

# **Immersive Learning Objects in Four Dimensions (ILO - 4D): Applications in biomedical and health professional training.**

**Principal Applicant:**

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## **Key Words:**

- 1. Virtual-Augmented Reality,**
- 2. haptics,**
- 3. e-learning,**
- 4. embedded learning-objects**

## **ABSTRACT**

Healthcare training requires learning in multiple dimensions. Arthroscopic surgery or heart catheterization for example, involve a sense of force (resistance to insertion) and navigation in 3D space, disconnected from natural frames of reference. Animal models and cadavers have limitations due to differences in anatomy and the absence of pathology. Virtual Reality, Augmented Reality and Haptics (VR-AR-HA) offer multi-dimensional visualization and simulation to enhance learning experiences. These affordable technologies do not require special facilities and can enable students to practice at home or in conventional classrooms before accessing scarce anatomy and advanced simulation facilities. Using VR-AR-HA simulations students experience pathologies and anatomical abnormalities that may otherwise take a whole career to encounter. This TLEF will build capacity to develop VR-AR-HA learning objects for healthcare professional training, introduced in a controlled way to learning sessions with students and evaluated using a mixed methods strategy in at least 3 courses. (146 words)

## **PROPOSAL**

### **Study Objectives:**

- Development of 5 learning objects that enhance multidimensional visualization and learning that incorporates virtual reality, augmented reality, haptics or a combination of these techniques.
- Evaluation of integrated blended reality objects and platforms to support enhanced understanding, training and knowledge retention for health sciences students.
- Develop guidelines for best practices development of VR-AR-HA to be deployed and evaluated for education and training in health sciences using a learner-centric approach?

### **Project Description:**

This project will be undertaken in three parts:

1. The development of capacity and best practices for the creation and dissemination of learning objects that can be used in the training of healthcare professionals where 3D visualization and in some cases the sense of feel through haptic feedback are important to improve effectiveness and efficiency in achieving learning objectives.
2. Implementation of the capacity developed in (1) to create 5 learning objects. The content will respond to expressions of interest from instructors who offer courses in the health faculties at University of Alberta.
3. Evaluation using IT-generated usage statistics and an online mixed methods approach to determine how effective VR-AR-HA learning objects are in enhancing the effectiveness and efficiency of learning complex tasks and concepts.

### **Part 1 – Capacity Development**

A collaborative initiative, coordinated by the Office of VP(Research) has been established between the Faculties of Engineering, Science, Medicine and Rehabilitation Medicine to develop VR-AR-HA applications to enhance research and development, learning and practice in the health professions. Each faculty has contributed \$50K per year for 2 years to support the initiative. The part of the initiative that focuses on enhanced learning will provide funds to match this TLEF proposal. Most of the capital infrastructure and expertise needed to develop VR-AR-HA learning objects for healthcare applications is in place and the ability of this team to work together effectively has been demonstrated.

Capacity development will involve several key elements:

- Development capacity is already in place that has demonstrated a framework for creating VR-AR-HA learning objects. Examples include:
  - The use of AR to interact with real MRI images
  - A learning object delivered by synchronous learning on the topic of measuring the Cobb angle associated with spinal scoliosis (world first demonstration given by our team in Feb. 2015)
  - A media training suite using VR
  - A VR application for cardiovascular training and remote monitoring
  - Routine use of VR-HA in surgical planning for patients undergoing extensive head and neck cancer surgery
  - Dynamic sequence of MRI images used to create an immersive environment to plan heart valve replacement surgery
- Development of a pedagogy that integrates the learning context with the use of VR-AR-HA technologies
- Development of guidelines for the most appropriate selection of VR-AR-HA technologies to achieve a particular learning goal. For example in some cases donning a pair of VR goggles, leaving the hands and body free to move in space works best. In other cases the integration of AR learning objects with a textbook

or an online learning session may be more effective in reducing disruption to the flow of information.

- Training of a team of developers with an understanding of the healthcare context (most working on an hourly basis and often remotely). This is necessary to build high quality applications and access to HQP to support development of high quality learning objects.
- Identification and development of a library of “snippets” that can be used in the creation of VR-AR applications.
- Capacity to compile applications that integrate VR/AR + HA and sound for a range of platforms (e.g. IOS, Android, desktop and fully immersive).
- Develop evaluation best practices that incorporate analytics from web-based usage statistics as well as more conventional online questionnaires and interviews.
- Develop capacity to navigate within very high resolution static and dynamic MRI images (e.g. virtual immersion within the thoracic region of the body) to create a highly interactive experience for learning anatomy with applications focussed on functional anatomy, mobility and also in radiotherapy. Dr. Dhillon has provided images and will assist with future access to MRI images for this purpose.
- Development of a simple haptics device to simulate catheter insertion force feedback.

## **Part 2 – Development of 5 Learning Objects**

The PI and team have undertaken a number of consultation and outreach activities intended to increase awareness for non-IT-specialists of the opportunity that colleagues with extensive clinical content expertise can bring to the development of VR-AR-HA learning objects for their field of specialization. On September 15<sup>th</sup> 2015 the PI and team held a seminar and networking event (VR After Dark) that attracted over 250 participants. Several public presentations have been conducted to raise awareness to many hundreds of participants of the opportunities associated with these new technologies. Lunchtime sessions have been held with clinical instructors that have resulted in 5 detailed proposals being submitted to our team for the development of learning objects. These have been submitted by the Department of Dentistry, Department of Radiology and the Simulation Group led by Dr. Gibson. We are therefore confident that will be able to select 5 excellent and diverse topics for learning object development that will be tested by the instructors and their students, and will incorporate a comprehensive evaluation of their effectiveness relative to convention learning approaches.

