Learn More About 360 Video, VR, AR, MR & Metaverse for Education
Content

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2. Five aspects of each immersive learning experience
   - Characteristics
   - Examples
   - Strengths
   - Constraints
   - Development Process
3. Summary
   - Final Output Comparison
   - Development Cost Comparison
Introduction

“Immersion is a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences.”[1] - Witmer & Singer
Introduction [continued]

- There are different emerging technologies for creating immersive learning experiences to engage students.

- Two technological variables contributing to high level of immersion - Dengel:
  - Vividness\(^2\) (生动 / 栩栩如生, Representational richness of the environment in both breadth and depth)
  - Interactivity\(^2\) (Speed, range and mapping of interaction)

- Nowadays, sensory fidelity or tangibility could further enhance level of immersion via different devices and technologies (e.g., Real-time realistic 3D rendering engine, haptic device, smell generator or spatial sound effect, etc.)

- However, it is important to understand different types of current immersive learning experience and how to make use of them to improve our students’ learning efficiency and effectiveness.
Introduction [continued]

Five Aspects:

- (A) Characteristics
- (B) Examples
- (C) Strengths
- (D) Constraints
- (E) Development Process
FIVE ASPECTS OF IMMERSIVE LEARNING EXPERIENCE

Characteristics, strengths, constraints, examples and development process
Immersive Video (aka 360-degree video)

**Characteristics**

- Viewers can view the video in different angle with an immersive feeling
- Interactive content and embedded media (texts, images, videos) can be added
- Suitable for virtual site-visit and demonstration
  - Facilities or location visit
  - Heritage or tourist attractions tour
  - 1st / 3rd person prospective video
Immersive Video [continued]

**Example:** Virtual site visit at the inpatient pharmacy in Queen Mary Hospital
Immersive Video [continued]

**Strengths**

- Much reasonable cost
- Able to capture real environment or situations
- Easy to delivery in different device/OS
- High accessibility

**Constraints**

- Highly depend on availability of target venue or location (i.e. need more preparation time)
- Limited Interaction compares to other emerging technologies
- Unable to change position around inside the video although able to change the viewing angle
- Unable to interact with objects in video
- Linear content delivery in a fixed sequence or paths
# Immersive Video [continued]

## Development process

<table>
<thead>
<tr>
<th>Process</th>
<th>Pre-production</th>
<th>Production</th>
<th>Post-production</th>
<th>Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planning</td>
<td>Video shooting</td>
<td>Video editing</td>
<td></td>
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<tr>
<td></td>
<td>Storyboarding</td>
<td></td>
<td>Audio editing &amp; mixing</td>
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<tr>
<td></td>
<td>Location scouting</td>
<td></td>
<td>Adding interactive elements</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Software</th>
<th></th>
<th></th>
<th>(C) VR headsets (prepared by learners: web browser, phone, tablet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A) 360-degree camera</td>
<td>(B) High-end computer</td>
<td>Premiere Pro, After Effects, Marzipano, etc.</td>
<td></td>
</tr>
</tbody>
</table>
Augmented Reality App

What is augmented reality (AR)?

“Computer-generated imagery overlaid on the real environment”[3]
AR App [continued]

**Characteristics**

- Usually deployed on mobile, tablet, laptop and desktop
- Virtual elements overlay in the physical object or surroundings
- Suitable for 3D visualization, e.g.
  - Interior or fashion design
  - Exhibition/ Museum Guided Tour
  - Human anatomy
Example: KidneyAR
Example: Cranial AR Teaching
AR App [continued]

**Strengths**
- ✔ High mobility
- ✔ Easy to delivery in different device
- ✔ High accessibility
- ✔ Custom game rules (e.g. levels, missions, scores)
- ✔ Generally, only small space is needed (e.g., a surface of table)

**Constraints**
- ✗ Games are not interconnected
- ✗ Limited interaction
- ✗ Long development time
### Development process

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Planning</td>
<td>3D asset modeling</td>
<td>Integration</td>
<td>(A) High-end computer</td>
<td>(Prepared by learners: laptop, phone, tablet)</td>
</tr>
<tr>
<td>Storyboarding</td>
<td>Animation</td>
<td>Coding</td>
<td>(A) High-end computer</td>
<td></td>
</tr>
<tr>
<td>Prototyping</td>
<td>Audio recording</td>
<td>Deployment</td>
<td>(B) phone/tablet</td>
<td></td>
</tr>
<tr>
<td>3D asset and environment design</td>
<td>UI design</td>
<td></td>
<td>Unity, Unreal Engine, Visual Studio, etc.</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>Hardware</th>
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<tbody>
<tr>
<td>(A) High-end computer</td>
<td>Blender, Substance Painter, Mixamo, etc.</td>
</tr>
<tr>
<td>(B) phone/tablet</td>
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</tbody>
</table>
Virtual Reality App

What is virtual reality (VR)?

“An immersive experience in a completely computer-generated environment”[3]
VR App [continued]

Characteristics
- VR headset (aka Head Mounted Display | HMD) required
  - App base (IOS/ Android)
  - System base (Local)
  - Single player vs multi players
- Fully immersive experience by placing user in a specific virtual environment
- Suitable for procedural task training involving specific setting and physical interaction, e.g.
  - Medical procedures
  - Machine operation
  - Fire escape
VR App [continued]

Example: Animal handling game
VR App [continued]

**Strengths**
- ✔️ Highly customizable 3D graphics
- ✔️ Wide range of interactions possible
- ✔️ High Interaction
- ✔️ Custom game play (e.g. levels, missions, scores)

**Constraints**
- ✗ Low flexibility in terms of device and platform
- ✗ Very long development time
- ✗ Lots of programming tasks and testing are involved
- ✗ Need sufficient space
VR App [continued]

Development process

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<td>Hardware</td>
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<tr>
<td>Storyboarding</td>
<td>3D environment construction</td>
<td>Coding</td>
<td>(B) VR headsets</td>
<td>(A) High-end computer</td>
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Mixed Reality App

What is mixed reality (MR)?

