

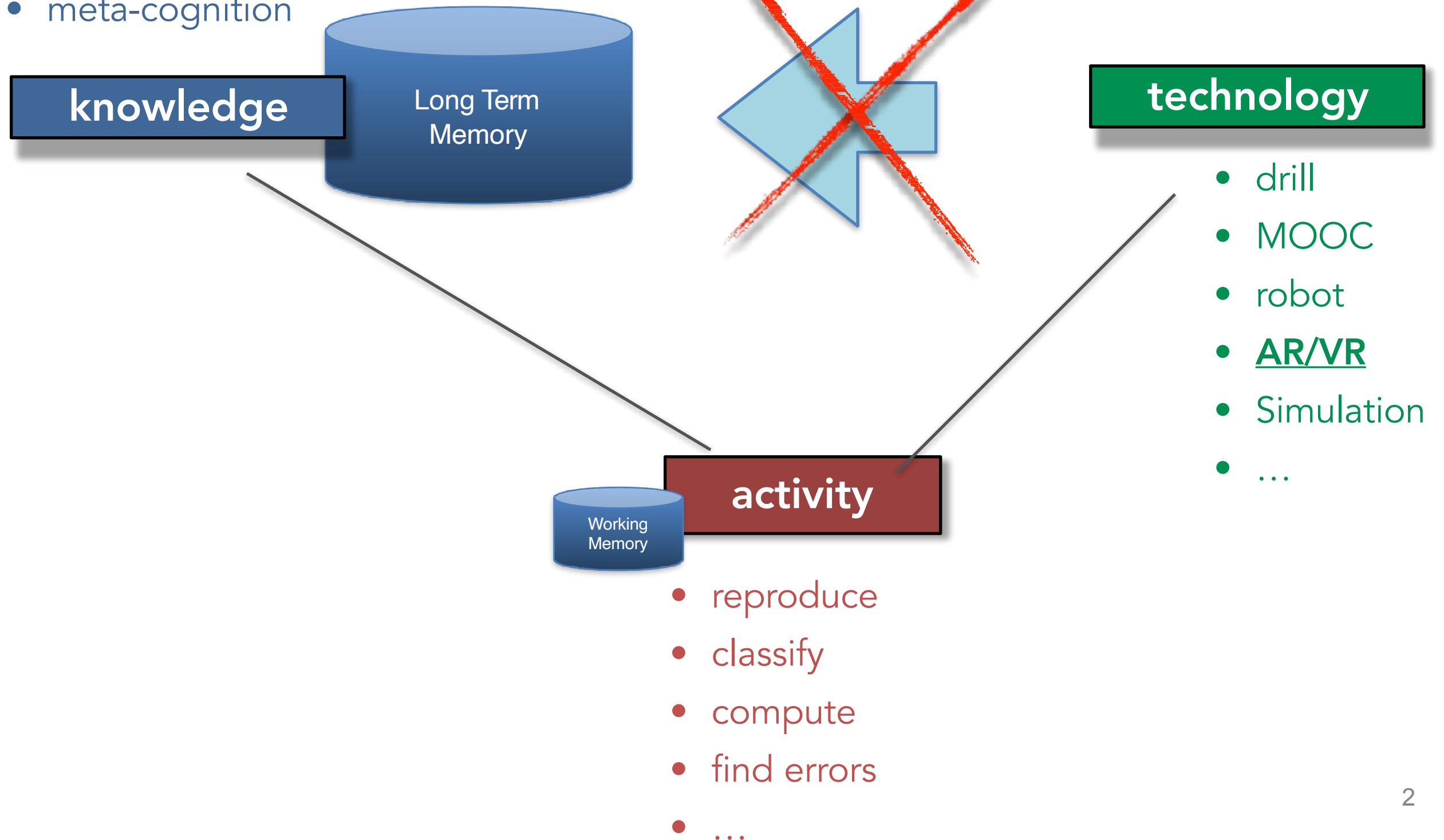
CS-411 : Digital Education

# Chapter 9: Extended Reality for Learning

**EPFL**

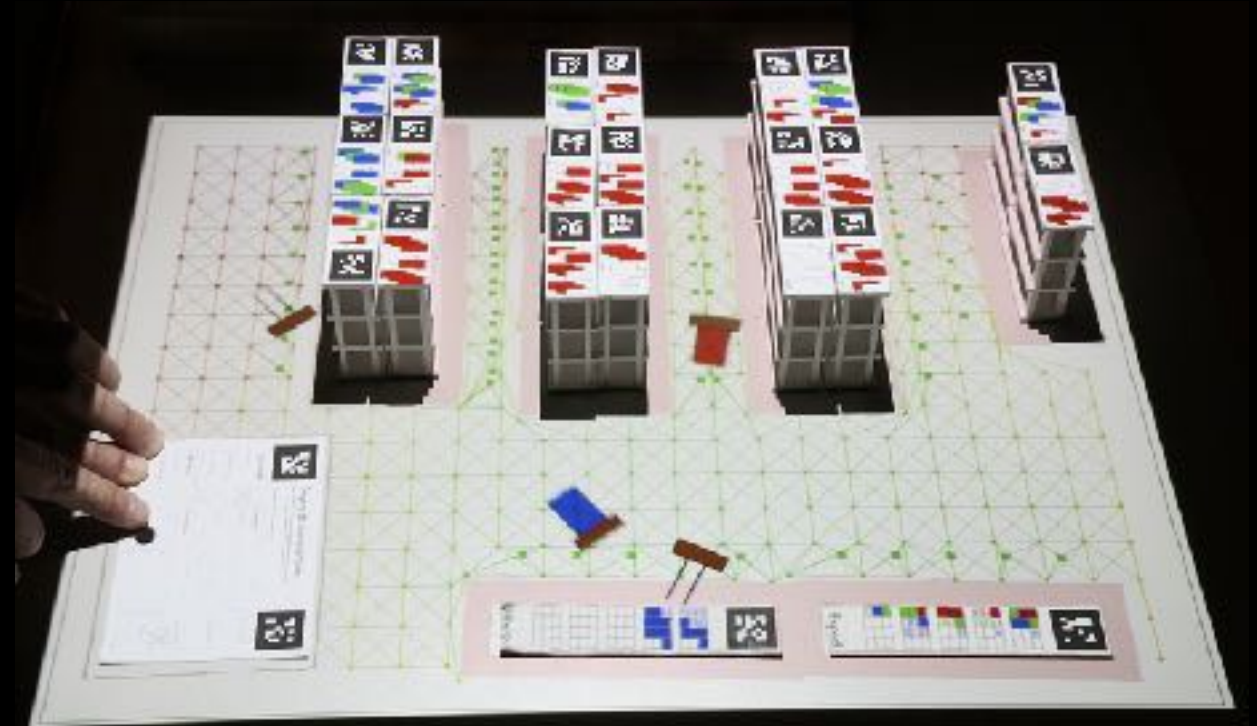
Prof. Pierre Dillenbourg

- fact, concept, rule, theory, ...
- declarative, procedural, heuristic
- meta-cognition



# « Extended Reality (XR) »

1. Augmented reality (AR): digital images **superimposed**  
on real images or real objects
2. Virtual reality (VR)
3. Mixed reality (MR)
4. Metaverse



**A**dding digital elements to  
**R**eal images / objects





Alignment ?





