OPERATIONALIZING EXTENDED REALITY TOOL KIT

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Introduction

There are many articles available on extended reality (XR); yet there is a lack of clarity on the definitions of extended reality. For this toolkit, extended reality (XR), virtual reality (VR), augmented reality (AR), and mixed reality (MR) have been defined to clarify the content included. In literature, the variations can become overwhelming. This may lead to confusion on not knowing where to begin when developing a simulation session/program. It is the hope that the Operationalizing Extended Reality Tool Kit will serve as a quick start guide. There are helpful tips, information and questions when considering extended reality.

In this document, click the tabs on the side to move from topic to topic without scrolling. Please note, each topic is 2-3 pages log so it is necessary to scroll within the topic area. This document is color-coded to assist with navigation.

Key Points

- Extended Reality is one type of simulation modality. The Healthcare Simulation Standards of Best Practice are foundational in employing Extended Reality based simulation.
- Always go back to your course and program objectives when determining if XR is a good fit and all the way through your process.
- Pull in supports and stakeholders early
    - Information technology and network security
    - Contracts and purchasing
    - Faculty and administration
    - Others specific to your institution
- Always refer to manufacturer recommendations.
- The unique capabilities of XR allows learners to repeat! Students will get out of it what they put into it.

XR

Overview and Types of XR

The field is rapidly evolving and there is wide variation in the use of these terms, especially the term virtual reality. The following definitions provide clarity on the rapidly changing field of XR. It is necessary for shared terminology as the field moves forward. For the purposes of this tool kit the following definitions will be used:

Extended Reality (XR): a broad term to cover all types of reality--augmented reality (AR), virtual reality (VR), and mixed reality (MR) (Abersold et al., 2021)

Augmented Reality (AR): overlays information without spatial awareness into the real world by superimposing digital objects into the physical space (Ulrich et al., 2021)

Mixed Reality (MR): mixes digital content with the real world using a headset without isolating the learner from the real world (Ulrich et al., 2021)

Hologram: mixed reality experience in which a life-sized virtual patient's image is placed over the real environment (Collins & Ditzel, 2018)

Virtual Reality (VR): the use of computer technology to create a 3-d world that is interactive based on individuals' actions or decisions, providing the sense of being present in the virtual world in which they are immersed (Abersold et al., 2021)

Degrees of Freedom (DOF): the ways an object can move in the virtual environment; 3dof: allows for rotational movement. The learner can look in all directions but is unable to get close to an object or walk. 6dof:allows the learner to experience the whole room and objects in the room.

Cave Audio Visual Experience (CAVE): an environment is projected around learner immersing them in a simulated environment (Cruz-Neira et al., 1992)

Computer Based Simulation: (Also known as Screen based simulation) an interactive simulation experience presented on a computer, may have video recordings or images and texts (Lioce et al., 2020)

Product Selection

Multiple factors must be considered when selecting an XR product for an institution. These factors will be defined below.

Metrics in Virtual Reality

Metrics in Virtual reality is critical in measuring the success of an activity, and to identify areas of improvement of the program and the learning needs of the participant. Additionally, the program goals need to align with the organization goals to demonstrate the value of the program and to demonstrate that there is a return on investment (ROI). When using metrics, one should consider metrics related to technology, product and process, the functionality of the product, engagement of the learner, how well did the learner comprehend the information and the features functionality of a product.

Special considerations: Some learners will have difficulty using an immersive headset due to cybersickness or the inability to tolerate the weight of the headset. The selection of XR should address the need for accessibility for all learners.

Cybersickness: Many users of headsets develop symptoms like motion sickness. The Simulator Sickness Questionnaire (SSQ) can be used to evaluate cybersickness by evaluating three symptoms, nausea, oculomotor and disorientation (Kennedy et al., 1993). Symptoms generally appear within 5-15 minutes (Augusto et al., 2019).

