Virtual and Augmented Reality in Education

Centre for Education and Learning

Nesse van der Meer
nessvdmeer@gmail.com

Bibeg Limbu
bibeglimbu@gmail.com

Universiteit Leiden The Netherlands

TU Delft Delft University of Technology

Erasmus University Rotterdam

Content

1. **Virtual-, Augmented-** and **Mixed Reality**: **definitions, principles** and **differences**
2. **Virtual Reality** in **Education**
3. **Augmented Reality** in **Education**
4. **Virtual-, Augmented-** and **Mixed Reality** at the **Centre for Education and Learning**

Definitions of VR and AR

Virtual Reality:

“The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet (...)”

Augmented Reality:

“A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.”

Oxford / Lexico

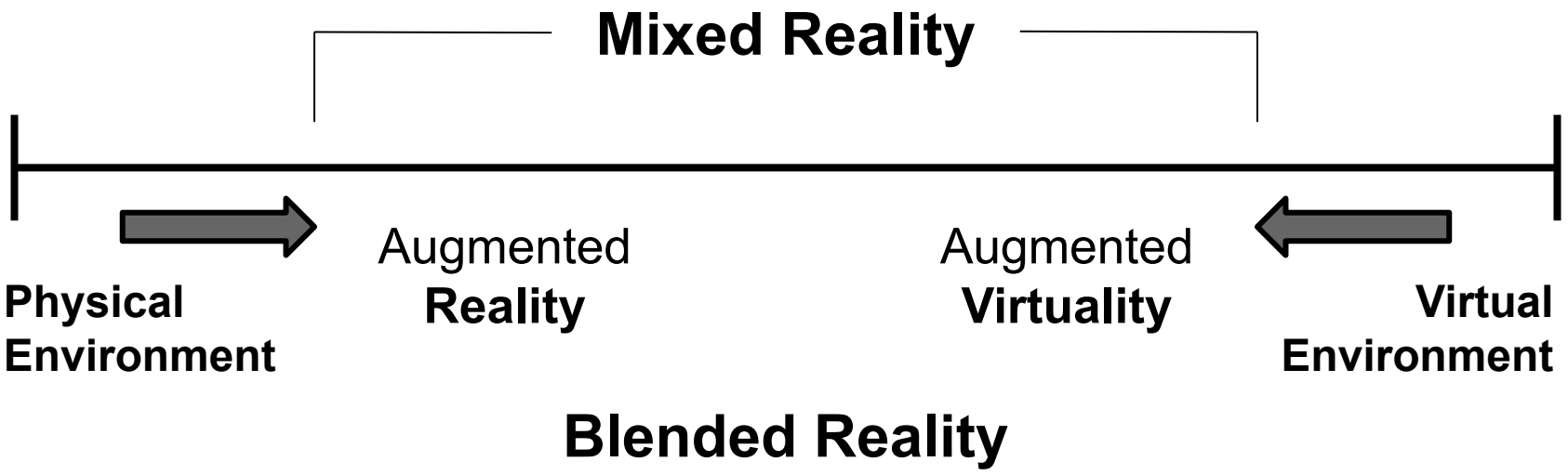
Virtual Reality (VR)

- **Gaze tracking** is fundamental
- **Contextual** (environmental) **awareness** is optional
- The user is “cut off” from reality; vision and hearing are simulated

Augmented Reality (AR)

- **Gaze tracking** is optional
- **Contextual** (environmental) **awareness** is fundamental
- The user (and the device) should to some extent be able to hear and see reality

Mixed Reality (MR)



Blended reality in relation to the physical-virtual environment continuum
(adapted from Milgram & Kishino, 1994, as presented in Bower et al, 2010)
(known as the reality-virtuality continuum)

Virtual Reality in Education

VR - Hardware options

1: Cardboard

2: Stand-alone

3: Tethered

VR Hardware - Cardboard

+ Cheap*
+ Portable (no cables)
+ Easy-to-use

- Requires mobile device
- Uncomfortable
- Technically very limited

Google Cardboard (2014)

McDonalds Happy Meal (2016)

Nintendo Labo VR (2019)

VR Hardware - Stand-alone

+ Different options
+ Portable (no cables)
+ Inside-out tracking

- Technically limited (compared to tethered)
- Costly
- Battery life

Oculus Go (2018)

HTC Vive Focus (2018) (China)

Oculus Quest (2019)

