Augmented Reality: 3D Holograms for Engaged Learning

Dr. Janet Holland
Emporia State University, Emporia, KS, USA

The Future of Education, Pixel Conference, Florence Italy, June 27-28, 2019

AR Presentation Bases

Literature

Experiences

Benefits

Challenges

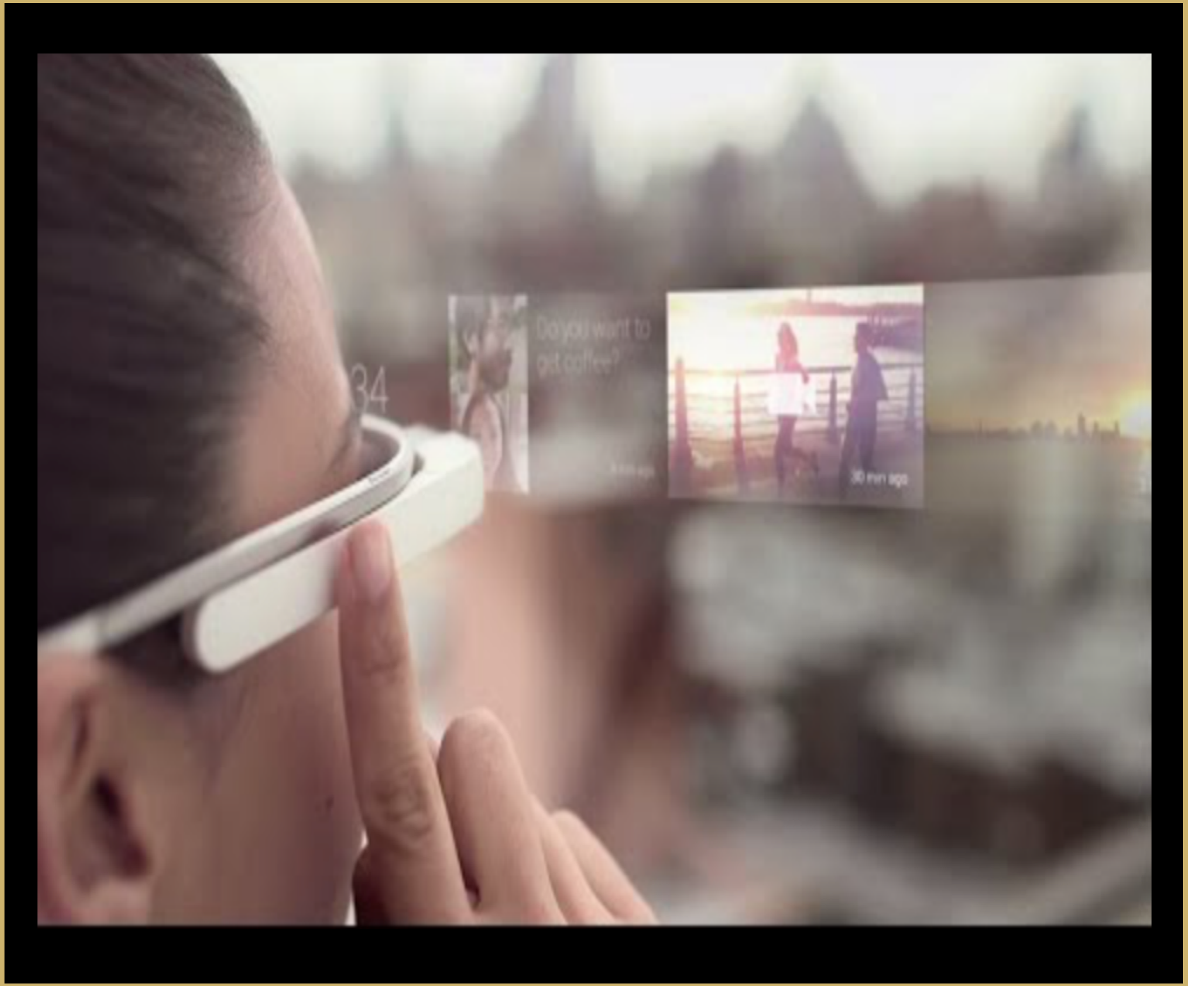
Educational strategies for effective implementation.

History of AR

Major tech companies- Apple, Facebook, Google, Intel & Microsoft are investing in AR's future to bring it to a mass audience.

Richard Corps (2017). http://adsreality.com/

Google Glass, 2012



Experiment wearing Glass for one month.

