

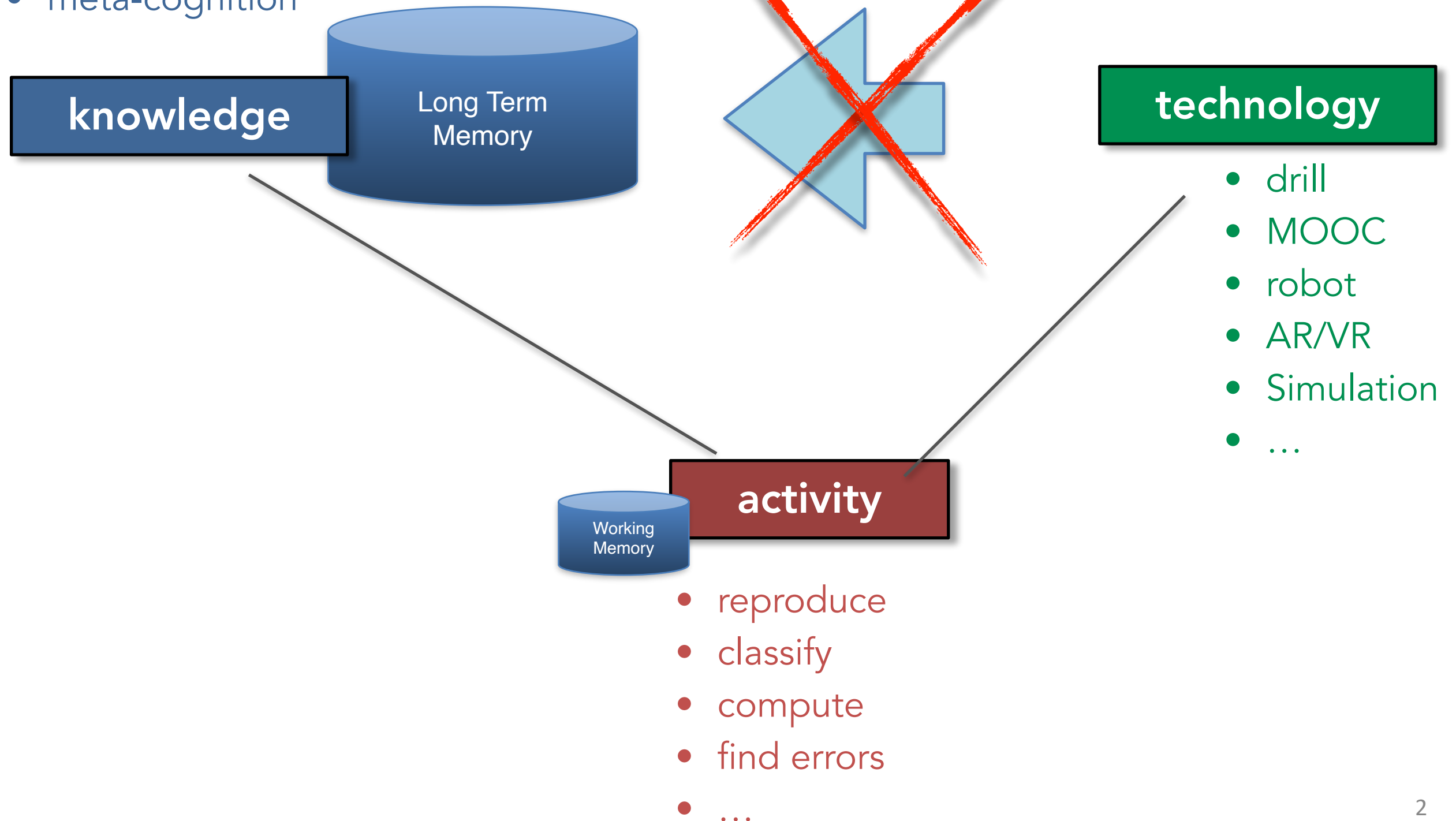
CS-411 : Digital Education

Chapter 9: Extended Reality

EPFL

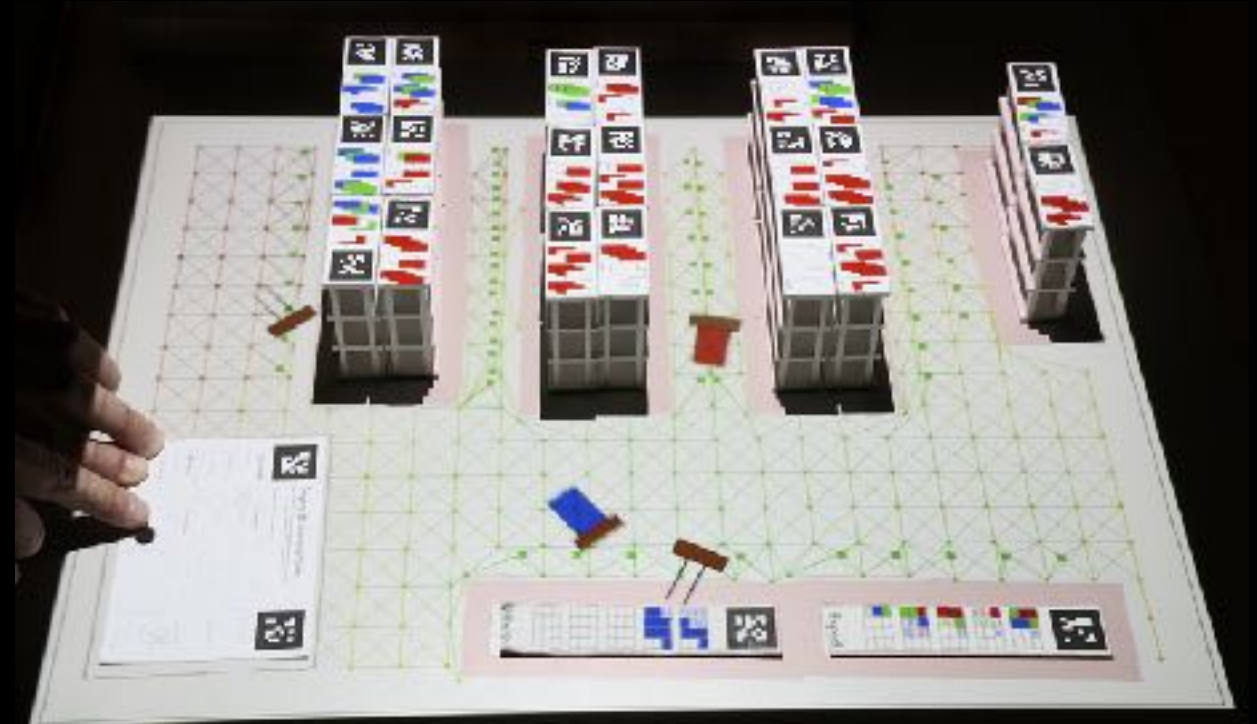
Prof. Pierre Dillenbourg

- 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



