The Learning Affordances of Virtual Reality

Professor Tassos Anastassios Mikropoulos
University of Ioannina, Greece

17th ECEL, 1-2 November 2018, University of West Attica
Why Virtual Reality?

“Over the last 50 years, VR has evolved from science fiction and crude graphics to a thriving research community with many commercial applications.

Clearly, no one questions the potential and ultimate development of VE, including applications not yet conceived”.

(Hale & Stanney, 2015)
Why VR now? From enlightenment to productivity
Defining Virtual Reality

“Virtual Reality (VR)” is a field of study that aims to create a system that provides a synthetic experience for its user(s). The experience is dubbed “synthetic,” “illusory,” or “virtual” because the sensory stimulation to the user is simulated and generated by the “system.”

(Kim, 2005)
Defining Virtual Reality

We describe VR as a mosaic of technologies that support the creation of synthetic, highly interactive and multisensory three dimensional (3D) **spatial** environments and worlds, which the participant experiences as the real ones.

(Mikropoulos & Natsis, 2011)
VR: a taxonomy [based on vision]

- **QuickTime VR telepresence**
- **SEMI-IMMERSIVE**
  - [3D glasses, dome, CAVE, CUBE, FLEX, PLEX]
- **AUGMENTED MIXED REALITY**
- **DESKTOP**
  - Window to the world
- **MUVEs**
  - Virtual worlds
  - Distributed VR
- **FULL IMMERSIVE HMD**

17th ECEL, 1-2 November 2018, University of West Attica
What can we do with VR (or any other technology) in the educational process?
What are the ways VR (or any other technology) could support teaching and learning?
Affordances

“An affordance signifies the perception of the environment of an agent in terms of the actions that can be afforded by it”.

(Gibson, 1979)

“Affordance is the property of objects to convey “important information about how people could interact with them””.

(Norman, 2013)

“Affordances “exist independent of being perceived” and “are specified by information and may be perceived”.

(Michaels, 2003)
Affordances of digital technologies

Unique technological features / attributes / characteristics

- They record and store data and information
- They process data and information fast

Unique characteristics for learning / Learning affordances

Representations
- Multimodal
- Dynamic
- Interactive

Communication
- Synchronous
- Asynchronous

17th ECEL, 1-2 November 2018, University of West Attica
Affordances, learning affordances and activities

Technological characteristics have certain potentials, they afford certain actions.

Technologies, such as virtual reality, involve certain affordances.

The unique [technological] affordances lead to unique learning affordances.

[Unique] learning affordances lead to certain learning activities.
Why affordances are important?

“The success with which technology is utilised for learning and teaching depends on the educator's ability to appreciate the requirements within the learning context and subsequently select and utilise technologies in a way that meets those needs”.

(Bower & Sturman, 2015)

“Many of the technologies available for educative purposes have not been designed specifically for learning and teaching, and thus the educator needs to analyse the affordances and constraints of such technologies to creatively repurpose them for the educational context”.

(Mishra & Koehler, 2006)
An example: the affordances of mobile technologies

Gamification
Recording
Simulation
Engagement
Educational quality
Feedback
Portability
social interactivity
Efficiency
personalization
active participation

CAROL, ORDER AN EXTRA BATTERY FOR MY MOBILE TECHNOLOGY PLATFORM.

DO YOU WANT THE ONE THAT STRAPS TO YOUR BACK OR THE ONE WITH ITS OWN WHEELBARROW?

