

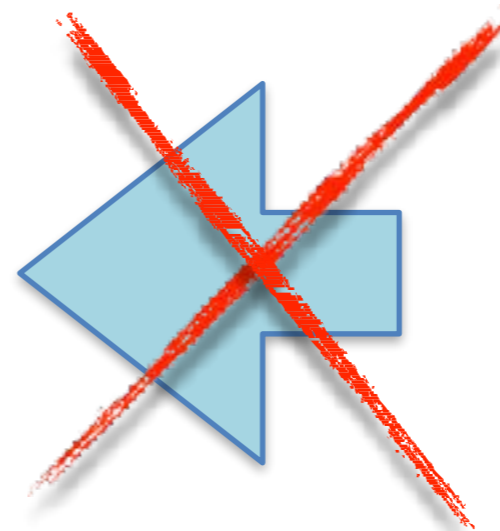
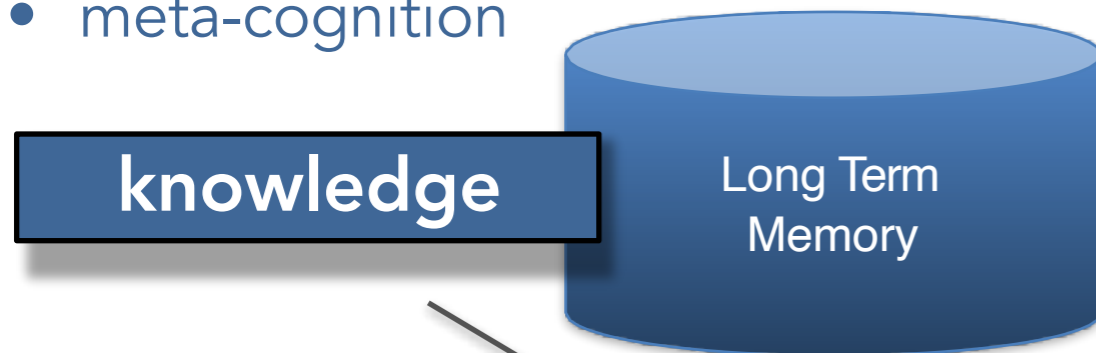
CS-411 : Digital Education

Chapter 10:
Extended Reality for Learning

EPFL

Prof. Pierre Dillenbourg

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



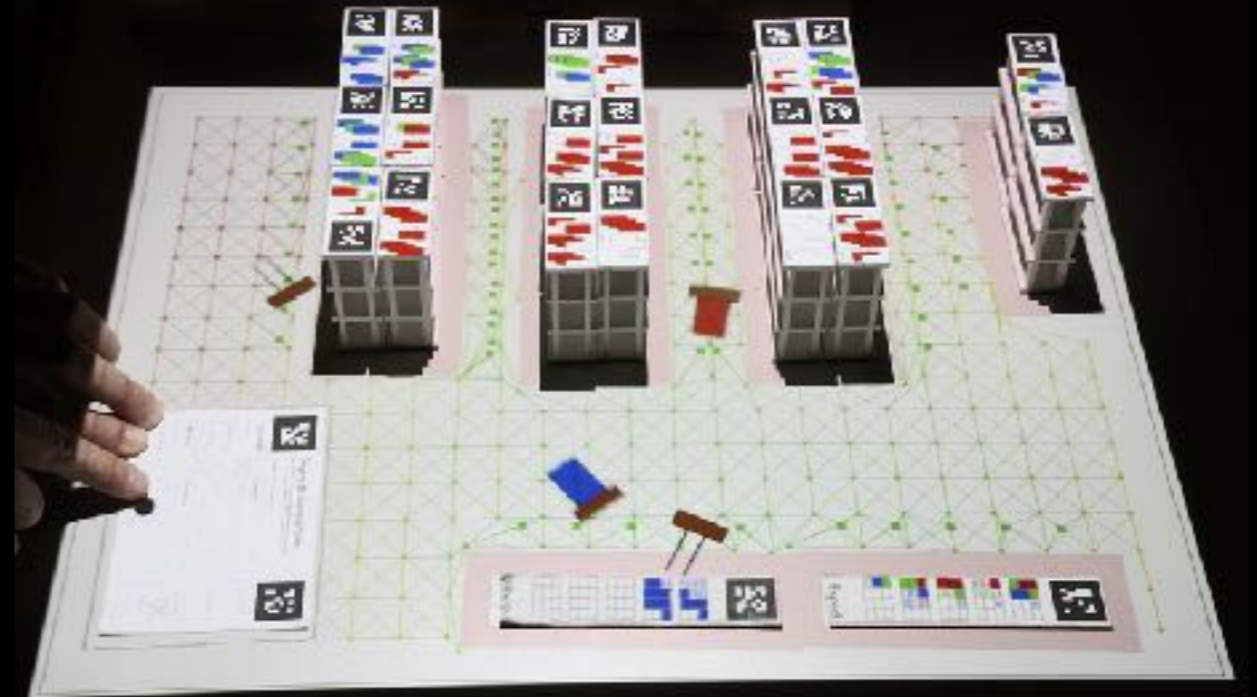
- drill
- MOOC
- robot
- AR/VR
- Simulation
- ...