VR Hardware - Tethered

+ Technically impressive
+ High performance
+ Add-ons

- Expensive
- Requires computer
- Cables

Oculus Rift (CV1) (2016)

HTC Vive (2016)

Valve Index (2019)

Benefits of VR in Education

Advantages of Educational VR	Research
Engaging; substantial interest in content	Froese (2019), Concannon, Esmail and Roberts (2019), Ferguson, van den Broek and van Oostendorp (2020)
Immersive; enhances participation and commitment	Freina, Ott (2015), Concannon, Esmail and Roberts (2019), Ferguson, van den Broek and van Oostendorp (2020)
Effective alternative to physical presence	Froese (2019), Le, Pedro and Park (2019), Freina, Ott (2015), Østergaard et al. (2019), Kim, Kim and Park (2019)
Facilitates learning	Sandu, Gide and Karim (2019), Concannon, Esmail and Roberts (2019), Freina, Ott (2015), Pirker, Holly, Lesjak and Gütl (2019)
Enhances motivation	Froese (2019), Freina, Ott (2015), Olmos, Cavalcanti, Soler, Contero and Alcañiz (2019), Pirker, Holly, Lesjak and Gütl (2019)
Effective method of training	Concannon, Esmail and Roberts (2019), Le, Pedro and Park (2019), Freina, Ott (2015), Hagita, Kodama (2020)
Interactive; enhances experiential learning	Li, Ip, Ma (2019), Concannon, Esmail and Roberts (2019), Ferguson, van den Broek and van Oostendorp (2020)
Social; enhances collaboration and cooperative learning	Le, Pedro and Park (2019), Wenzel, Meinel (2019), Godin, Pridmore (2019), Sun, Shaikh, Won (2019)
Enhances data visualisation	Garcia, Fernando (2019), Havarda, Trigunayat (2019), Donalek et al. (2014), Wang, Guo, Yuen and Luoa (2019)

Limitations of VR in Education

Limitations of Educational VR	Research
Relatively high costs (for most hardware)	Wenzel, Meinel (2019), Olmos, Cavalcanti, Soler, Contero and Alcañiz (2019)
Creating or finding new educational content can be challenging to educators	Jensen, Konradson (2018)
Research on pedagogy of VR still lacking	Smith (2019), Freina, Ott (2015), Fowler (2014)
Physically taxing; limited use advised	Spiegel (2018), Bonner, Lege (2018)
Virtual Reality sickness	Olmos, Cavalcanti, Soler, Contero and Alcañiz (2019), Spiegel (2018), Wei, Fu, So (2017)
VR systems can require a complex setup	Wenzel, Meinel (2019), Jensen, Konradson (2018)
Lack of clarity on effects on younger users	Freina, Ott (2015)

