Learning Analytics for ‘end-users’:

from Human-centred Design to Multimodal Data Storytelling

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MONASH University

Acknowledgement of country

I would like to acknowledge the Traditional Owners
of the land on which I am today,
the Yalukit Willam clan of the Boon Wurrung People, and the Traditional Owners
of the land where you all are at the moment.
I would like us to pay our respects to their Elders past, present and emerging.
We acknowledge and respect their continuing
relationship to the lands upon which we meet.

The power of storytelling

The “yarning circle”
Aboriginal pedagogy: www.8ways.online

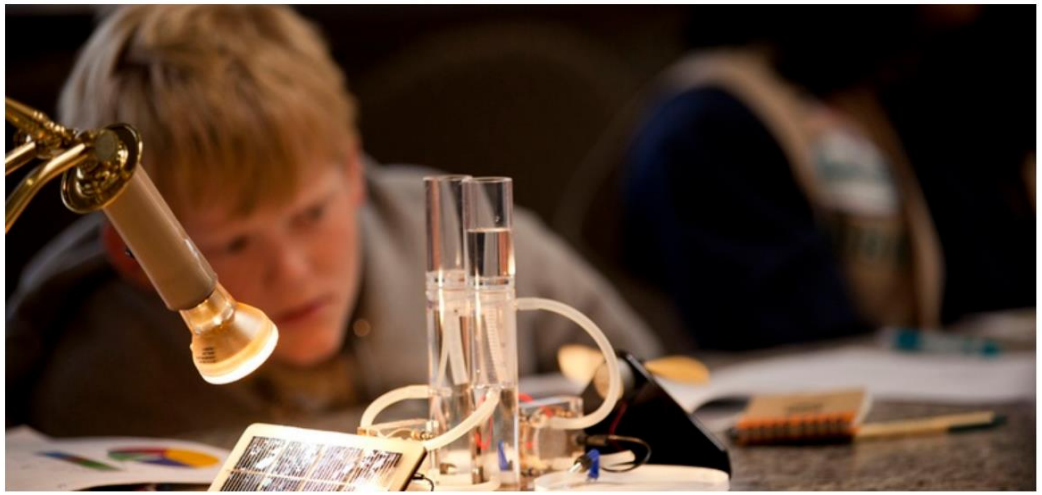
“We dream in narrative, daydream in narrative, remember, **anticipate, hope, despair, believe, doubt, plan**, revise, criticize, construct, gossip, learn, hate and love by narrative” Barbara Hardy - (1968, 5)

Storytelling in Journalism

Educators can adjust online classes to fit learning styles

Published April 15, 2020

By Shawna De La Rosa
Contributor, K-12



Flickr; Energy.gov

Dive Brief:

- Educators must balance many learning preferences as students adjust to online learning, which will be a good fit for some and difficult for others, District Administration reports. Some students will struggle

Search · Australia edition

The Guardian
For 200 years

University Guide 2022
Online learning

How has the pandemic changed the way you'll learn?

As students gradually return to campus, many universities will be offering blended learning – mixing face-to-face lectures with the best of digital teaching

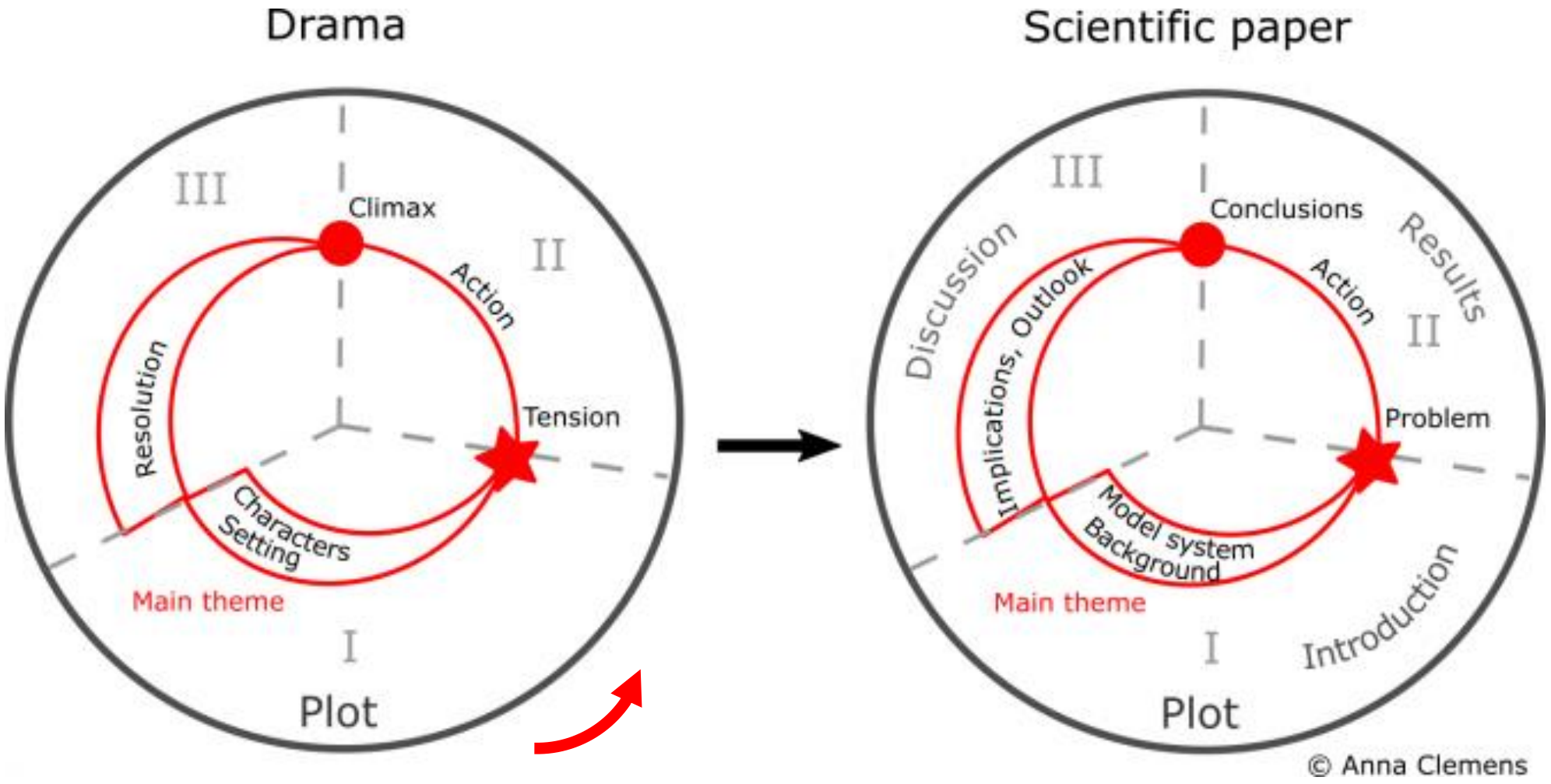
The 2022 league table

Rachel Hall
@rachela_hall
Sat 11 Sep 2021 21.00 AEST

▲ Many universities are shifting large lectures online because they believe it's a better way for students to learn
Photograph: Martin DM/Getty Images

person teaching to motivate you and to meet new people? Some universities are offering a variety of options to suit different learning styles and personal circumstances.

