



Technology Enhanced Learning Spaces

PROF. DR. MARCUS SPECHT
WELTEN INSTITUTE
RESEARCH CENTRE FOR LEARNING, TEACHING AND TECHNOLOGY
OPEN UNIVERSITEIT NEDERLAND
MARCUS.SPECHT@OU.NL
TWITTER, FLICKR, FACEBOOK: MARCUSPECHT



#1 DESIGNING TECHNOLOGY
ENHANCEMENT DRIVEN BY ...

NEW DIGITAL CONTENT

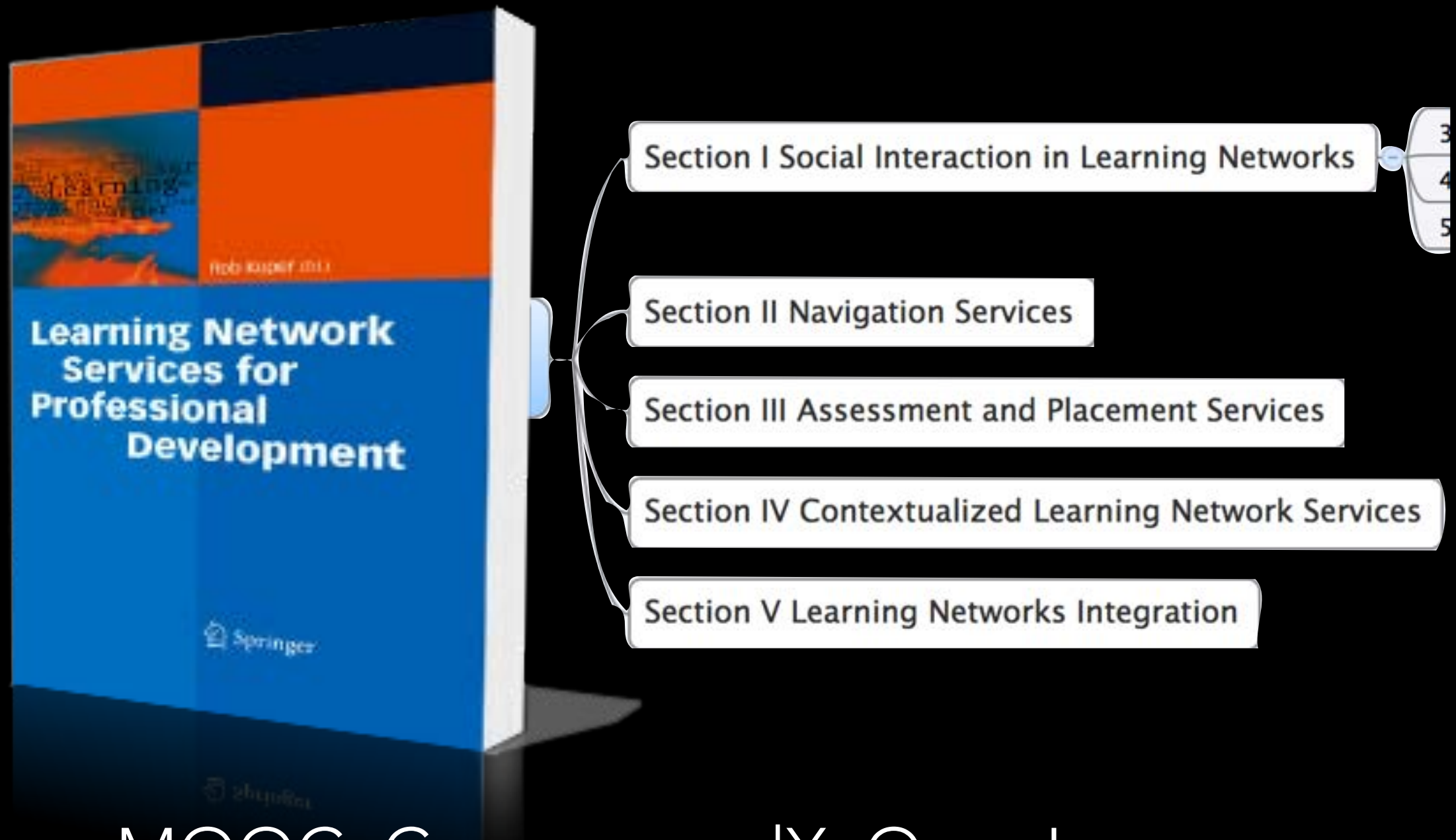


OER, iTunes U, Youtube EDU, ...

LOR: GLOBE, Ariadne, ODS, MACE, Sharetec,...

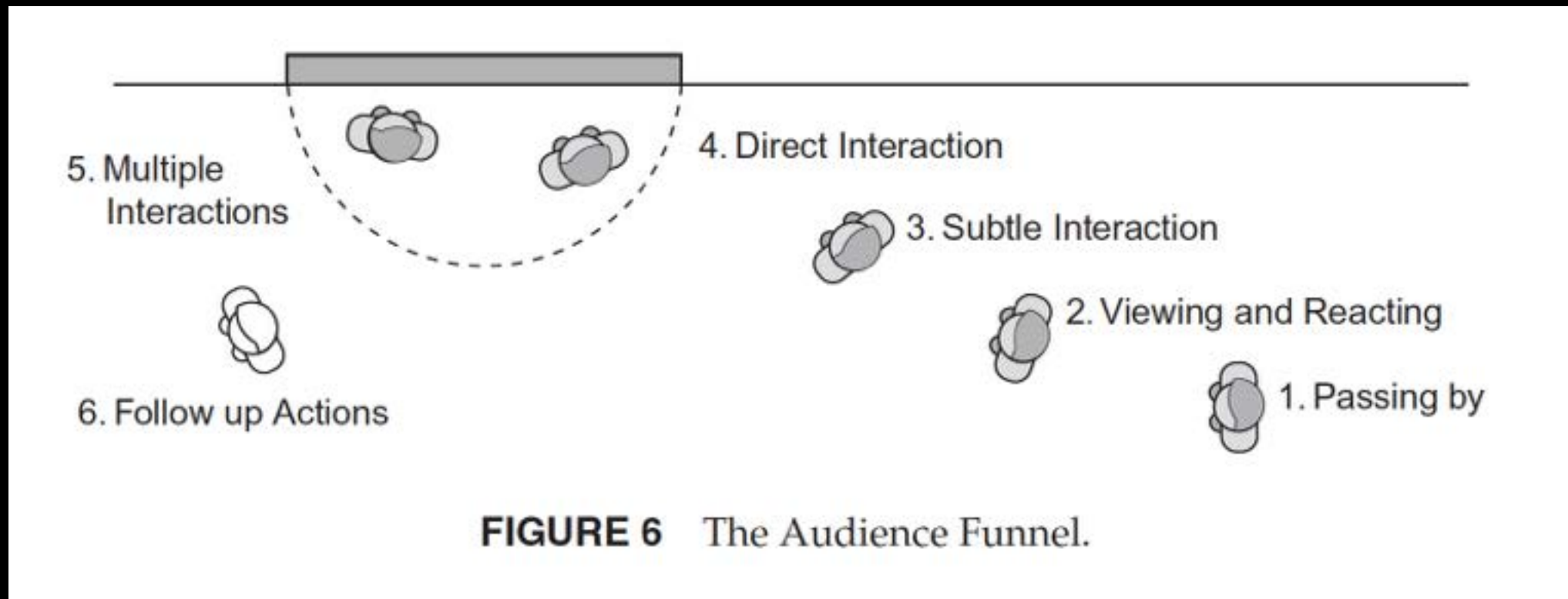
Mobile: GLOBE, Ariadne, ODS, MACE, Sharetec,...