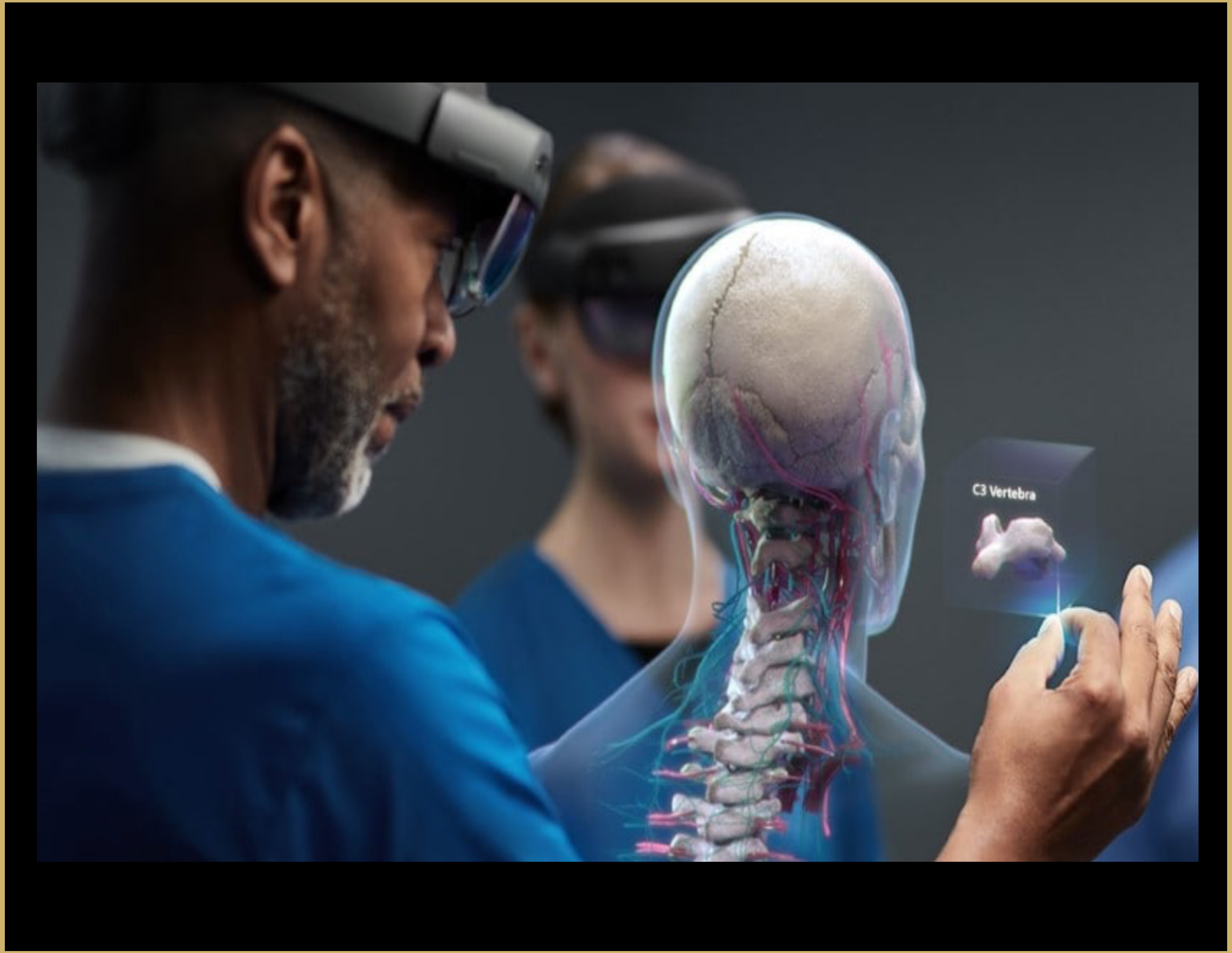
New: Google's Discover Glass, 2019

Enterprise Edition for business

Meta 2 Development Kit, 2016

Graduate assistant experimented using Unity programming to create 3D objects.

Microsoft HoloLens 2016 & 2019

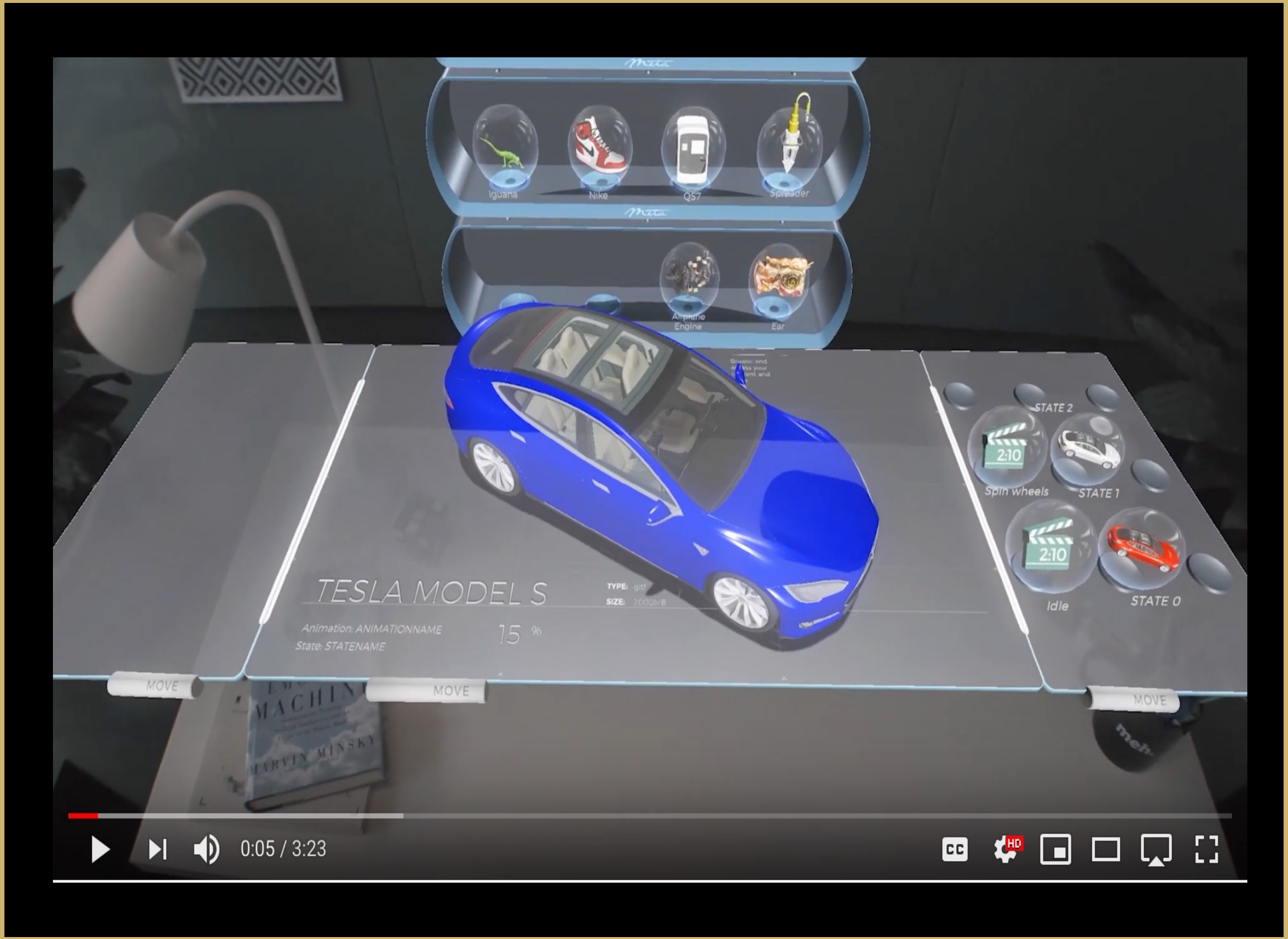


Updated in 2019

What is Augmented Reality?

3D hologram objects are overlaid on the real-world environment.

Manipulate & view objects from any angle.



