simulation laboratories for nursing education, with the latest research in this field focusing on the educational influence of these mannikins in learning clinical skills and reasoning (Handeland et al., 2021). Clinical skills training and healthcare simulation are conducted in these laboratories that are often based in nursing education institutions and/or affiliated hospitals. In Africa, a handful of nursing education institutions have established clinical skills or simulation laboratories with different forms and types of simulators ranging from task trainers for the teaching of basic nursing skills to computerised mannikins that respond physiologically to nursing interventions (Burch, 2014). The Nursing Education Partnership Initiative (NEPI) supported nursing education institutions in developing and acquiring simulation laboratories with computerised mannikins in five African countries (Middleton et al., 2014). However, the overall educational effect of simulation-based education in Africa has not been realised.

Most African states do not have set standards for simulation and/or clinical skills laboratories, especially in undergraduate nursing education in as much as they are regulated by professional bodies (Moabi and Mtshali, 2022). The lack of standards for simulation and/or clinical skills laboratories contributes to a variation in available resources in these laboratories (Moabi and Mtshali, 2022) which may be linked to inconsistent learning opportunities for undergraduate nursing students within the same institution, across institutions in a country and across countries in a region. Inconsistent learning opportunities generally affect the attainment of learning outcomes, which may result in poor clinical skills. The poor training in clinical skills compromises the competence of nursing students and eventually the graduates from such nursing programmes. Poorly trained nurses negatively influence infection related indicators, and these nurses may require re-training. Re-training in practice is expensive, and due to limited resources, healthcare institutions in Africa may not have the opportunity, money, or capacity for their nurses to be re-trained in a critical competence such as infection prevention and control.

Even though simulation-based education, is reported to have supported multiple institutions in providing consistent and standardised training opportunities (Swart et al., 2019), inequality, lack of diversity and exclusivity are possible unintended outcomes in nursing education. Structural inequality is overt within the African region in relation to health workforce training due to various political, economic, and cultural reasons. Inequality unfolds in various layers, including systemic, political, and structural forms (Sorensen, 1996; Assari, 2019; Amadeo, 2022). The variation in healthcare simulation-related resources are nested within structural inequality are evident across an education institution, country and the African region, advantaging students in specific contexts over others (Maloney and Haines, 2016; Tjoflåt et al., 2021). At a localised scale, differences between campuses of the same university enshrine structural inequality (Kaufman, 2016). Institutions in the same country, as seen in South Africa, have different resources related to simulation-based education for healthcare students. Some universities have state-of-the-art simulation facilities that include computerised mannikins that are accessed by most students on campus while other universities within the same country do not have any established laboratories for learning (Thurling, 2016). Furthermore, the capabilities of skillfully designing and integrating simulation activities in education vary across settings even when related to a priority healthcare issue such as infection prevention and control.

External diversity, specifically circumstantial diversity is compromised in situations where external circumstances and resources are dissimilar across and within contexts. However, external variables associated with circumstantial diversity, such as physical resources, can be modified through innovation or additional funding (Cooks-Campbell, 2022). Modifying external variables through innovations provides an opportunity to enhance diversity, inequality, and inclusivity. Nursing education must be inclusive and provide nursing students with fair opportunities to practice or learn, especially for a universal nursing competence such as infection prevention and control.

## 4. Virtual reality simulation a pathway to standardised training

Virtual reality is a possible simulation modality that can create standardised training resulting in equitable, diverse, and inclusive infection prevention and control education for nursing students. As an immersive application, virtual reality enables users, such as nursing students, to feel present in a digitally generated healthcare environment (Lotte et al., 2013; Fabroyir and Teng, 2018). Aligned with the principles of simulation-based education, virtual reality can be designed to support students in developing critical thinking and clinical reasoning skills related to infection prevention and control which are essential attributes for competent nurses. Presented as a mobile or desktop application, students engage in standardised training, asynchronously re-engage, practice clinical competence and receive real time feedback on their practice (O'Connor et al., 2021). A virtual reality simulation modality can be a vehicle to address standardisation in nursing education further addressing structural inequality among students, institutions and the region towards an infection controlled Africa (Barrera-Cancedda et al., 2019).

A multi-country initiative in Africa is aimed at developing and implementing a virtual reality simulation for infection control in

undergraduate nursing students that is based on a desktop and/or cell phone. Ideally, the students will receive a link to the virtual reality site where an initial download will be done to save the virtual reality application on their desktop or cell phone. Due to economic limitations in African settings, the virtual reality simulations will be engaged on through low-cost data modes or most cases, without the need for data. Students will be able to engage with the self-paced virtual reality simulation receiving instant feedback on their practice at various locations, including their homes. The virtual reality simulation will standardise infection prevention and control education as all students will be exposed to universal infection prevention and control principles. Virtual reality simulation has been reported in some nursing education institutions in Africa and is showing potentially positive outcomes. The development of the virtual reality intervention needs to be informed by the context.