Time in headset for simulation: Cybersickness usually appears within 5-15 minutes while using immersive headsets (Augusto et al., 2019). Walking in a simulation may create a greater feeling of cybersickness while teleportation may decrease this sensation (Martirosov et al., 2022).

Alternative modalities: Cybersickness tends to be highest in Cave Automatic Virtual Environment (CAVE) or on a PC versus an immersive headset (Martirosov et al., 2022); therefore, it is recommended to have an alternative to immersive headsets for learners who are unable to tolerate the headset.

Product Selection

Metrics in Virtual Reality *(continued)*

Course and program objectives: XR can enhance the learning experience for students, but cost, fear of technology, and usability of equipment create challenges to implementation (Oigara, 2019). The program selected for the course should align with course and program objectives and outcomes.

Purchasing considerations (user vs headset vs institution): Not all users are able to tolerate a headset for a variety of reasons (history of seizures/trauma, vision or hearing difficulties, etc.) so an alternative method or assignment should be available. Learners should be screened for potential problems prior to participating in an immersive headset experience.

Headsets vary in price, weight, abilities, and number of available software programs. The type of headset purchased must meet the software requirements (tethered or standalone) and the budget of the institution.

Accessibility to the headsets and software programs also need to be considered prior to product selection. An adequate number of headsets for learners, available locations, and an alternative assignment that meets the same objectives should be available.

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Integration

This section will begin with the importance of creating a safe environment and psychological safety and progress to the theoretical framework.

It is the responsibility of the facilitator to create a learning environment that adds excitement, anticipation, and a readiness to learn under the right conditions. It is also the responsibility of the facilitator to ensure participants respect each other's diversity, views, feelings, thoughts and the different levels of skills set they bring to the simulation training. By doing so, it creates a safe environment and psychological safety.

Safe Environment

During the prebrief, the facilitator needs to provide an overview of what is virtual reality and how it works, objectives, and an overview of the case scenario. Additionally, the instructor ensures the participants are in a safe environment and free of obstacles that could cause injury.

Not every learner can tolerate virtual reality for various reasons. The facilitator should observe the participants for signs of dizziness, headaches, nausea, etc. It might be a good idea for learners to have a buddy system to support and keep each other safe. For those learners that cannot use virtual reality, the facilitator should consider a back- up plan such as computerized based learning or an online module.

Psychological Safety

Creating psychological safety during simulation education includes a judgment free environment and that it is all right to make mistakes in a simulated setting as the learners may not have all the answers, or the skills set. Any mistakes made during the simulation, the facilitator should use it as an opportunity to understand the learner's perspective and turn it into a teaching moment.

After the simulated session, a debrief should follow. Utilizing a debriefing tool will add structure to help facilitate discussions with meaning, stay focused, and gives the learners the ability to ask questions, speak freely and not be judged. If more than one facilitator is involved with the debriefing, it is critical they are trained in how to debrief and maintain psychological safety.

Integration

There are many educational theories on how a student learns. Two common theories are Pedagogy and Andragogy. Pedagogy is a method used to teach learners. Historically, Pedagogy has been associated on how children learn. What is learned and the methods used to teach depend on the teacher. Andragogy are methods associated on how adults learn, which is self-directed. (Tezcan, 2021)

Because learning is ongoing, it becomes a natural progression to shift to and from pedagogical and andragogical methods of teaching. Instructors need to consider both theories as there is a variability in how students learn. Additionally, the curriculum goals and objectives should be considered to determine the type of teaching methods to be used.

Below is a table which compares Pedagogy and Andragogy Methods of Teaching.

Andragogical Principles	Pedagogy	Andragogy
The need to know	Learners do not need to know what and why they need to learn	Learners want to know what and why they need to learn
Learner’s self-perception	Dependent personality	Self-directedness
Role of experience	Experiences play little role	The role of experiences is a rich resource for learning
Readiness to learn	Learners are ready to learn what they have to learn	Learners are ready to learn what they need to learn
Orientation towards learning	Subject-oriented	Life/task/problem-oriented
Motivation to learn	External motivations (parental pressure, teacher’s approval or rejection, grades)	Internal motivations (job satisfaction, self-confidence, self-esteem, quality of life)

Table I (Tezcan 2022)

Integration

Theoretical Frameworks on Pedagogical Concepts

Overview

There has been an increase in interest in extended reality (XR), not only in an academia setting but also in patient care settings. XR allows the learner to experience situations or events which would not necessarily be possible in a live environment.