Use-case examples of VR in Education

1: Individual-user VR

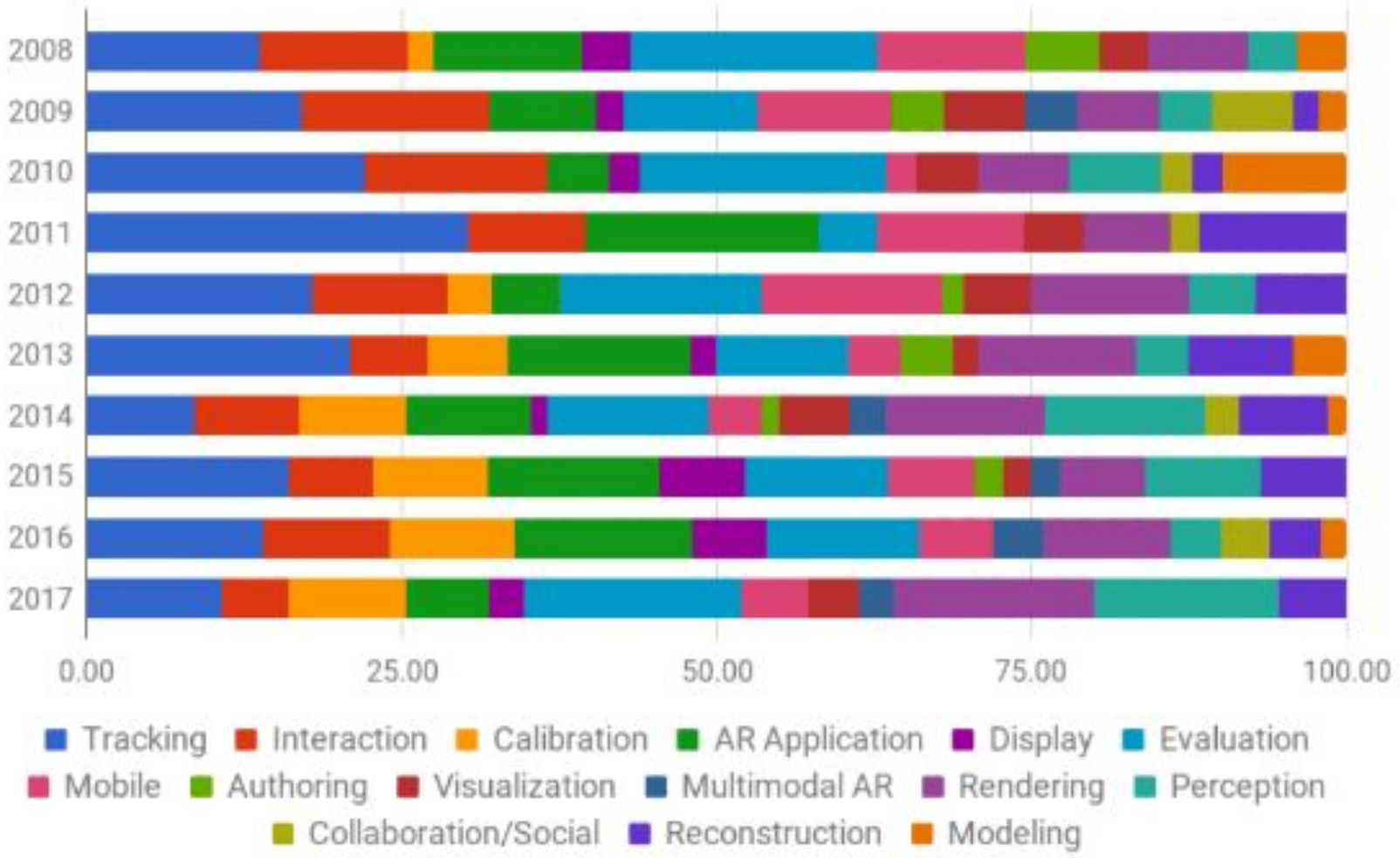
2: Multi-user (collaborative) VR

Augmented Reality in Education

AR - Hardware options

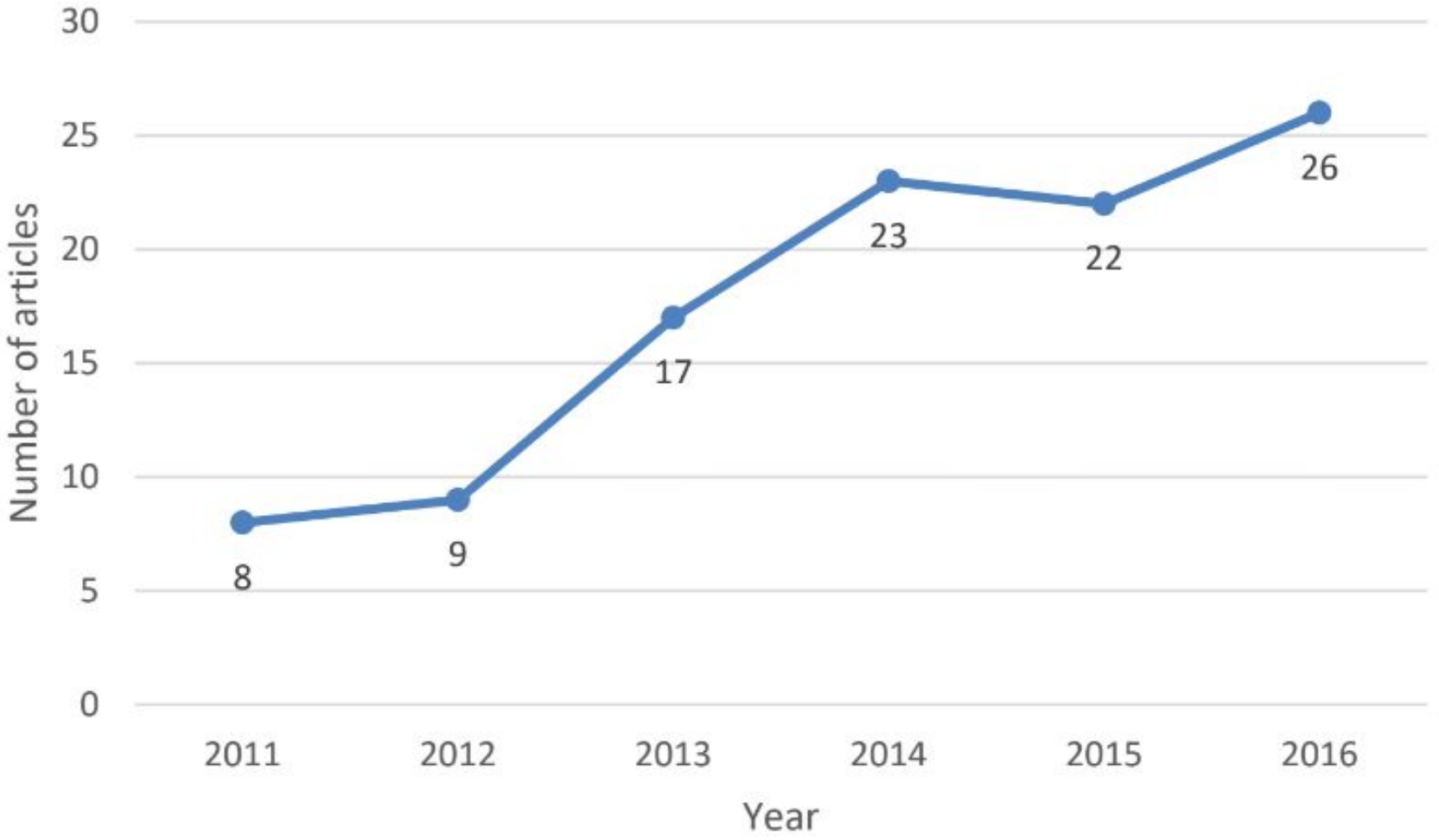
1. **Marker** based
2. **Geo-location** based
3. **Infrared sensors** based