Scaling Processes



MOOC: Coursera, edX, OpenLearn,
Futurlearn, yOUlearn

NEW INTERFACES



Mobile Access, Augmented Reality

Tangibles, Sensor-Based Interfaces, Tabletops

Situated Displays, Ambient Displays, Public Displays

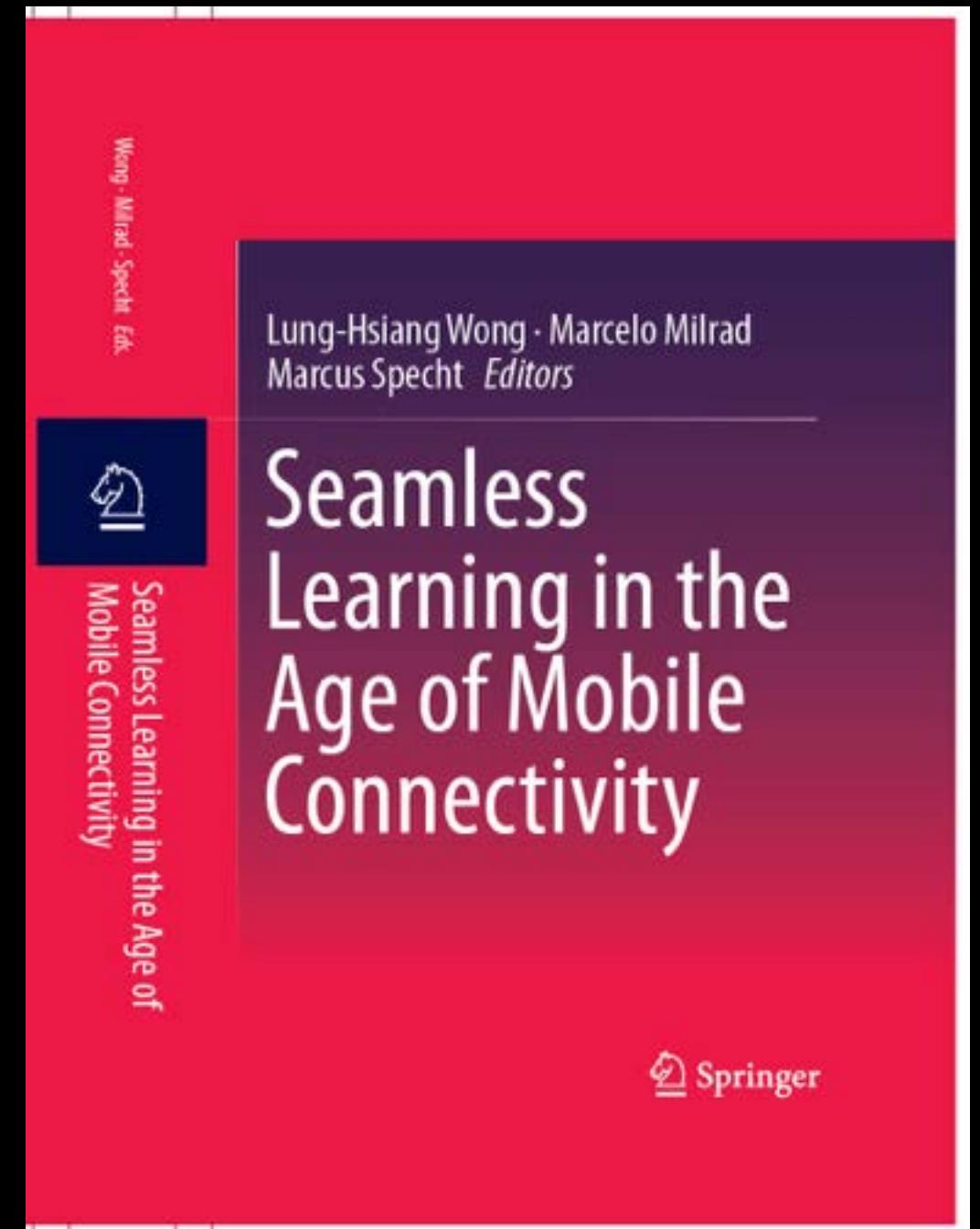
LEARNING SPACES



RESEARCH AND DESIGN CHALLENGE:

HOW TO DESIGN SEAMLESS LEARNING SUPPORT IN TEL SPACES?

- Formal and informal learning;
- Personalized and social learning;
- Across time; locations, social contexts
- Combined use of multiple device types;
- Physical and digital worlds
- Multiple learning tasks knowledge synthesis



HOW TO CREATE LINKS BETWEEN DIGITAL AND PHYSICAL

#1 LINKING THE WORLDS



Participants

	Name	Role
	Mo	Scout
	Marcus	Data Gatherer
	Lucia	Annotator
	Nick	Researcher
	Milos	Analyst
	Alex	Reporter

Communication



from	subject	time
Lucia	A new task for you!	11:35
Nick	Can you please...	11:27
Marcus	Question concerning task 1	11:22
Mo	Hello	11:21
Roderick	What shall we do next?	11:17















New message

Reply

Mo Hello 11:21

Hi, here you are some more flower pictures.
Just tell me if you need more or different ones...

Task Overview

Task	Subtasks	Status	Participants	Repository
Flower Task	• Collect pictures of at least 10 different flowers you can find on the meadows.	<div><div></div><div></div><div></div><div></div></div> finished	 Mo (Scout)  Marcus (Data Gatherer)  Lucia (Annotator)	 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	• Find out at which places they preferably grow and check if that matches your findings.	<div><div></div><div></div><div></div><div></div></div> ongoing	 Nick (Researcher)  Milos (Analyst)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	• Ask the expert which of the flowers is the rarest and which he likes best.	<div><div></div><div></div><div></div><div></div></div> pending	 Alex (Reporter)  Sian (Comm. Manager)	
Add Subtask		Change	Add / Remove	
Tree Task	• Collect pictures of at least 10 different flowers you can find on the meadows.	<div><div></div><div></div><div></div><div></div></div> ongoing	 Mo (Scout)  Marcus (Data Gatherer)  Lucia (Annotator)	 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
	• Find out at which places they preferably grow and check if that matches your findings.	<div><div></div><div></div><div></div><div></div></div> ongoing	 Nick (Researcher)  Milos (Analyst)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

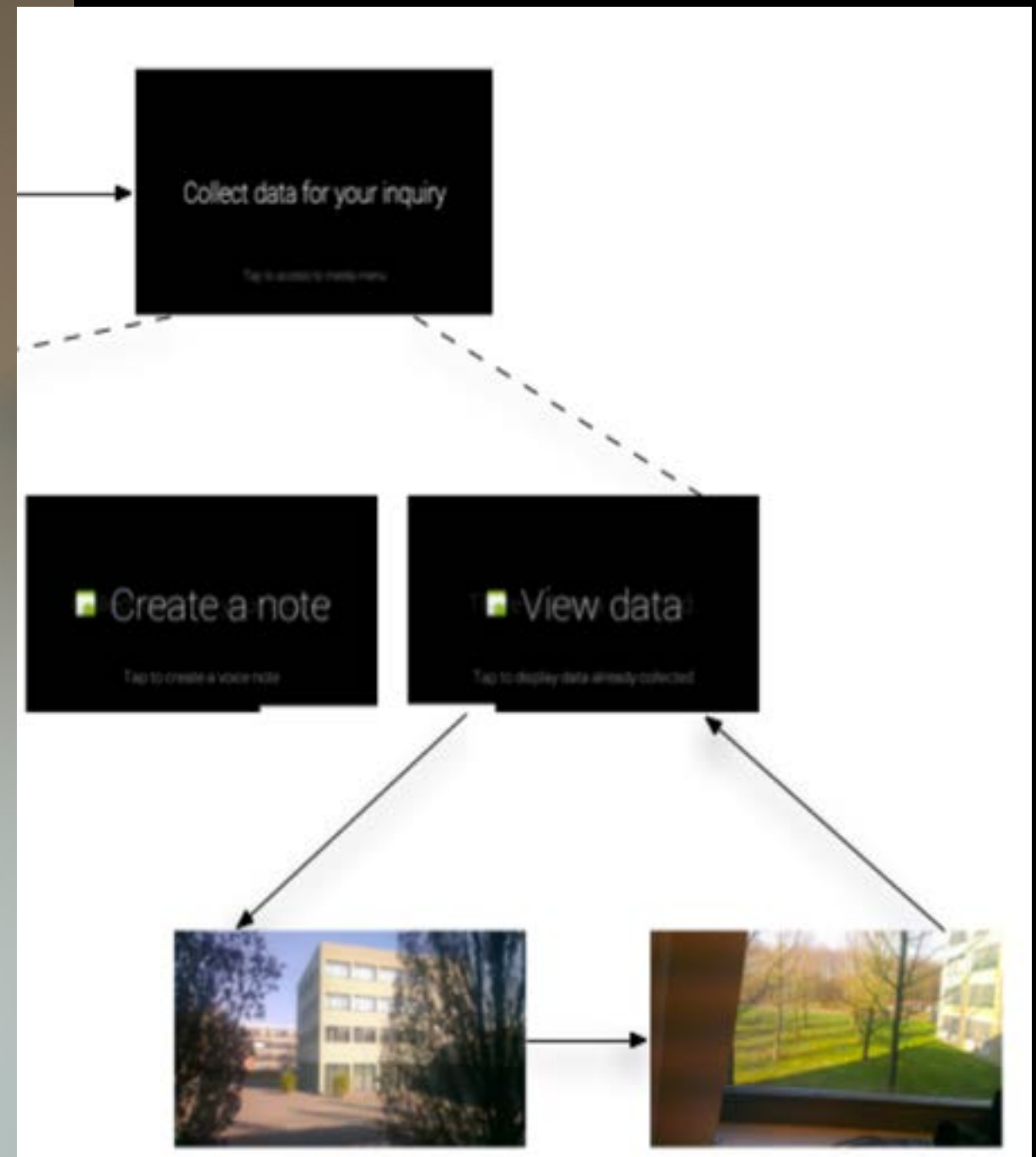
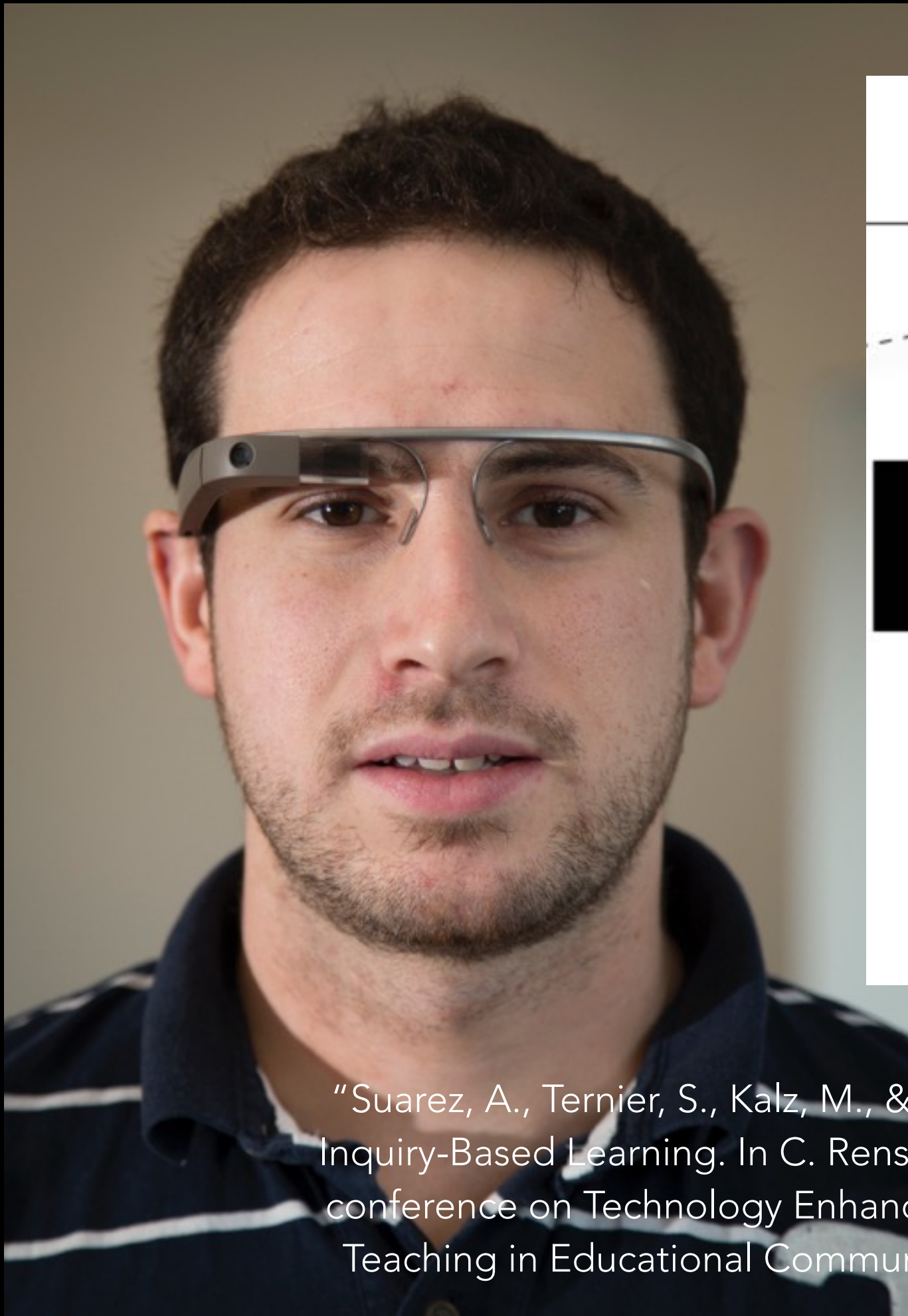
Navigation