I THINK I JUST LOST A LUNG.
An example: the affordances of mobile technologies

1. Ubiquity and pervasiveness
2. Geolocation
3. Sense
4. Finger control.
The affordances of Virtual Reality

Technologies that support the creation of synthetic, highly interactive and multisensory three dimensional (3D) spatial environments and worlds, which the participant experiences as the real ones.
The affordances of Virtual Reality

- Multisensory intuitive and real time interaction
- Immersion of the participant in the VE (immersive VE)
- Presence
- Autonomy
- Natural semantics for the representation of objects and facts
- Participants’ representation through avatars
- First-person user point of view
- First-order experiences
- Size in space and time
- Transduction and reification.
The learning affordances of Virtual Reality

- free navigation
- multichannel communication
- collaboration and cooperation
- content presentation and/or delivery
- creation
- modeling and simulation
The learning affordances of Virtual Reality and enacted learning activities

(Mantziou, Papachristos, Mikropoulos, 2018)
Free navigation

The learning affordance of free navigation comes mainly from the affordances of:

- 3D spatial representations
- first-person user point of view and
- first-order experiences.

Free navigation refers to actions like meaningful virtual fieldtrips and tours, as well as game play such as scavenger hunts.
A Virtual Environment for Training in Culinary Education: Immersion and User Experience.

The aim was to evaluate user experience with two different levels of immersion: low (desktop) and high (head-mounted display—HMD). Results showed no significant differences in terms of spatial presence, usability, and workload between the two groups. Nevertheless, participants using the HMD needed more time to complete a recipe and experienced much higher simulator sickness.

(Papachristos, Ntalakas, Vrellis, Mikropoulos, 2018)
Factors that Influence Presence in Educational Virtual Environments.
The aim was to investigate the sense of presence of 12-year-old pupils within an EVE representing an ancient Greek house through a sense of embodiment and the ability to handle task performance, while using various peripheral devices.

(Mikropoulos & Strouboulis, 2004)
Factors that Influence Presence in Educational Virtual Environments.

Environmental richness and the high level of interactivity resulted in a high degree of presence.

Presence was significantly correlated with pupils’ degree of association with their virtual bodies.
Multichannel communication comes mainly from the affordances of

- multisensory intuitive and real time interaction and
- participants’ representation by avatars.

Communication relates to actions such as discussions, chatting, lectures and conferences.
Primary school students’ attitude towards gesture based interaction.
A construction activity involving the assembly of simple models of primitive solid objects.
32 primary school students had to create a house model by combining a cube and a pyramid, and a tree model by combining a cylinder and a cone.

(Vreillis, Moutsiouli, & Mikropoulos, 2014)
Do children in the spectrum of autism interact with real-time emotionally expressive human controlled avatars?

The child with high functioning autism showed an interest in interacting with the teacher in all modalities, although a better acceptance was observed in the modalities involving the ICT tools. The low functioning child did not interact at all with ICT modalities. He preferred only face to face interaction.

(Mantziou, Vrellis, & Mikropoulos, 2015)
Collaboration and cooperation rises from all the affordances and is enhanced by the presence a participant might sense.

Collaboration and cooperation relate to actions like meetings, role-play, and social interaction.
Collaboration and cooperation

Learning outcome, presence and satisfaction from a science activity in SL.

A constructivist EVE:

• Focuses on knowledge construction not reproduction
• Provides multiple representations of reality
• Presents authentic tasks
• Provides real world, case based learning environments
• Supports collaborative construction of knowledge.
Collaboration and cooperation

The aim was to compare a simple laboratory PBL activity in both the real and virtual worlds, in terms of learning outcome, satisfaction, and presence.

The sample consisted of 150 undergraduate university students. The results show that the MUVE (SL) provided similar learning outcome and satisfaction to the real-world condition. Presence was positively correlated to satisfaction but not to the learning outcome.

(Vrellis, Mikropoulos, & Avouris, 2016)
Content presentation and delivery comes from all affordances and especially from tools like SLOODLE and shared interactive whiteboards.

Content presentation and delivery relate to actions like presentations and exhibitions.
Technological Factors, User Characteristics and Didactic Strategies in EVEs.

The results show that the viewing condition (mono/stereo) does not affect attention allocation, suspension of disbelief, and spatial presence.

(Natsis, Vrellis, Papachristos, & Mikropoulos, 2012)
Content presentation and/or delivery

Technological Factors, User Characteristics and Didactic Strategies in EVEs.