- reproduce
- classify
- compute
- find errors
- ...

« 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



Adding digital elements to Real images / objects



Alignment ?



Caméra + Modélisation des trajectoires

Alignment ?

Caméra + GPS + GIS





Peak Lens



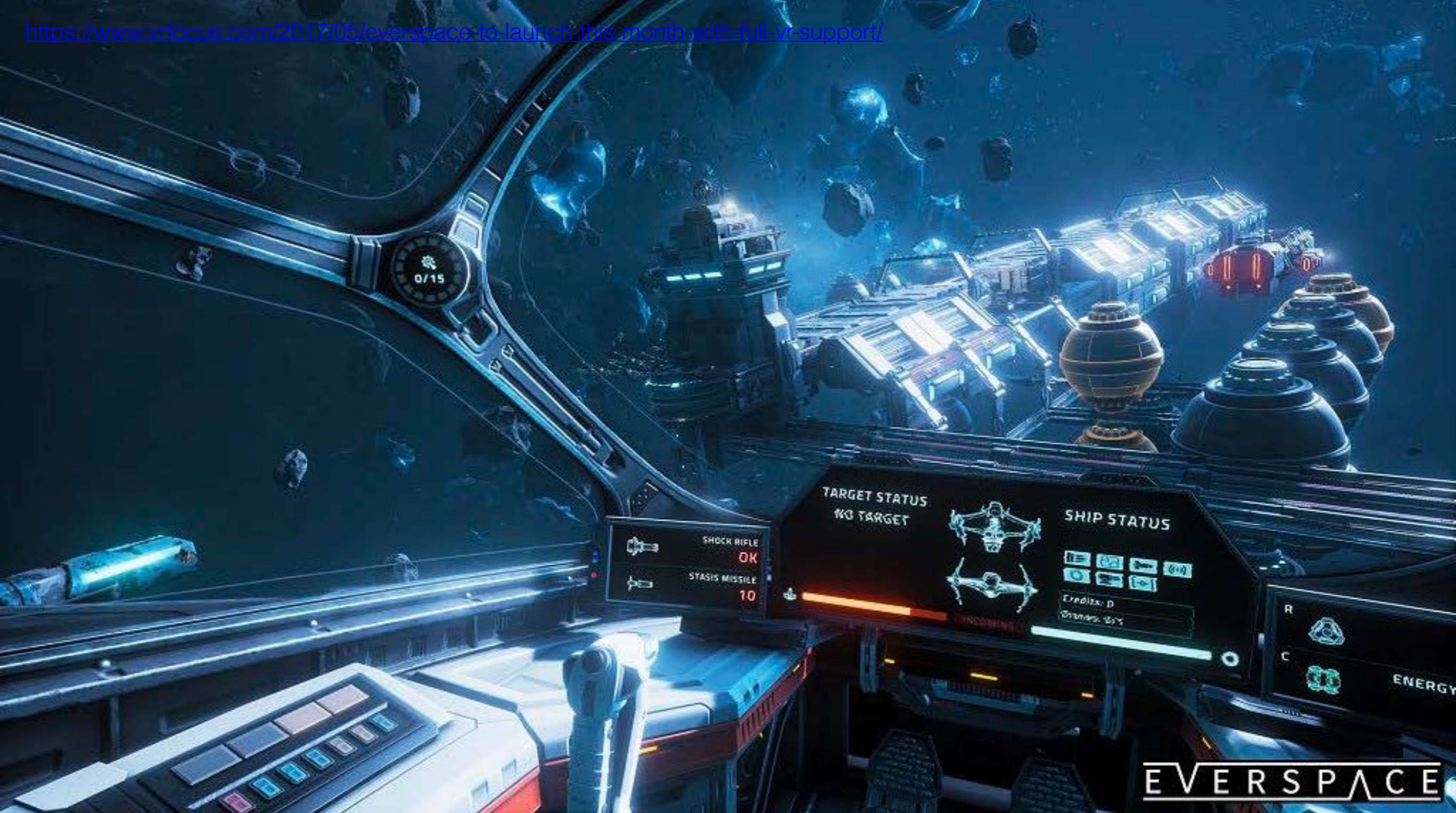
Alignment

« 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

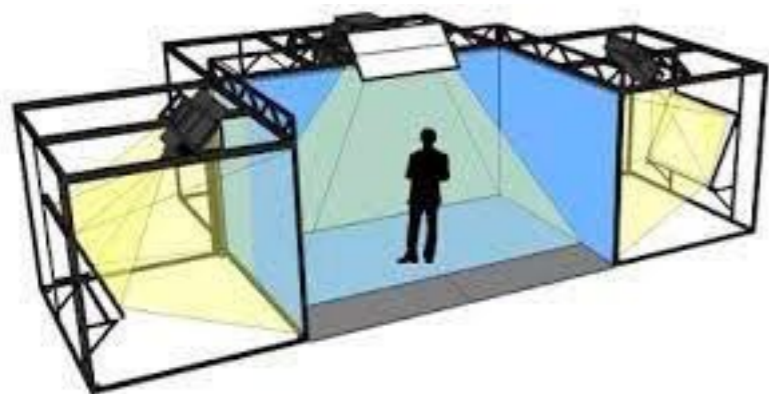


VR = computer-generated (fictitious) 3D environments

CAVE



https://sky-real.com/wp-content/uploads/2020/09/image_articlecave8-e1600960536904.jpg







« Extended Reality (XR) »

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4. Metaverse



<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
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4. Metaverse: network of 3D **immersive** virtual worlds, focused on **social** interaction, made of **persistent** spaces, navigated through VR/AR

Immersive ?