Adding digital elements to
Real images / objects



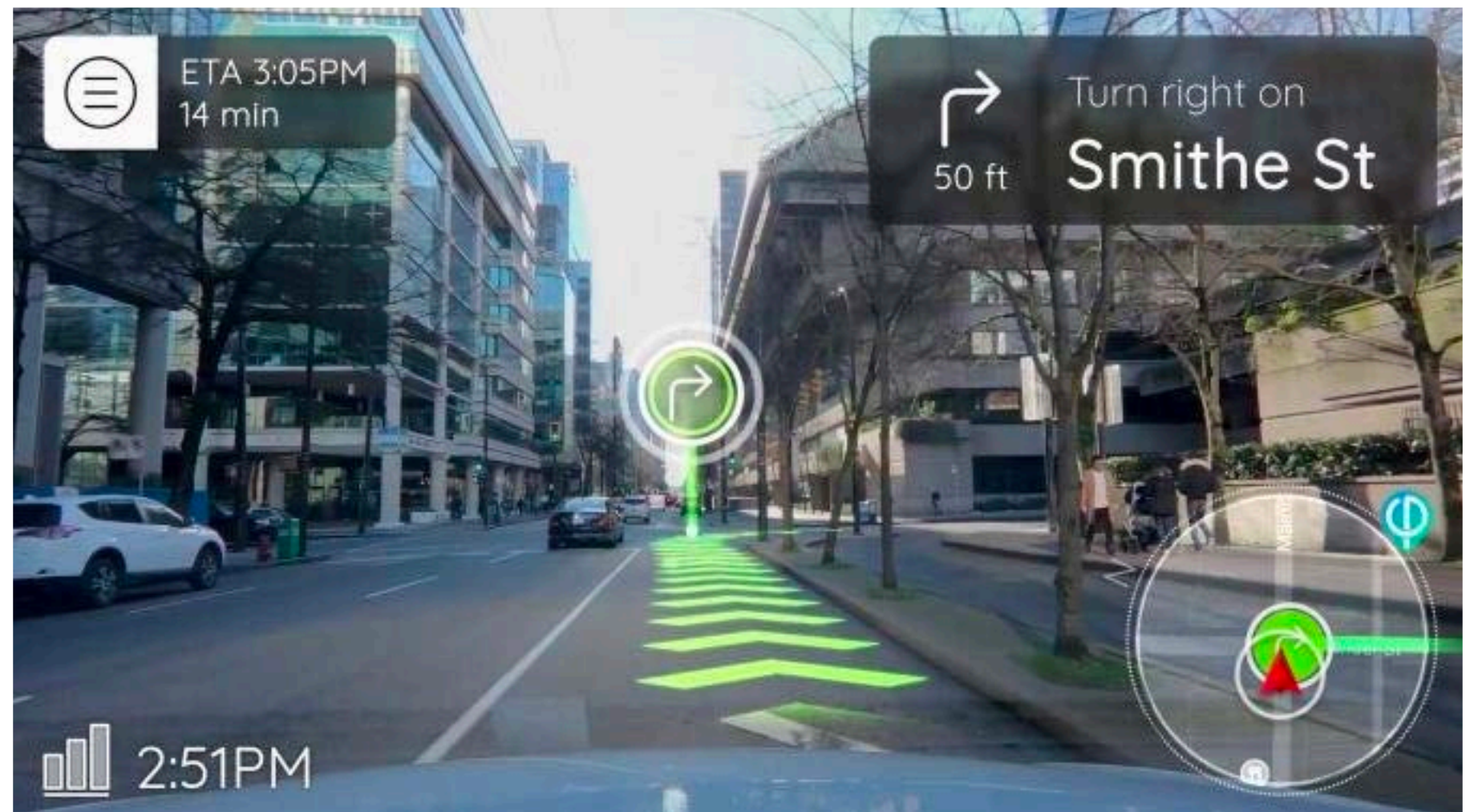
Alignment ?

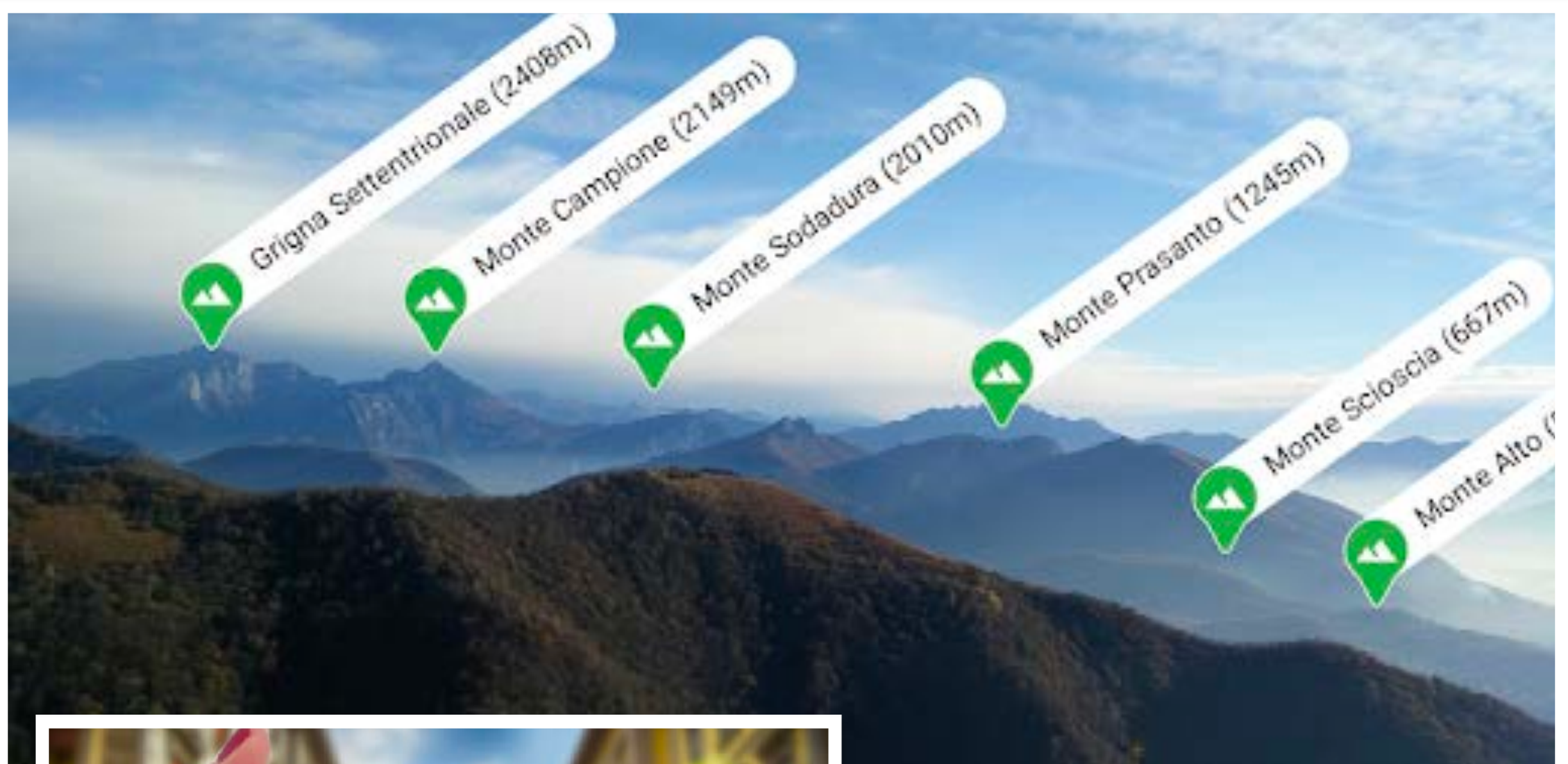


Caméra + Modélisation des trajectoires

Alignment ?