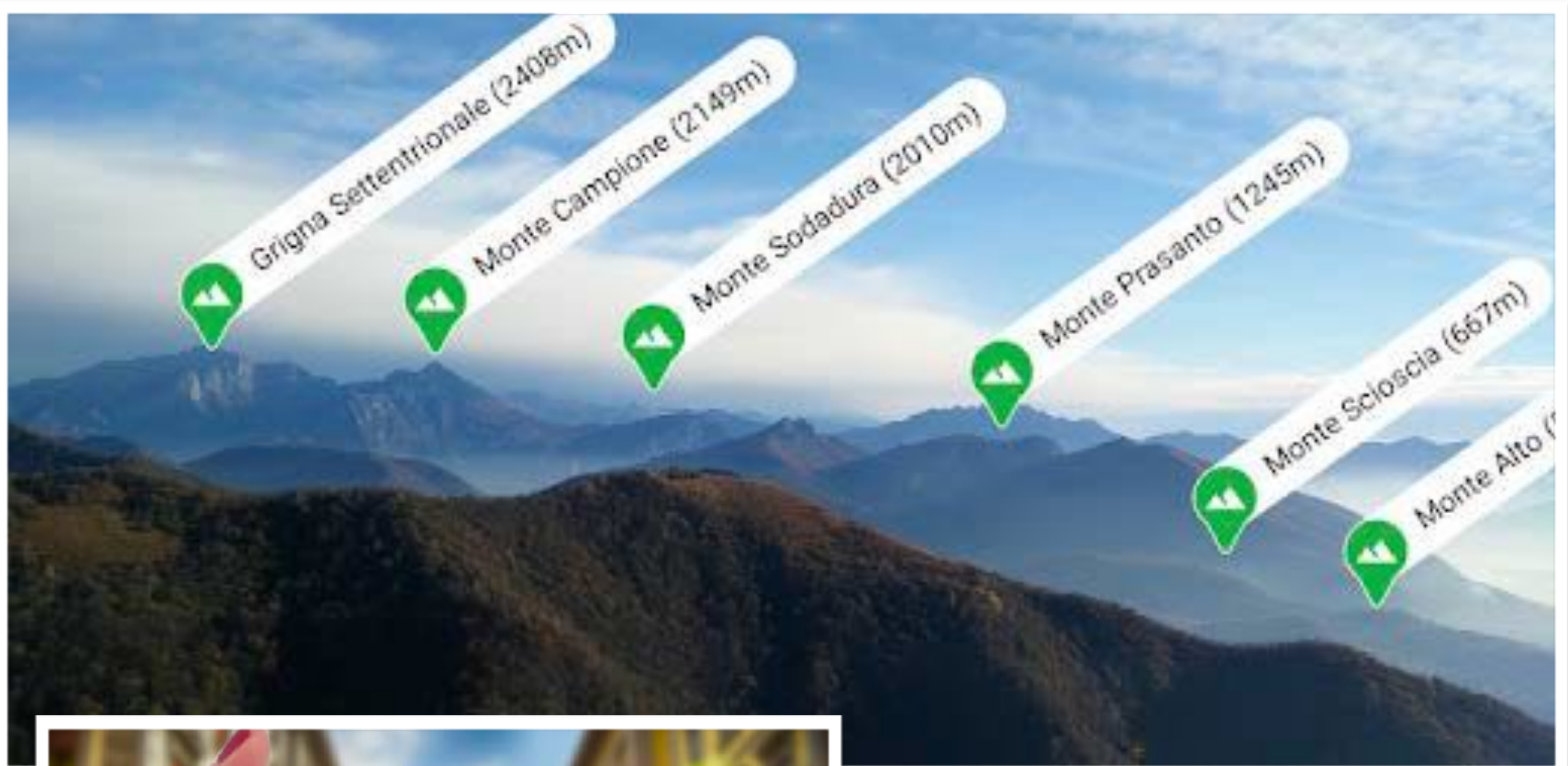
Caméra + Modélisation des trajectoires

Alignment ?

Caméra + GPS + GIS







Peak Lens



# Alignment

# « Extended Reality (XR)»

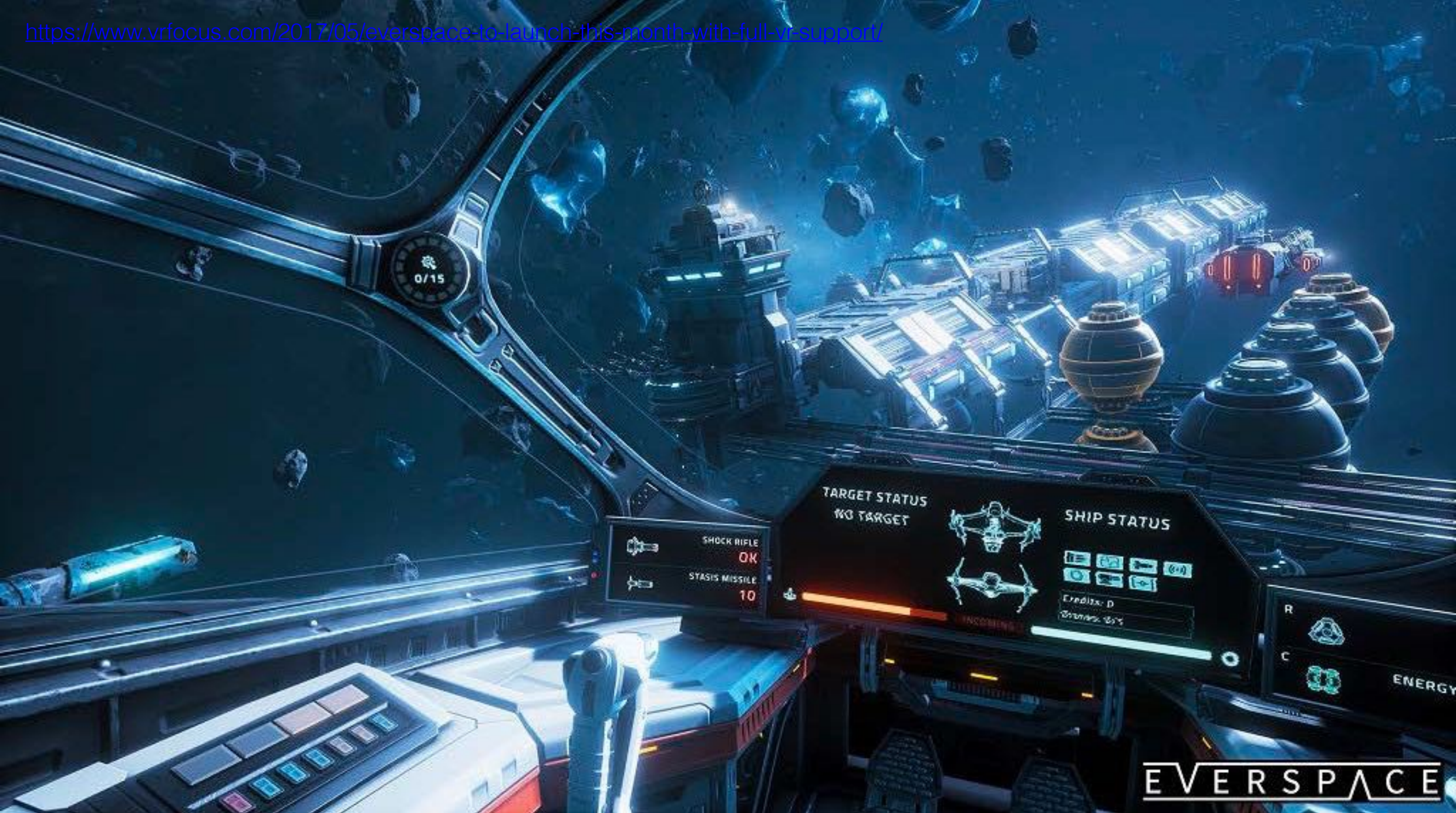
1. Augmented reality (AR): digital images **superimposed** on real images or real objects
2. Virtual reality (VR): a 3D computer-**generated** world that **reproduces** a real or fictional world