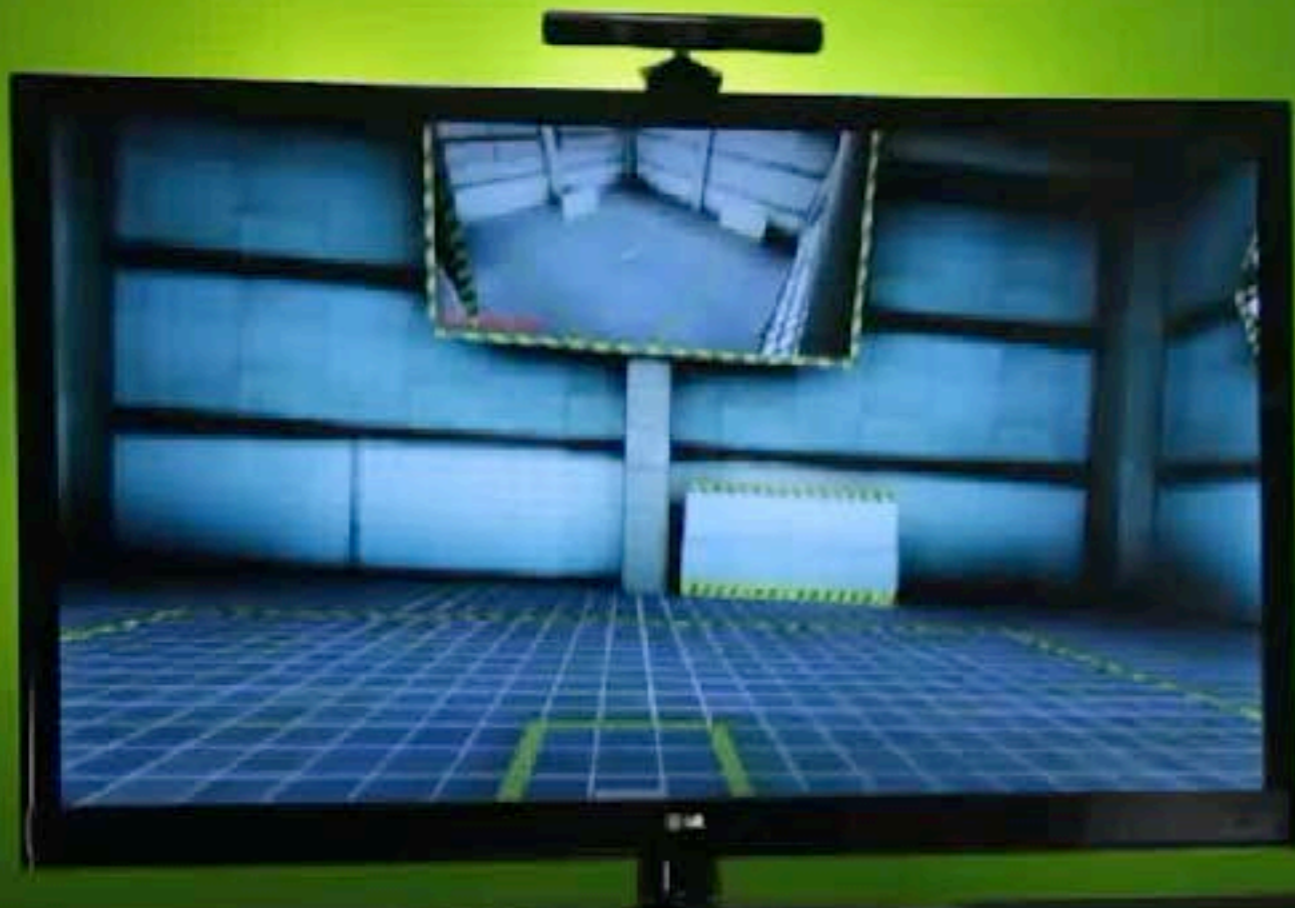
A virtual reality environment is IMMERSIVE if it generates **stimuli** for the user similar to those she would perceive in a real environment similar to the one being simulated (Sight, Touch, Hearing, ...)



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>

sandbox
TEN





Dario Floreano, EPFL

Birdly





FlyJacket.epfl.ch

Immersion ?

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



Who is the bad one ?