Meta Interactions

Walk around 360 Degrees

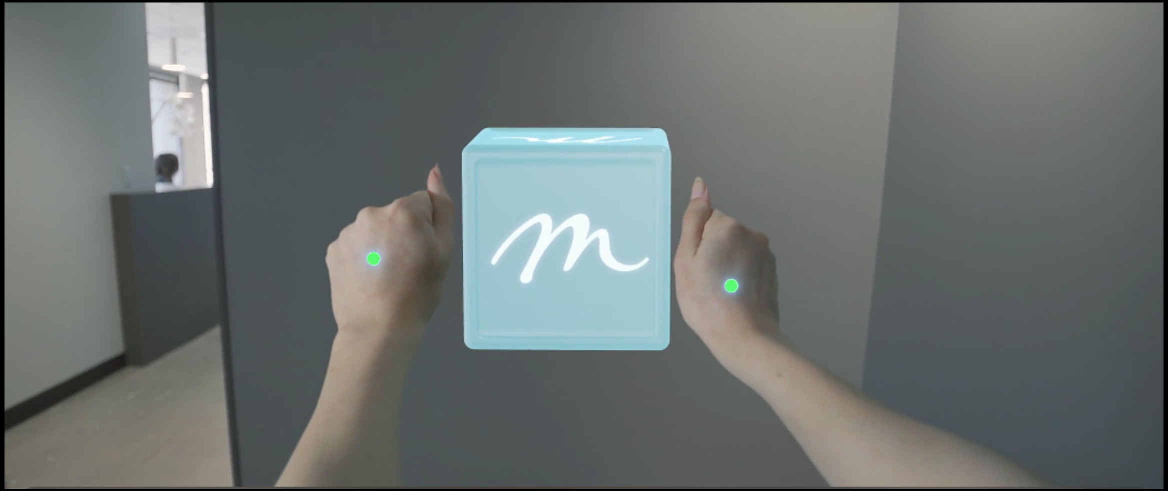
Look Over - Under

Look Inside - Outside

1 Hand Grab & Move

2 Hand Grab & Scale, Rotate, Tilt

Point to click



Instructional Goals

Needs Analysis

Identify Goals & Objectives

Want interactions with the tech, content, & applications to be enjoyable, productive, engaging, & memorable.

Have a positive impact on learning.

AR Learning Benefits Cited in Literature

Social, cognitive and emotional improvements have been found when the learning environment is realistic or authentic.

Long-term memory retention by conceptualizing abstract concepts increased understanding.

Learning spatial structures

Physical task performance.

Transparent layers provide multi-depth views & help transfer to authentic work tasks.

Collaboration

AR Learning Challenges

Usability, ineffective integration, and learner differences.

Attention tunneling caused some learners to overlook important information presented, due to the higher levels of sensory input competing for attention.

AR Technology Challenges

Internet connections

Lag time & crashes

Lack projection

No live virtual conferencing

Tethered with wires limiting movement.

Weight of the devices

Non-intuitive navigation

AR Cost Challenges

Tight budgets

Reductions in funding

Students financially stretched, making the purchase of costly new and emerging technologies difficult.

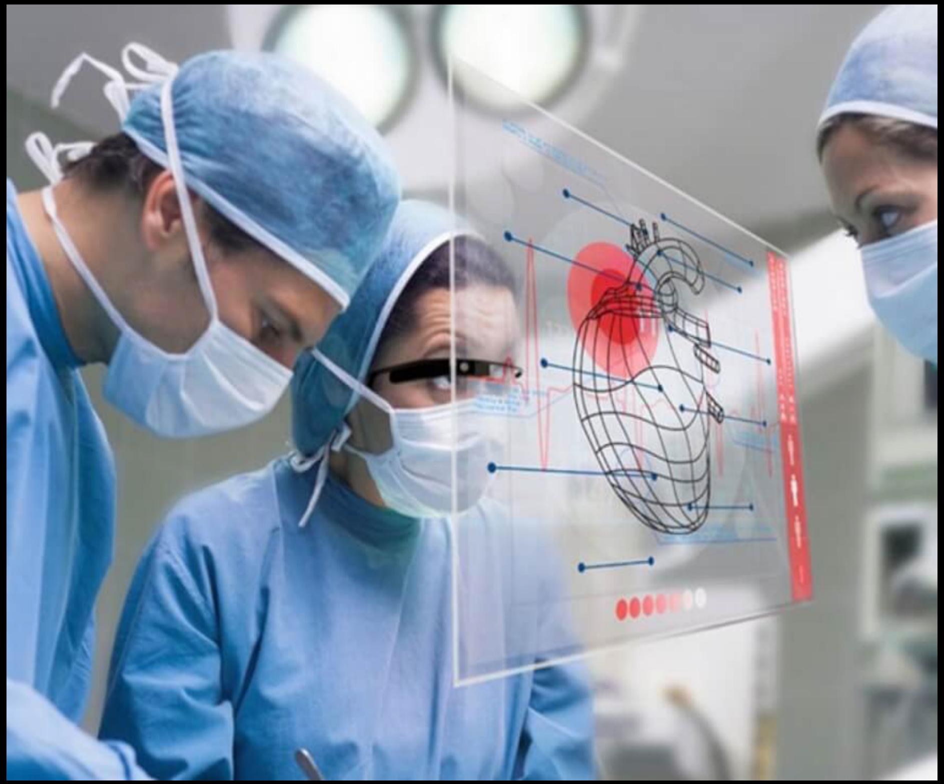
All Fields Applications

Biology, Anatomy, Astronomy, Chemistry, Math, Geometry, and Physics.

Especially difficult to understand abstract concepts can be illustrated visually in three dimensions; such as the solar system, molecules, atoms, and the human body.

A great way to demonstrate changes over time while showing sequence of events.

Learners construct information, develop cognitive thinking skills, experience meaningful authentic hands-on learning.



Education Benefits

Enable logical learning

Experiment observations

Understand theoretical knowledge and activate visual knowledge.

Increase motivation, interest, curiosity to foster positive attitudes towards learning.