Caméra + GPS + GIS





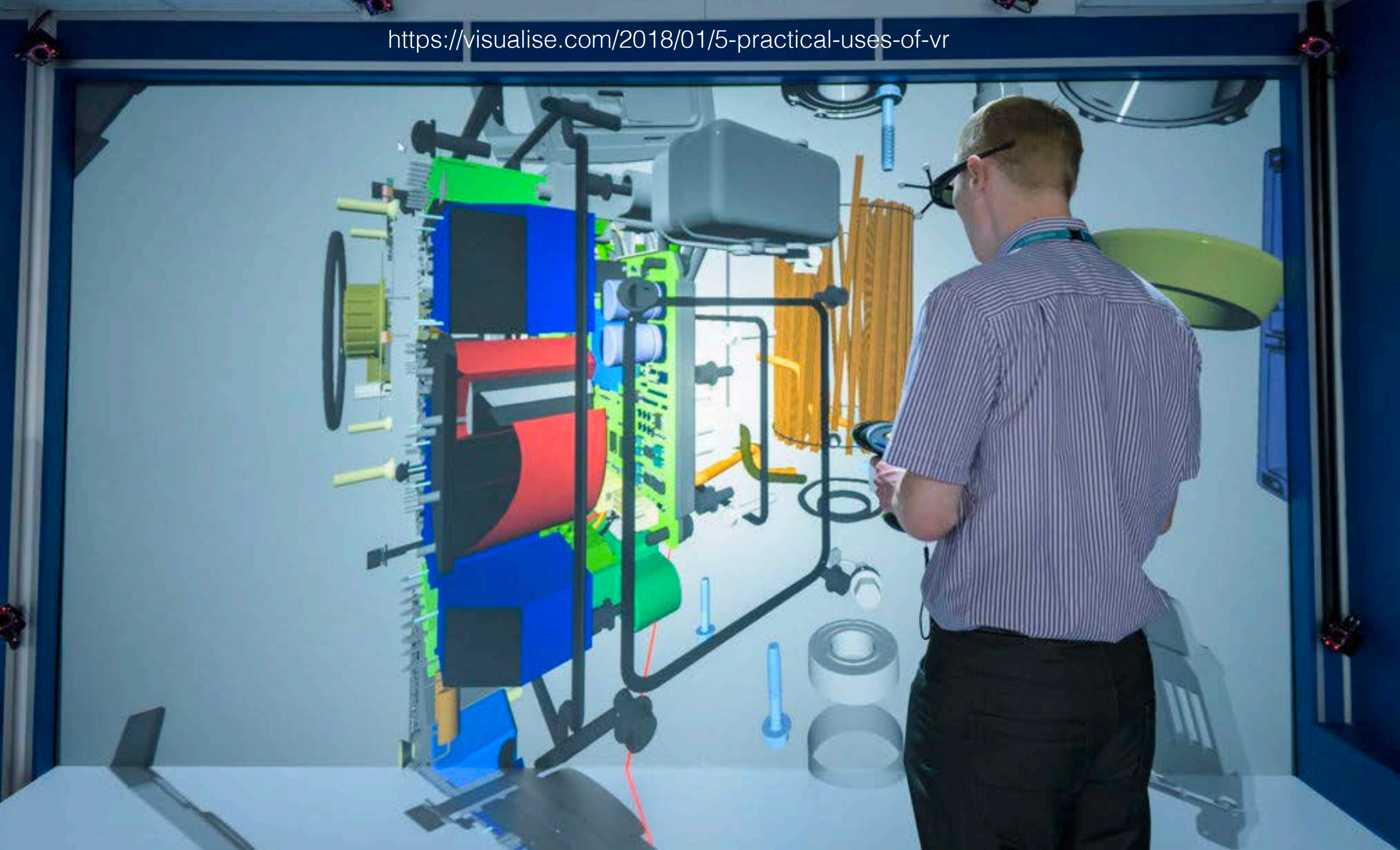
Peak Lens



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

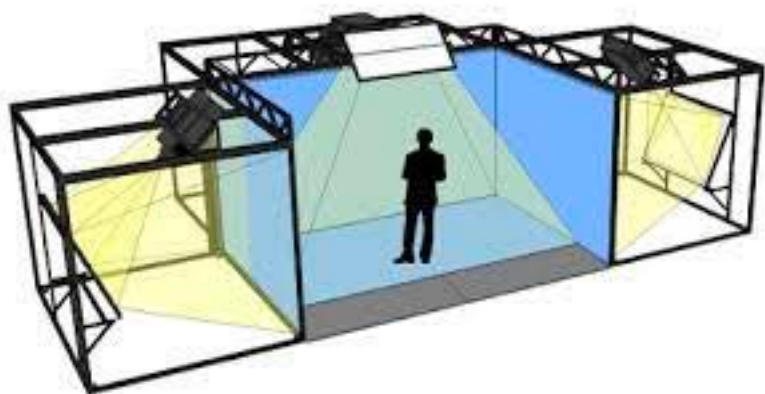


VR = computer-generated (fictitious) 3D environments



CAVE

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







« Extended Reality (XR) »

1. Augmented reality (AR): digital images **superimposed** on real images or real objects
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3. Mixed reality (MR): virtual interface **acting** on real objects
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
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 ?



<https://www.berlitz.lu/fr/total-immersion>

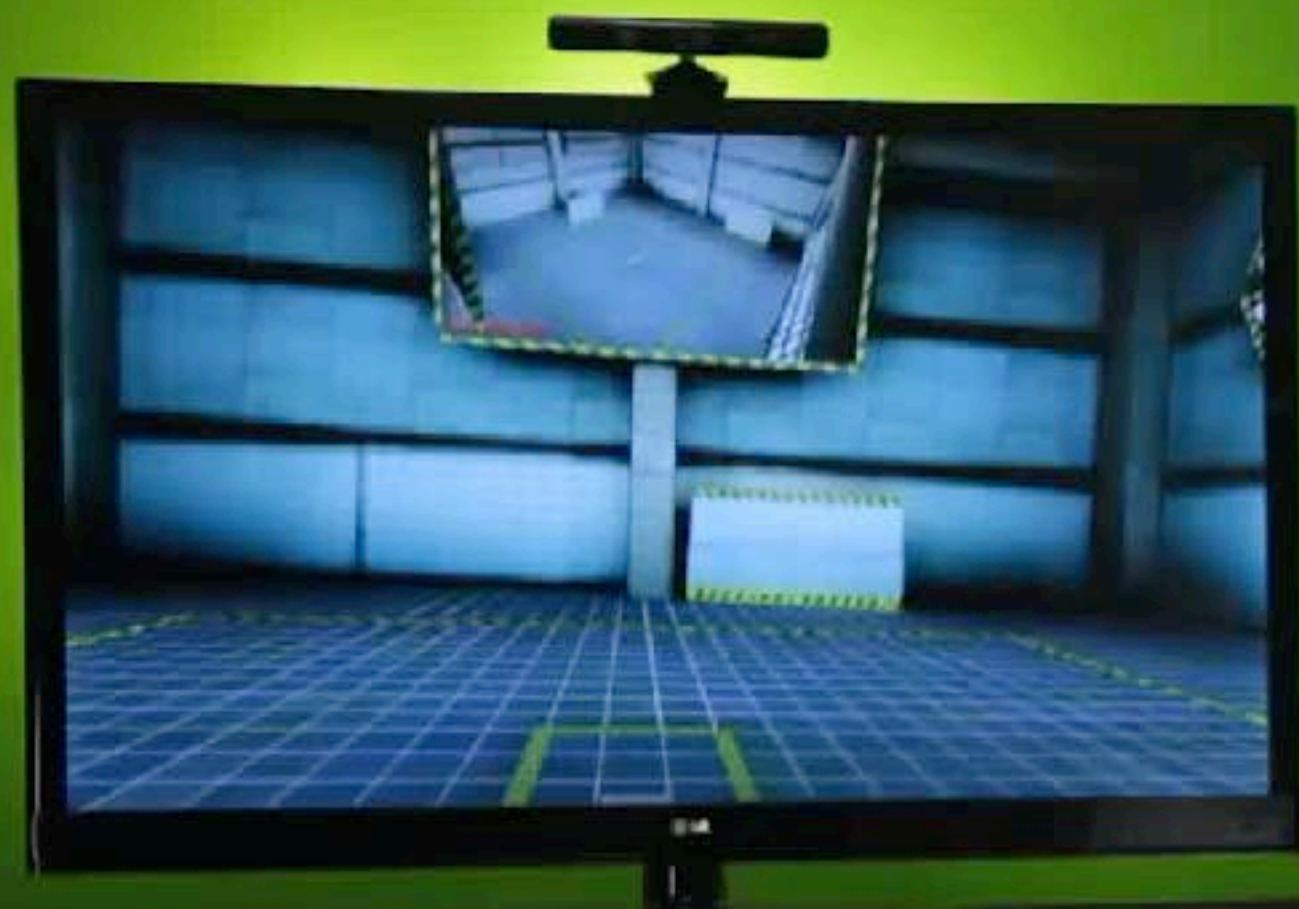
A virtual reality environment is IMMERSIVE if it generates **stimuli** for the user similar to those she would perceive in a real environment similar to the one being simulated (Sight, Touch, Hearing, ...)



