Submitted on: 14.08.2023

Librarian-Scientist(s) Collaboration in Harnessing the Potential of Augmented Reality (AR) and Virtual Reality (VR) for Veterinary and Animal Sciences Education and Training: A Success Story of Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana

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Abstract:

The livestock sector is a key component of the global food system, having a vivacious role in securing food and nutritional security, and generating rural employment. The competency and skills of veterinary professionals are primary to the progression of the livestock sector. The veterinary professionals go through rigorous academic programme(s) comprising of clinical and para-clinical subjects, aimed to develop them as accomplished veterinary professional(s) to serve the speechless creatures. Consequent upon absence of precise understanding of processes/ procedures involved in handling cases, failure on part of professionals may lead to the mortality of animal(s). Besides, animal protection regulatory bodies may impose restrictions over in-situ cadaver exposure, leaving a few opportunities for veterinary students to learn with live animals in a practical setting. The two-dimensional graphics, texts, and/or videos in veterinary instruction as an alternative have their own shortfalls. In such a scenario, Augmented Reality (AR) and Virtual Reality (VR) open up new vistas to address these problems permitting real like animal handling experiences and an immersive environment for experiential learning. These technologies allow students to understand intricate procedure(s) meticulously and enhance their clinical reasoning abilities to support healthy livestock sector.

This paper discusses the success story of librarian-scientist(s) collaboration for harnessing the potential of this novel technology in veterinary and animal sciences education and training at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (India), which was an outcome of exposure to the technology at IFLA WLIC 2019 at Athens, Greece. In addition, instances of use of AR and VR in veterinary and animal sciences, globally, have been discussed.

Keywords: Augmented Reality, Virtual Reality, Veterinary, Education and Training, Ludhiana.

Introduction

The technological interventions have persistently intrigued and transformed the educational system drastically, making education not only accessible and affordable, but also engaging and interesting. The use of digital technologies taking in its ambit the multi-media and visual aids facilitates students to have the in-depth understanding of the subject(s), providing them a virtuous milieu required to grasp the practical components in a better way. The widespread use of potent technologies in conjunction with adaptable delivery methods, astute integration strategies, and efficient policies improves access to high-quality education and self-directed learning (Senteni, 2014; Groff, 2013). The education system has witnessed a substantial and strategic revamp after COVID-19 pandemic breakout, leading to implementation of Learning Management System(s), real time remote learning across the physical space, emergence of learning portals, blended learning models etc.

The contemporary era is beholding the emergence and application of various technological tools and platforms to supplement teaching-learning activities including Artificial Intelligence (AI), the Internet of Things (IoT), 3D printing, Augmented Reality (AR), and Virtual Reality (VR), giving a positive flip to learning by enabling individualised, customized, practical and more realistic learning experiences, encouraging the active participation from students and other stakeholders. These have escalated the human-digital interactions beyond traditional flat panel displays. AR and VR technologies create an engaging learning environment where learners can exercise control over their learning and the ability to engage with digital things in both a real-world and virtual environment (Almoosa, 2018).

Augmented Reality (AR) and Virtual Reality (VR)

The Augmented Reality (AR) and Virtual Reality (VR) are the novel technologies having application in various fields including automotive (Čujan, 2020), transport industry (Paule, 2021), civil infrastructure (Xu and Moreu, 2021), in-house Logistics (Wang et al., 2020), tourism (Pestek and Sarvan, 2021; Tuli and Arora, 2023), Aviation (Eschen et al., 2018; Neretin et al., 2021), Education (Lampropoulos et al., 2022; Tzima, 2019) and so on.

Though, both AR and VR involves digital object(s) for intended purpose(s), the level of immersion differentiates these technologies. Augmented Reality (AR) magnifies information from print and/or digital media by fusing the real and virtual worlds (Almoosa, 2018), improving the physical environment and/or object(s) in the real world. In this technology, the artificial cues are superimposed on the real world to encourage users' engagement with the information. Azuma (1997) defines AR as digital superimposition of "virtual objects onto physical objects in real space so individuals can interact with both at the same time". The accessibility and affordability of mobile phones equipped with digital technologies and internet feature has led to expansion of AR tools (Almoosa, 2018).