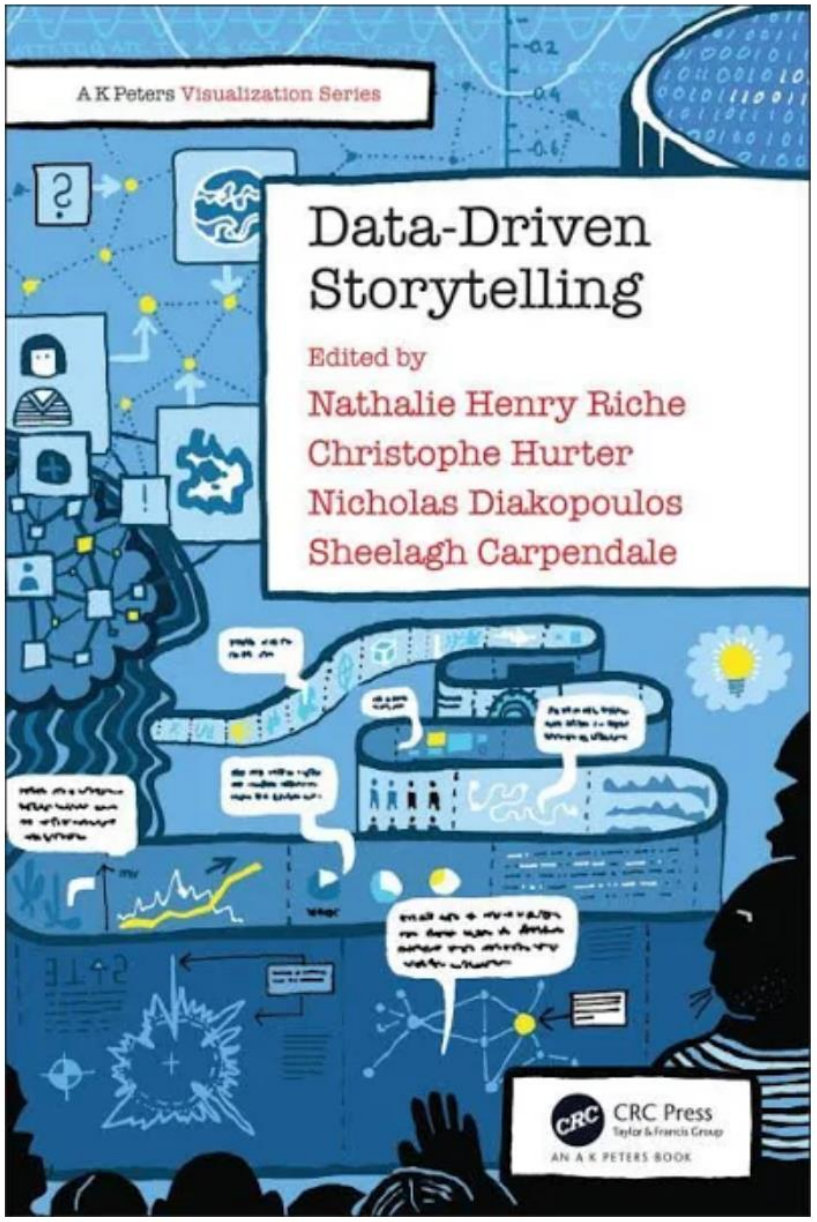
Storytelling in Academia



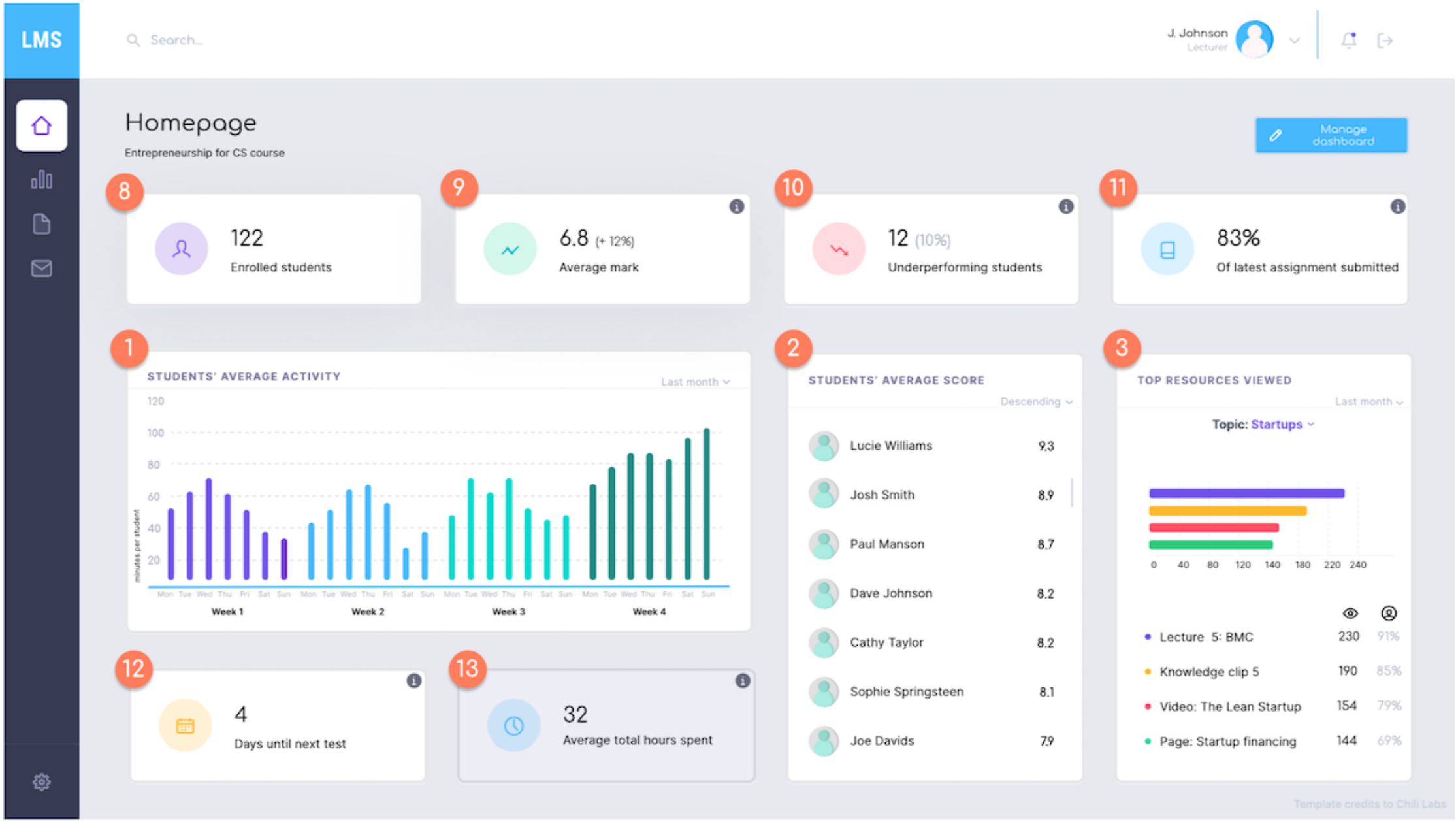
https://www.socialsciencespace.com/2018/06/how-to-tell-a-story-in-your-research-paper/