AR Trends in Education (1)



Trends in ISMAR research by topics, 2008-2017

AR Trends in Education (2)



Number of Articles on AR and education by year

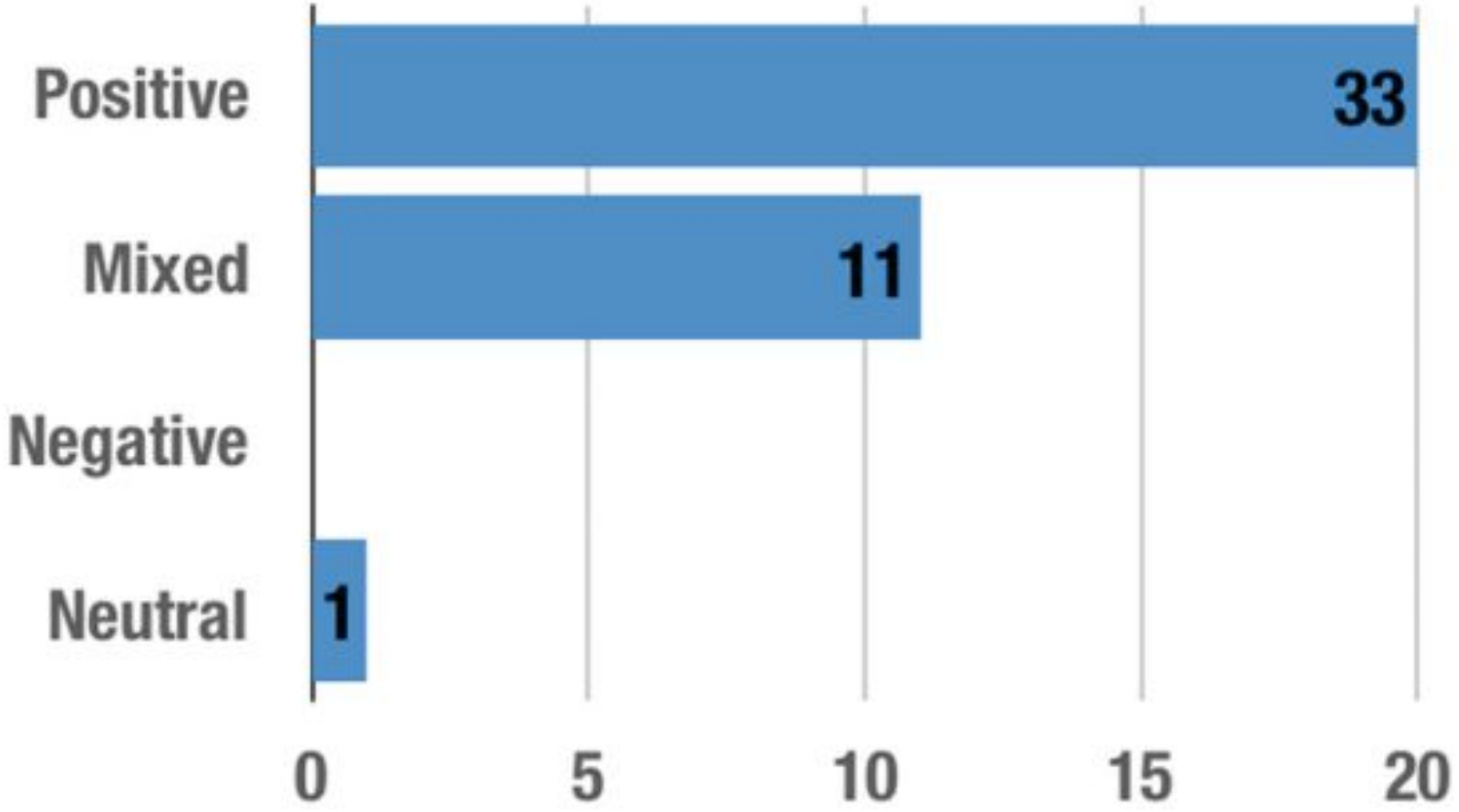
Use of AR in Education (1)