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>

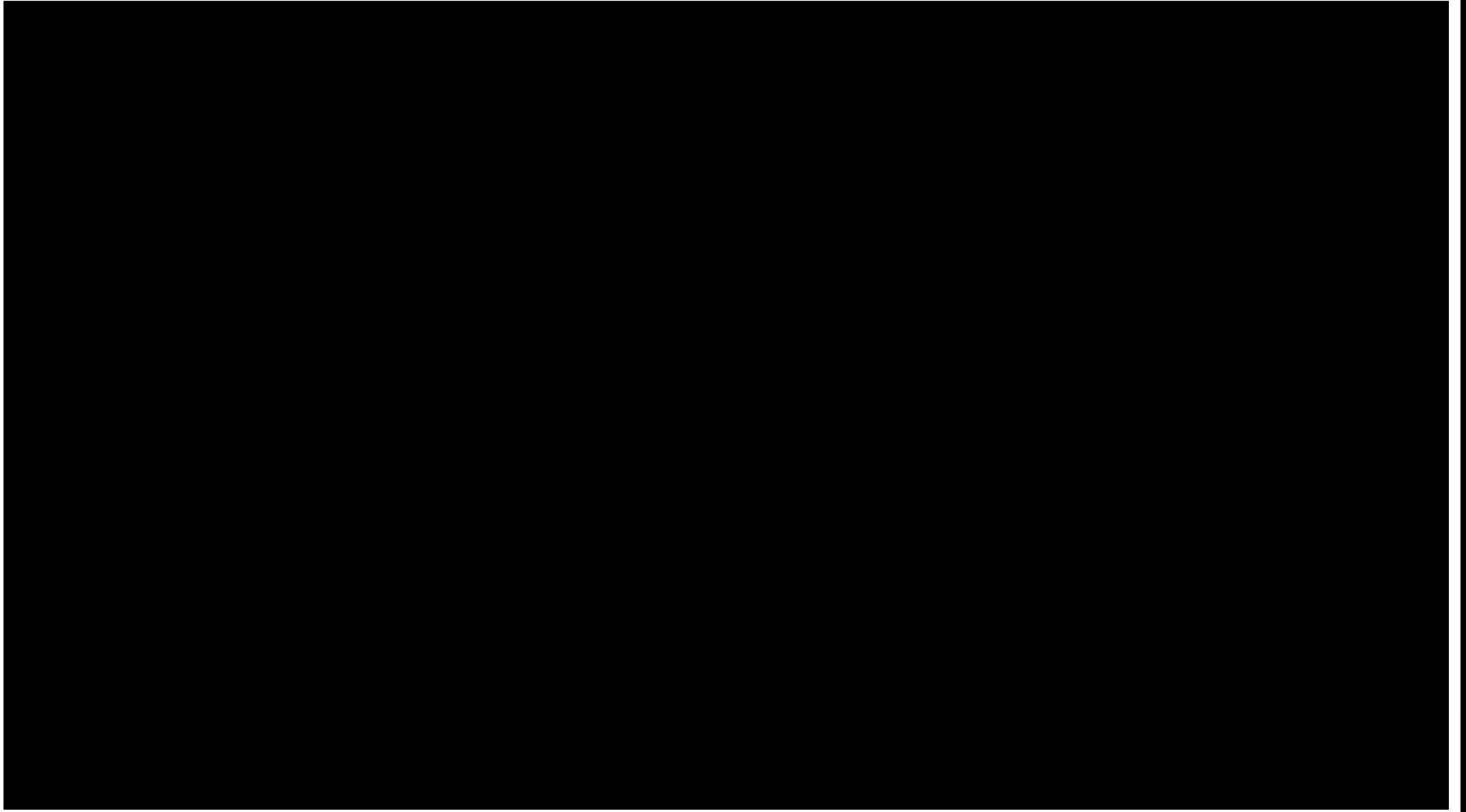




Dario Floreano, EPFL

Birdly





Dario Floreano, EPFL

Birdly



FlyJacket.epfl.ch

Immersion ?

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



Who is the bad one ?

Heider & Simmel, 1944

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

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

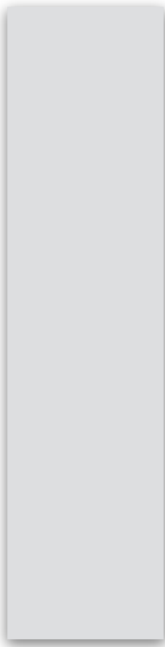




what's in it for learning ?



learning gains (**X**R) > 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



<https://www.ubisimvr.com/fr/plateforme-de-formation/>

Is virtual experience
as good as the real experience ?

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



8-11 millions





« It will be Hudson »

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

....





learning gains (**X**R) > learning gains (R)

virtual experiment

real experiment



Real, recorded real, simulated?

Prof. Jean-Philippe Ansermet



learning gains (**X**R) > learning gains (R)

AR warehouse

real warehouse



Logistics assistants (warehouse employees)





Unit 1

0 m
2 m
10 m

3.50 m



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

Cognitive fidelity

Gerbeur

20 étages



$$SB = 288 \text{ m}^2$$

$$SBST = 244 \text{ m}^2$$

Degré d'utilisation 86%
SH = 50 m²

Degré 2 = 17%

Degré 3 = 20%

surface brute de stockage: 240 m²
degré d'utilisation (1): 83%
surface net de stockage: 68 m²