Data-driven Storytelling

“data-driven storytelling is the **ability to turn raw data into easy-to-read and easy-to-understand plain stories** that help us turn insights into action”



Learning Analytics in the Classroom



Daryl Zandvliet thesis work. ictinstitute.nl/learning-analytics-research

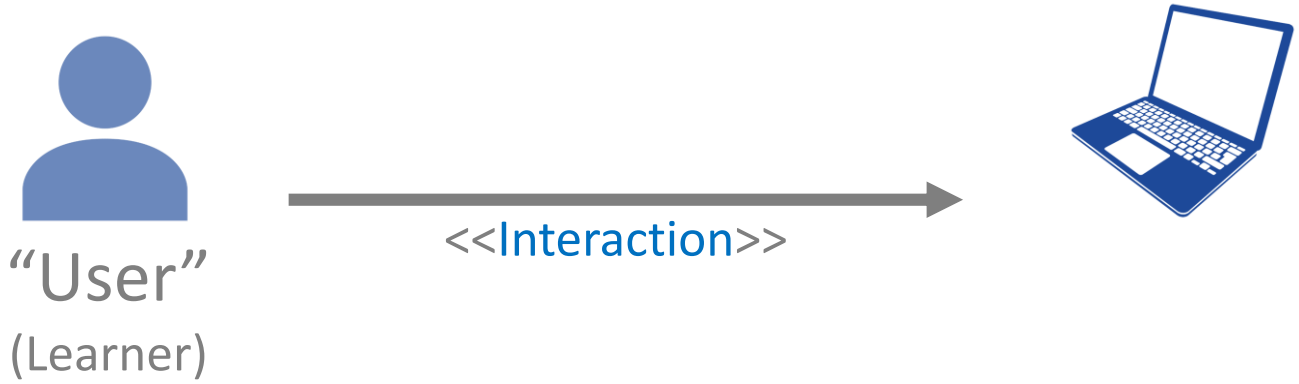
Dashboards are **not** delivering their promises

Students find it difficult to interpret/act on data to improve learning
(Bodily & Verbert, **2017**; Jivet et al., **2018**; Matcha et al., **2019**; Valle et al., **2021**)

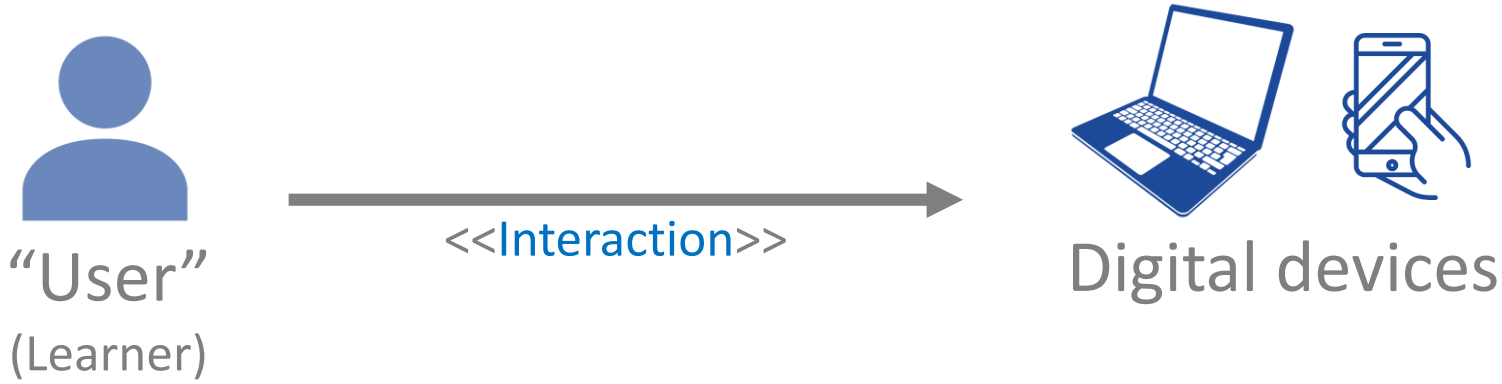
….and the same applies to **teachers** (Mangaroska & Giannakos, **2018**).

Bodily, R., & Verbert, K. (2017). Trends and issues in student-facing learning analytics reporting systems research. LAK'17
Jivet, I., Scheffel, M., Specht, M., & Drachsler, H. (2018). License to evaluate: Preparing learning analytics dashboards for educational practice. In LAK'18
Matcha, W., Gasevic, D., & Pardo, A. (2019). A Systematic Review of Empirical Studies on Learning Analytics Dashboards: A Self-Regulated Learning Perspective. IEE TLT
Valle, N., Antonenko, P., Dawson, K., & Huggins-Manley, A. C. (2021). Staying on target: A systematic literature review on learner-facing learning analytics dashboards. BJET
Mangaroska, K., & Giannakos, M. N. (2018). Learning analytics for learning design: A systematic literature review of analytics-driven design to enhance learning. IEEE TLT

The Learning Analytics “loop”



The Learning Analytics “loop”