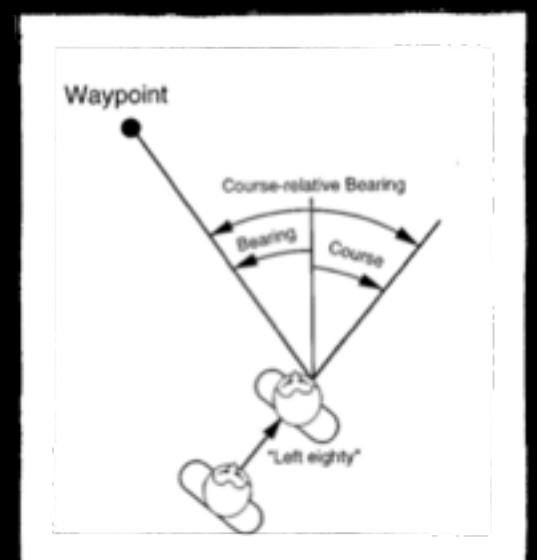
Comment:

Here are a lot of different flower different flowers and old trees.

FIELD TRIPS
LOCATION-BASED



"Suarez, A., Ternier, S., Kalz, M., & Specht, M. (2014). GPIM: Google Glassware for Inquiry-Based Learning. In C. Rensing et al (Eds.), Proceedings of the 9th European conference on Technology Enhanced Learning - EC-TEL 2014: Open Learning and Teaching in Educational Communities, LNCS 8719 (pp. 530-533). Graz, Austria.."



audio augmented spaces ...

OPENSOURCE FRAMEWORK FOR MIXED REALITY GAMES

ARLEARN



LANGUAGE LEARNING

- <http://www.elena-learning.eu>



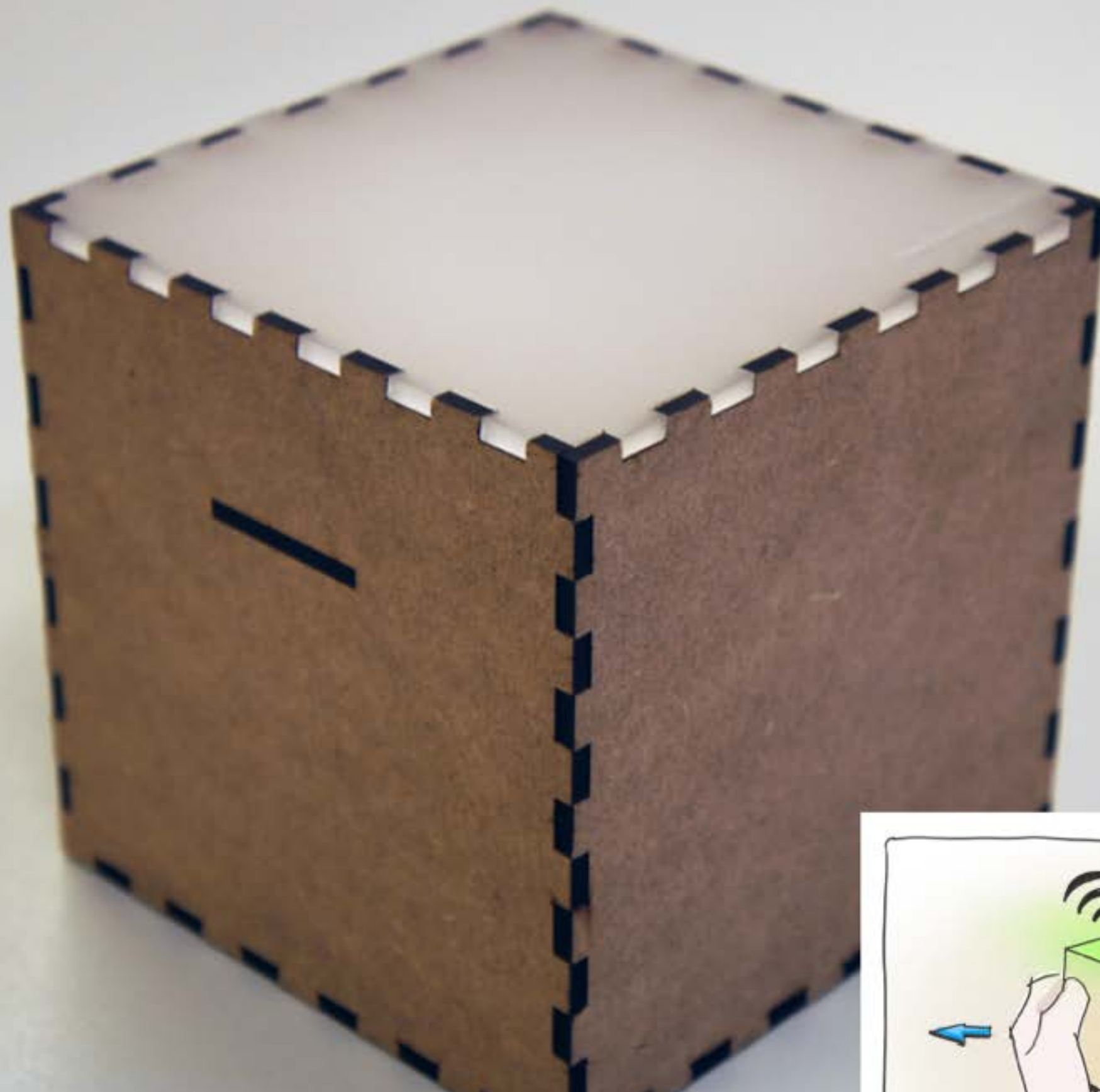


mæve

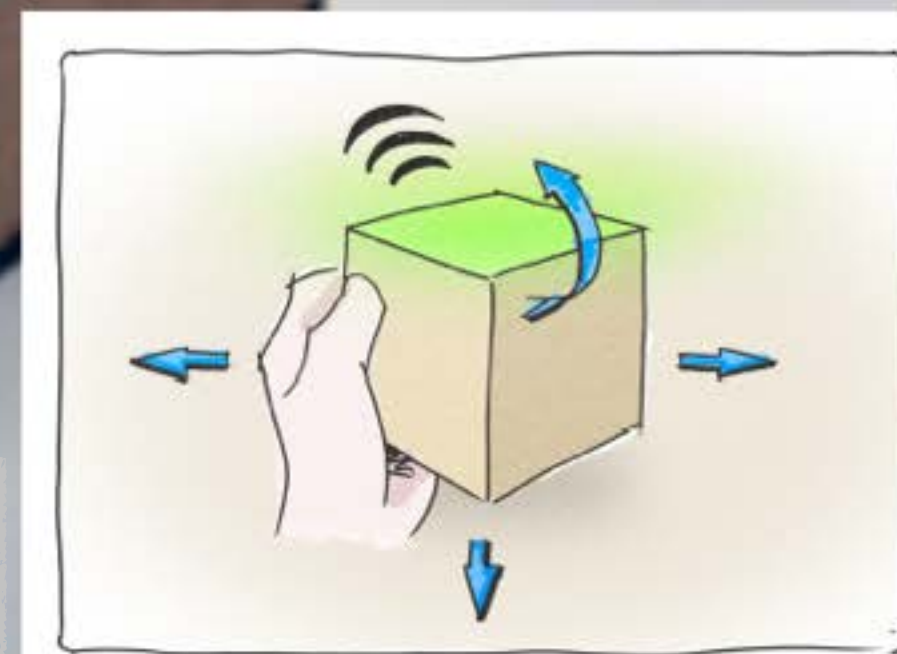
MACE | EVERYVILLE

interactive installation at the Venice Biennale '08

objects as controllers of ambient displays ...



actuator/controller ...