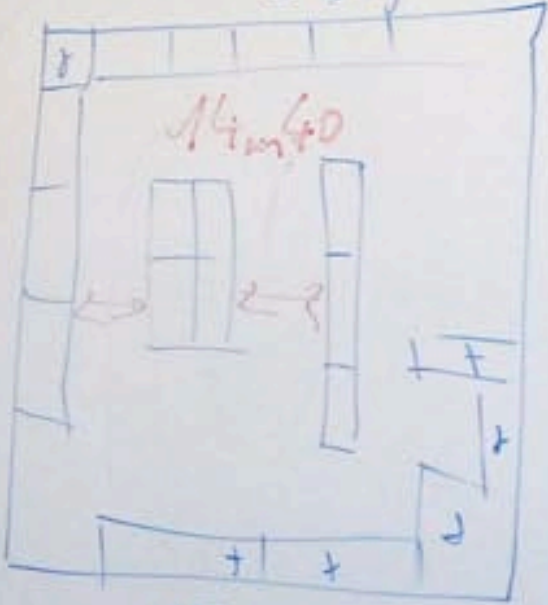


$$\frac{\text{surface net de stockage}}{\text{brut}} = 23\%$$

$$\frac{\text{net de stockage}}{\text{brut de stockage}} = 28\%$$

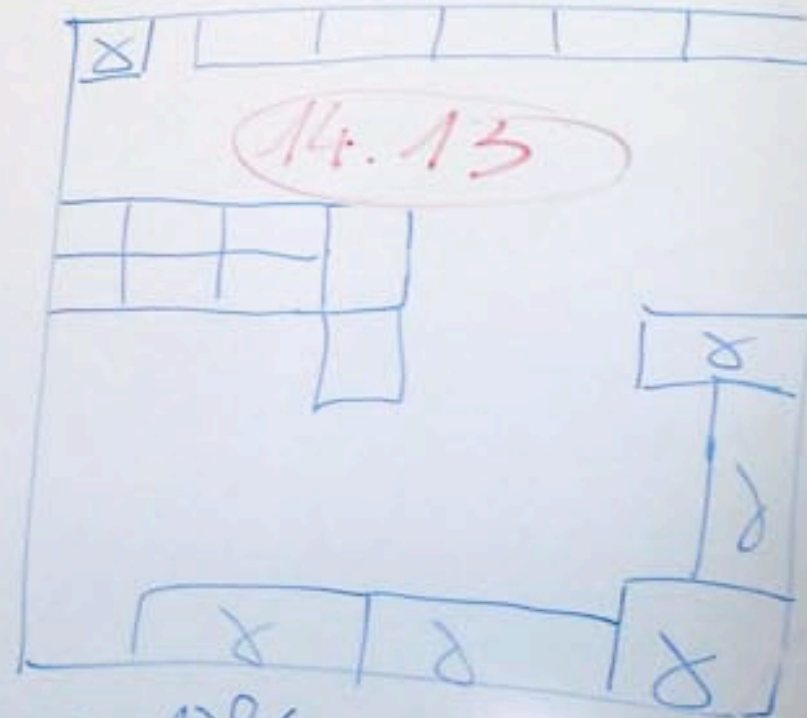
Contre poids

13 étages



$$= 15\%$$

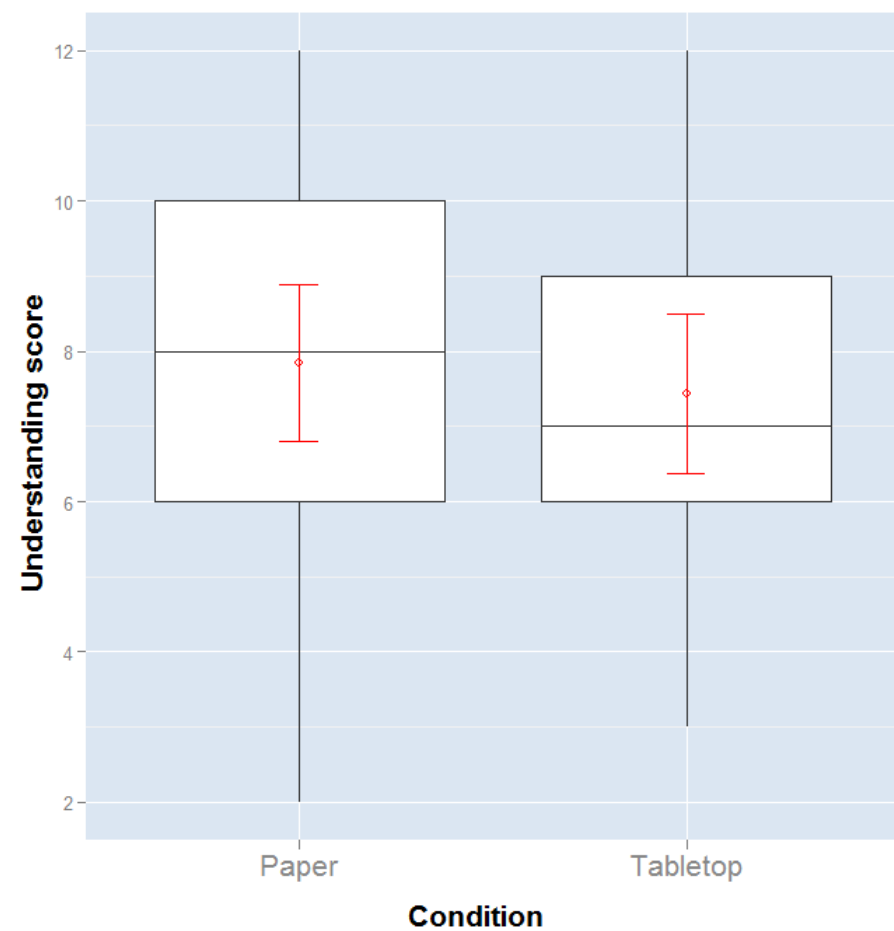
$$= 19\%$$



$$= 13\%$$

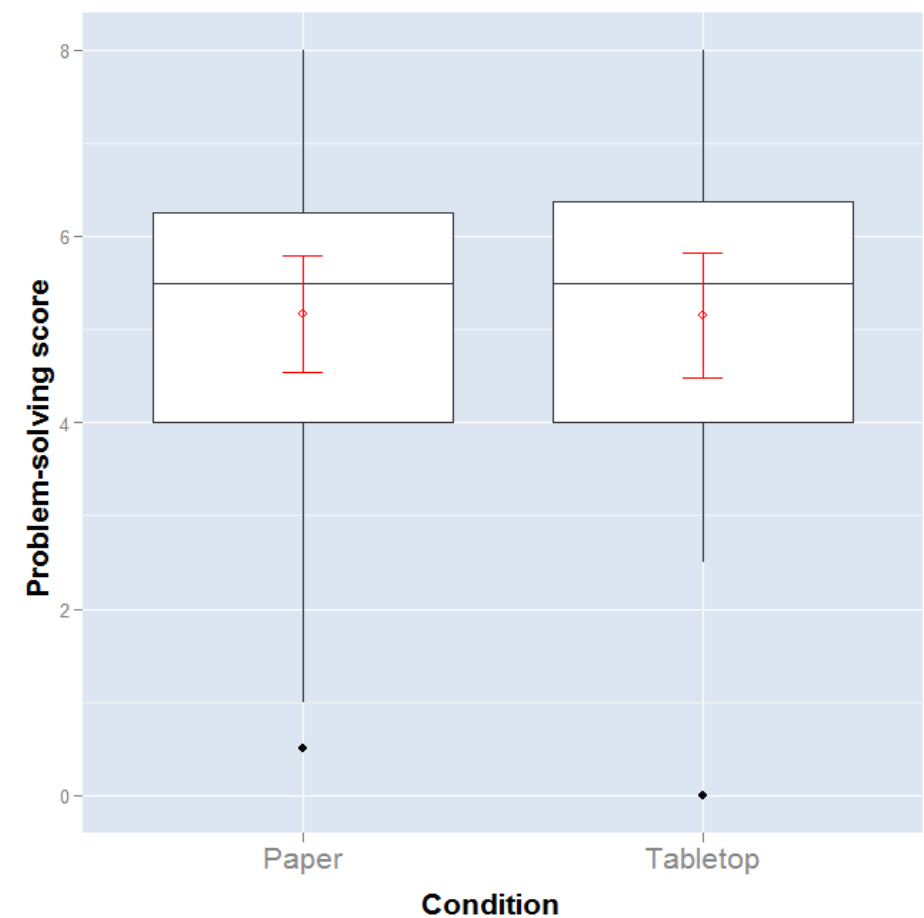


No sign. effect in
understanding



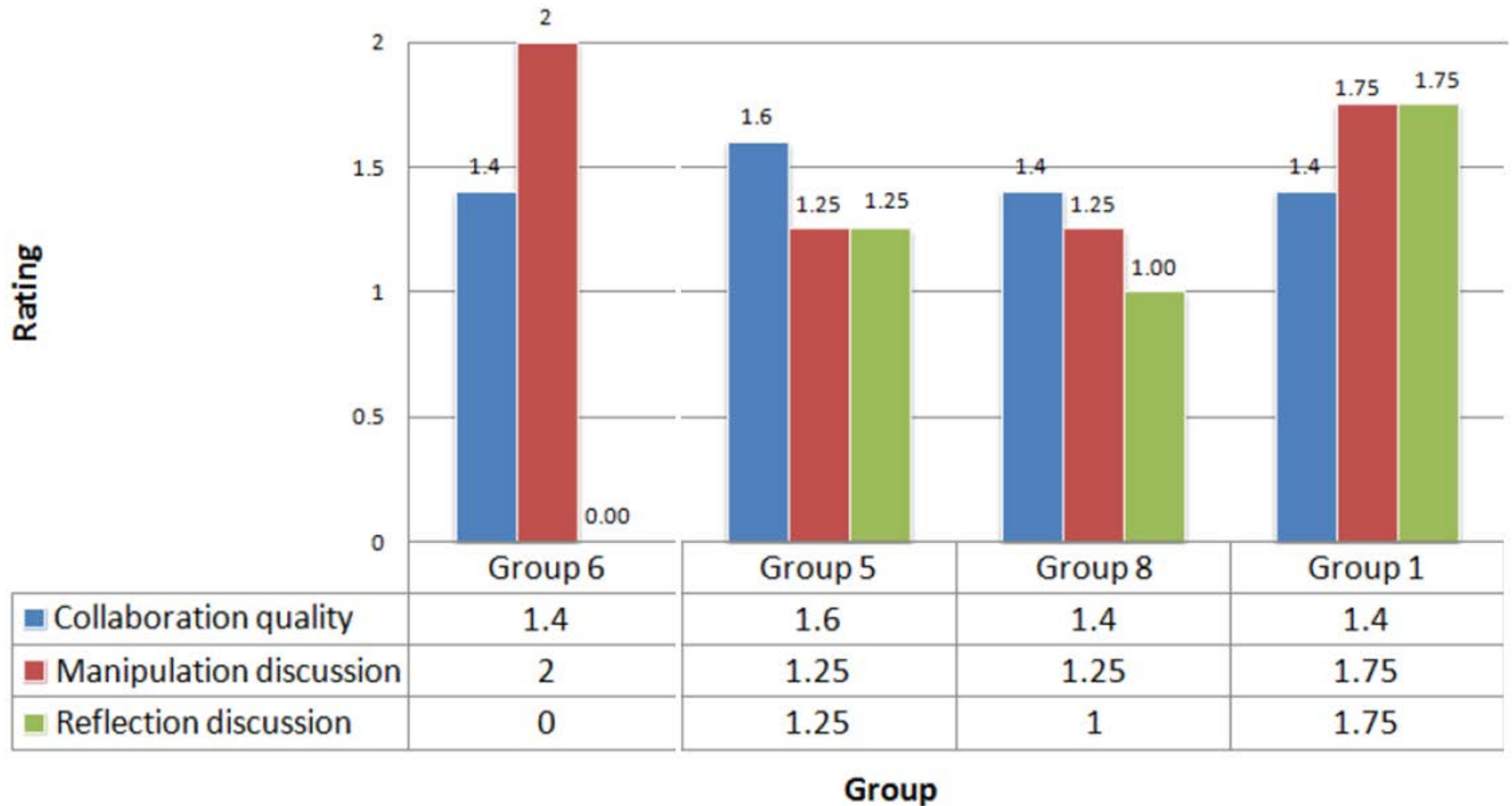
mean = 7.84 vs. mean = 7.43
 $F(1,14) = .25; p > .05$