Education Field	f
Biology Education	17
Engineering Education	11
Medical Training	10
Other	10
Physics Education	6
Informal Education	6
Language Education	5
Chemistry Education	5
Mathematics Education	5
Special Education	4
Preschool Education	3
History Education	2
Astronomy Education	2

Use of AR in Education (2)

Sample Level	f
Undergraduate students	32
Secondary school students	17
Primary school students	10
High school students	6
Special education	5
Teachers	5
Parents	4
Other	4
Preschool students	3
Graduate students	1

Impact of AR on Education



(Silva et. al, 2019)

Affordances of AR in Education

Foster collaboration

Constructivist learning / Situated learning

Contextual awareness

Augmentation of perception

Visualization of phenomenon

Multimodal Interface

Authentic practice

SENSORS

Benefits of AR in Education

Limitations of Educational VR	Research
Increases achievement	Chian, Yang and Hwang (2014), Estapa and Nadolny (2015), Ferrer-Torregrosa et al. (2014)
Facilitates learning	Carlson and Gagnon (2016), Kamarainen et al. (2013), Yoon, Elinich, Wang, Steinmeier and Tucker (2012)
Enhances motivation	Chiang et al. (2014), Ferrer-Torregrosa et al. (2014), Solak and Cakir (2015)
Ensures permanent learning	Perez-Lopez and Contero (2013)
Increases interest towards lessons	Chen and Wang (2015), Zhang et al. (2014)
Increases student participation in classes	Bressler and Bodzin (2013), Dunleavy, Dede and Mitchell (2009), Liu and Tsai (2013)
Develops positive attitudes	Akçayir, Akçayir, Pektaş and Ocak (2016), Hwang, Wu, Chen and Tu (2016), Lu and Liu (2015)
Enhances spatial skills	Ho, Chung and Lin (2012), Lin, Chen and Chan (2015)
Ensures cooperative learning	Bressler and Bodzin (2013), Han, Jo, Hyun and So (2015), Martin-Gutiérrez et al. (2015)
Ensures learning by having fun	Ibáñez, Di Serio, Villarán and Kloos (2014), Yilmaz (2016)
Decreases cognitive load	Bressler and Bodzin (2013), Küçük et al. (2016)

Limitations of AR in Education (1)

Limitations of Educational AR (sub-category)	Number of studies
Between 31-100	41
Between 11-30	14
Between 101-300	13
Between 1-10	6
More than 1000	1

- Short study sessions

Limitations of AR in Education (2)

Limitations of Educational AR (sub-category)	Number of studies	Percentage (%)
Designed for a specific knowledge field	1	3.13
Teachers cannot create new learning content	1	3.13
Difficulties maintaining superimposed information	3	9.38
Paying too much attention to virtual information	2	6.25
Short periods of validation	1	3.13
Intrusive technology	2	6.25

Use-case examples of AR in Education (1)

1. Wekit.One
2. Authoring tool
3. Expert based
4. Sensor recording
5. Training

Wekit.eu

Use-case examples of AR in Education (2)