**VR** = computer-**generated** (real) 3D environments





**VR** = computer-generated (fictitious) 3D environments

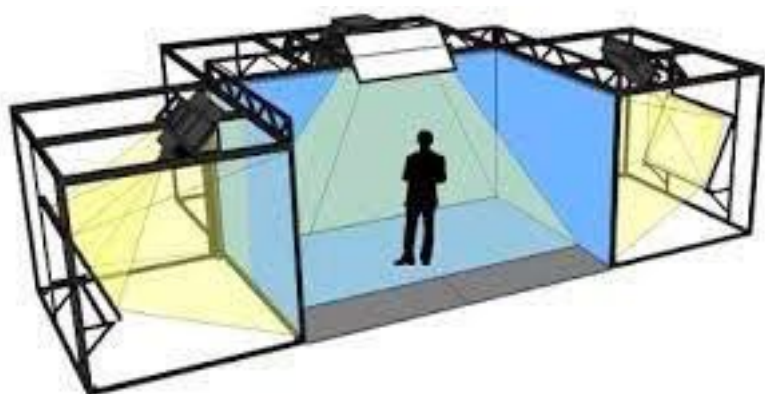


# CAVE



[https://sky-real.com/wp-content/uploads/2020/09/image\\_articlecave8-e1600960536904.jpg](https://sky-real.com/wp-content/uploads/2020/09/image_articlecave8-e1600960536904.jpg)













# « Extended Reality (XR) »

1. Augmented reality (AR): digital images **superimposed** on real images or real objects
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<https://virsabi.com/mixed-reality/>

**Mixed reality (MR)** : merging of **real** and **virtual worlds**, physical and digital objects co-exist and interact in real time





Remove generator cable J1 using channel locks



Maintenance: J. henderson and S. Feiner, Columbia University  
<https://www.youtube.com/watch?v=mn-zvymISvk>



Player one



Player one in-headset view



Player two

VR + haptic Feedback

# « Extended Reality (XR)»

1. Augmented reality (AR): digital images **superimposed** on real images or real objects
2. Virtual reality (VR): a 3D computer-generated world that **reproduces** a real or fictional world
3. Mixed reality (MR): virtual interface **acting** on real objects
4. Metaverse: network of 3D **immersive** virtual worlds, focused on **social** interaction, made of **persistent** spaces, navigated through VR/AR



# Immersive ?



A virtual reality environment is IMMERSIVE if it generates **stimuli** for the user similar to those she would perceive in a real environment similar to the one being simulated (Sight, Touch, Hearing, ...)