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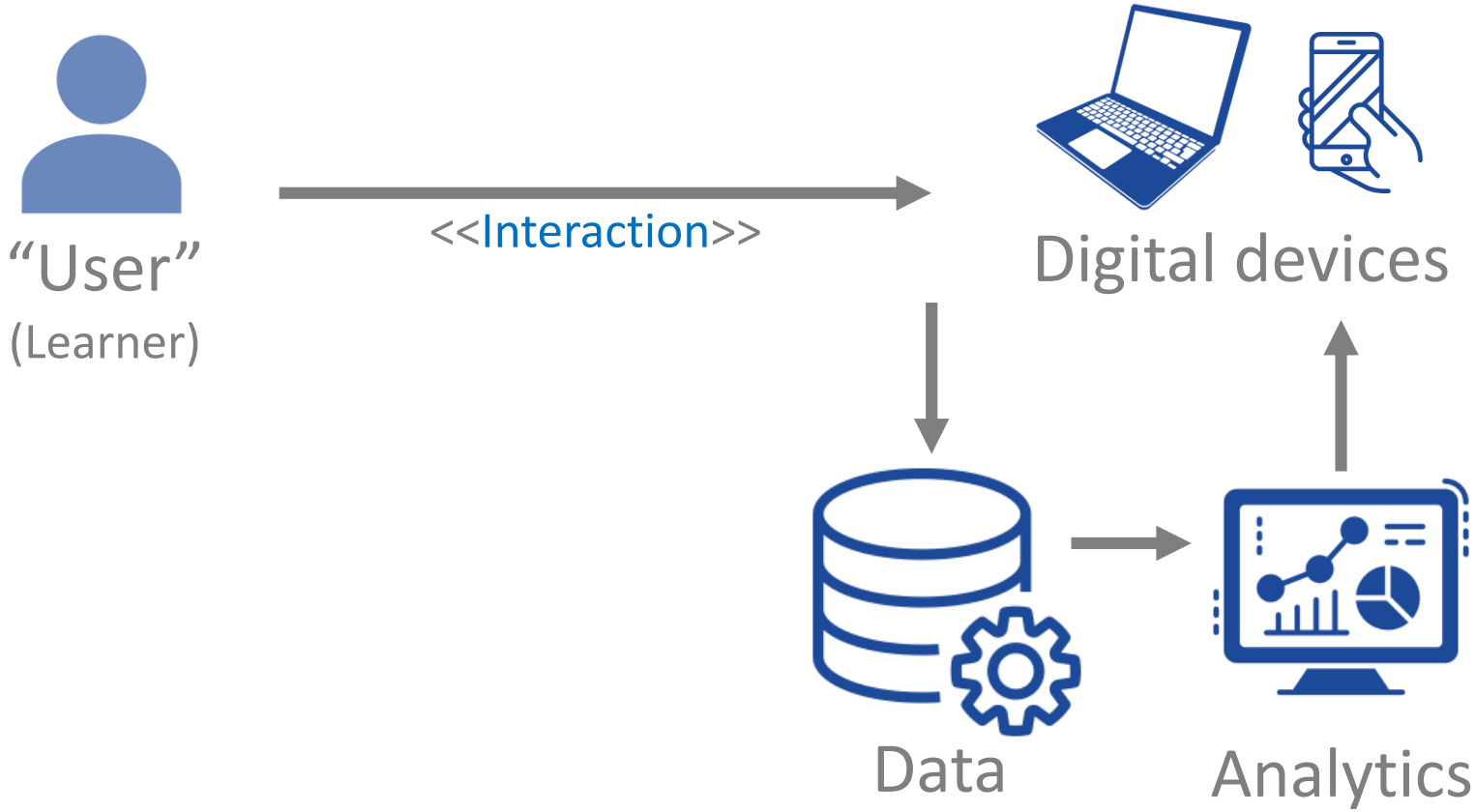

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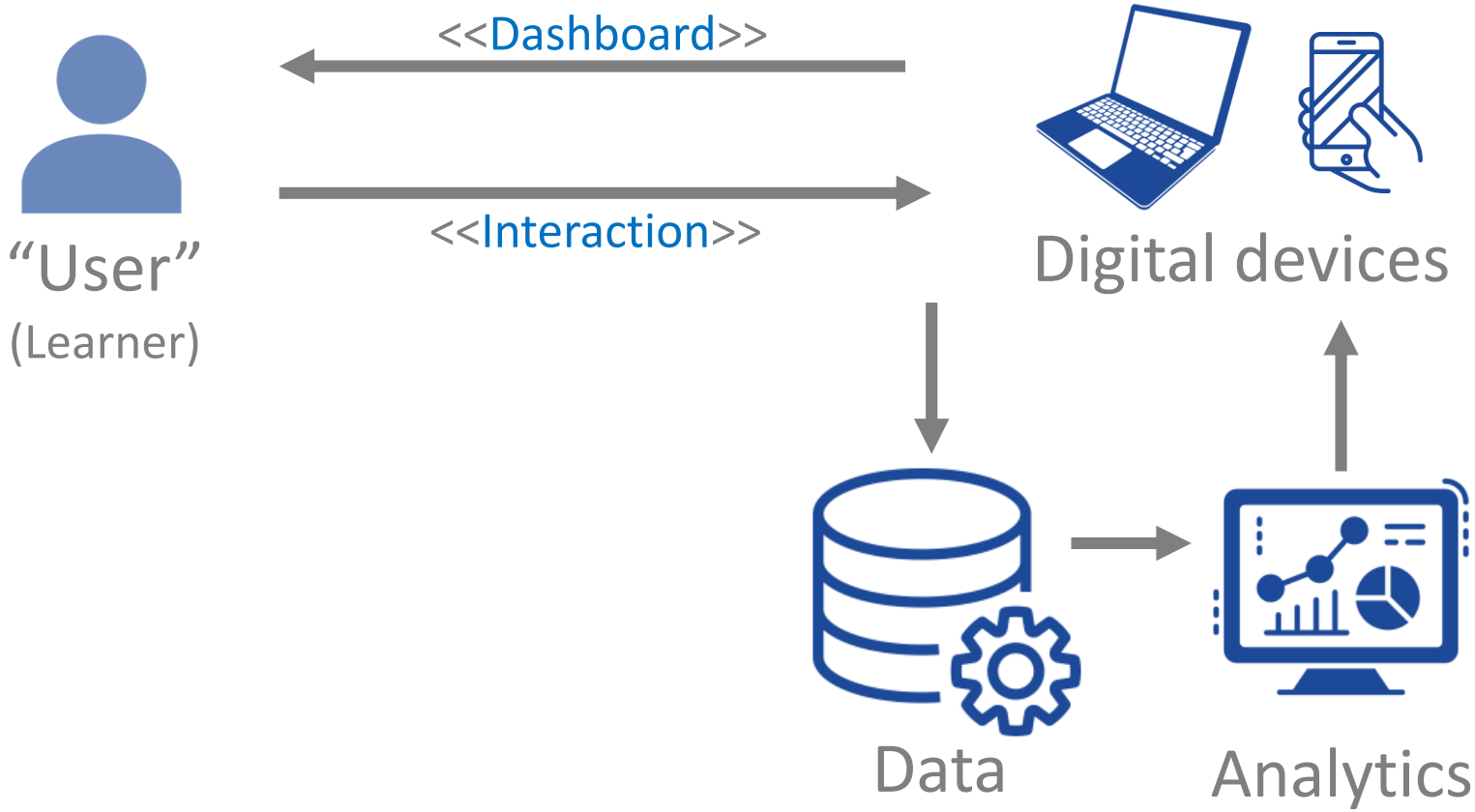