When developing simulation education, one should consider a theoretical framework to improve the effectiveness of an activity, to meet the program goals and to enhance the learner's experience. Below is an overview of the different theoretical frameworks that have been applied for simulation education and how they can be applied to pedagogical approaches.

Behaviorism

Theory Overview: Behaviorism is based on the interactions with the environment and learner's response to the environment stimulus. Behaviorism strategies are best applied in learning that requires a recall of facts, defining concepts, or automatically performing a physical skill or task (Ross, 2021).

Practical Pedagogical Application: Behaviorism can be directly applied to simulation-based learning activities with a focus on psychomotor skills. The actions are reinforced in real time and the use of repetition becomes critical in behaviorism strategy as it reinforces stronger associations with actions and behaviors and enhances memory (Ross, 2021).

Social Cognitive Theory (SCT)

Theory Overview: "Modeling is a critical component of the SCT, as a learner displays changes in behavior, knowledge, or affect from observing one or more models. Observational learning allows individuals to acquire knowledge, rules, skills, beliefs, and even attitudes through the observation of others." (Ross, 2021). Examples of observational learning are the observation of a person; it can be symbolic in nature either through movies, podcasts or social media or it can verbal or written instruction (Ross, 2021).

Also, an important component of SCT is self-efficacy. Self-Efficacy establishes how one feels, thinks, and how they motivate themselves (Ross, 2021).

Integration

Social Cognitive Theory (SCT) *(continued)*

Practical Pedagogical Application: Social Cognitive Theory can be applied through team-based learning which includes collaboration, establishing individual and team roles. Facilitators can build learners self-efficacy by applying classroom concepts for the opportunity for learners to self-reflect, self-regulate and self-direct. Ultimately to apply the knowledge and behaviors observed in the simulation to future patient encounters. Facilitators can provide positive feedback to promote self-efficacy (Ross, 2021).

Constructivism

Theory overview: "Cognitive constructivism relies heavily on the internal cognitive processing of the individual, with meaning solely constructed by the individual" (Ross, 2021). Pre-existing knowledge amongst learners may exist thus when new knowledge is introduced, a cognitive dilemma may exist with a desire to resolve it (Ross, 2021).

Practical Pedagogical Application: The scenario should include prebriefing, the event and debriefing to provide a framework that supports a constructivism approach. The scenarios must be based on the student curriculum and current knowledge base allowing the learners to be challenged with their skill and critical thinking (Ross, 2021).

Experiential Learning

Theory Overview: Experiential learning theory was established in the 1980's by David Kolb. According to Kolb, the experiential learning cycle consists of four phases:

1. **Concrete Experience** - This is the experience of which the learner is a part of.
2. **Reflective Observation** - The learner reflects on the experience, the event's details, and their personal response to it.
3. **Abstract Conceptualization** - This phase is where the learner can think logically on the experience, focusing their observations into new thoughts or approaches for a future similar situation.
4. **Active Experimentation** - This phase allows for the testing of these new ideas in a new experience (Ross, 2021).

Integration

Experiential Learning *(continued)*

Practical Pedagogical Application: Experiential Learning is a common theory used in simulation-based learning. All four phases must be applied to be considered Experiential Learning. Learning occurs during the concrete experience phase, which provides the opportunity for the learner to identify any knowledge gaps. During the debriefing phase, it is important for the facilitator to apply the remaining of the three phases (Ross, 2021).

Below is a table which compares the Theoretical Frameworks and its Pedagogy Applications.