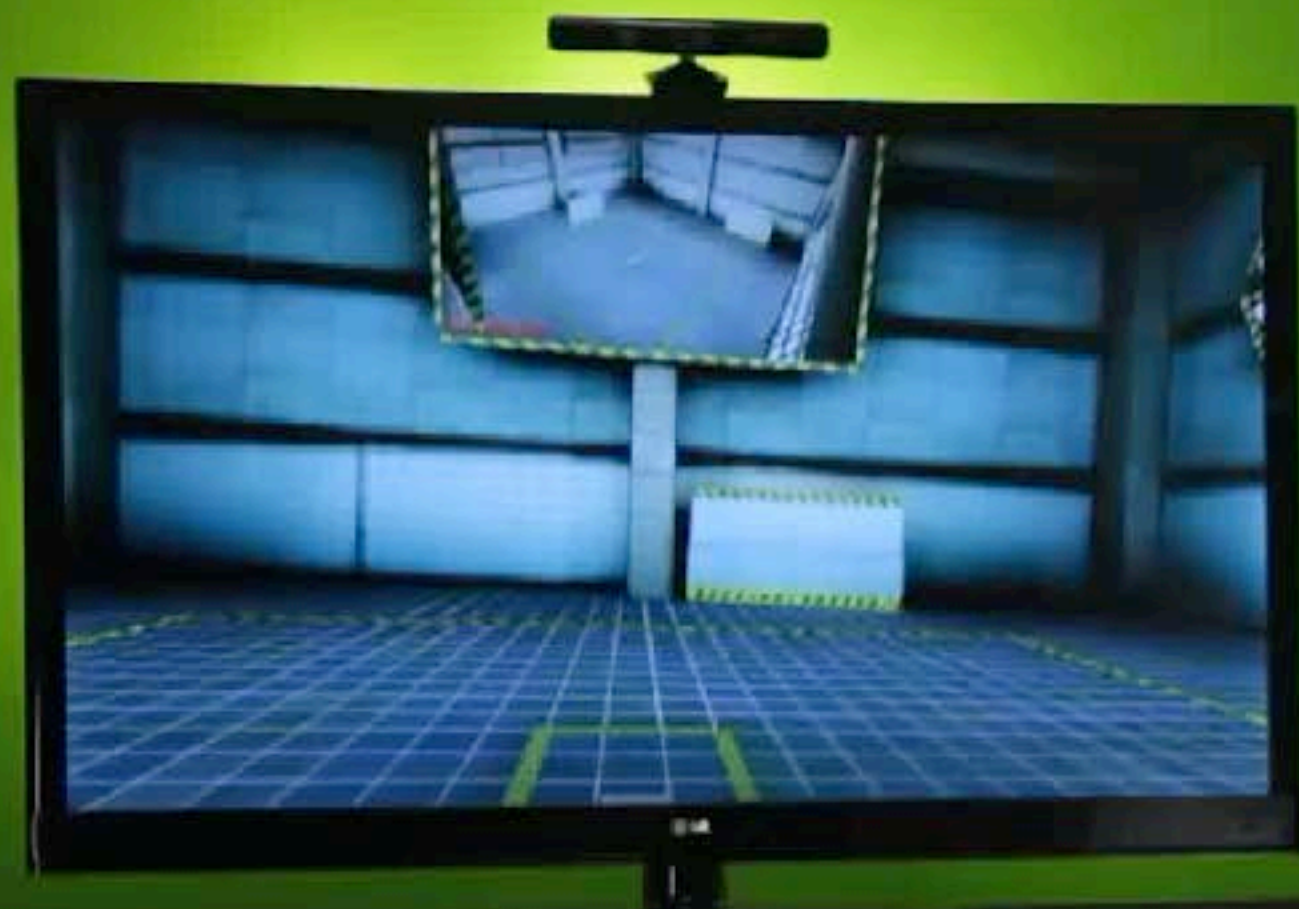




## The Pitt Experiment

Stanford VR Lab

A virtual reality environment is IMMERSIVE if it generates for the human user **stimuli** similar to those he would perceive in a real environment



WORLD  VIZ





# Immersive ?

<https://www.youtube.com/watch?v=9cma-1DNIZU>





Dario Floreano, EPFL

Birdly



# Immersion ?

<https://www.youtube.com/watch?v=VTNmLt7QX8E>



Heider & Simmel, 1944 ?





[FlyJacket.epfl.ch](http://FlyJacket.epfl.ch)

# Immersion ?

<https://www.youtube.com/watch?v=VTNmLt7QX8E>



Who is the bad one ?



Each step becomes more difficult. My feet are bleeding and the blood is mixing with the dust. This rocky maze is never-ending... What a pain! My sweat fogs up my glasses, already cracked by my falls. In what state of mind are they waiting for me? Have they forgotten the hatred they had towards me?



virtual ← **perceptual distance ?** → real



The similarity hypothesis: transfer

$$\text{transfer}(V \rightarrow R) = f(\text{distance}(V, R))$$



**what's**

**in it for**

**learning ?**

for





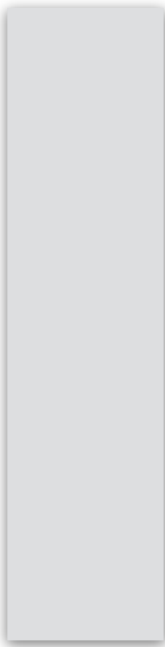
learning


gains

(XR)



> learning gains (R)



learning gains (**X**R)  ~~zero~~ learning gains (R)

too small, too large  
too slow, too fast  
too dangerous  
too expensive  
too rare

....



# Too Dangerous ?



<https://vrworldtech.com/2020/07/27/fire-fighting-vr-training-can-save-lives/>

## Training Firemen

Did you ever  
put your life in the hands of a professional  
of trained with immersive VR ?





8-11 millions



Trop dangereux !  
Trop cher !  
Trop rare !  
Trop petit !  
Trop lent !







**Real, recorded real, simulated?**

Prof. Jean-Philippe Ansermet



learning gains (~~X~~R) = learning gains (R)