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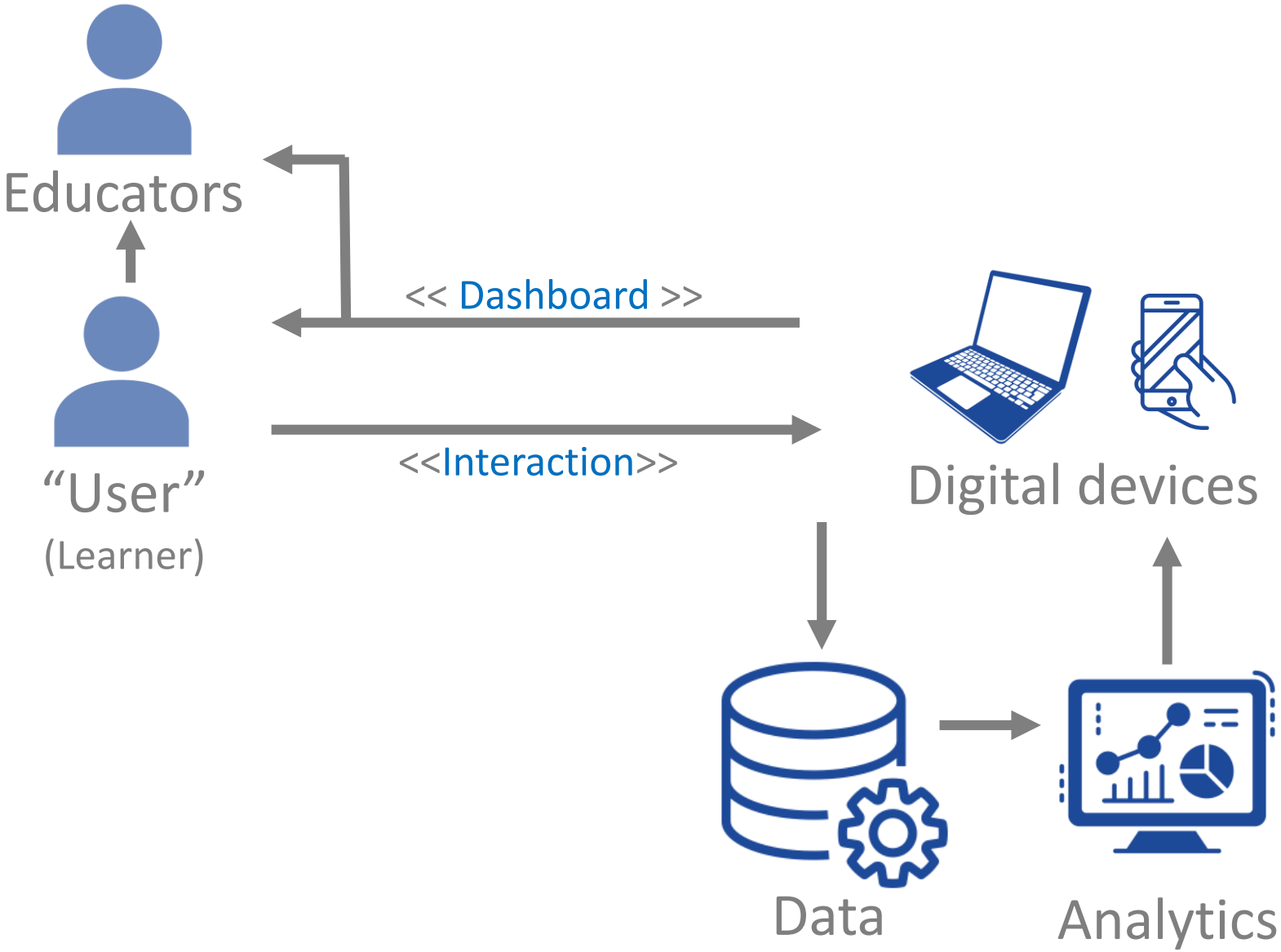
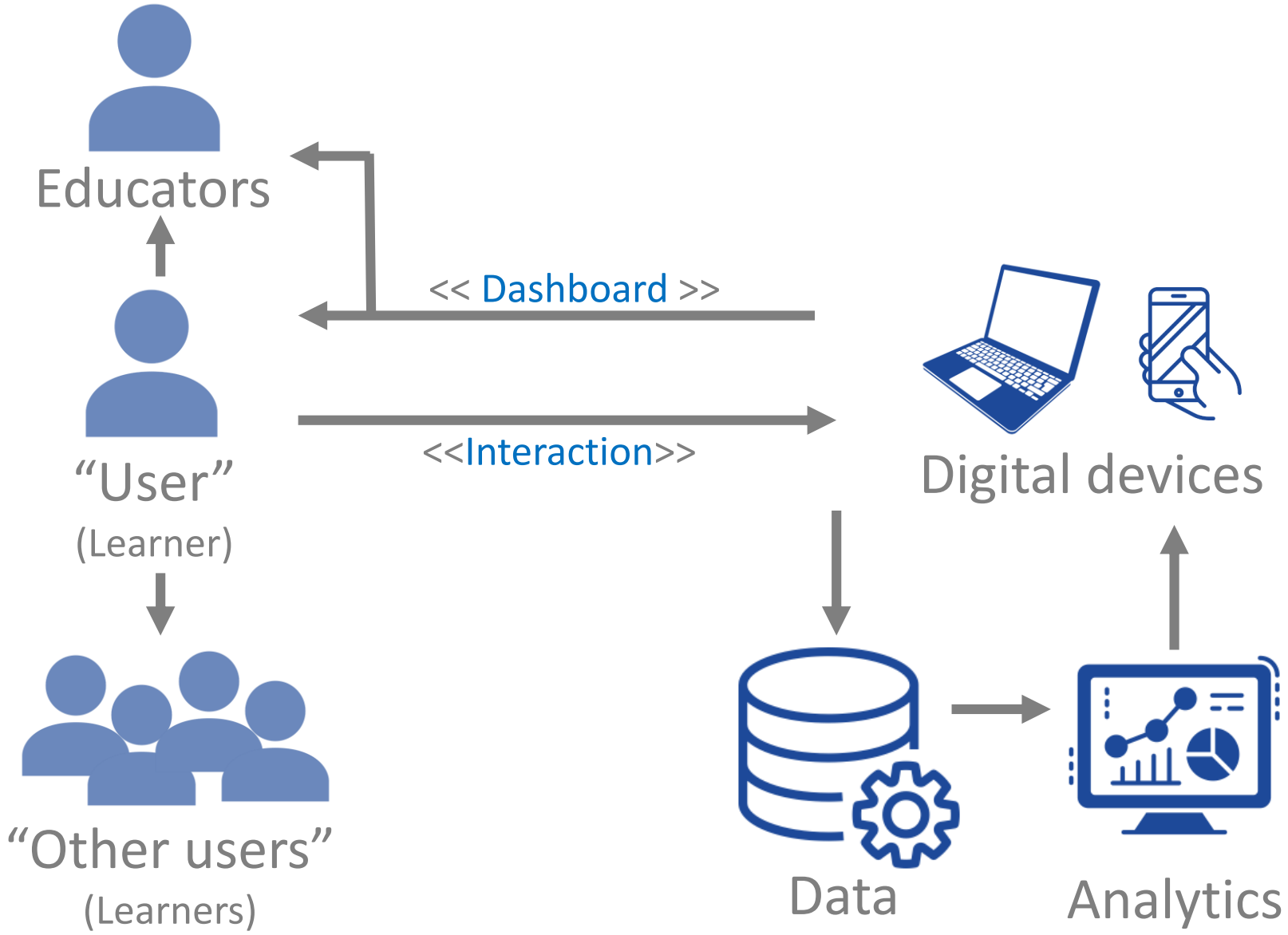


The ideal Learning Analytics "loop"