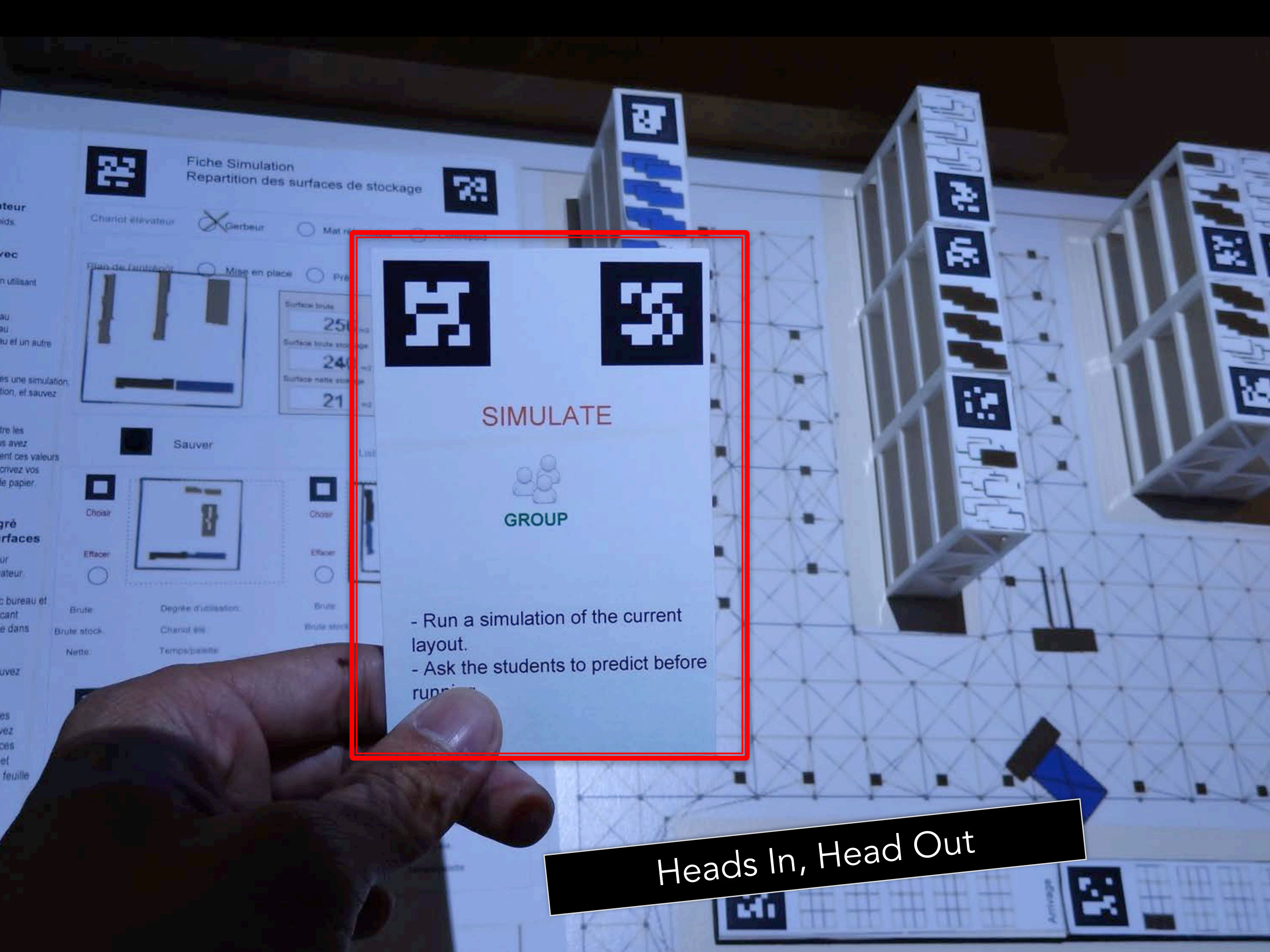
No sign. effect in
problem-solving



mean = 5.16 vs. mean = 5.15
 $F(1,14)=.06, p>.05$

Is this engaging ? Too much !





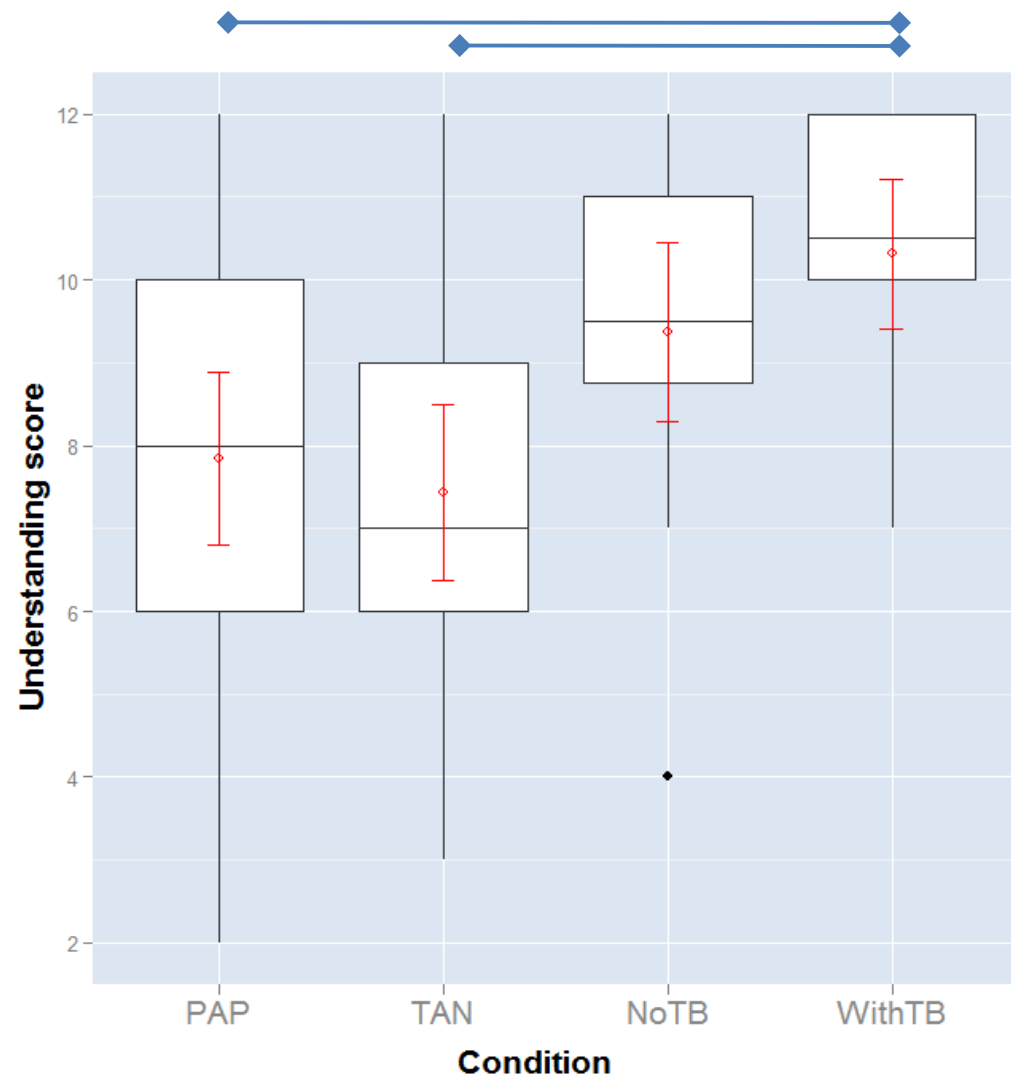
SIMULATE



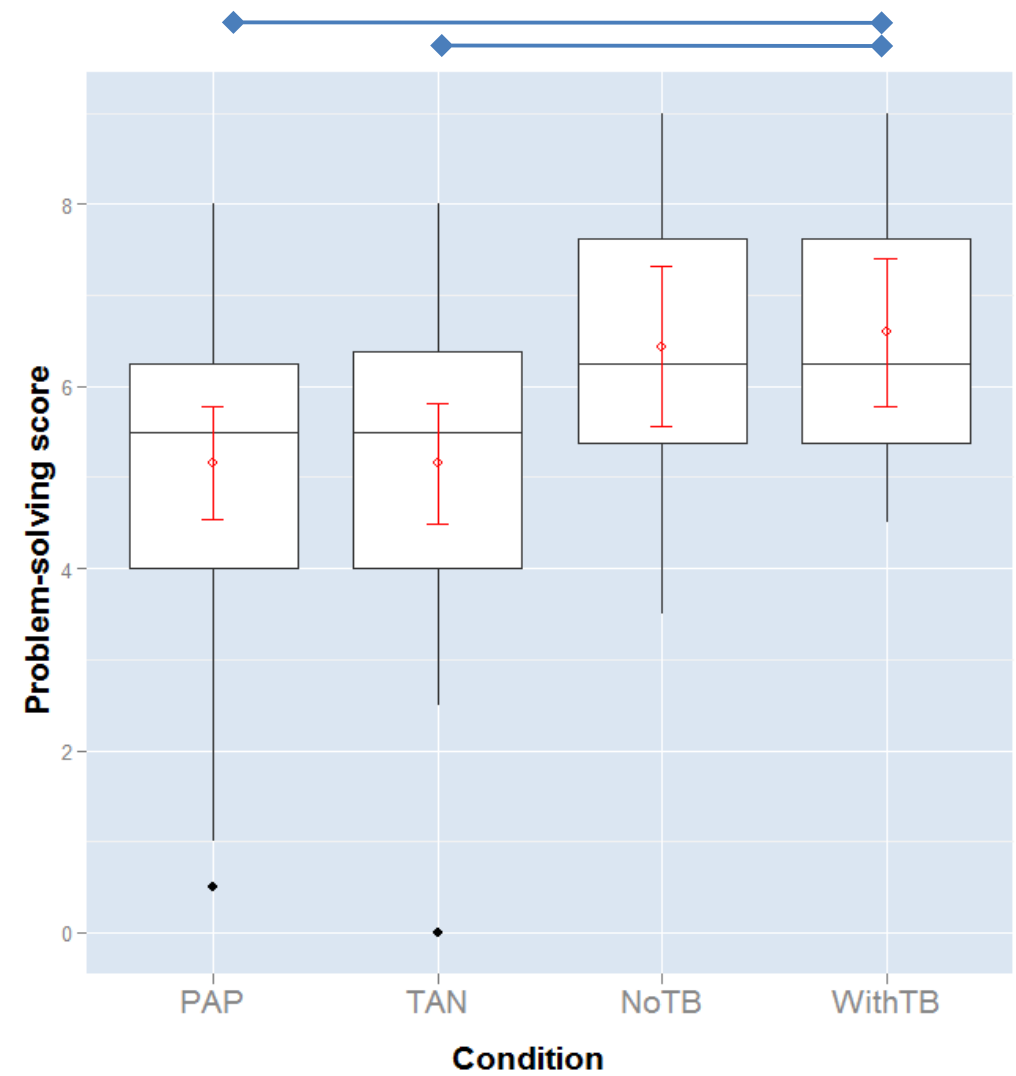
- Run a simulation of the current layout.
- Ask the students to predict before running.