virtual experiment

real experiment



Perceptual fidelity —> Immersion —> Engagement? —> Learning

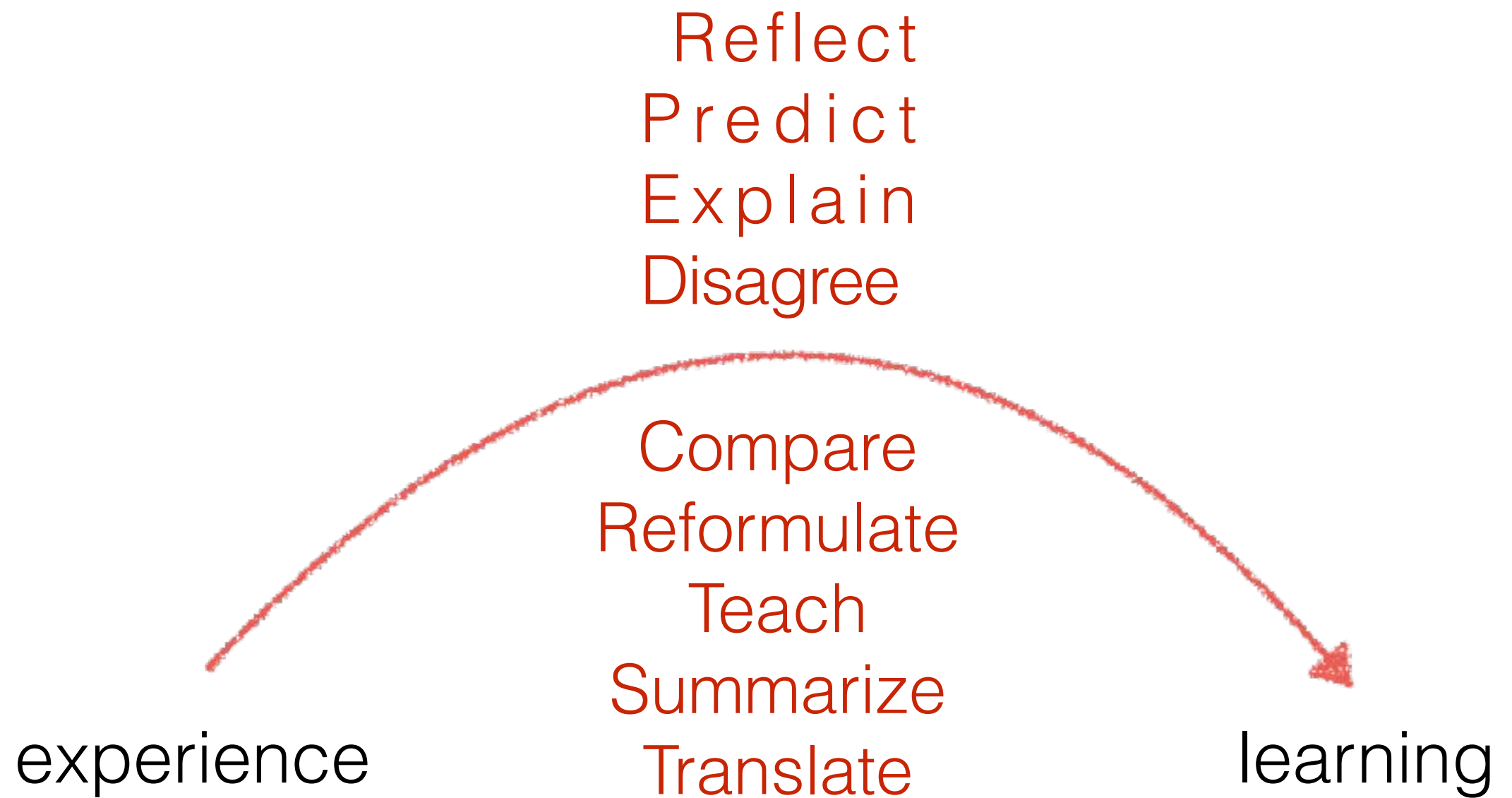


AR warehouse

real warehouse



~~Preceptual fidelity~~ —> Immersion —> Engagement? —> Learning  
Cognitive fidelity