The real Learning Analytics situation

Motivations
Feelings
Dispositions

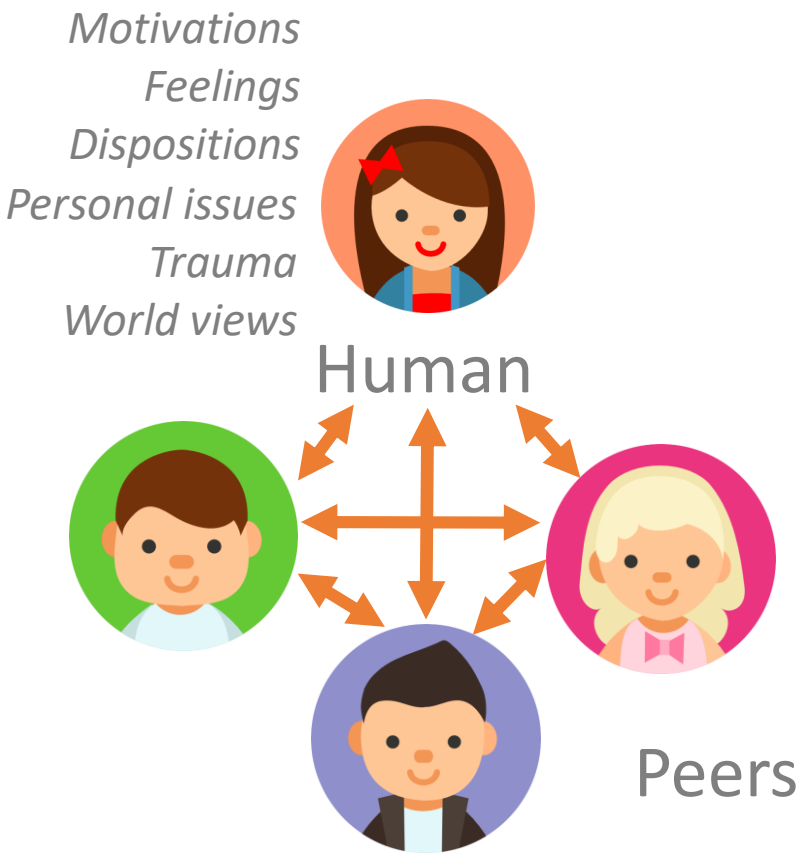
Human

The real Learning Analytics situation

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

The real Learning Analytics situation



The real Learning Analytics situation

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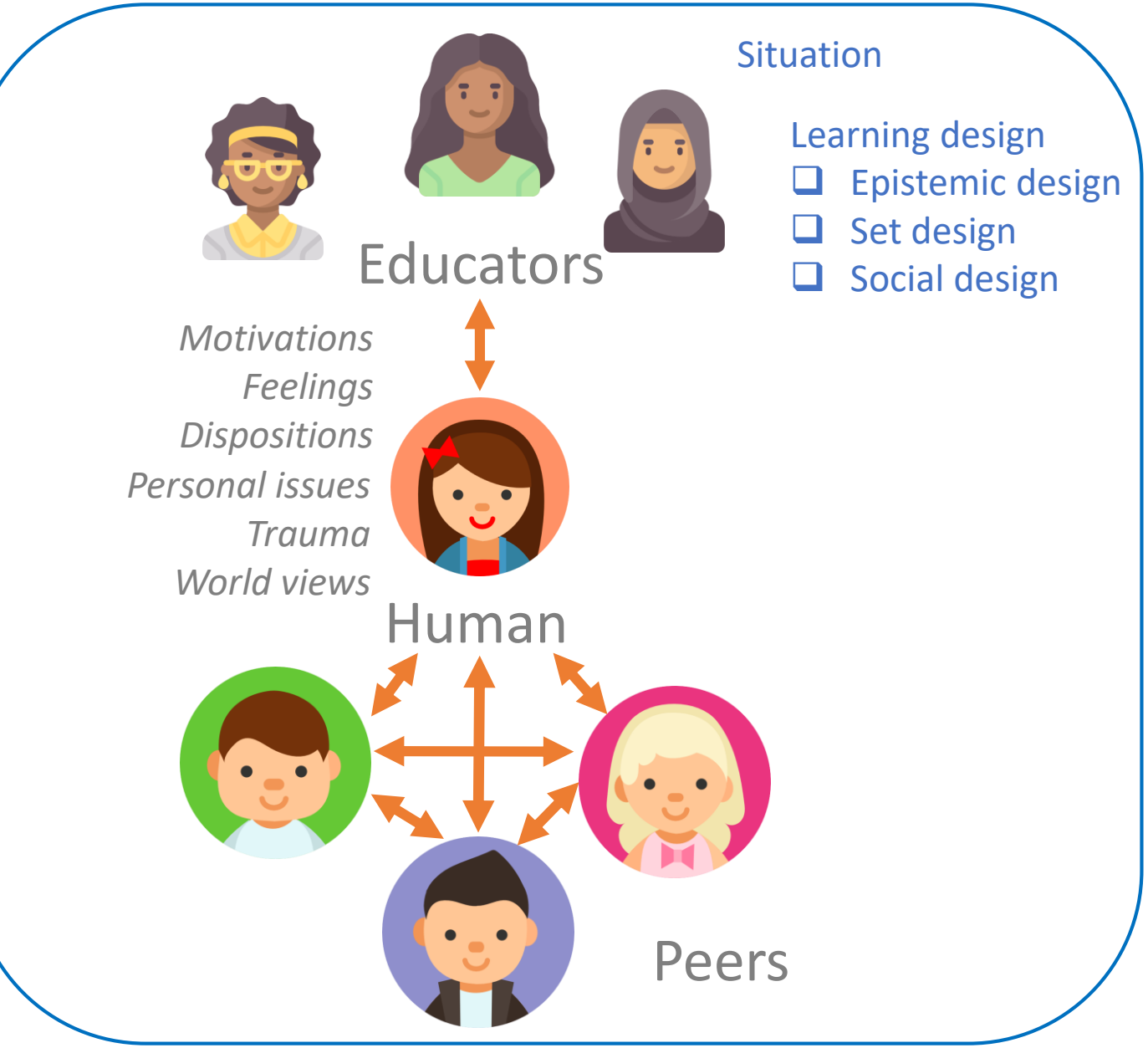
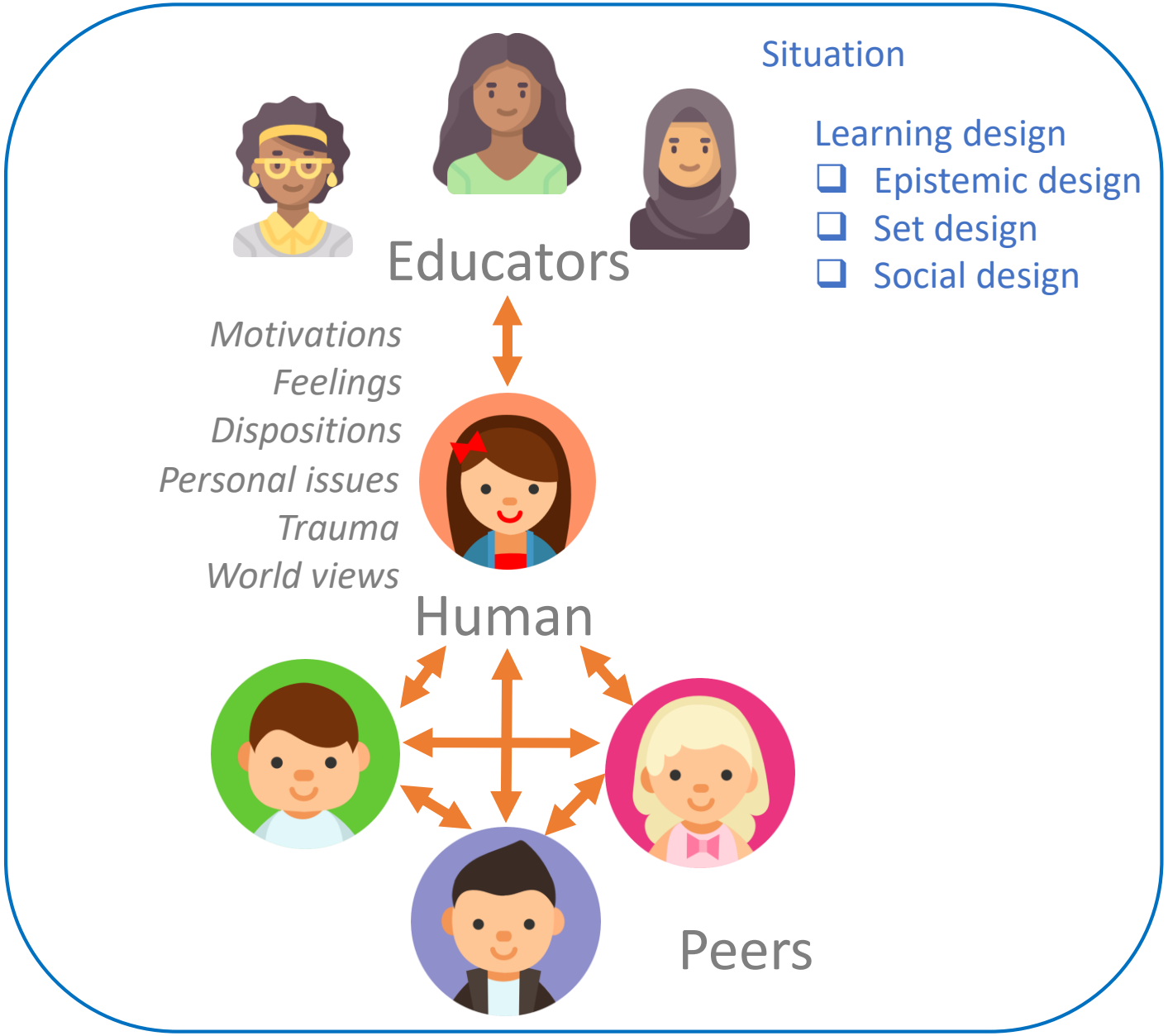