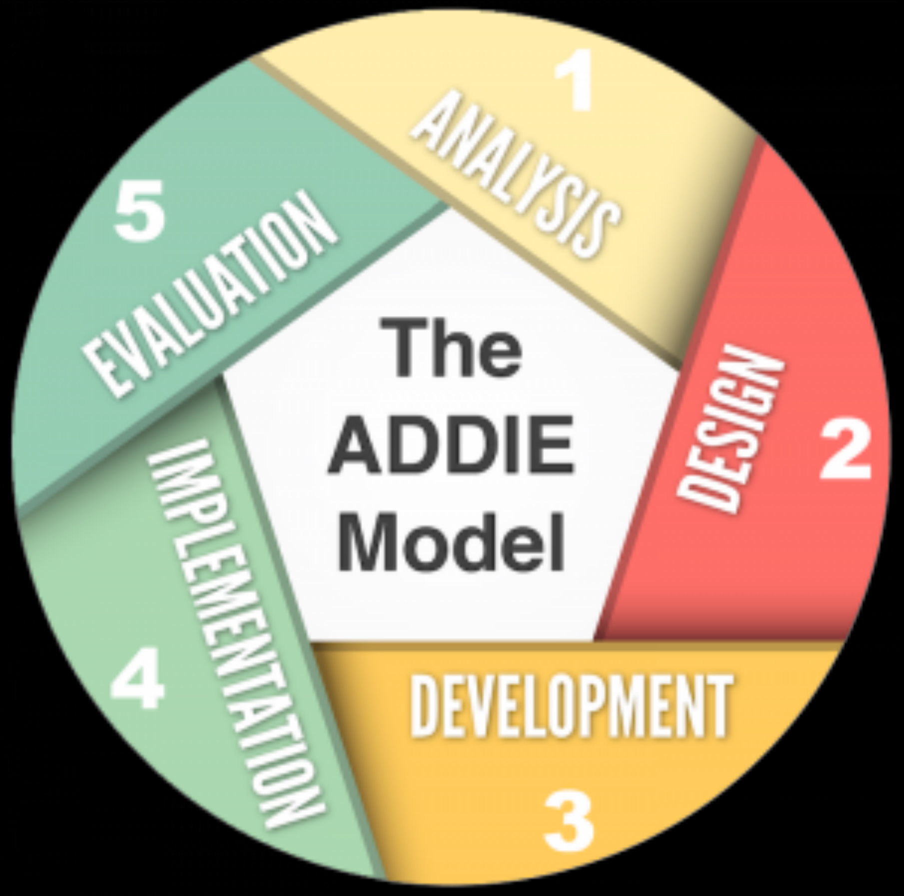
Instructional Design Strategies

Analyze learner needs

Set goals & objectives

Design to enhance and facilitate teaching & learning

IDT strategies include; problem-based discovery, inquiry, authentic experiential contextual learning, kinesthetic, cognitive, and engaging motivational immersion.

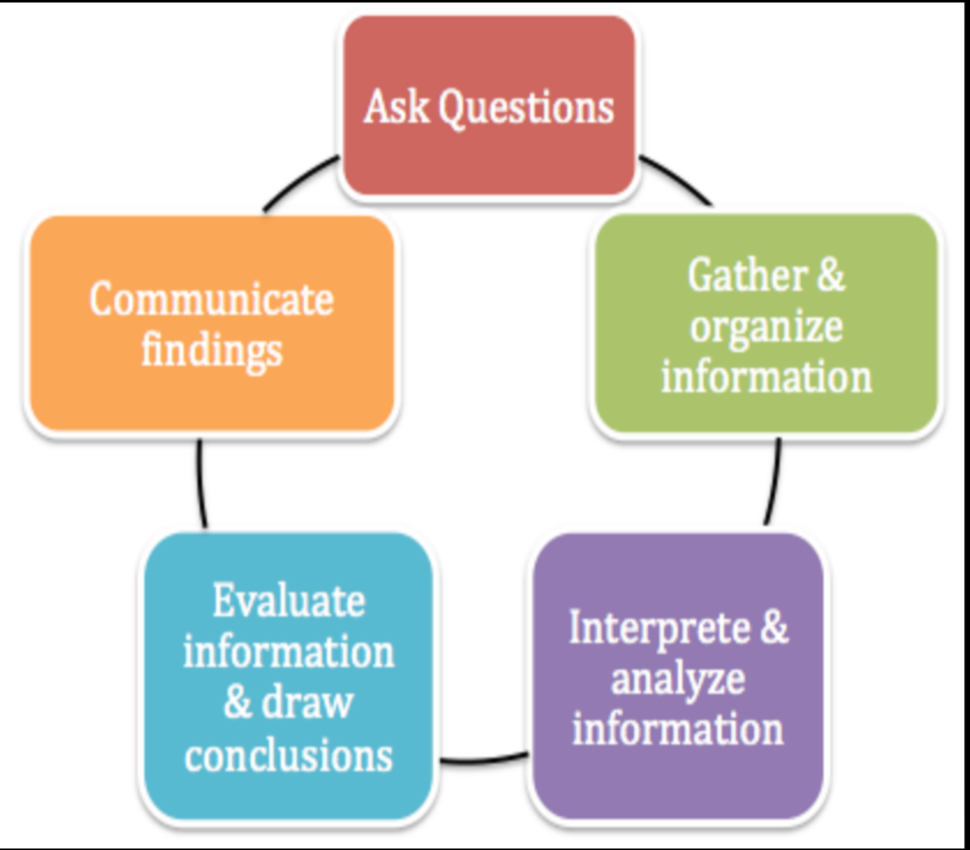


Discovery & Inquiry Design Strategies

Problem-based with learners discovering knowledge.

Use well integrated, organized, relevant materials, while simulating actual field conditions to improve learning performance.

Develop deeper high-level learning and self-responsibility.



Experiential Contextual Design Strategies

Learn new concepts through familiarity, learning by doing, applying concepts, collaboration, while transferring knowledge to new situations.

In education, concrete experiences can serve as the basis for observation and reflection to formulate new theories to test.

Immersion Engagement Design Strategies

Bridge between a real-world environment overlaid with three-dimensional interactive objects, at the same time.

Increase motivation and confidence to improve learning outcomes through increased engagement and time on task.

Knowledge Acquisition Design Strategies

Focus on learning

How the research is set up, with clear directions, training, practice, and ongoing scaffold support.

Learner centered inquiry-based learning goals and objectives is a critical factor for improving achievement.

3D Learning Objects Sources

Pre-made

Modified from basic shapes

Original code

Free or fee based resources

Highly complex layered 3D objects can take a great deal of time to create, as a result they are often costly to buy.