For each learning object application selected, the learning objectives and an instructional design strategy will be developed in collaboration with the Technology in Education team led by Dr. Janet Welch. Working interactively with the instructor, a storyboard approach will be developed to create the outline of the learning object for implementation by the VR-AR-HA design and development team. Once a basic implementation has been developed, “scrum sessions” with the whole team will be conducted to critique the prototype version of the learning object, resulting in a series of revisions ready for final rendering of the learning object ready for testing and evaluation in the classroom.

### **Part 3 – Evaluation and Implementation**

In this initial phase of development we will adopt a flexible approach to generating usage analysis working across platforms using built-in analytics. This will enable us to track in detail usage statistics of the students using the learning objects. In some cases, where they are mounted on learning management systems such as Moodle or Blackboard Communities, the analytics capabilities of the platform will also be incorporated. Eventually, should learning objects be embedded in MOOCs, the analytics capabilities of the MOOC platform provider (e.g. Coursera, edX) would also be deployed.

Instructors will be asked to provide the learning objects to students in their class. The whole class will be surveyed to obtain feedback about their learning experience for the content relating to the learning object. The survey will be designed to gather both quantitative information (e.g. level of understanding, perceived difficulty in learning on a Likert Scale) and also qualitative information provided as free text feedback as well.

A key priority of this project is to investigate how healthcare learning objects might be made more widely available. There are no technical barriers to providing learning objects as apps, available through an iTunes-like app store. However one of the challenges we anticipate will be how such apps might be effectively embedded within the primary content of the course. In some cases embedding might suit an instructor best if it could be incorporated in a PowerPoint presentation. Compatibility with tools such as Adobe Captivate that support “plug and play” strategies will be determined. Other situations might include integration of VR-AR-HA learning objects as part of an online synchronous or asynchronous session or even in a MOOC or Campus-wide Online Course. AR might be best embedded in textbooks or e-Books. The option to use VR-AR-HA learning objects as part of a homework assignment in preparation for a more sophisticated simulation session will also be considered. VR-AR applications developed by our team to date have demonstrated the innate flexibility of the technology. A learning object developed for an iPhone can be readily compiled to run on an Android mobile device, a desktop, through a web-browser, using goggles, using 3D projection or even in a total immersion system like a “cave”. This project will report on how these options for distribution might be developed further.

#### **Innovation:**

This project involves considerable cutting-edge innovation, not just in terms of the technology used but also the way it can support novel approaches to pedagogy where multi-dimensional learning is involved. We hope through this project to set the stage for University of Alberta health sciences faculties to be at the leading edge of VR-AR-HA development and implementation, in the classroom and online. The opportunity to develop large numbers of healthcare learning objects and applications is driven by access to highly respected clinical and academic content experts, sophisticated instructional design and a team of accomplished VR-AR-HA technical developers. This project could set the stage for Edmonton to become a leader in VR-AR-HA development in clinical education and in the delivery of enhanced clinical care.

### **Technology Considerations:**

The Rehabilitation Robotics Laboratory, working collaboratively with the Dr. Boulanger's Lab in Computing Science, Dr. Gibson's Simulation Group in the Faculty of Medicine and Dr. Welch's Technology in Education group brings to bear unique facilities that can be deployed for this project. The learning objects development equipment and software licenses are in place. Team members are trained to use them employing rigorous code development practices, flexible development tools such as Unity, version control and software documentation systems such as GitHub and reusable libraries and snippets. State of the art hardware including Oculus Rift VR goggles, Google Cardboard that enables VR to be viewed using cell phones, a 4-walled VR immersion cube are already in place. We will utilize the funding in this proposal (including the matching funds) to develop our haptics and audio feedback capabilities. Additional software licenses and maintenance of existing licenses are also required.

### **Project Management and Timeline:**

The team that forms the core of this project has an established track record for working together and has gained the confidence of key faculties in providing a pool of funding to support the development of a major UofA VR-AR-HA initiative. A framework for the management of projects for this initiative has already been put in place and addresses both the cross-faculty administration of the work and also its technical and academic leadership. Details of this arrangement are provided in the Appendix. The timeline for the project is provided in the Table below.

<b>Activity</b>	<b>Start</b>	<b>Finish</b>	<b>Comment</b>
<b>Part 1 - Capacity Development</b>	<b>July 1 2016</b>	<b>Dec. 31 2016</b>	See narrative for subtasks including recruitment of instructor/content experts' learning object projects.
<b>Part 2 – Build 5 Learning Objects</b>	<b>Jan 1 2017</b>	<b>1 August 2017</b>	Overlap and sequence to be determined by course schedules for evaluation phase
<b>Part 3 - Evaluation</b>	<b>Sept. 2017</b>	<b>End of project</b>	Depends on course schedules
<b>Part 3 – Implementation Planning</b>	<b>Jan 1 2017</b>	<b>End of project</b>	See narrative
<b>Report and Dissemination</b>	<b>Ongoing</b>	<b>May 2017 and beyond</b>	Dissemination will be ongoing after completion of project with presentations to colleagues on Campus including through Health Sciences Council and at conferences, including those of the instructor/content experts. Social media will be used throughout the project to maintain engagement.