[HTTPS://WWW.YOUTUBE.COM/
WATCH?V=RL-JAI4IN8](https://www.youtube.com/watch?v=RL-JAI4IN8)

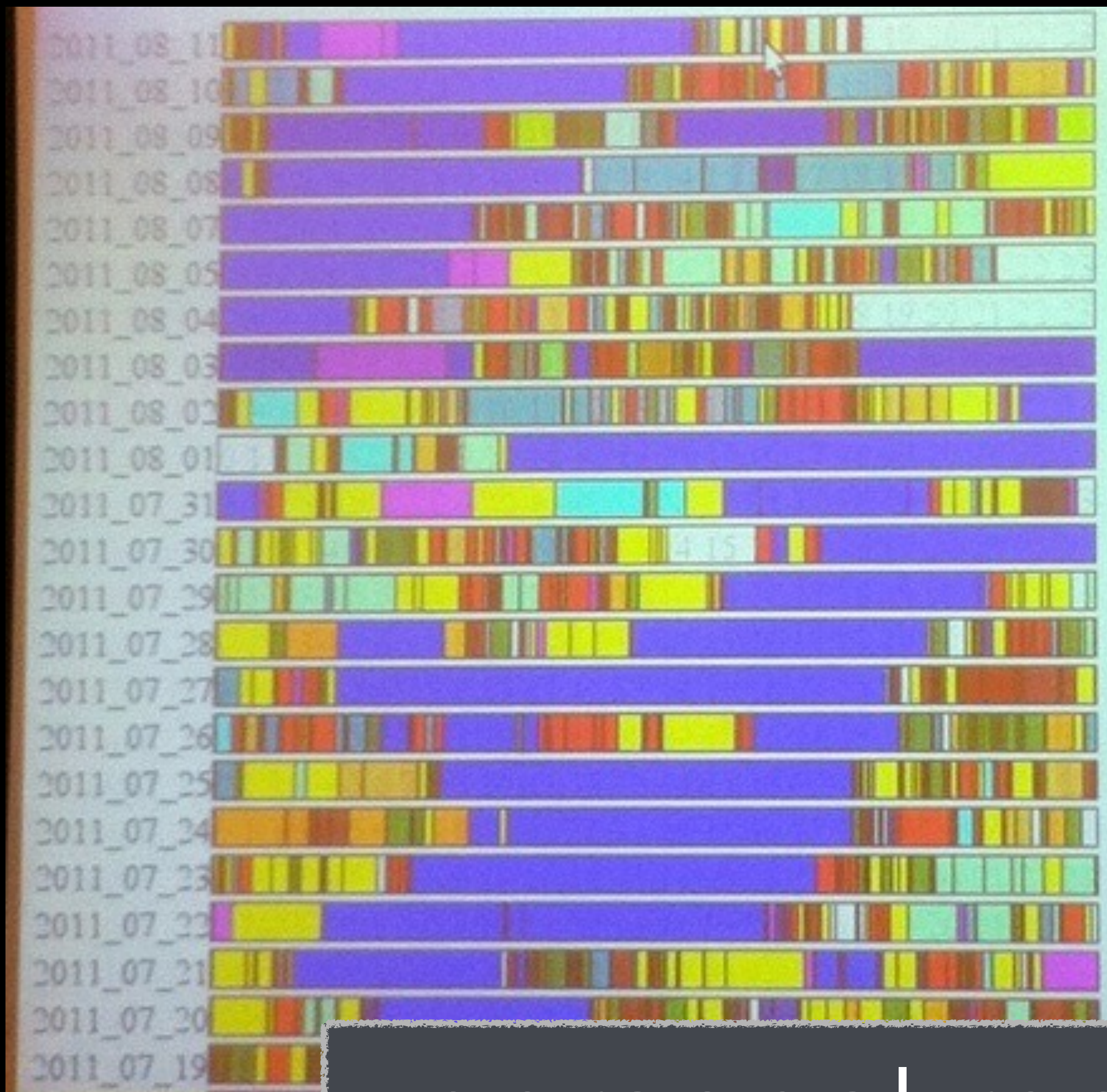
embedded trackers ...

MULTI-DEVICE OUTPUT



AGGREGATION AT
SOCIAL SPOTS

personal and social views ...



Vessyl

personal records...

Sensor data

▼ 1. audio

- a. volume analysis
- b. frequency analysis
- c. rhythm analysis

▼ 2. video

- a. face recognition
- b. lighting conditions
- c. image and object recognition

▼ 3. accelerometer

- a. vibration
- b. movement
- c. activity
- d. agility

▼ 4. magnetometer

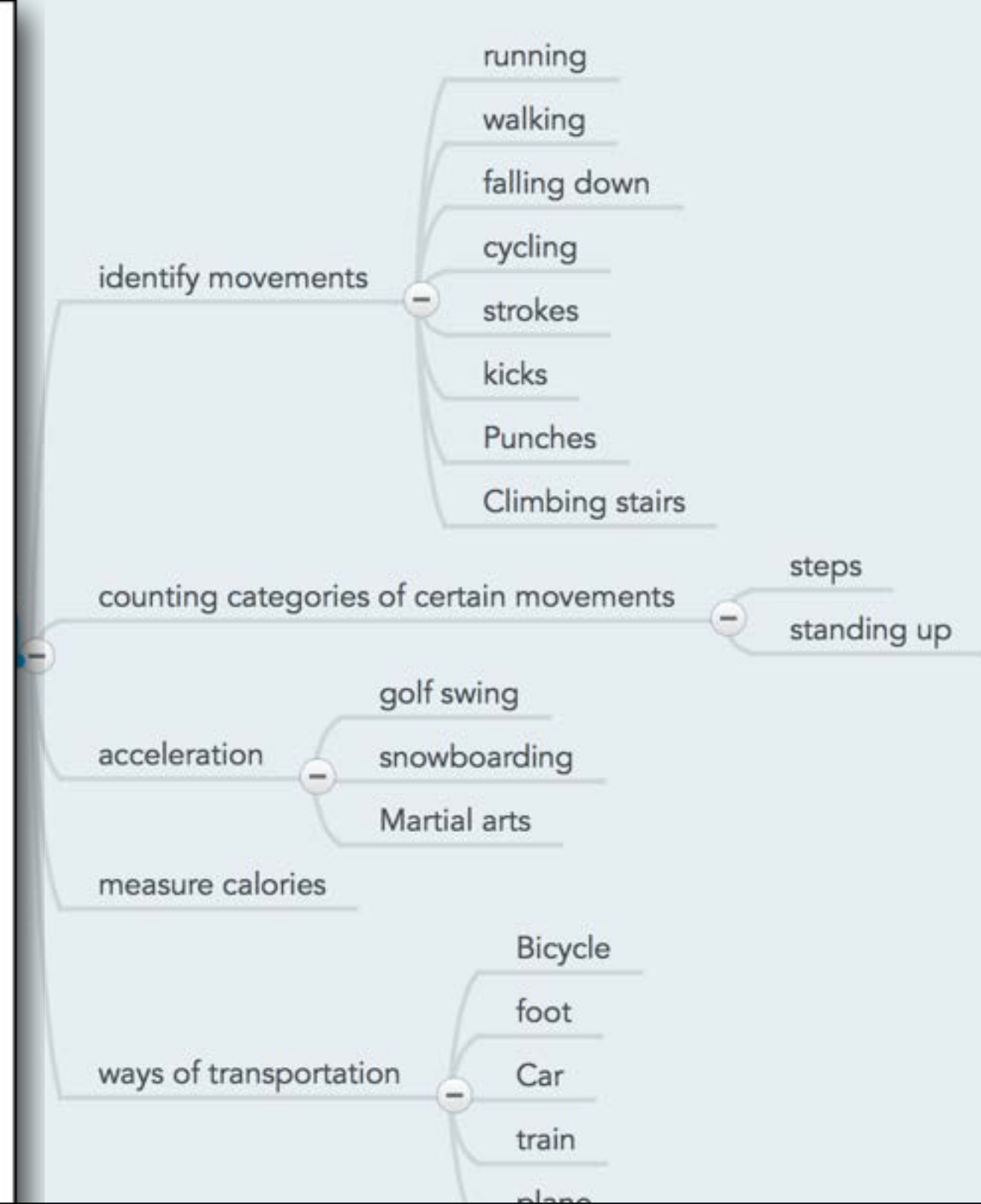
- a. orientation
- b. magnetic field
- c. shaking
- d. absolute orientation

▼ 5. gps

- a. location
- b. environment
- c. proximity

▼ 6. user input (ESM)

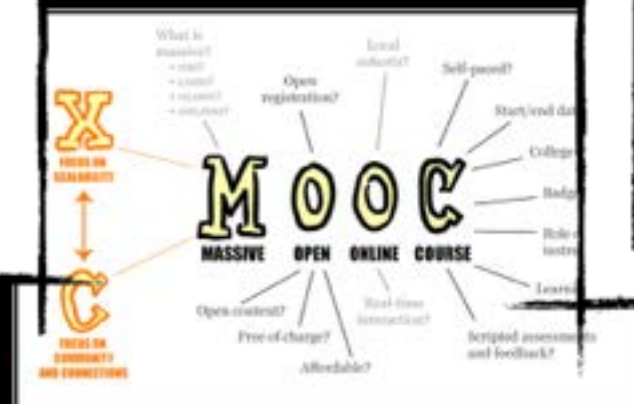
- a. everything else



[HTTP://WWW.LUMOBODYTECH.COM/LUMOBACK/](http://www.lumobodytech.com/lumoback/)

sensor data for...