GitHub & Internet sites

Evaluating AR

Learning Processes

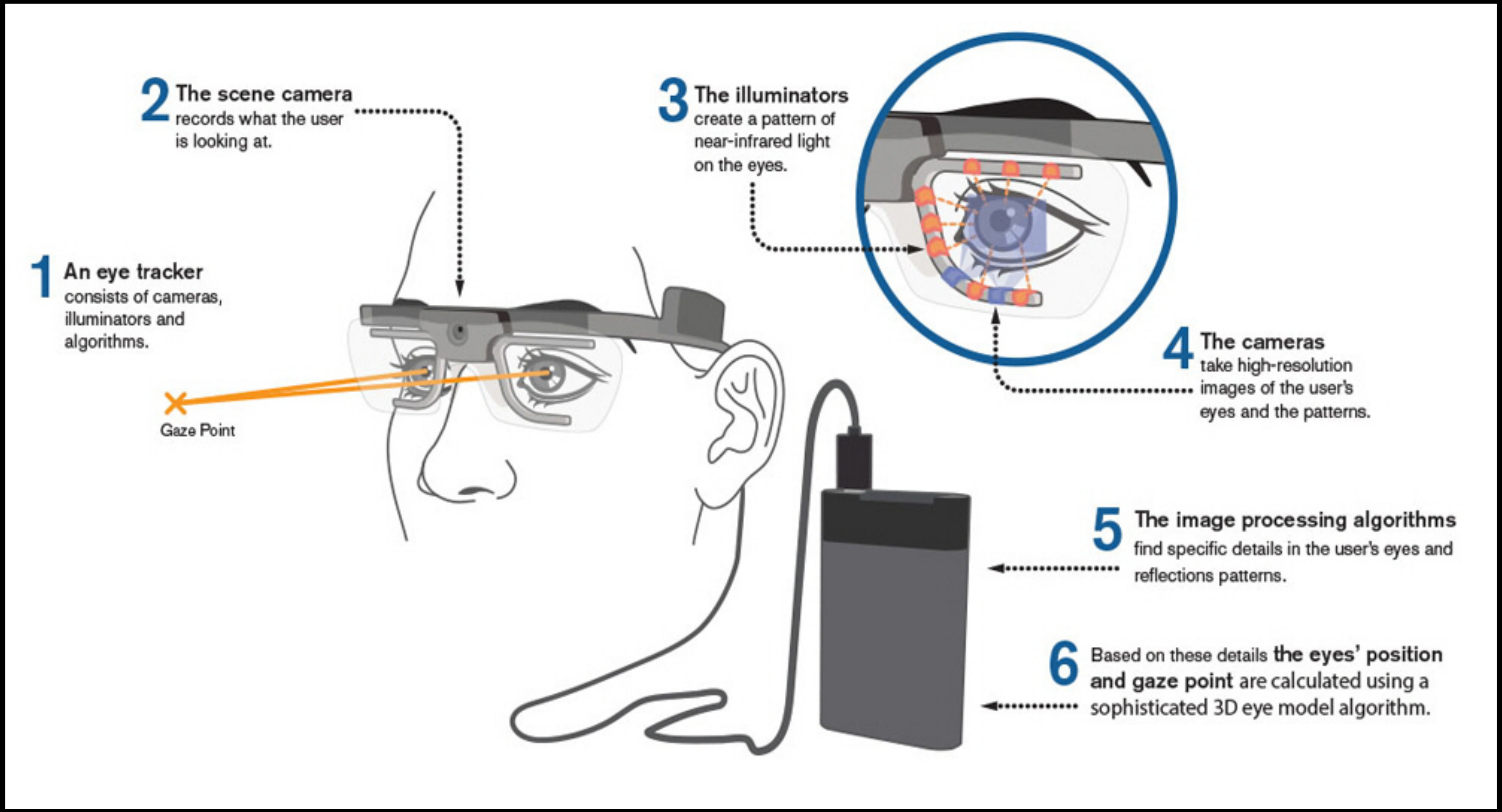
Observations of user behavior & performance

Attention & engagement

Usability

Human factors

Eye Tracking Evaluation of AR



Common Eye Tracking Metrics Examined

(Jacob & Karn, 2003).

Number of fixations, overall.

Gaze % (proportion of time) on each area of interest.

Fixation duration mean, overall.

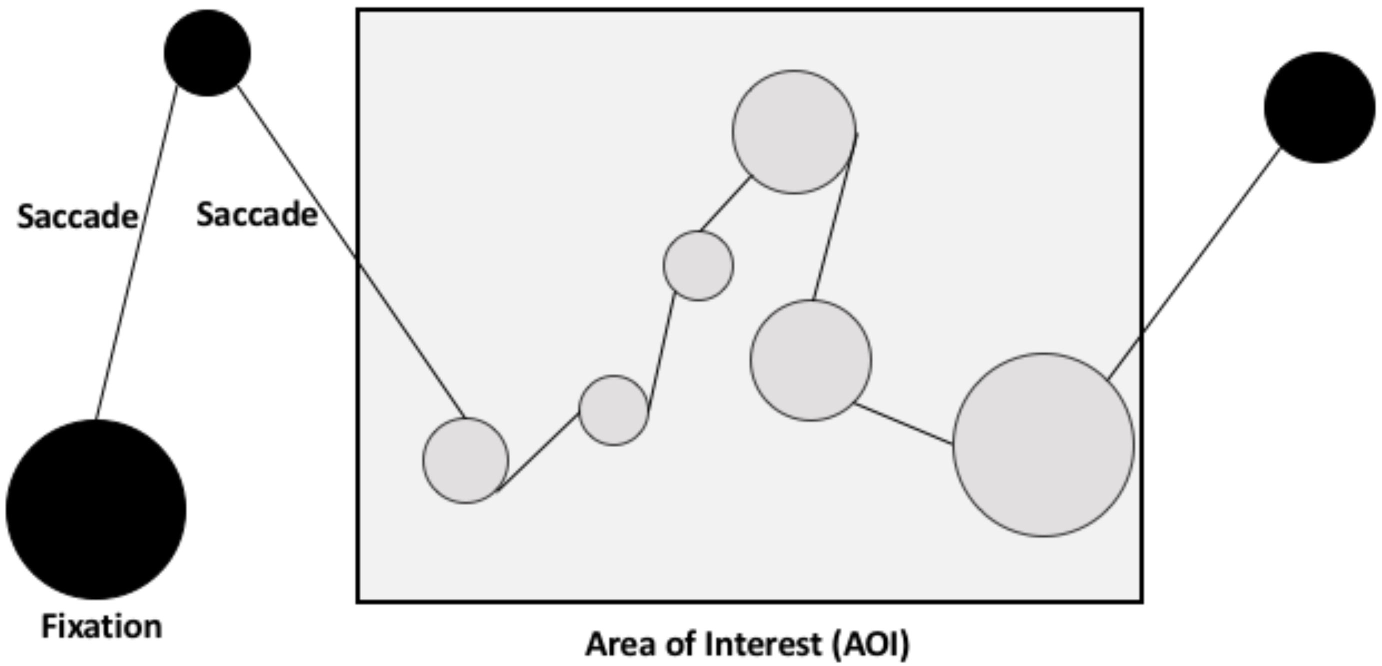
Number of fixations on each area of interest.

Gaze duration mean, on each area of interest.

Fixation rate overall (fixation/s).