Learning outcomes are better in the monoscopic viewing condition. Didactic strategy has an impact on suspension of disbelief and learning outcomes.
Stereoscopic perception of women in real and virtual environments: A study towards educational neuroscience.

This work presented comparative results of adult women on the effects of stereoscopic perception in three different static environments; a real, a 2D and a stereoscopic 3D, all with the same content.

Electric brain activity of 36 female students was analyzed at θ, α, β and γ frequency bands.
The real and 3D environments caused similar cognitive processes, while the 2D caused an increase of anxiety.

\( \beta \) and \( \gamma \) activity showed that participants perceived the third dimension of the stereoscopic environment as in the real one, something that did not happen in the 2D environment.

Our findings indicate that stereoscopic 3D VEs seem to approximate the real ones as far as it regards the cognitive processes they cause.

(Zacharis, Mikropoulos, & Priovolou, 2013)
Creation comes mainly from

- multisensory intuitive, real time interaction and
- natural semantics.

The learning affordance of creation involves building and scripting and refers to actions like the design of a virtual learning environment, building a virtual building, writing the code for the behavior of a virtual object, and course content design.
Creation

An educational laser laboratory.

An empirical study in higher education (Physics students).
Aim: to study the quality of interaction and the sense of presence.
Mouse: easier than the data glove in both navigation and interaction.

(Mikropoulos & Strouboulis, 2002)
Modeling and simulation

Modeling and simulation rises from almost all of affordances and especially from size, transduction and reification and encompasses visualization.

Actions referring to modeling include data presentation and interpretation, while simulation and visualization follow modeling and relate to the reproduction of a real system, the imitation of a natural phenomenon, a virtual experiment.

Game creation and the design of environments are among the activities that refer to modeling and simulation.
Modeling and simulation

Being inside the Quantum Atom.

Aim: to help students with limited background in physics and mathematics to deeply understand Quantum Mechanics principles and create the correct mental images of atomic models.

(Kontogeorgiou, Bellou, & Mikropoulos, 2008)
Modeling and simulation

Being inside the Quantum Atom.

Results: Positive learning outcomes, the sense of presence seems to play an important role.
The learning affordances of Virtual Reality

- free navigation
- multichannel communication
- collaboration and cooperation
- content presentation and/or delivery
- creation
- modeling and simulation
A review-based classification

Learning activities as enactments of learning affordances in MUVEs.

We have investigated the learning activities conducted in SL, as reported in 205 empirical studies, by associating them with the learning affordances they enact.