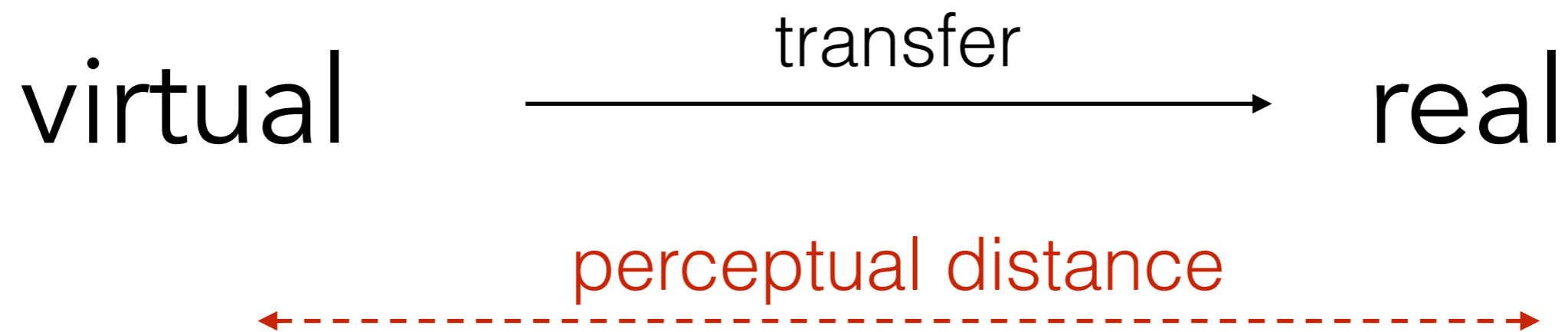
Each step becomes more difficult. My feet are bleeding and the blood is mixing with the dust. This rocky maze is never-ending... What a pain! My sweat fogs up my glasses, already cracked by my falls. In what state of mind are they waiting for me? Have they forgotten the hatred they had towards me?



virtual ← **perceptual distance ?** → real

The similarity hypothesis: transfer

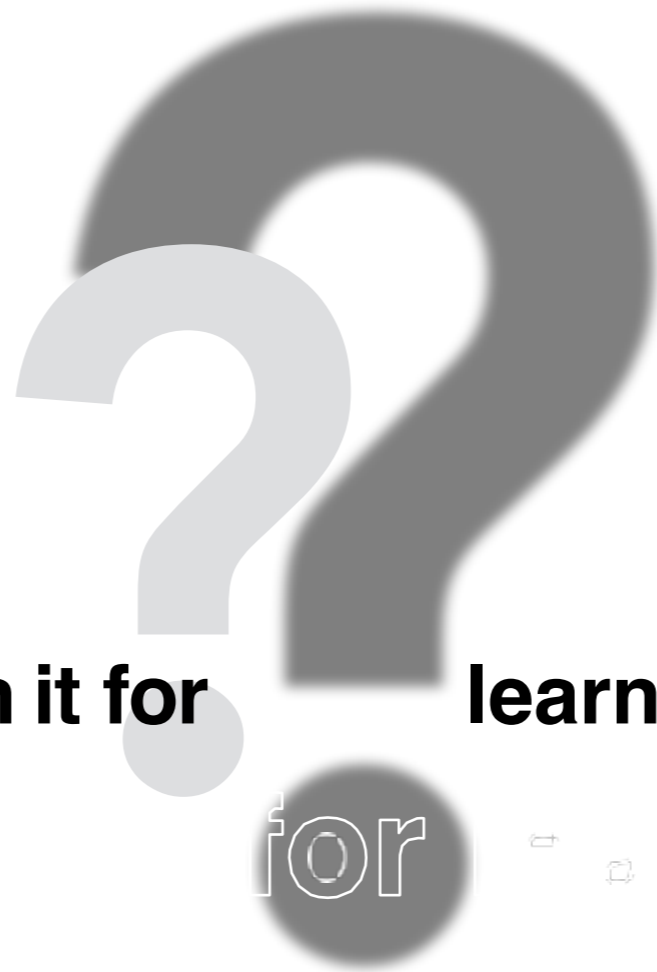
$$\text{transfer}(V \rightarrow R) = f(\text{distance}(V, R))$$



what's

in it for

learning ?



learning

gains

(XR)



learning gains (R)



learning gains (**XR**) $>$ learning gains (R)