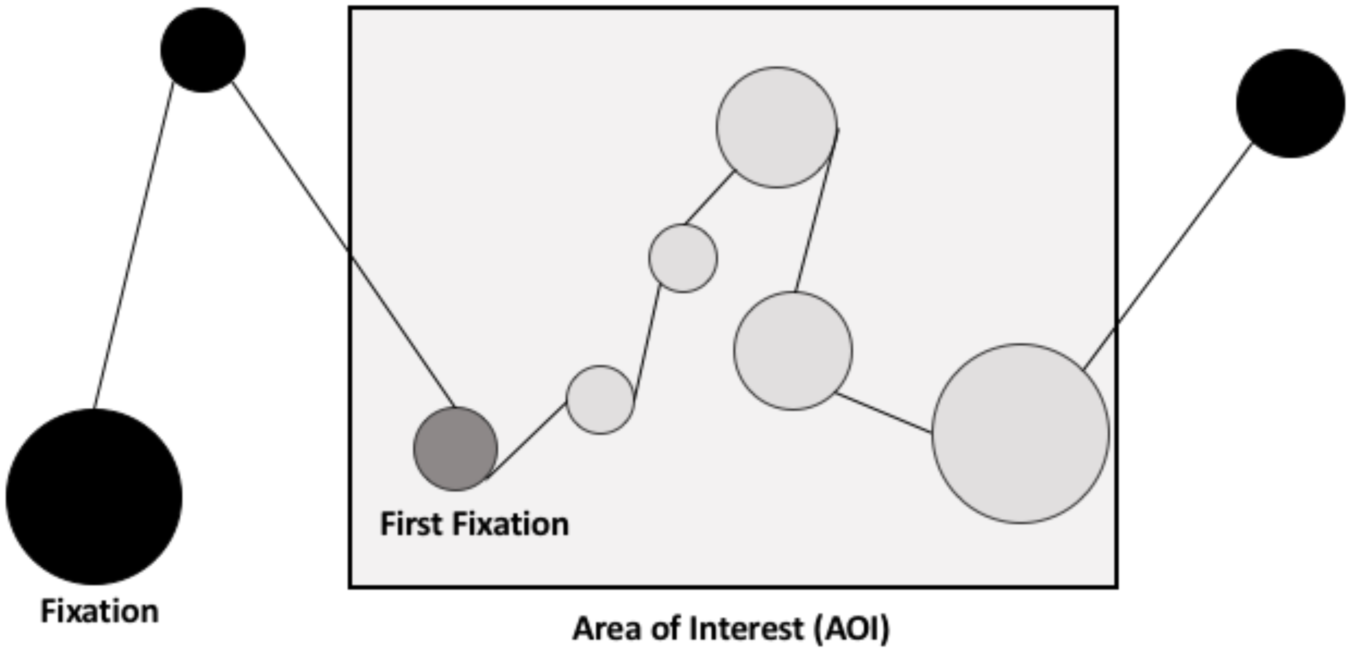
Fixation, Saccade, & Area of Interest

Gaze Plot Data



(Lee, Ryu, & Ke, 2018)

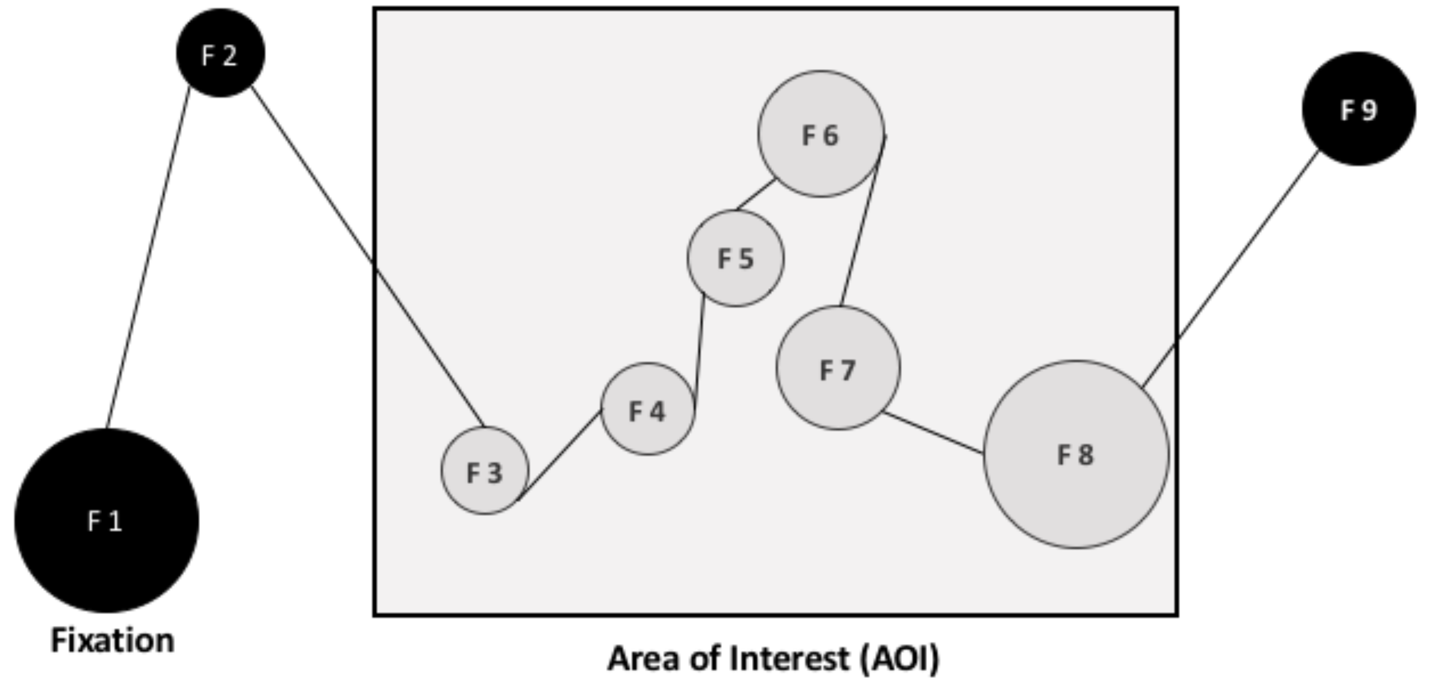
Time To First Fixation (TTFF) Data



(Lee, Ryu, & Ke, 2018)