“Computer-generated imagery merged with the real environment that the user can interact with”[3]
MR App [continued]

Characteristics

- Mixed reality headset like HoloLens required
- Interaction possible between user, virtual elements and real-world elements
- Suitable for procedural training requiring real-world environment, e.g.
  - Real machine operation with virtual instructions
  - Lab procedures
  - Graffiti
MR App [continued]

Example: Mixed reality laboratory

Mixed Reality Laboratory

Tissue culture technique
## MR App [continued]

### Strengths
- ✔ High interactivity compared to AR game
- ✔ Blended with realistic environment
- ✔ Custom game rules (e.g. levels, missions, scores)

### Constraints
- ✗ High hardware cost
- ✗ Low flexibility in terms of device and platform
- ✗ Long development time
- ✗ Lots of programming tasks and testing are involved
- ✗ Need sufficient space or specific location (sometimes)
MR App [continued]

Development process

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<td>(A) High-end computer, (B) MR headsets</td>
<td>Unity, Unreal Engine, Visual Studio, etc.</td>
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<td>(B) MR headsets</td>
<td></td>
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</table>
**XR** (Cross/ Extended Reality)

- Crisscrossing realities with vibrant, high-resolution XR passthrough.
- Using your hands - Navigate, click, drag, scroll, and type with natural hand and finger movements.
- Glasses-free.
- Battery - Hot-swappable and replaceable.
What is the metaverse?
- A concept with diverse, ambiguous definitions
- "A three-dimensional virtual world inhabited by avatars of real people" [5]
- Current state of metaverse: social platforms containing user-created virtual environments

Virtual Space
- Collection of virtual environments
- Interactions and device compatibility: depend on platform

VS

XR App
- Independent experiences
- Interactions and device compatibility: customizable
Virtual Space [continued]

Characteristics

- Focuses on Peer-to-Peer interaction
- Common built-in features
  - Avatars
  - Voice chat
  - Face camera
  - Emotes
  - Screen sharing
  - Media sharing (images, videos)
  - File sharing (Word, Excel, PPT, PDF)
Virtual Space [continued]

Characteristics
- Suitable for hosting online events with large number of participants
  - Exhibition
  - Seminar/lecture
  - Discussion
  - Social gathering

Spatial
Roblox
Rec Room
Horizon Worlds
Virtual Space [continued]

Example: Floor plan design exhibition on Spatial
## Virtual Space [continued]

### Strengths
- Highly flexible in terms of device and platform
- Fast and Easy delivery
- High accessibility
- Short development time  
  (e.g. use 3D Environment template)
- Different communication channels in the platform  
  (e.g., text chat, voice, emoji, ... etc.)
- Support large group of learners simultaneously

### Constraints
- Limited and non-customizable interaction with virtual objects or game rules
- No custom UI
Virtual Space [continued]

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<tr>
<td>Planning</td>
<td>3D asset modeling</td>
<td>Integration</td>
<td>Trial run for event-based activities</td>
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<td>3D asset and environment design</td>
<td>T&amp;L material preparation</td>
<td>Publishing</td>
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<td>3D layout construction</td>
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<tr>
<td>Hardware</td>
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<td>(A) Computer</td>
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<tr>
<td>Software</td>
<td>Blender, Substance Painter, etc.</td>
<td>Spatial, Rec Room, Unity, etc.</td>
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</table>
Summary

Immersive video

AR app

VR app

MR app

Virtual space

VR system-based

App-based (IOS/ Android)
## Summary [continued]

### Final Output Comparison

<table>
<thead>
<tr>
<th></th>
<th>Vividness</th>
<th>Interactivity</th>
<th>Delivery/Accessibility</th>
<th>Ease of use for learners</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Immersive Video</strong></td>
<td>★★</td>
<td>★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
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<tr>
<td><strong>AR App</strong></td>
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<td><strong>VR System-based</strong></td>
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<td><strong>VR App-based</strong></td>
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</table>
## Summary [continued]

### Development Cost Comparison

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Hardware cost</th>
<th>Software cost</th>
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</thead>
<tbody>
<tr>
<td><strong>Immersive Video</strong></td>
<td>Medium</td>
<td>Medium</td>
<td>Vary*</td>
</tr>
<tr>
<td><strong>AR App</strong></td>
<td>High</td>
<td>Medium</td>
<td>Vary*</td>
</tr>
<tr>
<td><strong>VR System base</strong></td>
<td>High</td>
<td>High or Vary*</td>
<td>Vary*</td>
</tr>
<tr>
<td><strong>VR App base</strong></td>
<td>High</td>
<td>Low</td>
<td>Vary*</td>
</tr>
<tr>
<td><strong>MR App</strong></td>
<td>Very High</td>
<td>Very High</td>
<td>Vary*</td>
</tr>
<tr>
<td><strong>Virtual Space</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Vary*</td>
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</table>

* The software & hardware cost may depend on different factors like specific required features and the timeline of the project. However, there are numerous free tools on the market.
Currently, there is no perfect solution for immersive learning. Each type of experience has its characteristics, strengths, and constraints. The type of learning experience should be picked based on the learning objectives, so we can:

- Enhance the efficiency and effectiveness of learning and teaching
- Meet the learning style or needs of students
- Improve user-accessibility and time flexibility to engage learners

Feel free to tell us your ideas. We are here to help!
Let's
CUHK 2025 | Education Strategic Plan
“Meeting the Challenges of Tomorrow”

THANK YOU
References