## 5. Discussion

Africa is not one homogenous cultural region. Conversely, the level of diversity is not that perplexing. The design and implementation of an educational innovation must address and integrate the cultural dimensions of the targeted context. Meeting cultural dimensions of any context enables the educational innovation to be inclusive resulting in a high propensity of assimilation into mainstream education (Pell et al., 2011; Coast et al., 2016). Africa is a den of donor driven and donor funded educational initiatives which are often designed based on the originator country's socio-cultural dynamics. Superficial amendments, such as changing the skin tone of simulators, do not necessarily address fundamental issues of access, equity and inclusivity, resulting in some initiatives turning to "white elephants".

In his seminal work on cultural dimensions, Hofstede and Minkov (2010) presents five cultural dimensions that have an influence on the adoption of innovations. These dimensions are (i) power distance index, (ii) individualism, (iii) masculinity, (iv) uncertainty avoidance index, and (v) long-term orientation. Through a Values Survey Module, some African countries were generally regarded as "masculine", with a high-power distance index, borderline uncertainty index score and reflective of collectivism (Hofstede and Minkov, 2010). Masculinity in this context refers to a cultural context that values assertiveness and competition, while countries with high power index suggest that a level of inequality within the society is endorsed by the followers as much as the leaders manifesting in social hierarchical systems. A borderline uncertainty index reflects a moderate tolerance to change and ambiguity, while collectivism is aligned with cohesiveness and being group oriented-embedded in the concept of "ubuntu" which enshrines "collective relatedness, interdependence, communality, group solidarity, and conformity" (Kpanake, 2018). In as much as the Values Survey Module, has undergone several analyses related to validity, internal consistency and representativeness of outcomes, such findings are a foundation of interacting and engaging countries in Africa especially focused on introducing innovation such as virtual reality simulation to enhance equity, diversity, and inclusion.

The process of the development of virtual reality simulation to address infection prevention and control in undergraduate nurses integrated known cultural dimensions of the included countries in Africa. The initial configuration of the need for an inclusive educational innovation was discussed with various stakeholders, considering the available resources for development, experience, and expertise. One

university in South Africa has been at the forefront of virtual reality simulation in undergraduate nursing education – and based on that experience, has developed the necessary expertise (Botha et al., 2021). Authorities and leaders in various universities in Africa were contacted individually for discussion on the possibility of including these universities in the design and development process. Due to the social value placed on face-to-face and physical interactions, the authors travelled to universities for formal and informal meetings. Snyman and Rogers (2020) underscores that partnerships are concretised through personal and informal physical meetings. The focus of the meetings is on establishing partnerships, explaining, and showcasing virtual reality as a strategy for infection prevention and control and collaboration. Aligning with the socio-cultural norms and hierarchies of host institution, the leadership at the site hosts the meetings and directs the formal and social programme. Nurse educators present their programmes and discuss their approaches to the teaching and assessment of infection prevention and control. This information is the basis of the design of the virtual reality simulation. Finally, the nurse educators are incorporated into the design of the virtual reality intervention, acknowledging and bringing in their own experience and expertise as educators in their country.

The principles of infection prevention and control are universal and permeate frontiers, but structural and contextual differences influence how these principles are taught and learnt. Consideration must be made towards investigating the socio-cultural dimension of any context before engaging in any discussion around innovation, and the concepts as presented by Hofstede and Minkov (2010) may be useful foundational information. Hierarchy, power differentials and local culture must be prioritised when communicating, planning, and designing educational innovation for enhanced sustainability and inclusion. As Africa continues to battle with infection-related diseases mirrored against dwindling resources, we postulate that virtual reality simulation may be influential in undergraduate nursing education. Nurses who graduate with competence in infection prevention and control have a positive influence on their patients, the hospitals and society in general.

## 6. Conclusion

Therefore, offsetting inequality, lack of diversity and exclusion (Hofstede and Minkov, 2010) that can be brought about by some simulation modalities is possible with the development of custom-made virtual reality modalities. The simulation will provide

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standardisation in terms of training related to infection prevention and control across various countries in their undergraduate nursing education programmes. Embracing, understanding, and respecting the variations in local culture within the African university is an essential ingredient towards inclusive and diverse education practices. Through genuine partnership development, honesty, and respect there will be not only the development of an artifact, but its subsequent implementation resulting in nurse graduates that are competent in infection prevention and control and impacting on African indicators.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

## Funding

The research is funded by the researchers host institution, the University of the Free State.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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