1. HoloMarker
2. Collaborative annotation
3. Co-located

Can support remote collaboration and also across time

VR, AR and MR at CEL

Nesse's VR Research @ CEL

Nesse:

- CEL's "go-to VR person"
- Recently started PhD at TU Delft
- Current focus:
  Collaborative VR in Higher Education
- Currently working on literature review & PhD plan

Mixed Reality & Mechanical aptitude

Mixed Reality Prototype for Education:

- **Focus:** Mechanical aptitude
- **Goal**: easy-to-use, accessible and interactive MR for educational settings
- **Hardware**: (affordable) VR headset + camera
- **Current status**: conceptual stage

Bibeg's AR Research @ CEL

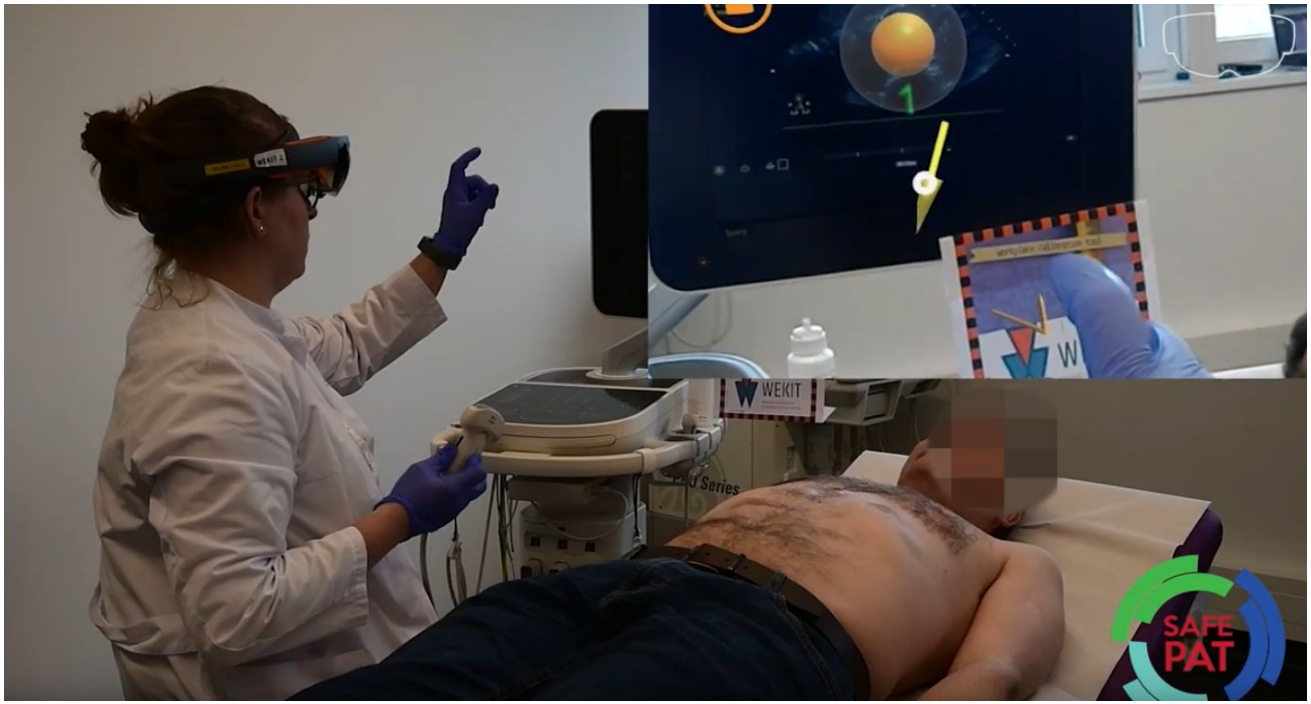
Bibeg:

- CEL's "go-to AR person"
- Final year Phd at Open University of The Netherlands
- Focus on **Multimodal data, AR and Expertise development**
- Interested in Game design, Instructional design
- Currently writing my thesis

Mixed Reality & Sonography

Mixed Reality Prototype for Education: Sonography

- **Goal**: General purpose sonography trainer, based on expert
- **Hardware**: Hololens
- **Current status**: implementation of features



Thank you!

Centre for Education and Learning

Nesse van der Meer

nessvdmeer@gmail.com

Bibeg Limbu

bibeglimbu@gmail.com

Universiteit Leiden The Netherlands

TU Delft Delft University of Technology

Erasmus University Rotterdam