Theoretical Framework	Applicability	Pedagogy Application
Behaviorism	Recall of facts, defining concepts, or automatically performing a physical skill or task	A focus on psychomotor skills, actions, and repetition
Social Cognitive Theory (SCT)	Observational learning allows individuals to acquire knowledge, rules, skills, beliefs, and attitudes through the observation of others	Useful in team-based simulation events
Constructivism	Learners construct their own learning; how they understand it is based on their own personal experience	Case scenarios are based on the student curriculum and current knowledge
Experiential Learning	For learning to happen it requires the four cycles: 1. Concrete Experience 2. Reflective Observation 3. Abstract Conceptualization 4. Active Experimentation	Simulation based learning build upon each phase of the experiential learning

Table II (Ross 2021)

Facilitation

The Healthcare Simulation Standards of Best practice guide the implementation of simulation including virtual simulation. The latest updates of the Standards of Best Practice recognized specifically that virtual simulation is a method of simulation and the standards apply in the same way they apply to other methodologies (standardized patients, manikin-based simulation etc.) (Watts et al., 2021). Educators employing extended reality simulations must be versed in the Healthcare Simulation Standards of Best Practice. This guide will include some considerations specific to extended reality as well as general concepts in simulation facilitation.

The role of the Facilitator: an educator managing the entire simulation-based experience guiding learners to achieving expected outcomes

Tips for Success!

- Train in simulation pedagogy and find a mentor in simulation and extended reality.
- Familiarize yourself with all aspects of the case. Complete the simulation more than once experiencing different actions and outcomes within the case.
- Get comfortable with the technology-including both the hardware and software chosen.
- Determine intentional plan for prebrief, simulation and debrief.
- Will the prebrief, simulation and debrief be synchronous or asynchronous? Will students complete individually or in a small group?
    - For groups, are there observers or are all learners active in the simulation?
    - How will learners observe?
- Will students repeat the simulation to mastery level learning?

Facilitation

PREBRIEFING FOR EXTENDED REALITY

Prebriefing is an essential part of every simulation experience including extended reality-based simulation. It prepares learner for the simulation-based experience and sets them up for success!

SET THE STAGE!

- ☐ Select pre-learning activities to support the objectives of the experience and level of the learners
- ☐ Establish a safe learning environment
- ☐ Set ground rules and expectations
  - Confidentiality
  - Fiction Contract
  - End date and debriefing plan if the XR experience will be completed asynchronously
- ☐ Share expectations related to evaluation and analytics

Many extended reality (XR) products have analytics and evaluation tools built within the software. Clearly communicate how learners can use this information and/or how you as facilitator will use this information. Consider, can students repeat the simulation for masterly level learning? Will this information be used as formative, summative or high stakes evaluation?

EQUIPMENT SET-UP AND ORIENTATION

- ☐ Orient to the device
  - Application of headset for clear visual field
  - Volume control
  - Controllers
  - Connecting to wi-fi as needed
- ☐ Orient to the software
  - App access (log-in, installation, etc.)
  - How to interact with patient, environment supplies and resources, and/or other participants in virtual environment
  - How to start each scenario specific to the role of the learner (i.e.: is there a report provided in the simulation)
- ☐ Safe physical environment
  - Ensure a space free of obstacles and large enough to meet needs of the experience
  - Setting up guardian as applicable
- ☐ Review plan for learners experiencing cybersickness or with other concerns effecting their participation

Expect initial orientation to take more time than subsequent experiences.

Considerations for initial orientation may include a group of simulation with XR projected on a large screen, viewing a prerecording of a specific app, or utilizing orientation scenario within the app as available.

The Healthcare Simulation Standards of Best Practice Prebriefing: Preparation and Briefing should be references for further information and guidance on prebriefing

Facilitation

Planning Guide:

Logistics	
Date(s): **Discipline:** **Simulation plan:** synchronous/asynchronous, individual, small groups	**Full Name:** **Student Level:** **Prebrief/Debrief plan**: synchronous/asynchronous, faculty led, self-debrief blended

Brief Case Description:
Patient Data: **Estimated Case Time:** **Primary Diagnosis:** **Overview:** **Learning Objectives:** **Expected Learner Actions:**

Prework:

List any activities students must complete prior simulation to ensure simulation readiness (psychomotor skills, knowledge, concept review, etc.).