(Mantziou, Papachristos, Mikropoulos, 2018)
<table>
<thead>
<tr>
<th>Selective coding</th>
<th>Axial coding</th>
<th>Open coding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content creation</strong></td>
<td>Building</td>
<td>Build object</td>
</tr>
<tr>
<td></td>
<td>Scripting</td>
<td>Build building</td>
</tr>
<tr>
<td></td>
<td>Multimedia design</td>
<td>Create exhibition content</td>
</tr>
<tr>
<td></td>
<td>Environment design</td>
<td>Design landscape</td>
</tr>
<tr>
<td><strong>Content exploration &amp; interaction with content</strong></td>
<td>Interaction with content</td>
<td>Manipulate object</td>
</tr>
<tr>
<td></td>
<td>Interaction with simulated environments</td>
<td>Interact with bot</td>
</tr>
<tr>
<td></td>
<td>Exploration of concepts through visualization/modeling</td>
<td>Explore visualization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explore model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Watch &amp; present slideshow/presentations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Watch videotaped lectures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explore instructional material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explore lab/simulation</td>
</tr>
<tr>
<td><strong>Place exploration</strong></td>
<td>Tour</td>
<td>Place exploration</td>
</tr>
<tr>
<td></td>
<td>Field trip in plant</td>
<td>Place in plant</td>
</tr>
<tr>
<td></td>
<td>Field trip in touristic / historical place</td>
<td>Place in touristic / historical place</td>
</tr>
<tr>
<td><strong>Social interaction</strong></td>
<td>Tutorial session delivery &amp; attendance</td>
<td>Attend lecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deliver lecture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attend conference</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Participate in tutorial meetings</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Communicate for task completion</td>
<td>Conduct interview</td>
</tr>
<tr>
<td></td>
<td>Discuss in discussion/meeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SLOODLE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communicate with mentors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Communicate in multidisciplinary context</td>
<td></td>
</tr>
<tr>
<td><strong>Interviewing</strong></td>
<td>Collaborate / Cooperate in task completion</td>
<td>Collaborate in task completion</td>
</tr>
<tr>
<td></td>
<td>Collaborate in games</td>
<td>Collaborate in games</td>
</tr>
<tr>
<td></td>
<td>Practice collaborative techniques</td>
<td>Practice collaborative techniques</td>
</tr>
<tr>
<td><strong>Role playing</strong></td>
<td>Play role</td>
<td>Play role</td>
</tr>
<tr>
<td></td>
<td>Play role in a simulated environment</td>
<td>Play role in a simulated environment</td>
</tr>
<tr>
<td></td>
<td>Play role as intern</td>
<td>Play role as intern</td>
</tr>
<tr>
<td><strong>Gaming</strong></td>
<td>Game play</td>
<td>Play with specific game content</td>
</tr>
<tr>
<td></td>
<td>Game creation</td>
<td>Play in game environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Play role inside game</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Play scavenger hunt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Play quiz</td>
</tr>
<tr>
<td><strong>Participation in representations of real life events &amp; situations</strong></td>
<td>Virtual internship</td>
<td>Participate in working scenario</td>
</tr>
<tr>
<td></td>
<td>Communication/collaboration with company</td>
<td>Work in virtual company</td>
</tr>
<tr>
<td></td>
<td>Virtual participation in social events &amp; actions</td>
<td>Communicate with real vendor/purchaser</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaborate with company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Participate in social event</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Participate in scenario of accident</td>
</tr>
</tbody>
</table>
A review-based classification

<table>
<thead>
<tr>
<th>Selective categories of learning activities</th>
<th>Learning Affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content creation</td>
<td>Creation, Modeling and Simulation</td>
</tr>
<tr>
<td>Content exploration/interaction with content</td>
<td>Free navigation, Content presentation and delivery</td>
</tr>
<tr>
<td>Social interaction</td>
<td>Multichannel communication, Collaboration and Cooperation</td>
</tr>
<tr>
<td>Gaming</td>
<td>Content presentation and delivery, Multichannel communication, Collaboration and Cooperation</td>
</tr>
<tr>
<td>Participation in representations of real life events/situation</td>
<td>Creation, Modeling and Simulation, Free navigation, Content presentation and delivery, Multichannel communication, Collaboration and Cooperation</td>
</tr>
</tbody>
</table>
Why do we need affordances and educational affordances?

Figure 1. The affordance analysis e-learning design methodology: matching tasks with technologies to construct e-learning designs.

(Bower, 2008)
Why do we need affordances and educational affordances?

- Technological Knowledge
- Pedagogical Knowledge
- Content Knowledge

17th ECEL, 1-2 November 2018, University of West Attica
Educational research, instructional design

VR, affordances, and learning affordances

Learning theory
Cognitive approaches
[Social] constructivism

Instructional model
Inquiry
Collaboration

Instructional techniques
Digital technologies
Experiment

Knowledge

Learning objectives [e.g., Revised Bloom taxonomy]
Remember | Understand | Apply | Analyze | Evaluate | Create

17th ECEL, 1-2 November 2018, University of West Attica
References


References


Μικρόπουλος, Τ. Α. & Στρουμπούλης, Β. (2000), Διαμορφωτική αξιολόγηση εικονικού εκπαιδευτικού εργαστηρίου laser, στο Β. Κόμης (επ.) Πρακτικά 2ου Πανελλήνιου Συνεδρίου, Οι Τεχνολογίες της Πληροφορίας και της Επικοινωνίας στην Εκπαίδευση, 382-386, Πάτρα