Virtual Reality provides "an immersive, completely artificial computer simulated image and environment with real-time interaction" (Khor et al., 2016). It enables digital context, created without using a physical setting, where users feels as present in a virtual milieu. The users can interact with the digital modules using a variety of technological devices, including Head Mounted Device(s) (HMDs), visualisation goggles, and/or haptic gloves etc. VR users may benefit from aural system in addition to visuals.

The use of AR and VR in education can prop learning stimulation, with engaging, real like and easy to use context. However, the potential of these novel technologies is under-utilized in livestock sector (Kiryakova, 2018).

AR/ VR in Veterinary and Animal Sciences Education & Training

The world population is projected to reach 9.1 billion by 2050, resultantly causing an increase in the demand for food, feed, and fibre by 70%. Furthermore, due to increasing urbanisation and fast changing lifestyle, the eating habits are anticipated to be transformed, with decrease in consumption of grains and pulses and a sharp rise in the consumption of vegetables, fruits, meat, dairy, and fish (FAO, 2009). Especially in developing nations, where people still experience hunger and poverty, this enormous challenge will result in grave scenarios (World Bank, 2014). In such a situation, the livestock industry will be amongst the major players to add food and nutritional security to the food basket, globally.

The livestock industry is a key component of the global food system, having a pivotal role in securing food and nutritional security, and generating rural employment. It also contributes to curb poverty and supplements house hold income for building a strong rural economy. The competency and pragmatic skills of veterinary students are fundamental to the growth and prosperity of the livestock sector. Thus, precise comprehension of clinical and para-clinical subjects is essential to be an accomplished veterinary professional to serve the speechless creatures. Else, the lack of knowledge and experience to handle the complex case(s) may result in animal mortality. Additionally, animal protection regulatory agencies may place limitations on *in-situ* cadaver exposure, leaving only a few opportunities for veterinary students to gain hands-on experience with live animals. Moreover, there is a risk of transmission of zoonotic diseases while handling animal(s). In this scenario, when the use of animals in research and education has become challenging, students are left with two-dimensional graphics, texts, and/or videos in veterinary instruction as an alternative, restricting the use of real animals (Xu et al., 2021). However, these sources have their own limitations, confining the avenues of practical learning.

Technology bids opportunities to combat the said challenges by offering real-like animal handling experiences and an immersive setting for enhanced practical learning. The Augmented Reality (AR) and Virtual Reality (VR) enable the students to comprehend complex processes and procedures more precisely, improving their clinical reasoning skills for the healthier livestock sector.

While AR extends learning to hand held gadgets, cutting across the space and time barriers, VR can be employed to sharpen the practical skills of students about the procedures and processes involved in diagnosing and treating animals. Moreover, one may practice the processes and procedures repeatedly, without risk of any harm to the animal(s) from an amateur professional. It also reduces the health risks associated with exposure to zoonotic diseases in real-world settings.

Global initiatives

Efforts have been made globally to utilize the potential of AR and VR for honing up the practical skills and capabilities of veterinary professionals to equip them to better serve the livestock sector. The notable initiatives have been listed here.

The Virginia-Maryland College of Veterinary Medicine at Virginia Tech created a virtual dog anatomy to help students better understand the subject. It enables the students to access, explore, and learn the locations of organs within the skeletal system of dogs (Virginia Tech, 2018). The College of Veterinary Medicine and Biomedical Sciences at Colorado State University created the Virtual Canine Anatomy project, which adds high-quality cadaver images to the university's first-year anatomy lessons (Stilwell, 2018). LlamaZOO in association with the Universities of Missouri and Saskatchewan developed the EasyAnatomy solution for veterinary stakeholders (LlamaZOO, 2017).