Facilitation

In Case Detail Overview for Faculty Reference
Assessment Findings:
Vital Signs:
Labs:
Orders/Mar:
Pathway variations:

Debrief:

Considerations for debriefing extended reality learning experiences:

- What theoretical framework will you use to guide your debrief?
- What is the timeframe for the debrief?
- Will your debrief by synchronous or asynchronous
- Will your debrief occur in a face to face or virtual environment?
- Will your debrief be facilitator-led, self-guided, or a blended approach?
- How will you ensure opportunity for feedback, debriefing, and guided reflection?

1. **Set the Scene**: "Let's spend about 45 minutes discussing this patient case recognizing that everyone here is intelligent, capable, and wants to improve."
2. **Reactions**: "Any initial reactions?"
3. **Description**: "Can one of the observers please provide a short summary of the case?
4. **Analysis**: *Objectives*: (enter sim objectives before you debrief students); *possible questions for analysis*:
    - What assessment data was most important? Why?
    - What additional information would you have liked to have for this patient?
    - What was your immediate concern? Why?

Facilitation

Possible questions for analysis *(continued)*

- What additional interventions would you include in the care of this patient?
    - What medications did you provide?
- What reassessments were completed?
- What if....?
- I noticed the patient was experiencing...Tell me about...
- Who else might you collaborate with from the interdisciplinary team?
- What education did you provide to the patient and caregiver?

5. **Application and Summary**:

- What will you take away from this simulation to incorporate into your clinical practice?
- Identify one thing you will try to do differently in your practice in the future.

Feedback before and after Extended Reality Training

There are various debriefing models used for prebrief and post brief for the purpose of providing feedback to the learner. Regardless of the model being used, it becomes important to reflect on the learners' experience.

Prior to a simulation activity, the facilitator should begin with a prebrief to discuss the activity, goals, objectives and outcomes. Immediately after the activity, the facilitator should provide a post debrief to answer questions, address students' concerns and perspectives, and to make the connection on how to apply the experience and knowledge learned in their clinical setting.

Debriefing for extended reality should occur for every simulation following the Healthcare Simulation Standards of Best Practice. However, there are multiple ways to complete a debrief and careful planning can help to meet the needs of learners with a direct focus on meeting learning objectives.

Considerations for debriefing extended reality (XR) learning experiences:

- What theoretical framework and/or evidenced based concepts will be used to guide the debrief process?
- How will the debrief be structured? Will the debrief be synchronous or asynchronous? What is the setting for the debrief?
- What is the timeframe for the debrief?
- How the debrief incorporate opportunities for essential components of feedback, debriefing, and/or guided reflection?

Adapted from the NLN Simulation Design Template 2019. https://www.nln.org/education/education/sirc/sirc/sirc-resources/sirc-tools-and-tips