PSP EMMA : EUROPEAN
AGGREGATOR,
LANGUAGE AND
INSTRUCTIONAL DESIGNS



PSP ECO: MASSIVE
MOBILE, UBIQUITOUS
AND OPEN LEARNING,
MOBILE EXTENSIONS OF
MOOCS

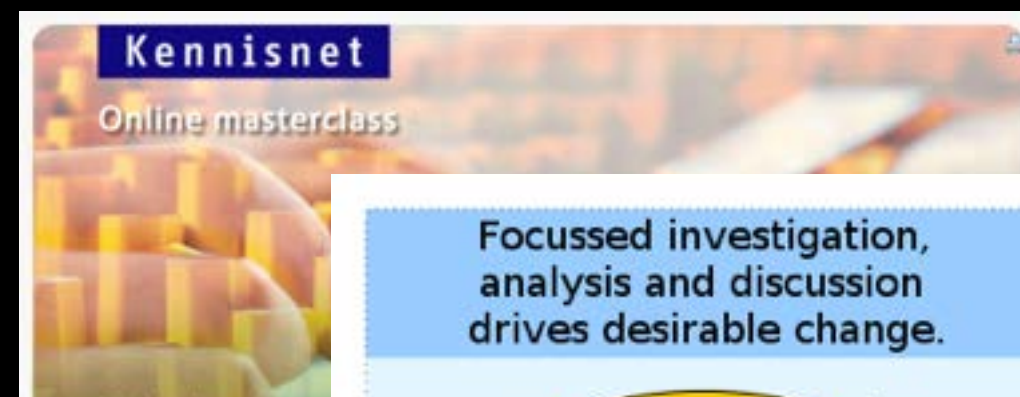
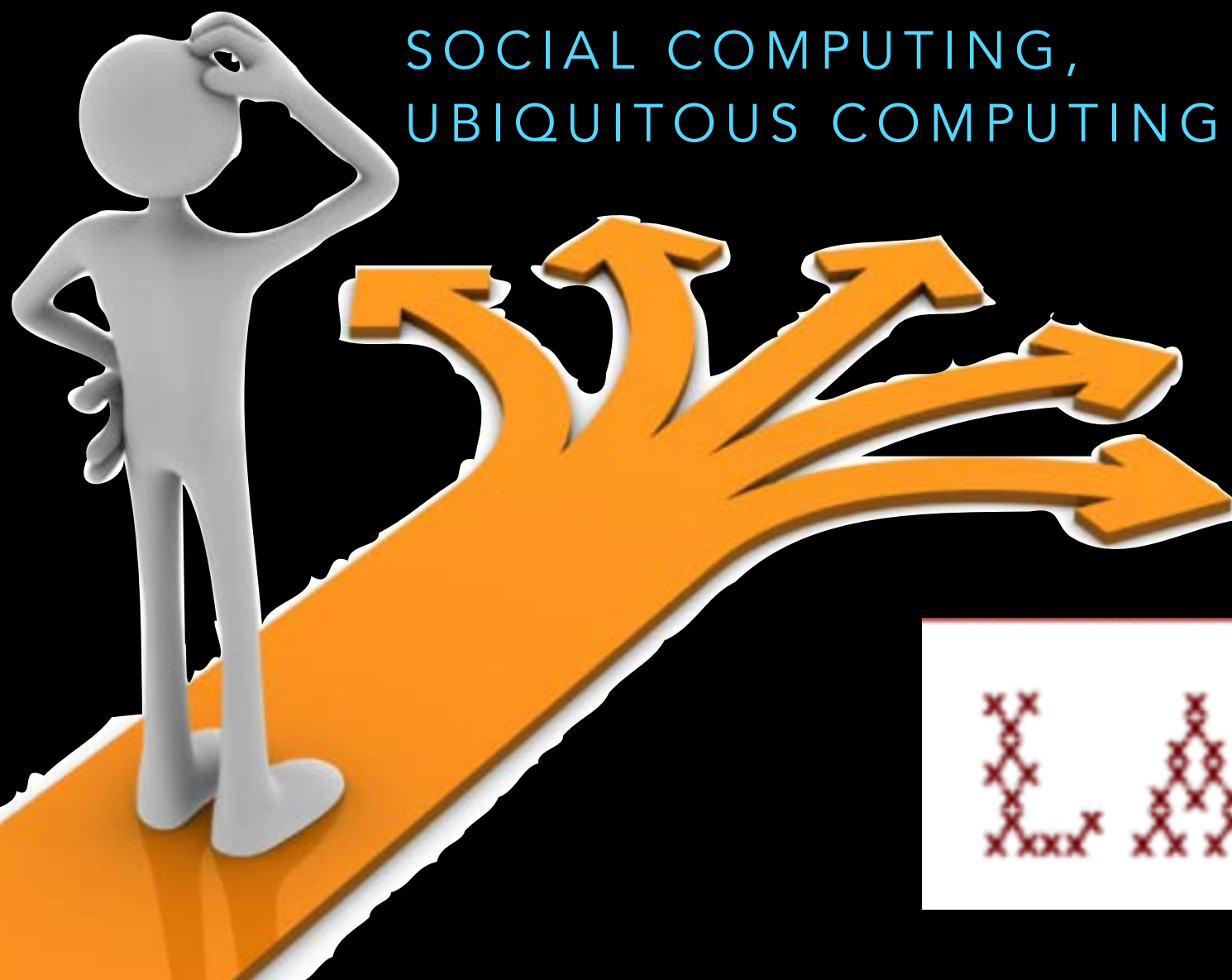
weSPQT

OPEN CONTENT AND DATA
SOCIAL COMPUTING,
UBIQUITOUS COMPUTING

BIG DATA

LINKED DATA

LEARNING ANALYTICS



Focussed investigation,
analysis and discussion
drives desirable change.

LACE



LOTS OF CHANGES

computers changed
they are

embedded in our daily interactions and
environments,

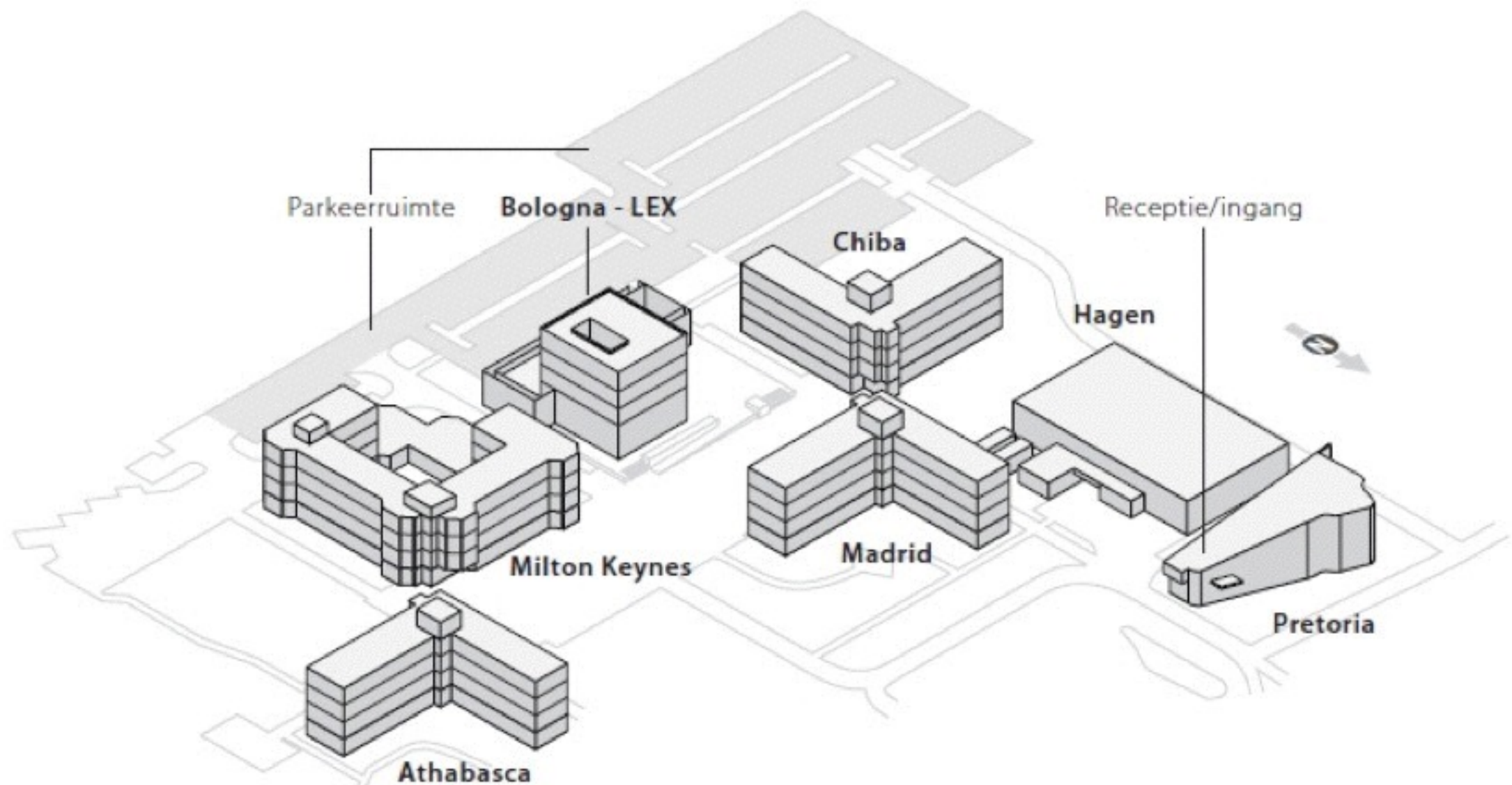
they **sense** our activities and analyse the data,