Cornell University has created an augmented reality application to assist DVM students in their study of the horse musculoskeletal system (Cornell University, 2019). The University of Pennsylvania School of Veterinary Medicine created an AR application for a challenging spinal cord surgery, facilitating the new entrants to the profession to interact with real anatomies and diseases virtually before working with patients in clinics (Adorno, 2018). A 3D representation of an equine heart created by the University of Liverpool's School of Veterinary Science can be accessed by learners through dedicated application by placing the smartphone next to the 3D model image (University of Liverpool, 2014).

Efforts have been made to provide the 3D modules in open domain, benefiting the veterinary and animal sciences stakeholders, globally. The Online Veterinary Anatomy Museum provides access to veterinary anatomical resources virtually. The content is organized by body region, body system and species, and is licensed under Creative Commons Attribution-Non Commercial – No Derivatives license (https://www.onlineveterinaryanat omy.net/). The Royal (Dick) School of Veterinary Science has also made 3D models of animal skeletons available publically.

Sketchfab has emerged as a mega platform providing access to 3D models contributed by various institutions/ organizations/ individuals on different subjects, including related to veterinary and animal sciences. This allows to publish, share, discover, buy and sell 3D, VR and AR content and provides a viewer based on the WebGL and WebXR technologies that allows users to display 3D models on the web, to be viewed on diverse digital devices including mobile phones, desktops and/or Virtual Reality Headsets. Sketchfab users can choose to make their 3D model files available for download under Creative Commons licenses or to sell them in the Sketchfab store (https://sketchfab.com/). The 3D models by the Royal (Dick) School of Veterinary Sciences, University of Nebraska-Lincoln, University of Zurich, Universidad de Sevilla, Sevilla, Espana; University of New England; Massey University, New Zealand; Advanced Visualization Lab, Indian University and St. George's University, West Indies are also accessible through Sketchfab.

Besides Veterinary Anatomy, AR/VR are also being utilized in veterinary medicine, surgery, pathology, and other fields. The Konkuk University has developed an augmented reality based intravenous (IV) injection simulator for training veterinary professionals to venepuncture dogs. The students using this simulator were found to be more skilled than the controlled group at IV injection technique using real dogs (Lee et al., 2013). Universidad Alfonso X El Sabio (UAX), Madrid, Spain evaluated the quality of experience using 360-degree immersive video in university education of fourth-year veterinary medicine students addressing areas of surgical pathology and surgery of equines. The students admitted that the exposure to VR has enhanced their practical learning (Guervos, 2019).

The AR/ VR have also been applied to control animal behaviours and movement (Simon and Prasad, 2017), enhance human-animal connection (Norouzi, n.d.; Oxley, 2022), to raise public

understanding of animal morphology and structures (Jones, 2022), to discuss the potential diagnosis with the owners/veterinary students and to analyse the radiographs (Packer, 2020).

Though, AR and VR have witnessed application in diverse subjects of Veterinary and Animal Sciences including surgery, medicine, pathology etc., majority of the initiatives revolve around teaching of veterinary anatomy. Anatomy is basic to other subjects and is taught in first year of veterinary programme(s) to enable students to understand the structure of the animal(s).

Nevertheless, these novel technological outcomes have proved to be avant-garde to augment the education and training in clinical and para-clinical domains with the addition of desired levels of complexities to better equip students to handle challenging situation(s), besides supplementing teaching-learning in anatomical and physiological structures.