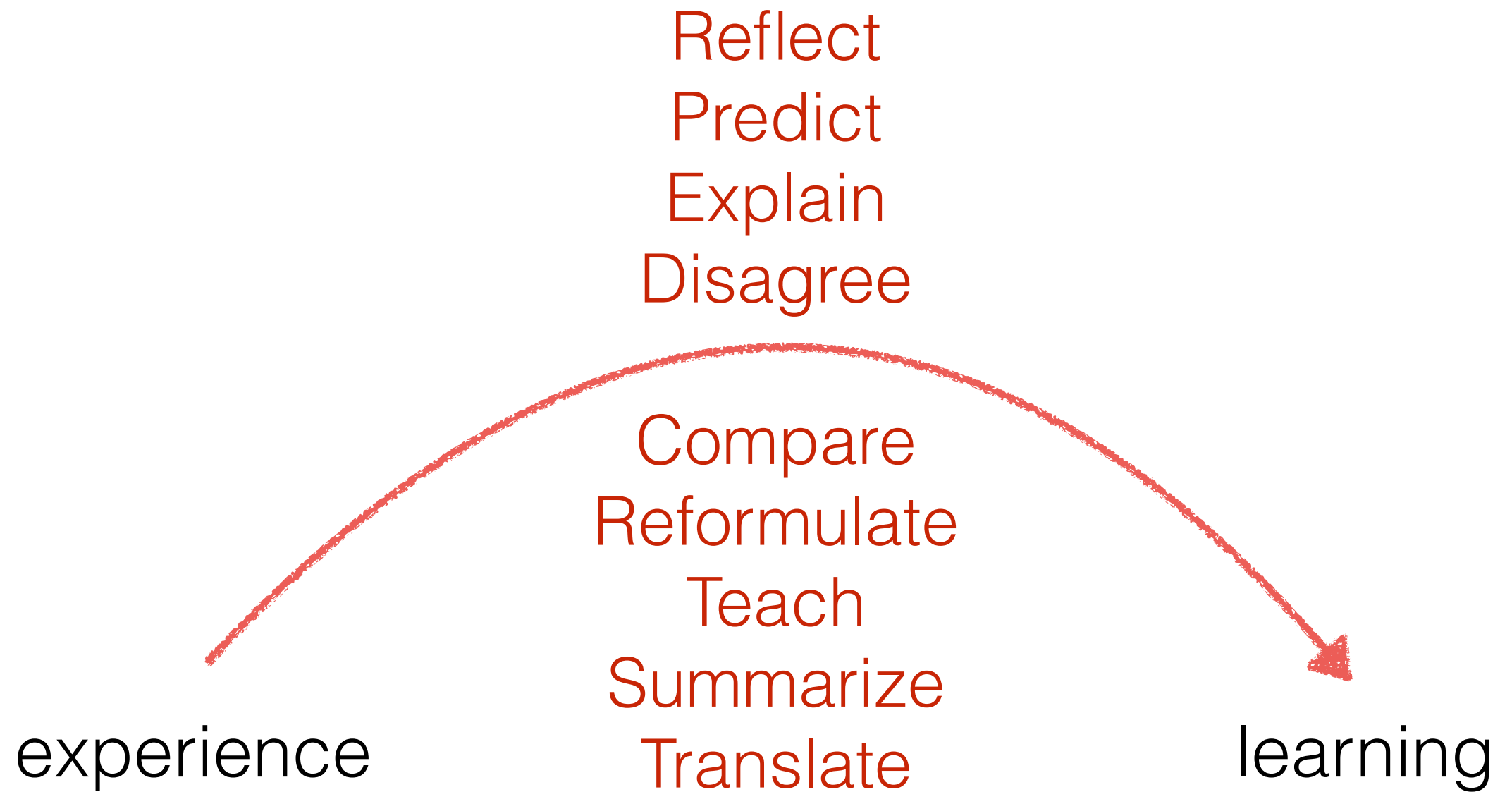
Heads In, Head Out

Sign. effect in
understanding



Sign. effect in
problem-solving





Engagement

—>

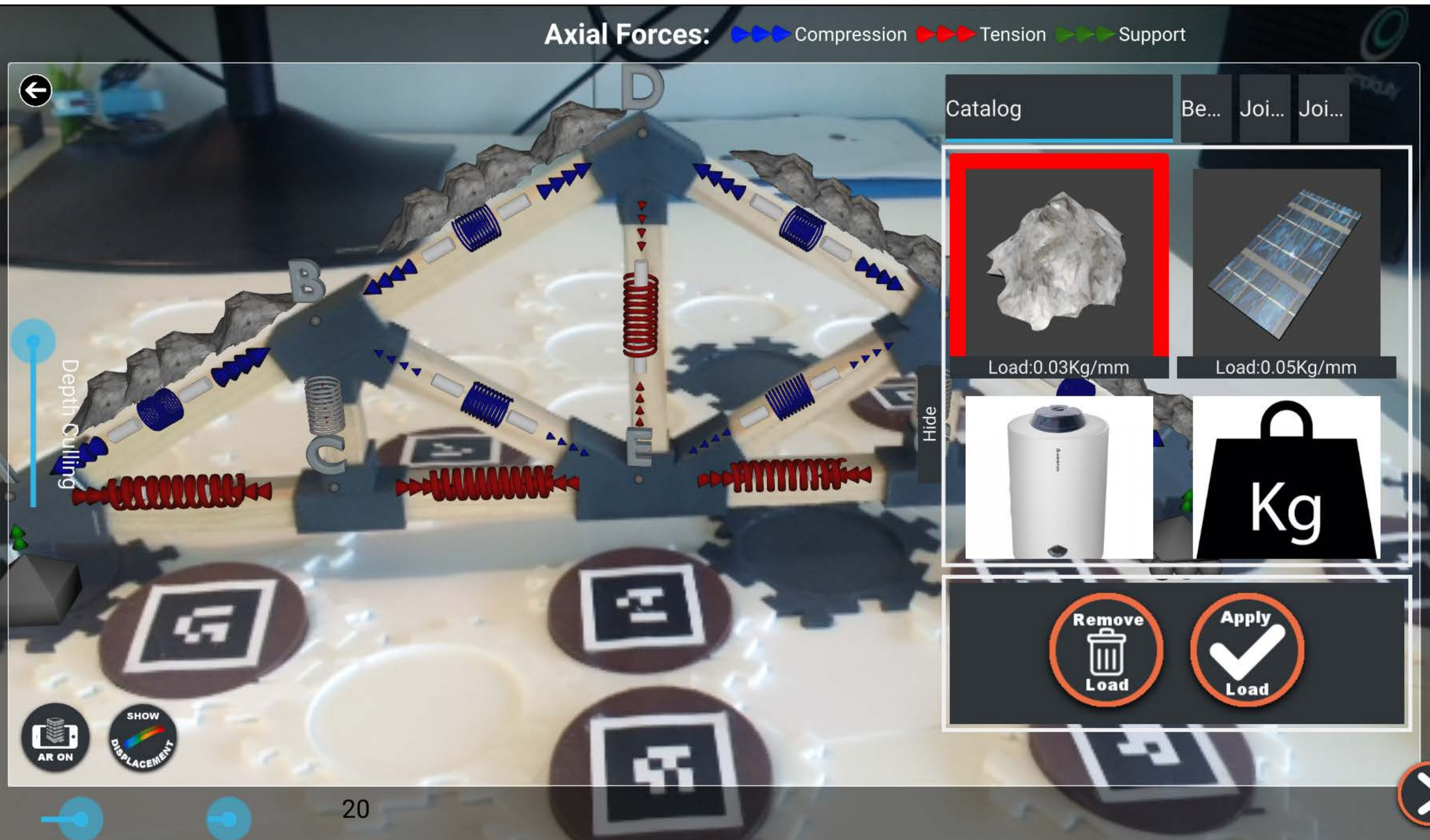
Learning

~~Visual fidelity~~ —> Immersion —> Engagement —> Learning
Cognitive fidelity + reflection + reification



Make the **in**visible visible

In the real world, we do not does see forces !