Fixation Sequence

Order of Importance Data

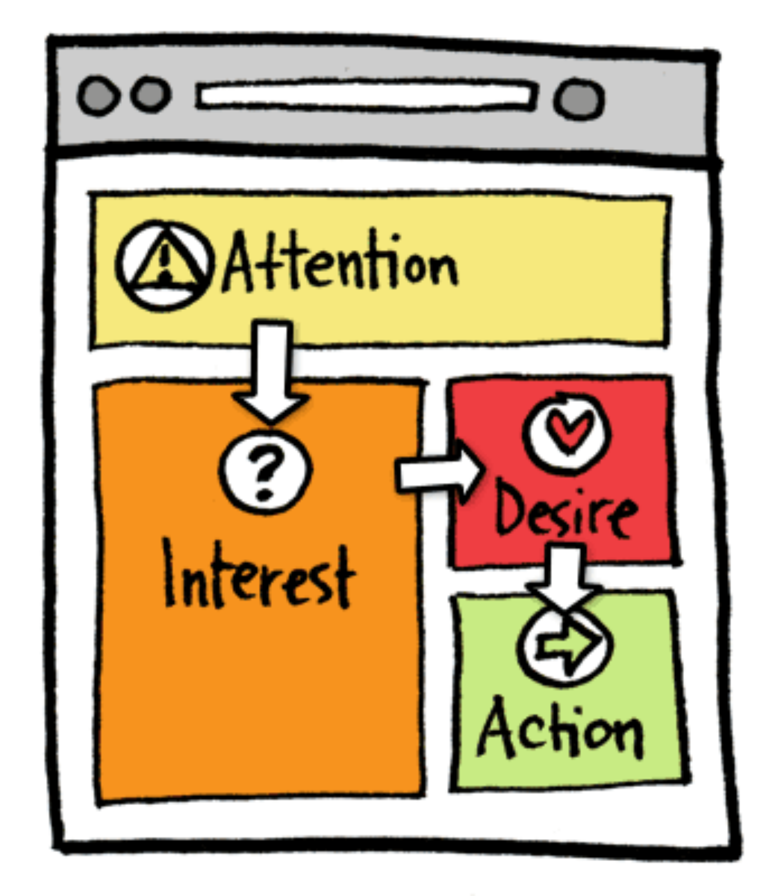


(Lee, Ryu, & Ke, 2018)

Attention = Interest

Attention is ahead of the eyes because it plans the next destination.

Knowing where the attention is directed helps the researcher to understand the data.



Combining Other Biometric Testing

Increase Validity

Increase Reliability

Better sense of users' levels of emotional engagement.

We are wanting to add:

- GSR Galvanic Skin Response
- Facial Expression Analysis

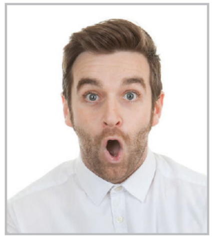
IMOTIONS	What is measured?	How is it measured?	Which metrics can be derived?	How can the data be interpreted?
Eye tracking (infrared)	Corneal reflection & pupil dilation	Infrared camera point towards eyes	Eye moments (gaze, fixations, saccades), blinks, pupil dilation	Visual attention, engagement, drowsiness & fatigue, emotional arousal
GSR (galvanic skin response)	Changes in skin conductance due to sweating	Electrodes attached to fingers, palms or soles	Skin conductance response (SCR)	Emotional arousal, engagement, congruency of self-reports
Facial Expression Analysis	Activity of facial muscles & muscle groups	(Web-)cam point towards face along with computer algorithms for feature extraction	Postion and orientation of head & facial landmarks, activation of action units (AUs) & emotion channels	Emotional valence, engagement, congruency of self-reports
(Facial) EMG (electromyogram)	Changes in electrical activity caused by muscle contraction	Electrodes attached to the skin (above muscles)	Muscle contraction onset, offset & duration, AU activity	Emotional valence, responsiveness to stimuli
ECG / EKG (electrocardiogram)	Changes in electrical activity caused by heart contraction	Electrodes attached to chest or limbs	Heart rate (HR, BPM), interbeat interval (IBI), heart rate variability (HRV)	Emotional arousal, stress, physiological activity
PPG (photoplethysmogram)	Changes in light absorption of blood vessels	Optical sensor attached to finger, toe or earlobe	Optical heart rate (HR)	Emotional arousal, stress, physiological activity
EEG (electroencephalogram)	Changes in electrical activity of the brain	Electrodes places on scalp	Frequency band power (delta, theta, alpha, beta, gamma bands), frontal lateralization & asymmetry index event-related potentials, wavelets	Attention, emotional arousal, motivation, cognitive states, mental workload, drowsiness & fatigue,

Face Expression Emotional Analysis

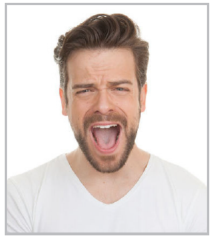
Joy

Anger

Surprise

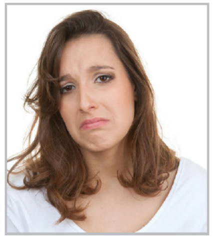


Fear



Contempt

Sadness



Disgust

Facial expression engines differ by the available metrics that are automatically coded:

Emotient FACET

- Head orientation (yaw, pitch, roll)
- 6 facial landmarks (ADD eye and nose position)
- 7 basic emotions, valence; complex states: frustration, confusion
- 20 Action Units
- respondent's sex and whether or not respondent wears glasses