Implementation of AR/VR at Guru Anagd Dev Veterinary and Animal Sciences University, Ludhiana

One of the author(s) of this paper attended IFLA-WLIC 2019 at Athens, Greece and experienced AR in the poster session. There was a poster presentation on use of this novel technology to attract and engage children at a public library in Taiwan. The interaction of author with the poster presenter(s) instigated interest in knowing more about this technological advancement. After coming back to India, IFLA WLIC attendee discussed this technology with the University Librarian (co-author of this paper), who envisioned to use this technology at the University for education and training of students and farmers. Thereafter, the authors explored literature, tried some free to use application(s) including Pokemon to get an understanding of the technology. After thorough study and developing the basic understanding of the technology, authors deliberated on the contemplated goal of harnessing its potential in veterinary and animal sciences for supplementing the education and training of veterinarians, trainees, farmers and other stakeholders. A developer of AR and VR content was invited to the university to explore the areas/topics in the discipline where this technology can be utilized. Discussions were held with various subject experts in the university. As the technology was very new to the institutional fraternity, it took some time for subject experts to get understanding of it. Once, all of the team members got familiarised with the technology, a project proposal was prepared and submitted to the Director of Research for further submission to the funding agency. On getting funds for the proposed project, a list of modules to be prepared as AR and VR in the subjects of Veterinary Anatomy, Pathology, Physiology, Medicine, Surgery, Gynaecology, Public Health, Dairy Science and Animal Nutrition was prepared. In addition, some of the topics were decided to develop 3D animation(s) with voice-over in vernacular language for creating awareness amongst farmers and general populace on concerned subjects. As development of AR and VR is a highly technical work, a technocrat firm was assigned the job of developing Ed-Tech modules for the University under the said project.

In this venture involving librarian(s), scientists and technological firm, librarian(s) served as technological gatekeepers, grasping the technological advancement(s) from outside and introducing those at the University, supporting the mandate of the University of producing competent human resources in livestock sector. Librarian(s) worked as a link between the scientists (subject experts) and technical firm developing the AR/VR modules. Being principal investigator of the project, Library and Information Science Professional (LISP) used to observe the technological developments periodically and shared the same with subject expert(s). Similarly, the scientific inputs of expert(s) were conveyed to the technical team

developing the modules. After developing AR and VR contents and 3D animations, the firm made an initial submission during September 2022. The contents submitted were shared by librarian with all experts seeking their comments, and suggestions for improvements, if any required. The scientist(s) examined the modules thoroughly, and observed that the submitted AR and VR modules needed improvements. The observations and suggestions of scientists to the correctness and accuracy in modules were recorded and provided to the firm. The firm tried to incorporate all possible changes in modules as suggested by subject expert(s) and submitted the improvised version in again in December 2022. Meeting(s) of subject expert(s) were conducted in Library and the submitted modules of AR/VR were examined and discussed again. The suggestions of scientists were again communicated to the technological experts and finally project was accomplished resulting into development of 14 modules of AR along with mobile application, 10 modules of VR and 3 modules of 3D animations. To enable the students and other stakeholders to utilize the fruits of this novel technology, an AR/VR Laboratory has been developed in the University as a section of Library. In coordination with the Deans of colleges and Heads of the Departments, students are provided exposure to various procedures through AR/VR modules for better serving the livestock sector with improvised practical skills.

The experience of AR/VR gained at WLIC and discussions with scientists back at University paved way for librarian(s)-scientist(s) collaboration for harnessing the potential of this novel technology in veterinary and animal sciences education and training. The resultant AR, VR and 3D animations developed are being successfully utilized in chiselling the skills of veterinary students, trainees *vis-à-vis* livestock farmers.