The real learning Analytics situation



Do students/educators have a problem that can be addressed using their data?

The real learning Analytics situation

Situation

Learning design
- ❑ Epistemic design
- ❑ Set design
- ❑ Social design

Educators

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

Peers

Data

The real Learning Analytics situation

<<Interaction>>

Situation

Learning design
- ❑ Epistemic design
- ❑ Set design
- ❑ Social design

Educators

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

Peers

Data

Meaning

The real Learning Analytics situation

Situation

Learning design
- ❑ Epistemic design
- ❑ Set design
- ❑ Social design

Educators

Motivations
Feelings
Dispositions
Personal issues
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World views

Human

Peers

Data

Meaning

Analytics

The real Learning Analytics situation

Situation

Learning design
- ❑ Epistemic design
- ❑ Set design
- ❑ Social design

Educators

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

Peers

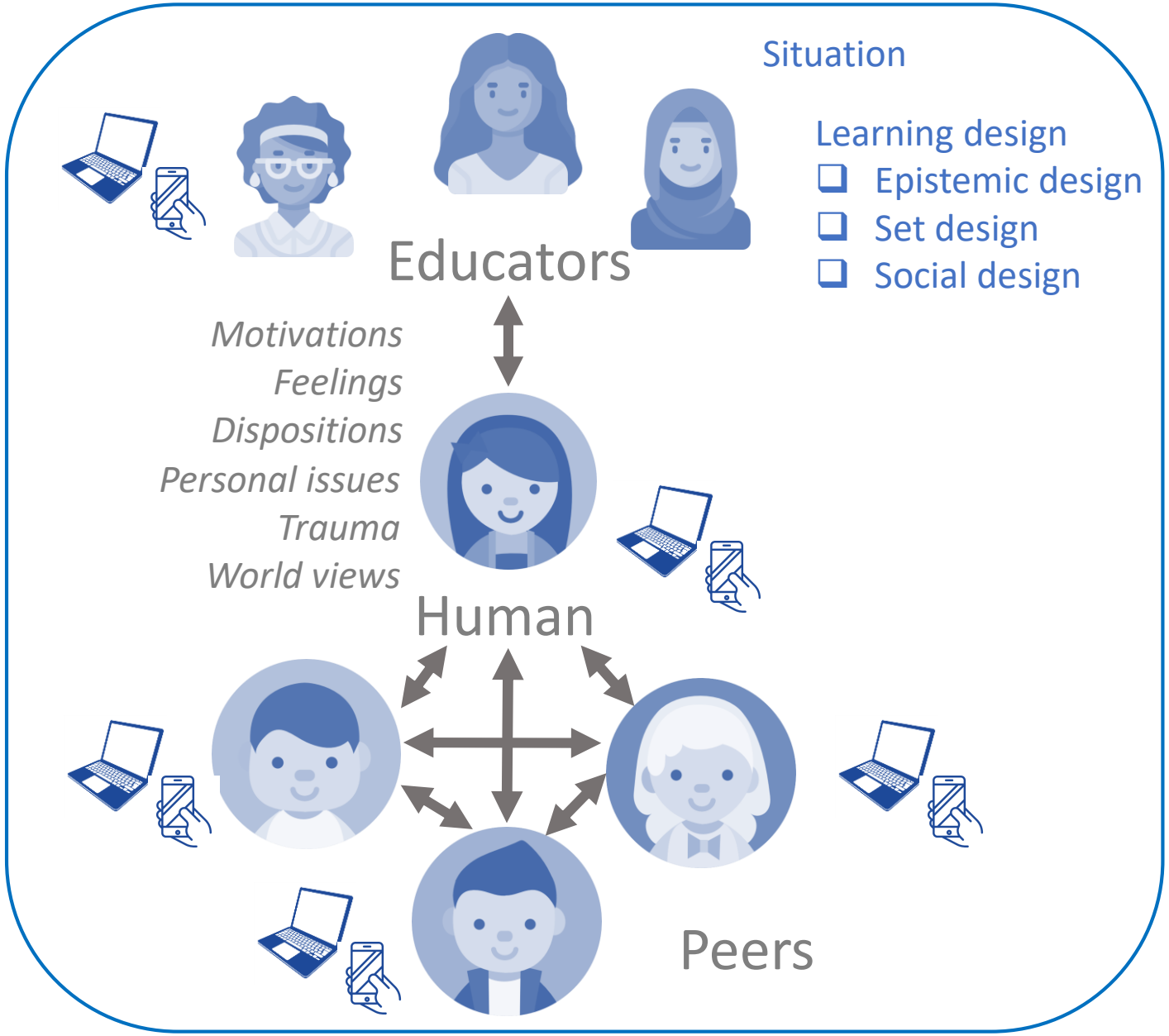
???