they **visualise** and integrate data in our personal space

#2 LINKING TO HUMAN LEARNING

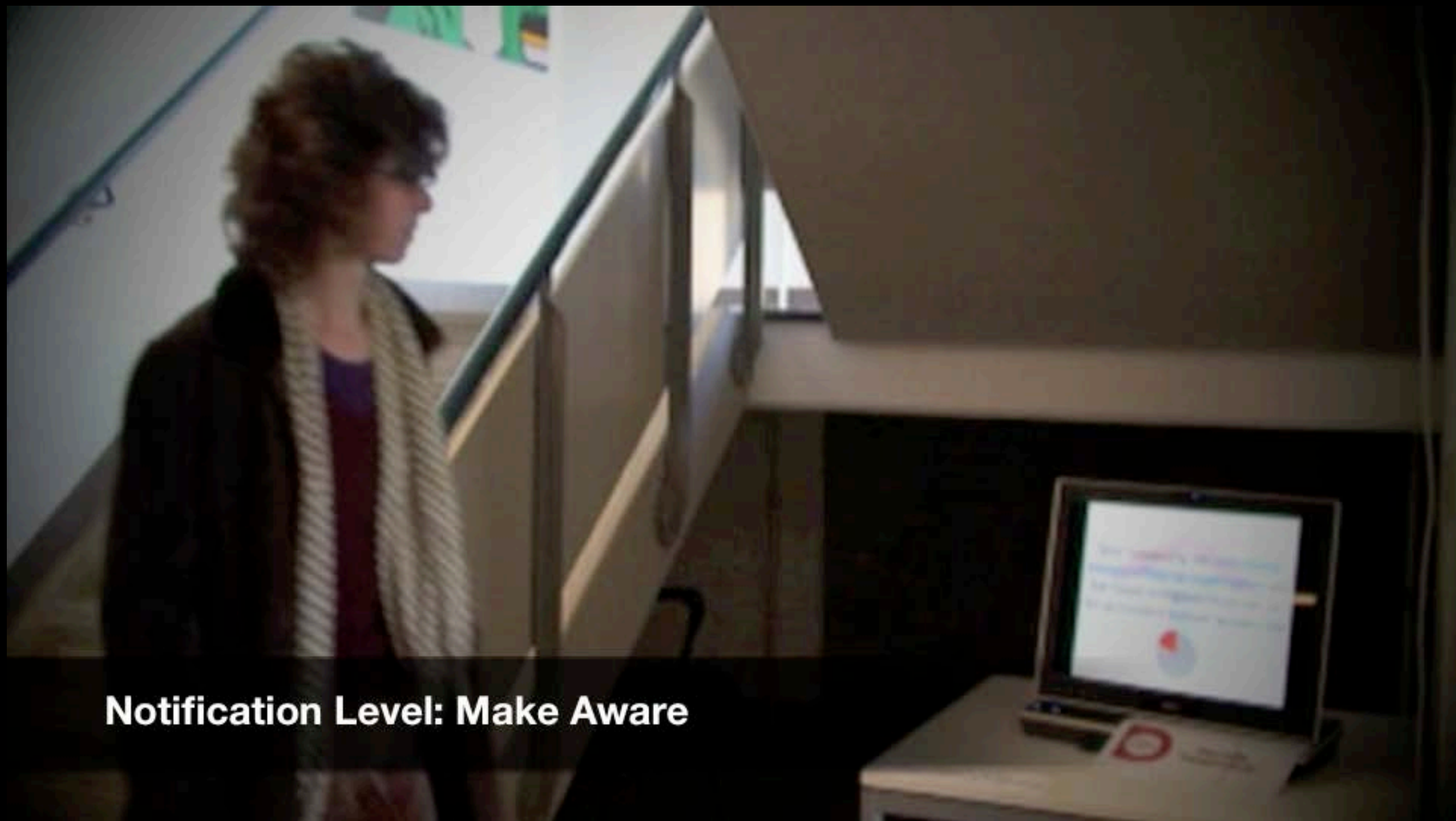
#2A AWARENESS

Conception



measuring power consumption on campus with standard facility management, plus sensors on workplaces and public devices, personal registration of power consuming activities.

Energy consumption ...



Notification Level: Make Aware

Information

Action

Challenge

Welcome

Second Floor

142 occupants

7,764

Kilowatt-hours



Flags

Single

QR code

Scan

Experience

Single

Statement

Audio

[Action] QR code

Great you found the Mindergie flags. The first thing you have to do here is to find the small QR code attached to the 'Athabasca' flag pole.

When you found it, simply press the scan icon below and use your camera to scan the code.



image #

1

3

12

21

last



MAIN RESULTS ENERGY AWARENESS

- Situated displays have a generic effect of raising awareness and energy consumption on a mid to long term
- Badge and social incentive systems must be embedded with social media to have an effect
- Real world action foster curiosity, discussion, and reflection about the topic when combined with public displays

#2B CONTEXTUALISED
SUPPORT

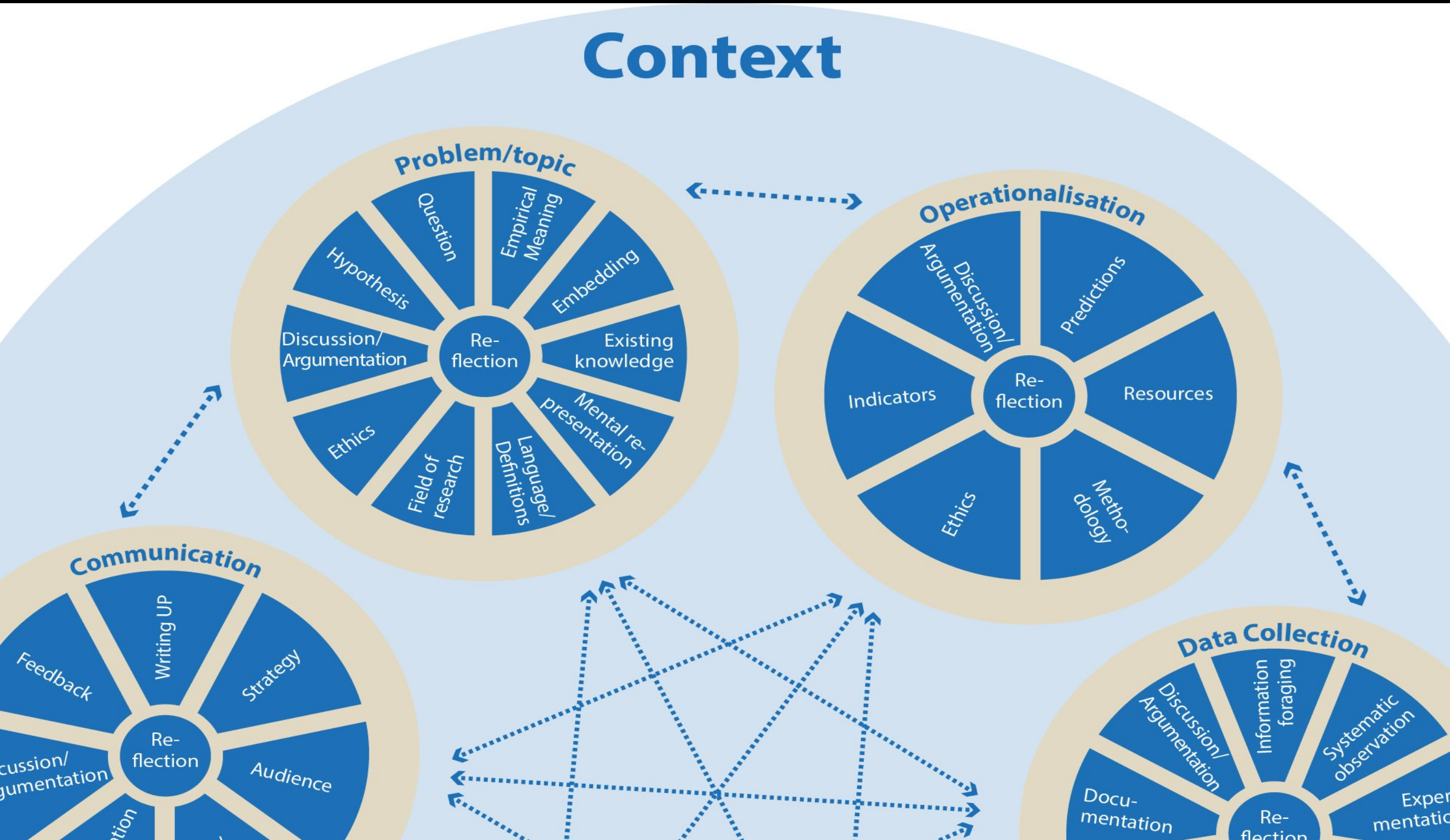
HUMANS STRUCTURE AND ...

EPISODIC MEMORY ...



A FLEXIBLE MODEL ON ...

INQUIRY-BASED LEARNING








Inquiries > Healthy food open inquiry

Healthy food open inquiry

More info

Leave inquiry

Export inquiry

 Share  Email  Print



Healthy food open inquiry

Open membership

Badges

Domain Structure

Inquiry activity

Inquiry help

Learning Analytics Dashboard

Quizzes

Problem / topic

Plan the method

Collect the data

Analyse the data

Discuss the findings

Communicate the results

I wonder ...

0 vote
0 Answer

Amount of calories

Is there a correlation between the time at which a meal is taken and the amount of calories that is consumed.

By Stefaan Ternier 58 days ago

Pre-knowledge resources



What types of research questions are there?

By Fleur Prins 55 days ago Comments (4)

Do this




weSPOT Inquiry Tool

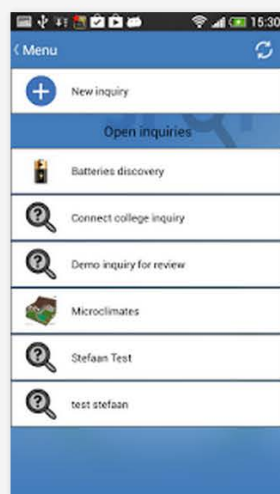
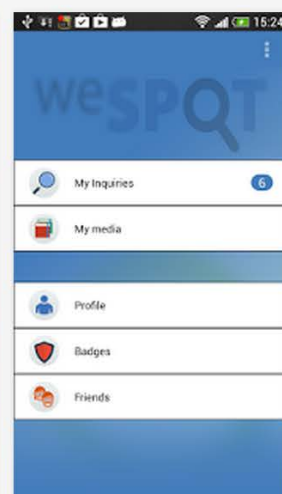
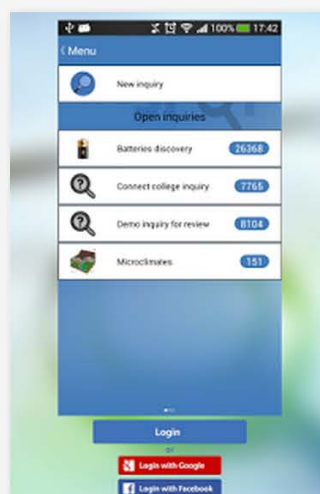
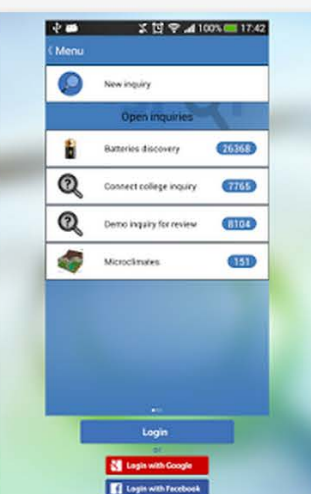
Stefaan Ternier, Welten Institute - 6 november 2014
Onderwijs

Geïnstalleerd

Deze app is compatibel met een aantal van uw apparaten.

★★★★☆ (4)

 +3 onder wie Bernardo



weSPOT inquiry						
HomeInquiriesMembersActivityHelp						
General inquiry atheneum		Alexander Mikroyannidis		Star rating none - 5		
Healthy food open inquiry		Angel Suarez Fernandez				
Heraklion Test Group Bulgaria		Fleur Prinsen				
Life on Earth		John Hendriks				
Name	Prob. ▾	Oper. ▾	Dat. Col. ▾	Dat. Ana. ▾	Inter. ▾	Comm. ▾
Alexander M <small>[Healthy food open]</small>						
Angel Suare <small>[Healthy food open]</small>						
Fleur Prins <small>[Healthy food open]</small>						

LINKING ACTIVITIES IN CONTEXT TO ...

REFLECTION ABOUT ACTION



Figure 7: The teacher invites the student to the tabletop

HUMANS DO NOT ALWAYS LIKE TO DO ...