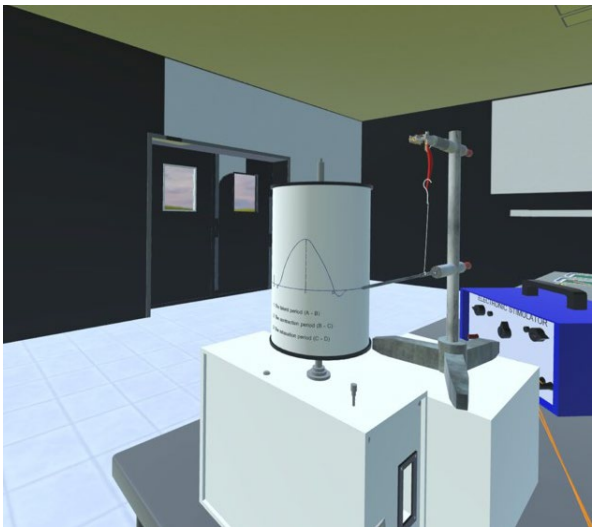
However, execution of the project was not free hurdles. Librarian(s) and scientists *vis-à-vis* technological personnel developing the AR/VR modules encountered many issues and challenges. Though the firm had vast experience of developing AR/VR modules for various sectors, it was experiencing the development of contents in veterinary and animal sciences for the first time. The modules were much more complex than the expectation of developers, which caused extension of deadline for accomplishment of the project. The technological firm being from another state sent its representative to the university to co-ordinate with Librarian and collect inputs from scientist(s) of the University. Librarian accompanied by the representative met subject expert(s) and collected inputs from them. The representative conveyed the inputs provided by subject expert(s) to developers, which sometimes could not get the concepts properly as the channels of communication increased. Moreover, the representative was also not from veterinary and animal sciences field, also facing difficulty in understanding the scientific terminology and/or procedures. Irrespective of this, the team work of all stakeholders and sincere efforts yielded results and lead to development of AR/VR modules to the expectations of scientist(s). Despite having potential to supplement the practical skills of learners, AR and VR are fairly pricy technologies. In addition, the devices to access modules including Head Mounted Displays (HMDs) are also quite expensive.

The veterinary professionals have hectic schedule, as in addition to teaching, they are supposed to carry out research, provide clinical services at the University hospitals and render extension services for transmitting scientific knowledge to the farmers. Thus, arranging meeting(s) with subject expert(s) at times convenient to the firm was also not possible at all times. The availability of all subject expert(s) during the visit of representative of the firm to the University was another challenge, as at a few instances, some of the expert(s) were on training abroad. But thanks to the technology, virtual meetings were arranged with them. Besides the issues and challenges encountered during development of project, the basic problems with over usage of

Virtual reality Headsets like headache, nausea, eyestrain etc. are also to stay. Moreover, AR/VR can not replace the real world, but are supplementary to the learning processes.

During the project execution, we learnt that a constant alliance and exchange of information between veterinary scientist(s) and technical developers is necessary for accuracy in modules, especially when dealing with complicated models. Thus, if possible, personal visits of scientists to the technical laboratories of the module developers and visits of developers to the scientists in the university be organised for better connexion amongst them to get desired result within given timeframe.

A few image(s) of the AR and VR modules developed by the University for capacity building of human resources in livestock sector under the Rashtriya Krishi Vikas Yojana (RKVY) project funded by the Government of India are given below:



(Stills from VR modules and 3D animation)

Conclusions

The potential of Augmented Reality (AR) and Virtual Reality (VR) to supplement the practical leaning in Veterinary and Animal Sciences has opened up new avenues for the stakeholders for repeated and self-learning without harming speechless creatures. Resultantly, various institutions across the world have developed AR and VR modules to overcome the snags of traditional education. Though these technologies are quite expensive, and require commitment, time and regular communique between subject expert(s) and technocrats for developing accurate and impactful modules, the benefits of these supersede all these issues and challenges. Inter-institutional collaborations and consortium initiatives can be pivotal to cut module development costs. The AR/VR project execution at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana owes it roots to the IFLA WLIC 2019. This reflects that LISPs being technological gatekeepers can play a pivotal role in introducing technologies to respective institutions and their collaborations with scientific fora may bring virtuous outcomes.

Acknowledgement

Authors are highly grateful to Dr. Inderjeet Singh, Vice-Chancellor and Dr. JPS Gill, Director of Research of the University to allocate funds under Govt. of India funded Rashtriya Krishi Vikas Yojana for introducing AR and VR in the University.

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