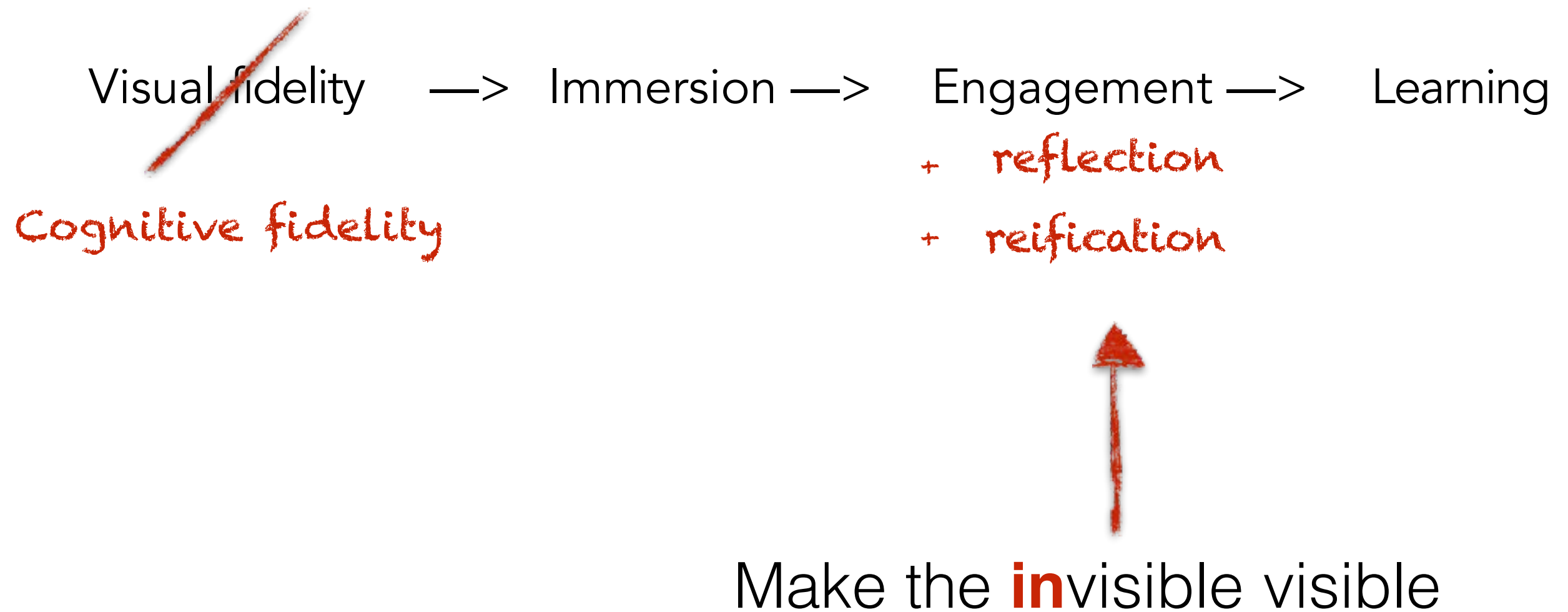


Engagement

—>

Learning









In the real world, we do not see forces !





In the real world,  
we do **not** move shelves with 2 fingers !