#2B REFLECTION IN AND ABOUT ACTION




WHAT MAKES IT PERSONAL IS ...

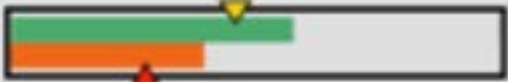
FEEDBACK ...



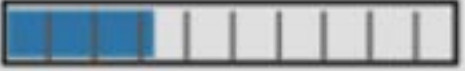
Goetz, T. (2011). Harnessing the Power of Feedback Loops | Magazine.
wired.com. Retrieved August 22, 2011, from http://www.wired.com/magazine/2011/06/ff_feedbackloop/5/

▼ **activity** 

▼ **tags** ComputerGames **ComputerHistory**
 ComputerScience Demos Design Flash **Flow**
FutureTechnologies GameBasedLearning
GraphicDesign GUI HCI Journals JSON
LearningTechnology Literature LSA Mace
 MMURPG MobileLearning OpenSource **Perl**
 SOAP SocialSoftware
TENCompetence Usability
 Visualisation Web WebAnimation
WebApplications WebDesign XML XUL

▼ **activity** 

▼ **tags** ComputerGames ComputerHistory
 ComputerScience Demos Design Flash
 FutureTechnologies GameBasedLearning Gaming
 GraphicDesign GUI HCI Journals JSON
 LearningTechnology Literature LSA Mace MMURPG
 MobileLearning OpenSource SOAP SocialSoftware
 TENCompetence Usability Visualisation Web
 WebAnimation WebApplications WebDesign XML
 XUL

▼ **activity** 

▼ **tags** ComputerGames ComputerHistory
 ComputerScience Demos Design Flash
 FutureTechnologies GameBasedLearning Gaming
 GraphicDesign GUI HCI Journals JSON
 LearningTechnology Literature LSA Mace MMURPG
 MobileLearning OpenSource SOAP SocialSoftware
 TENCompetence Usability Visualisation Web
 WebAnimation WebApplications WebDesign XML
 XUL



context indicators ...

Course: Dominique's Course - Mozilla Firefox

File Edit View History Delicious Bookmarks Tools Help

Dominique's Course Location: Time spent on course: 01:32:11 You are logged in as [Christian Glahn](#) (Logout)

Moodle1 ▶ DV101 Switch role to... Turn editing on

Activities

- Assignments
- Choices
- Forums
- Quizzes
- Stoodle Modules

People

- Participants

Search Forums

Advanced search ?

Administration

Course categories

- Main
- Testing
- All courses ...

GISMO


Topic outline


On this forum, you are requested to post at least two questions arising from your reading of the resources. All questions will be answered by the instructor.

[News forum](#)

1 Five Usability Principles in Web Design - COURSE MATERIAL

Indicators

Your Actions 


Peer Actions 

Latest News

Upcoming Events

Recent Activity

Indicators

My actions 

17 actions. Previous group in the course performed in average 73 actions (for an average final test score of 13/20)

Done Resource 9

reflection amplifiers ...

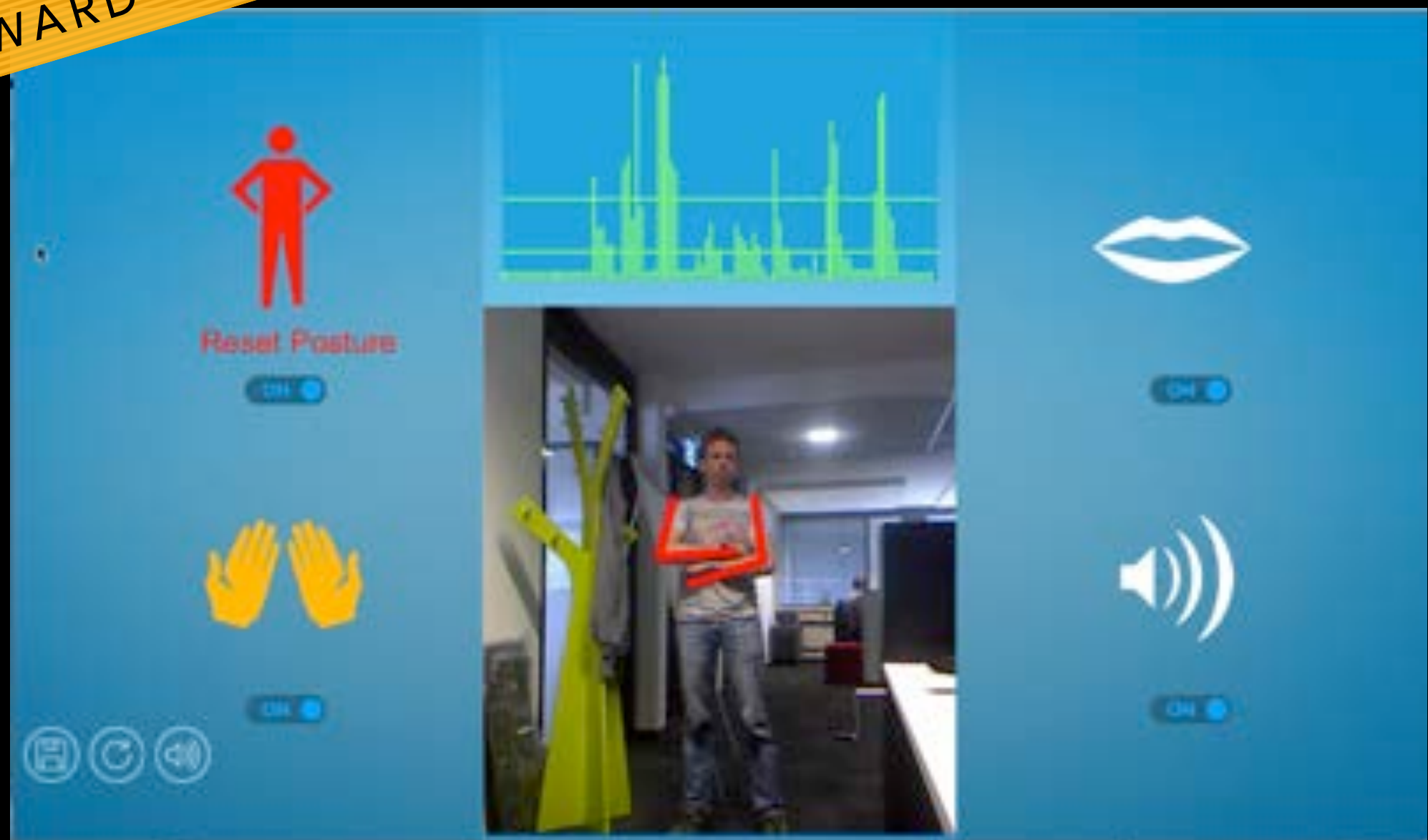
Personal Context Notifications



Figure 8.2. Student reflective practice a. Daily SMS received by students. b. What were your main learning channels today? c. How intense was your learning day? Rate it from 1 to 5.

PRESENTATION TRAINER

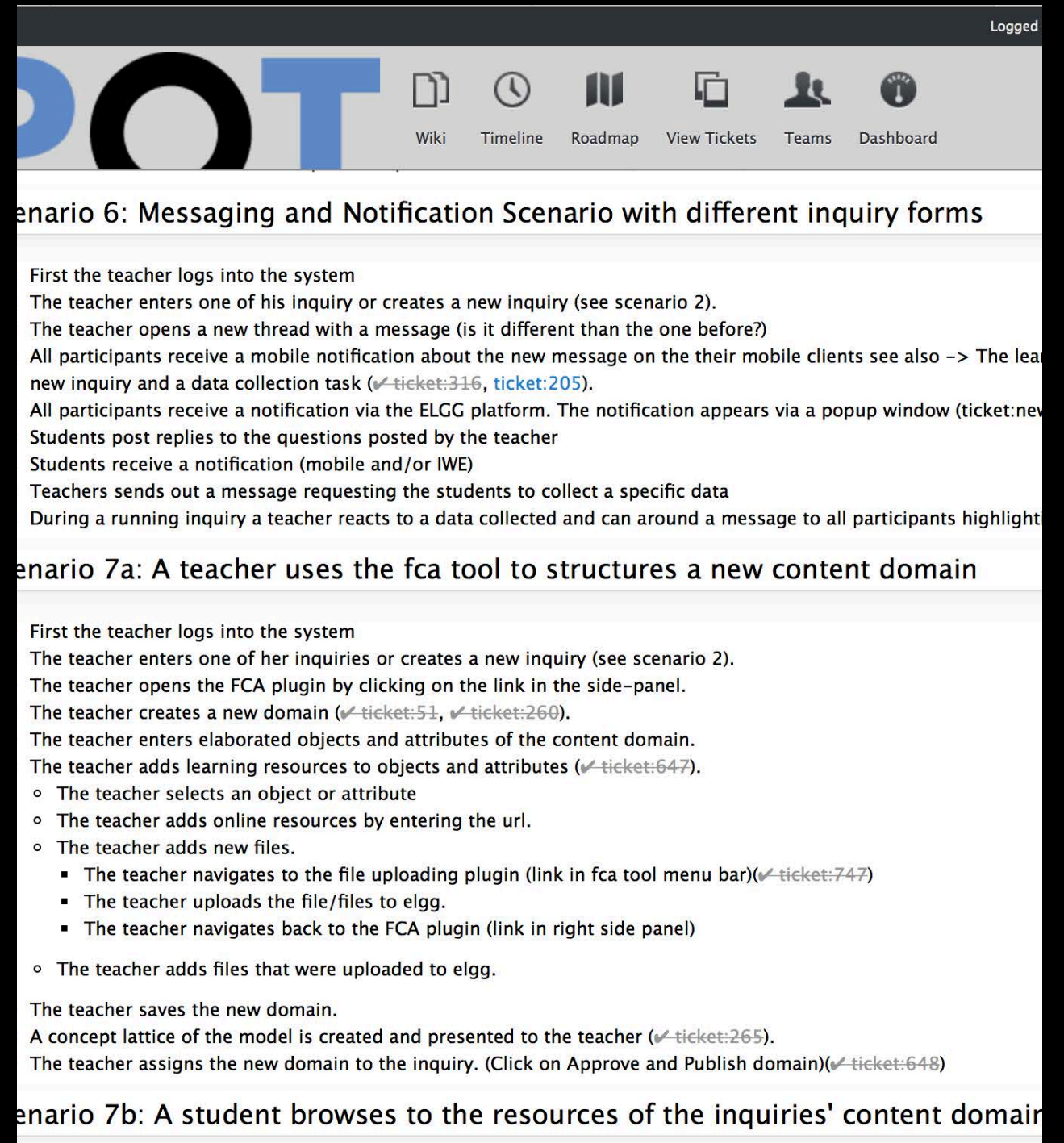
BEST DEMO AWARD - ECTEL 2014



#3 RESEARCH METHODOLOGY

DEVELOP YOUR TECHNOLOGY AGILE .. FOR BUILDING A COMMON GROUND WITH YOUR "CLIENTS"

user scenarios, early
prototypes, early user
feedback, foster
communication
between developers,
end users and
managers