~~zero~~

**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

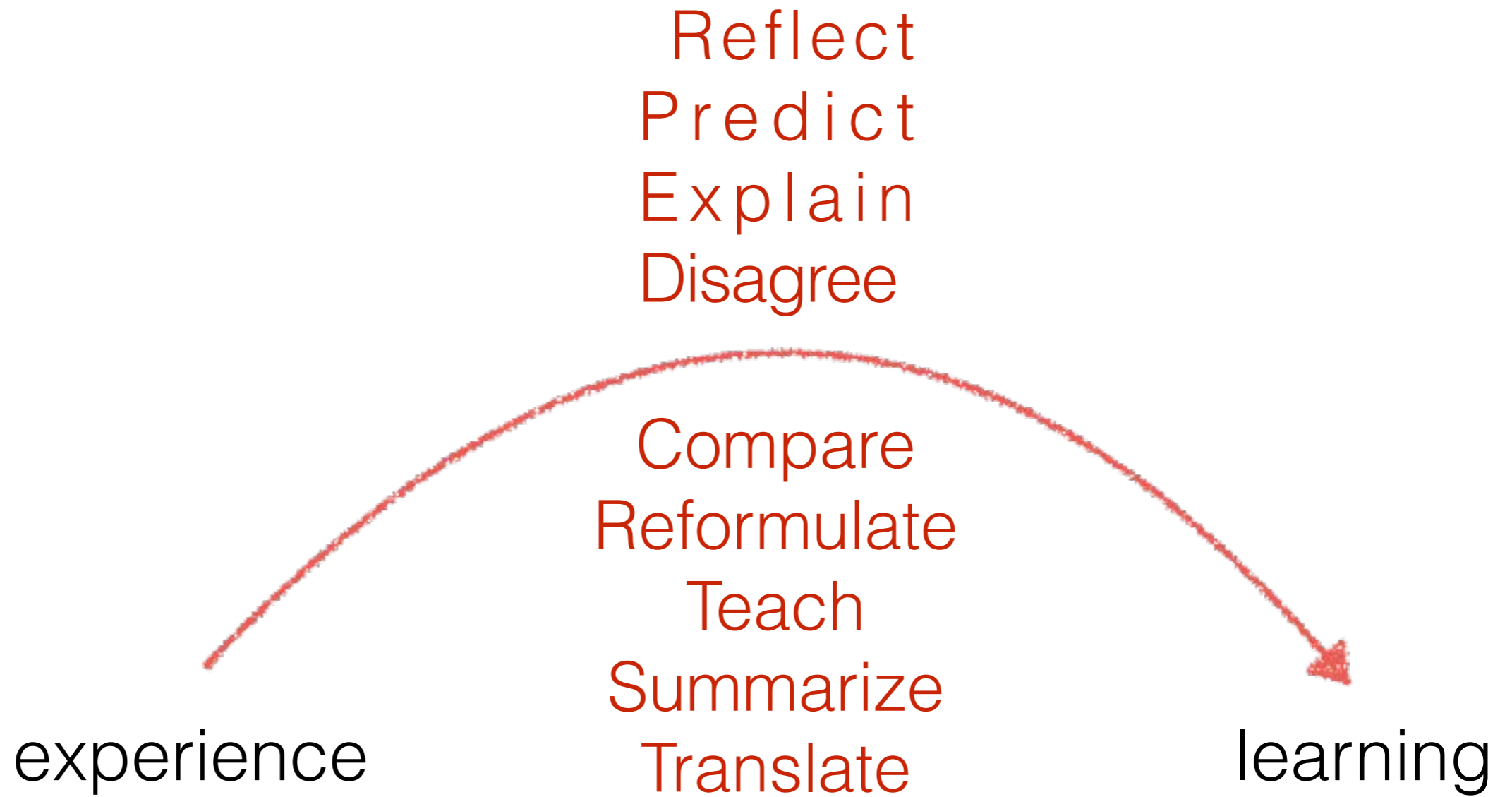


learning gains (**XR**) **>** learning gains (R)