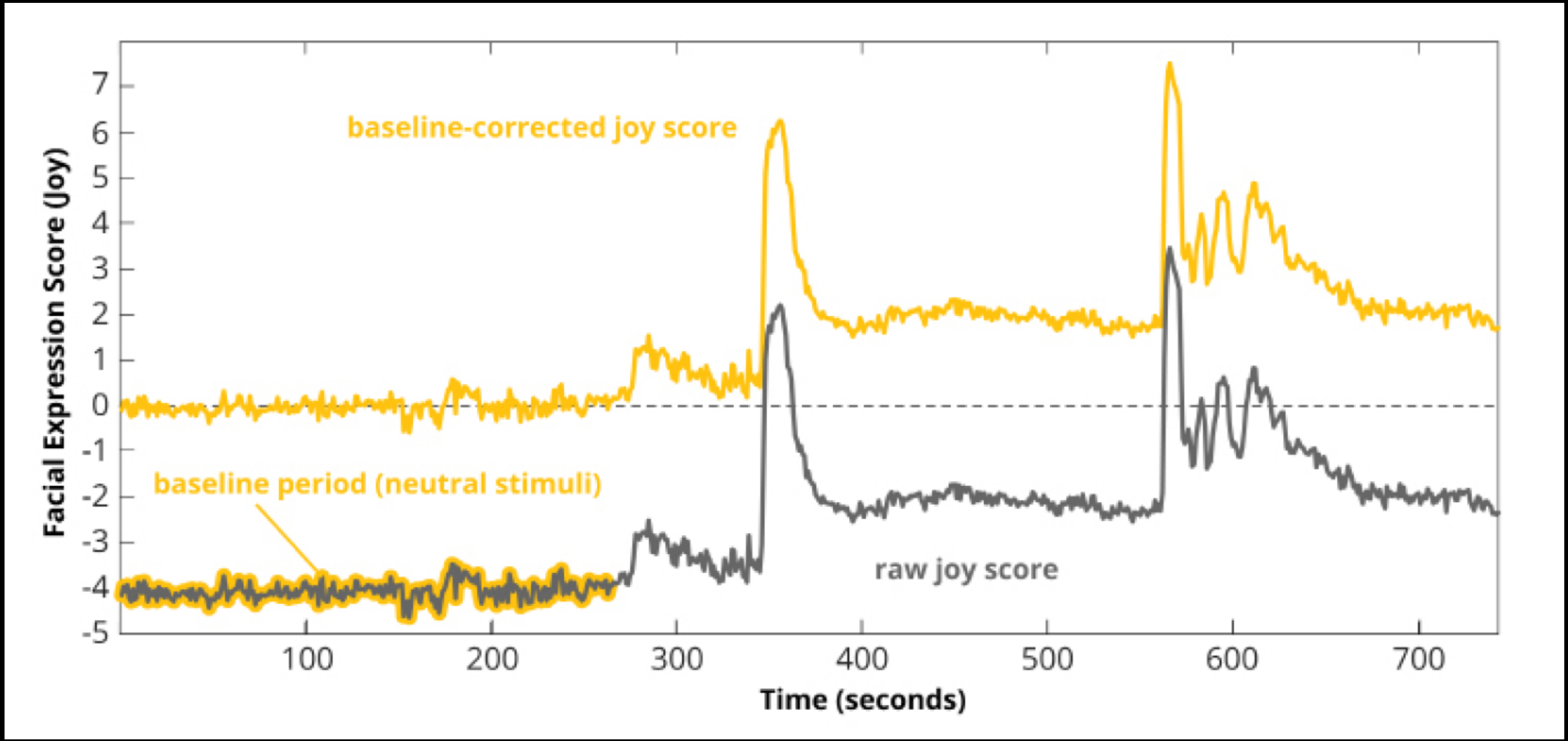
Affectiva AFFDEX

- Head orientation (yaw, pitch, roll)
- Interocular distance and 34 facial landmarks
- 7 basic emotions; valence, engagement, attention
- 14 facial expression metrics (similar to Action Units)

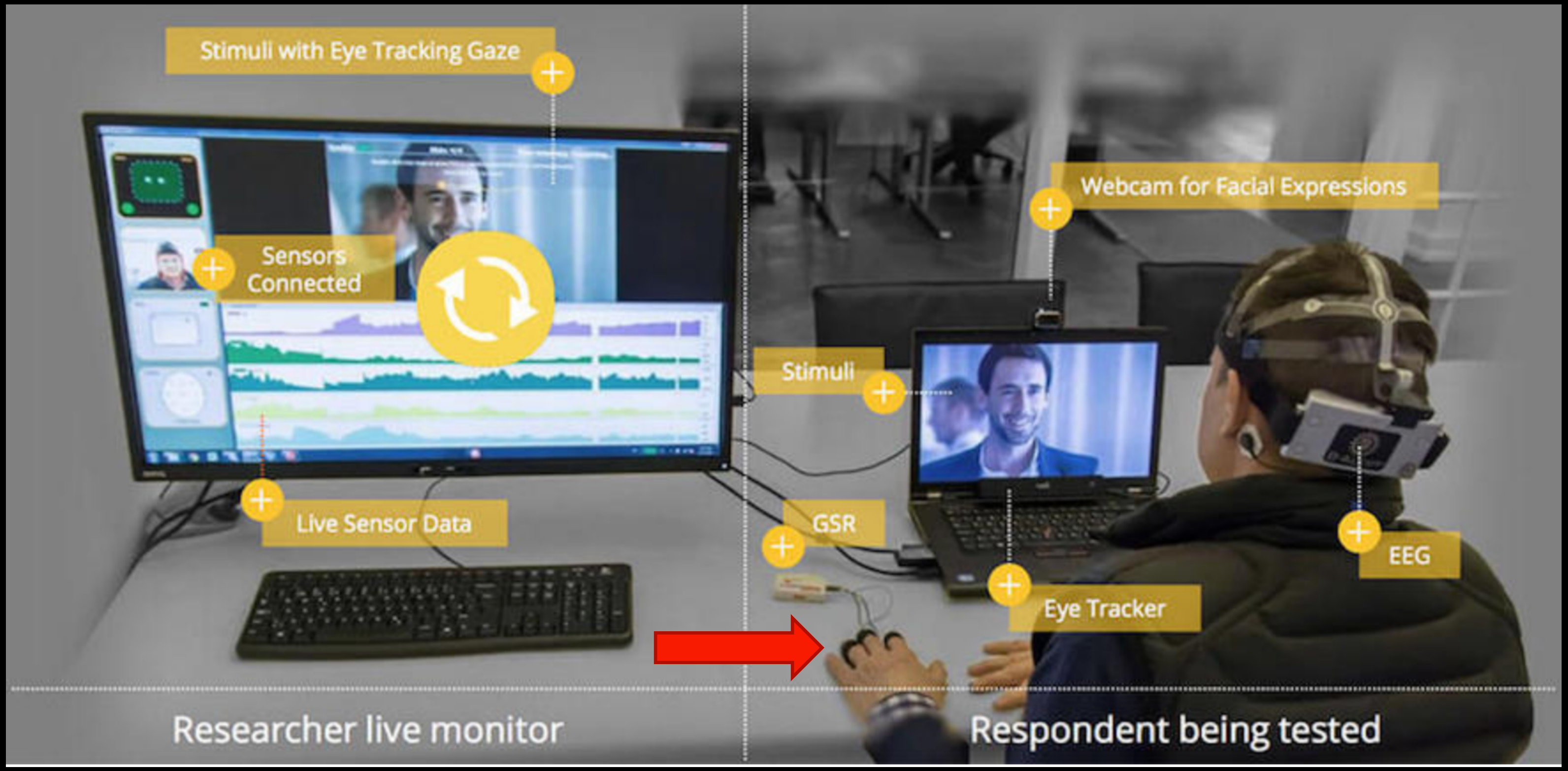
Noldus FaceReader

- Head orientation (yaw, pitch, roll)
- 6 basic emotions; contempt (experimental), arousal, valence
- 20 Action Units

Face Expression Emotional Analysis



Galvanic Skin Response (GSR)



Measure emotional arousal and stress by measuring changes in the conductivity of the skin.

Attention

Knowing what grabs attention and keeps it will help to improve instructional materials and experiences.

Able to keep learners on task to meet goals and objectives.

Findings

We just got our Biometric Testing Lab. Starting on a small scale, we hope to continue to grow it over time.

It is very exciting to think about how we will really know if the devices and applications are truly serving our needs.

Summary Reflection

To do it well, it will take knowledge, time, and experience.

In the end we will know more about what works to engage teaching and learning.

Able to prepare learners for new employment opportunities.

Questions & Shared Experiences

Questions?

Do any of you have prior experiences to share?