Logged

Wiki Timeline Roadmap View Tickets Teams Dashboard

Scenario 6: Messaging and Notification Scenario with different inquiry forms

First the teacher logs into the system
The teacher enters one of his inquiry or creates a new inquiry (see scenario 2).
The teacher opens a new thread with a message (is it different than the one before?)
All participants receive a mobile notification about the new message on the their mobile clients see also -> The lea
new inquiry and a data collection task (✓ticket:316, ticket:205).
All participants receive a notification via the ELGG platform. The notification appears via a popup window (ticket:nev
Students post replies to the questions posted by the teacher
Students receive a notification (mobile and/or IWE)
Teachers sends out a message requesting the students to collect a specific data
During a running inquiry a teacher reacts to a data collected and can around a message to all participants highlight

Scenario 7a: A teacher uses the fca tool to structures a new content domain

First the teacher logs into the system
The teacher enters one of her inquiries or creates a new inquiry (see scenario 2).
The teacher opens the FCA plugin by clicking on the link in the side-panel.
The teacher creates a new domain (✓ticket:51, ✓ticket:260).
The teacher enters elaborated objects and attributes of the content domain.
The teacher adds learning resources to objects and attributes (✓ticket:647).

- The teacher selects an object or attribute
- The teacher adds online resources by entering the url.
- The teacher adds new files.
 - The teacher navigates to the file uploading plugin (link in fca tool menu bar)(✓ticket:747)
 - The teacher uploads the file/files to elgg.
 - The teacher navigates back to the FCA plugin (link in right side panel)
- The teacher adds files that were uploaded to elgg.

The teacher saves the new domain.
A concept lattice of the model is created and presented to the teacher (✓ticket:265).
The teacher assigns the new domain to the inquiry. (Click on Approve and Publish domain)(✓ticket:648)

Scenario 7b: A student browses to the resources of the inquiries' content domain

ADOPTION OF INNOVATION IS CRITICAL ...

LAYERED ADOPTION

The screenshot shows a website with a header featuring a green and blue abstract background with black circles. The navigation bar includes links: 'le ouders...', 'Agora', 'Amazing Afternoons', 'Media', 'Q&A', 'Leerlingen aanmelden', and 'Contact'. The main content area has a large heading 'Aan alle ouders...' followed by a paragraph about the future of work and education. To the right, there are two partner logos: 'Stichting Onderwijs Midden Limburg' with the 'soml' logo, and 'Open Universiteit' with its logo.

le ouders... Agora Amazing Afternoons Media Q&A Leerlingen aanmelden Contact

Aan alle ouders...

Uw kind zit in groep 8 en uw zoon of dochter is rond de 11,12 jaar. Normaal gesproken be-
treedt in Nederland iemand rond zijn 25ste de arbeidsmarkt. Dat betekent dat uw kind de
verdubbeling van zijn huidige leven nog op school zal zitten! In 2025 neemt uw zoon of
dochter de stap om in de maatschappij te gaan werken.

Wij, maar ook anderen (wetenschappers, maar iedereen met gezond verstand) weten dat
we één ding weten, dat is dat we slechts bij benadering kunnen bedenken hoe die wereld
in 2025 eruit zal zien. Door de snelheid van de technologische ontwikkelingen zal dit ons
voorstellingsvermogen te boven gaan. Als wij u in 2000 verteld hadden dat leerlingen in
2013 zouden leren met een iPad als hulpmiddel, dat zijverbonden met elkaar via een inter-
net en communicerend met mobiele telefoons op zakformaat zouden leren, had u zich
daar op dat moment dan een concrete voorstelling van kunnen maken?

Stichting Onderwijs Midden Lim-
burg

soml

Key Partner

Open Universiteit

Spelregels

Wanneer u uw kind aan de school geeft, wordt u de verantwoordelijkheid voor de leer-
toetsen en de toetsen van de leerprestaties van uw kind overgedragen. Het is belangrijk dat u
beseft dat uw kind de school niet alleen voor de leerprestaties, maar ook voor de leerprestaties
van de leerprestaties van uw kind overgedragen wordt.

Wanneer u uw kind aan de school geeft, wordt u de verantwoordelijkheid voor de leer-
toetsen en de toetsen van de leerprestaties van uw kind overgedragen. Het is belangrijk dat u
beseft dat uw kind de school niet alleen voor de leerprestaties, maar ook voor de leerprestaties
van de leerprestaties van uw kind overgedragen wordt.



ANALYSE THE CONTEXT WELL ...

DESIGN-BASED RESEARCH



MEASURE THE RIGHT THING A TIME ...

ALIGN WITH DEV. LIFE-CYCLE

Development Lifecycle	Evaluation aspect / Variables	<i>Evaluation Phase</i>
Design phase (no system)	<u>Requirements</u> Domain Model	Phase A: <u>Conceptual Evaluation</u>
Low-fidelity prototype (<u>mockup</u>)	Usability Usefulness	Phase B: Qualitative and <u>formative</u>
High-fidelity prototype (running components)	<u>Usability</u> Measurement <u>Effectiveness</u>	Phase C: Quantitative and <u>formative</u>
Fully integrated system	Measurement <u>Effectiveness</u>	Phase D: Quantitative and <u>summative</u>

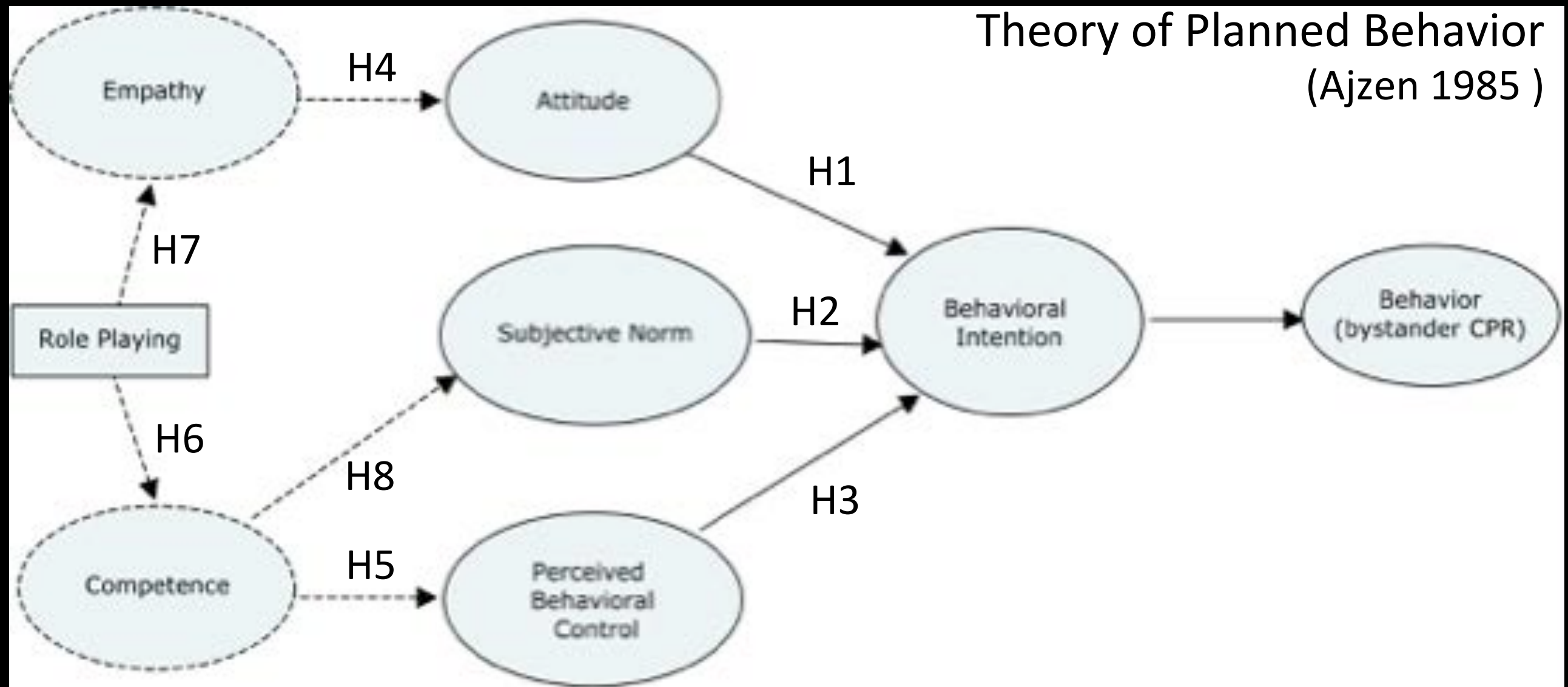
Experimental Designs ...



- raise and retain attention significantly better.
- lead **not** to higher cognitive load but to a significant higher knowledge gain.

HIDDEN VARIABLES CAN BE MORE IMPORTANT ...

TEL IN MULTI-VARIATE CONTEXT



#SUMMARY

SO ...

- #1 There are seams between the different learning contexts, locations, times, social contexts, ...
- #2 There are opportunities with new technologies that are open, ubiquitous, context-aware, and personalized.
- #3 look at the aimed effects on awareness, curiosity, creativity, knowledge, latent variables, ...
- #4 think careful about methodology and experimental designs dependent on your research questions ...

M.M. SPECHT

THANK YOU !