AR warehouse

real warehouse

~~Preceptual fidelity~~ → Immersion → Engagement? → Learning
Cognitive fidelity



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

Cognitive fidelity

+ reflection

+ reification



Make the **in**visible visible



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



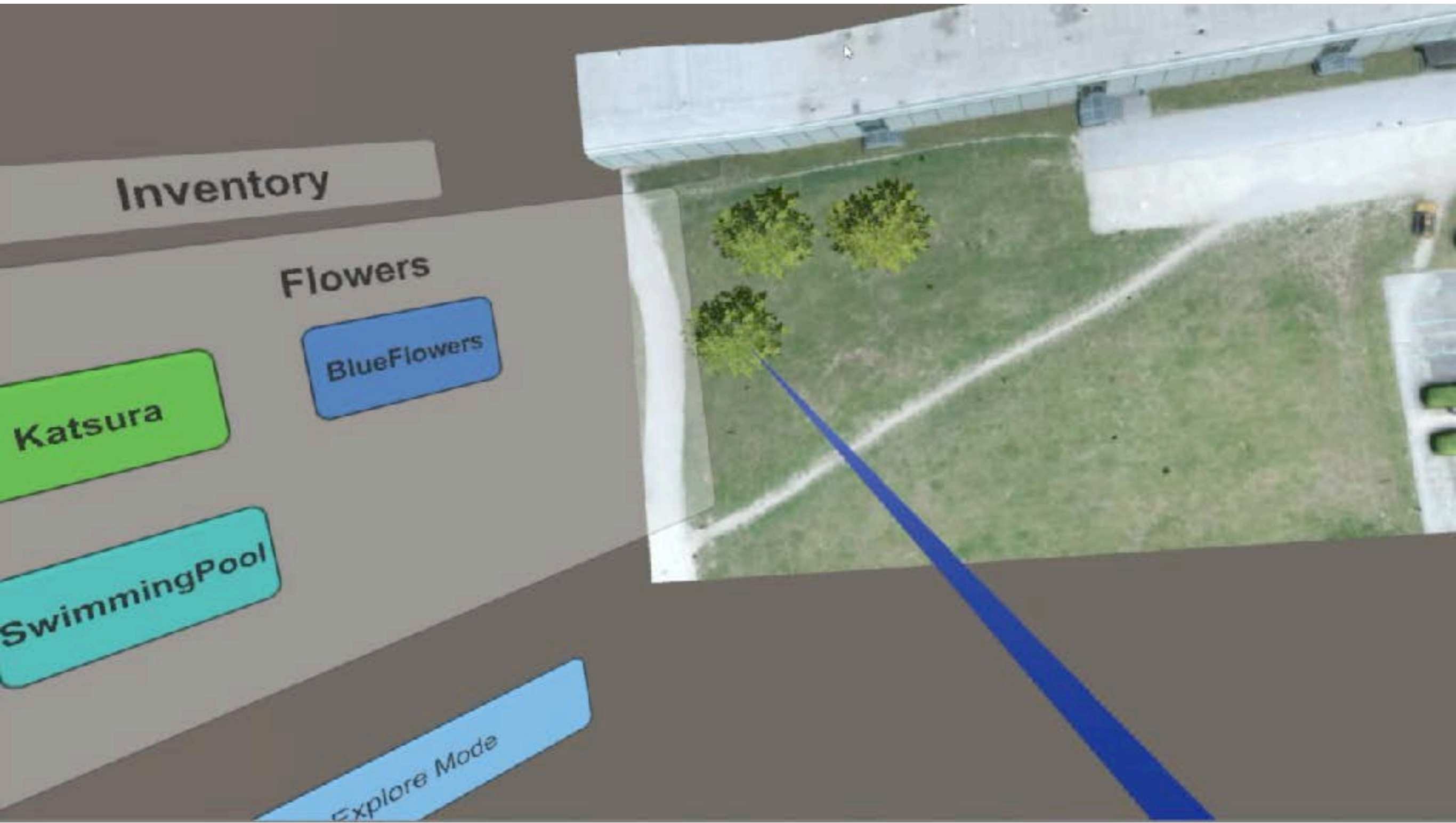
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AVANT | APRÈS



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