Facilitation

Healthcare Simulation Standards of Best Practice: Debriefing Process	Extended Reality is one type of simulation modality. The Healthcare Simulation Standards of Best Practice: The Debriefing Process can guide simulationists in successfully guiding learners to deepen their experience in the simulation, resolving gaps, and improving and transferring their learning to future practice. Debriefing must have a focus on the learning objectives.
Theoretical Framework/ Evidence Based Concepts	Some Extended Reality Experiences have built in debriefing and feedback models using a theoretical framework while others provide the experience and allow simulationists to guide learners through the debriefing process separately from the XR case. Frameworks included but are not limited to: • Debriefing with Good Judgement • Gather, Analyze, Summarize • Promoting Excellence and Reflective Learning in Simulation • Plus-Delta
Structure	*Synchronous debriefing strategies*: • Simulationist guided face to face debrief or virtual synchronous session *Asynchronous debriefing strategies:* • Learner guided debrief through worksheet or learning management system (i.e.: discussion board) • Debrief guided by XR software *Mixed debriefing strategies:* • Components of both synchronous and asynchronous strategies are utilized
Timeframe	• XR offers a unique opportunity for simulations to be completed by learners at variable timeframes synchronously or asynchronously. This may impact the timing of a debrief. • Will the debrief occur: ◦ Immediately after the simulation, during scheduled time? ◦ Between scenario attempts? *XR offers a unique opportunity for feedback and repeating of a simulation until mastery!* ◦ By a selected due date?
Essential Components	• Know what is available within the software being utilized. Some software has direct feedback during the simulation or after the simulation. Software may also include guided reflection questions that students need to complete within or outside of the software. • Regardless of what is included within the software, debriefing should always be structured to meet the learning outcomes with opportunity for the learners to debrief, reflect, and receive feedback extending their learning into future practice.

Operations

Operating an XR lab requires management of multiple areas. In addition to scheduling and staffing, there are multiple factors to consider.

Operations/Logistics

When an organization decides to incorporate virtual reality into their curriculum there are many factors to be considered. These will be described in greater detail below:

Cleaning: Establish an Infection prevention protocol to ensure learners safety. Headsets will require cleaning between users and several cleaning methods may be possible depending on the type of headset and face shield. Foam face shields may absorb sweat and makeup whereas a silicone face shield can be wiped to remove makeup. Disposable barrier devices may be purchased to minimize contact with the headset. Antimicrobial wipes use may vary by manufacturer guidelines and may not be recommended. This will vary by product. UV light sanitizing boxes or storage carts are available for purchase. Some of these containers will also store and charge headsets and controllers. Please refer to manufacturer's guidelines for cleaning and caring for your headsets and controllers.

Charging: Consider the cost and type of the VR device, program design, content development the maximum number of participants per licensure of the product before deciding who will absorb the cost. Battery life will vary based on the type of headset, age of battery, charging habits, and type of software. Before starting a simulation activity, it is best to have fully charged headsets and controllers. It is possible to purchase extra batteries or to charge a headset while in use for some brands. Controllers may use rechargeable batteries and others do not. The average length of time of use between charges may be an important factor when purchasing headsets. The age of batteries may impact the length of operation time. Always refer to the manufacturer's guidelines for charging and battery use.

Software deployment: Headsets require software to be loaded and updated. This can be done by manually loading and updating each headset individually or by using a device management system. Updates will be required for software and the frequency of updates will vary by company.

Operations

Scheduling: Establish scheduling protocol, frequency of program, length of training, number of participants per training and content experts. Multiple factors impact scheduling of rooms and headsets for XR use. The number of users, software licenses, and available room space should be considered. Wi-fi capabilities for each room can impact the number of users for a time slot. If learners need to speak during the simulation rather than selecting text, there may be a need for smaller groups in the area completing simulations at the same time. There is not a one size fits all formula for scheduling XR experiences.

Space: The physical space needed depends on the type of virtual reality experiences you are trying to achieve. Will participants be sitting or will they need to move around. XR simulations can be conducted in person at a facility or remotely if the learner has a headset or is completing a screen-based simulation. If in person, different programs require a variety of space for each learner. For example, if while in a headset, the learner is required to walk around a room without the use of a joystick or teleportation, there needs to be sufficient obstacle free space for the learner to move without injury. If the learner only moves by the joystick or teleportation, the learner may be seated and require a smaller space.

Device Management System: A device management system allows for applications and updates to be pushed to all devices at one time. There are several advantages to using this type of system including security, time savings, and ensuring all devices are up to date. Device Management Systems can be free or a subscription-based cost. The number of devices managed may impact the cost.

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The goal of this toolkit is for the toolkit to be used by nurse educators to assist in the implementation of XR into their program. Please contact Stephanie Justice at justice.85@osu.edu with questions or feedback.