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



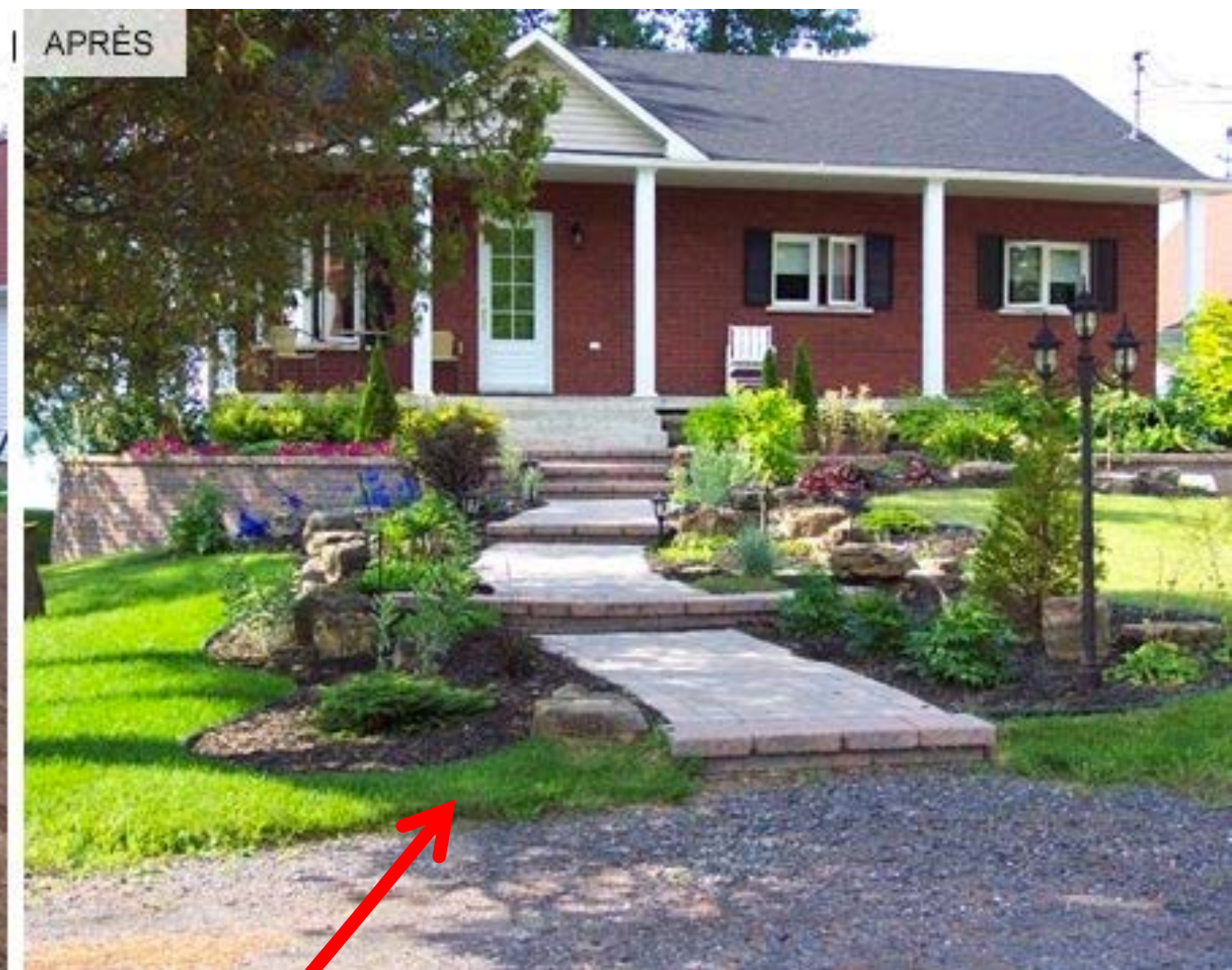
Make the impossible possible



~~Visual fidelity~~ —> Immersion —> Engagement —> Learning
Cognitive fidelity + reflection + reification

Make the invisible visible





EPFL

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



Garden Design Activity

Name :

English

Start

debug

In the real world,
gardens do **not** make children !

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

More...



et des cartes

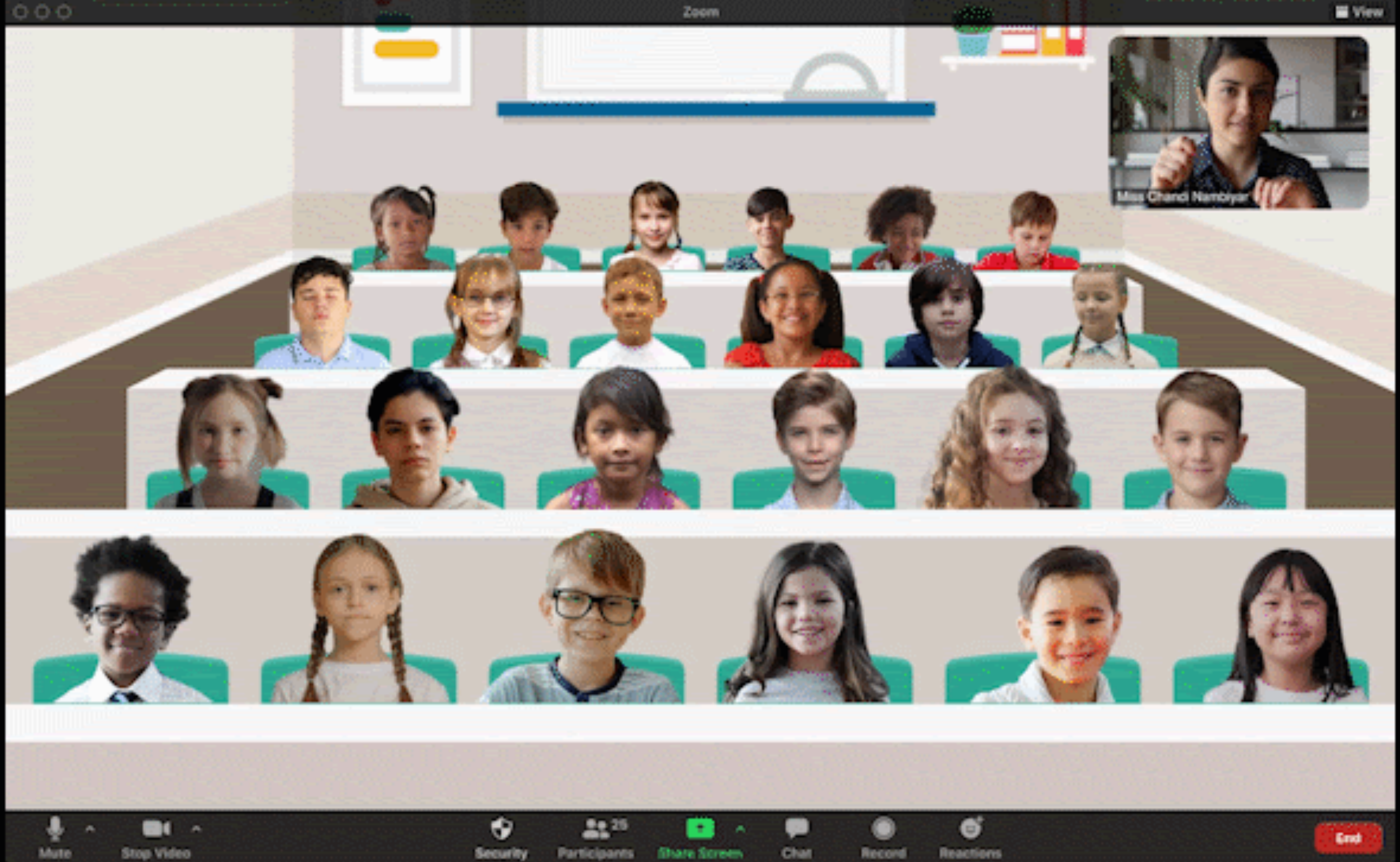
1. Fasten experience



Labster Virtual Labs

2. Lower the costs of experience

<https://wp.labster.com/high-school-science/>



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

Bonus ->

EPFL

ESCAPE REALITY

Accelerating Gardeners Experience

CHILI - COMPUTER-HUMAN INTERACTION IN LEARNING AND INSTRUCTION

Kevin Kim, Joseph Vavala, Catharine Oertel, Pierre Dillenbourg