# Make the impossible possible



~~Visual fidelity~~ —> Immersion —> Engagement —> Learning

+ reflection

+ reification

Cognitive fidelity

*Make the invisible visible*



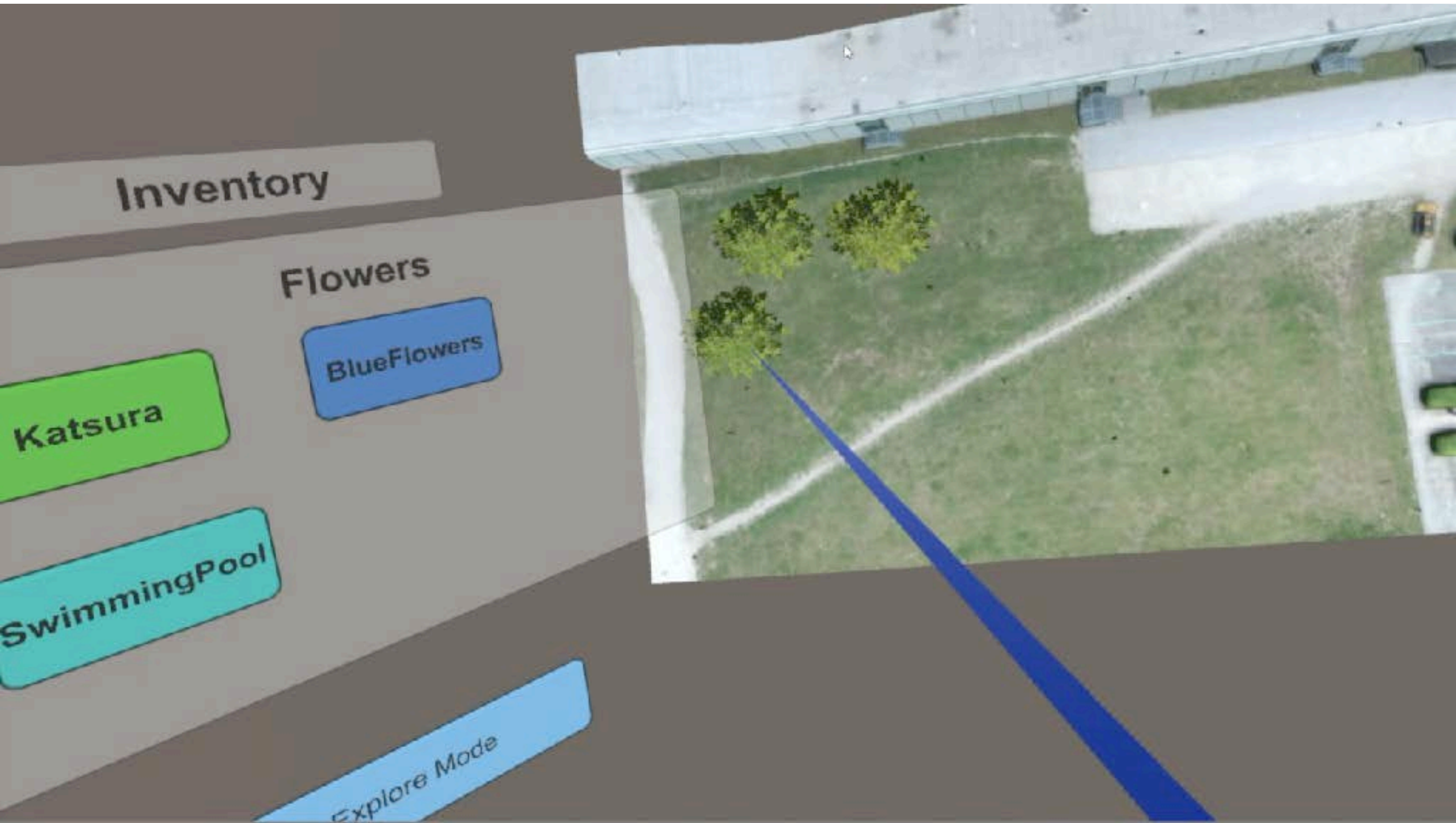




**EPFL**

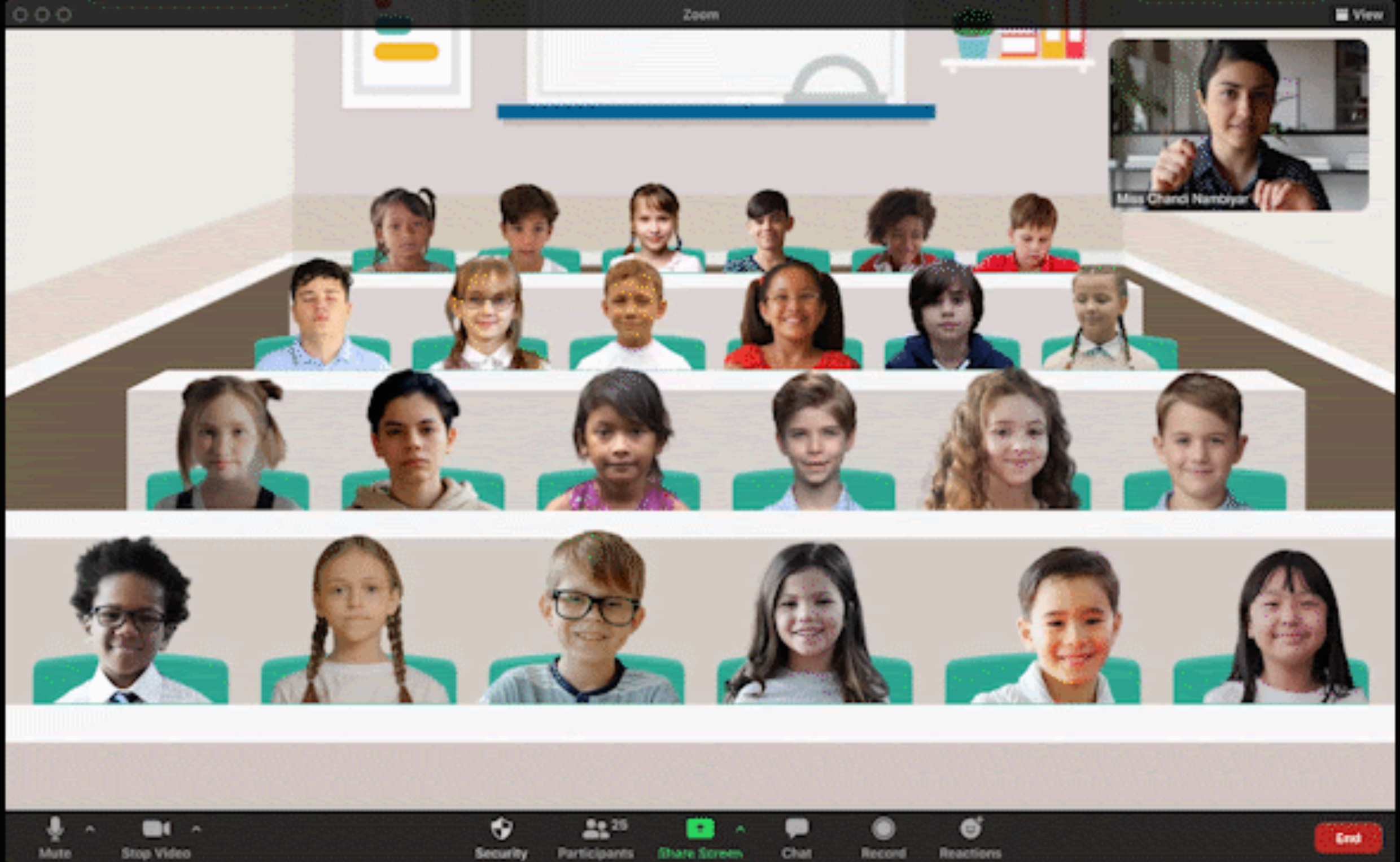


In the real world,  
we do **not** change seasons !



Two tracks for AR/VR in education :

- **Imitate**: create **perceptively**-realistic immersive training environments for behavioral training
- **Escape** from reality: create non-realistic features that enable **cognitive** process for knowledge acquisition



3. Expand the classroom



# serious 'wow'

1. There is **NO** INTRINSIC learning effects of XR: it is not because it's 'wow' that users learn, its about their cognitive activity
2. It is not R **OR** XR but R **AND** XR: when both are possible, they are complementary

# Green rooftop of the Rolex

EPFL

Time: Now  
Season: Summer

Saison:

Printemps

Été

Automne

Hiver

Été

Croissance  
des arbres:

<<

>>

maintenant