Analytics

Data

Meaning

The real Learning Analytics situation

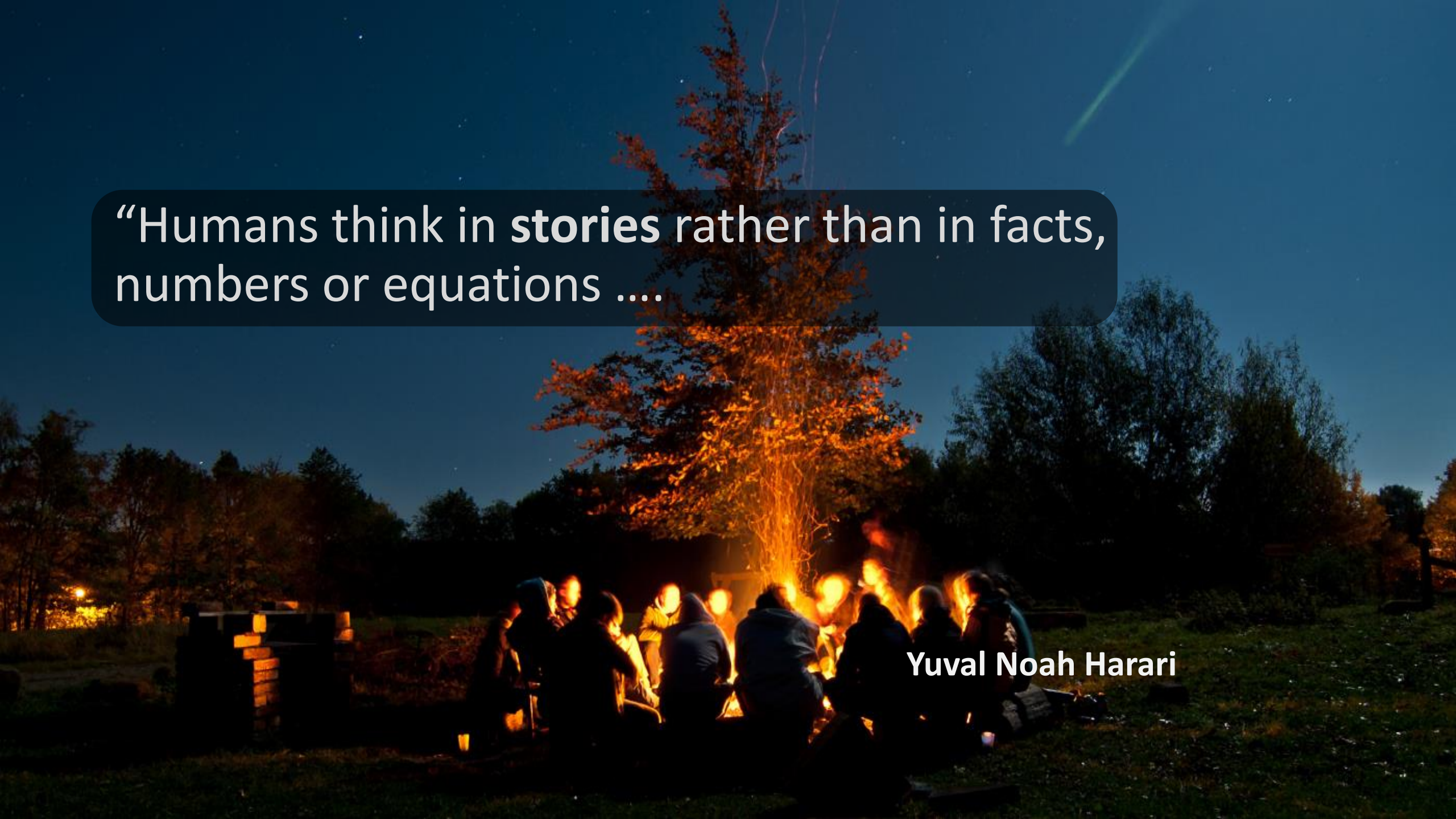


Stories

Analytics

Data

Meaning


“Humans think in **stories** rather than in facts, numbers or equations ….
Yuval Noah Harari

Outline

- ❑ Human centredness
- ❑ Multimodality
- ❑ Storytelling

What is human-centredness?

From a learning analytics perspective…

Human centredness has been identified in other fields as a characteristic of systems that have been carefully designed by:

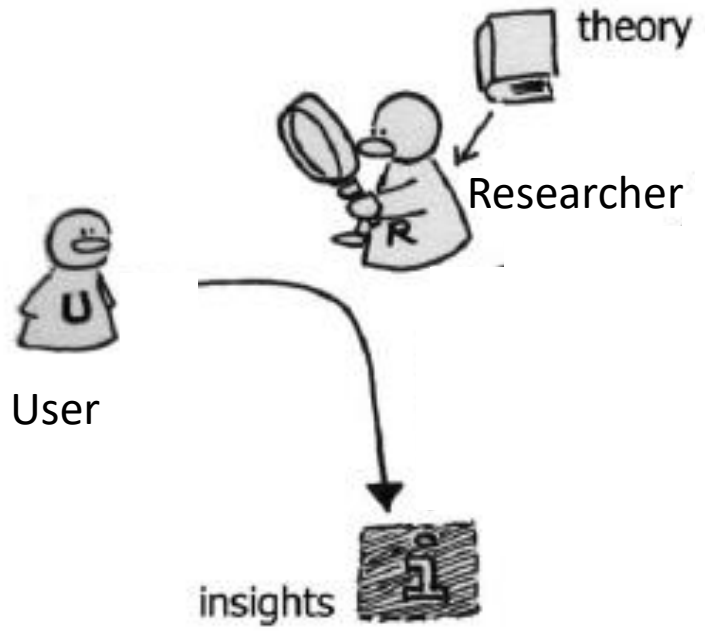
identifying the **critical stakeholders**,
their **relationships**, and
the **contexts** in which those systems will function

Buckingham Shum, S., Ferguson, R. and Martinez-Maldonado, R. (2019). Human-Centred Learning Analytics. Journal of Learning Analytics, JLA, 6(2)

User-centred design

Sanders, E. B. N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, *4*(1), 5-18.

User-centred design



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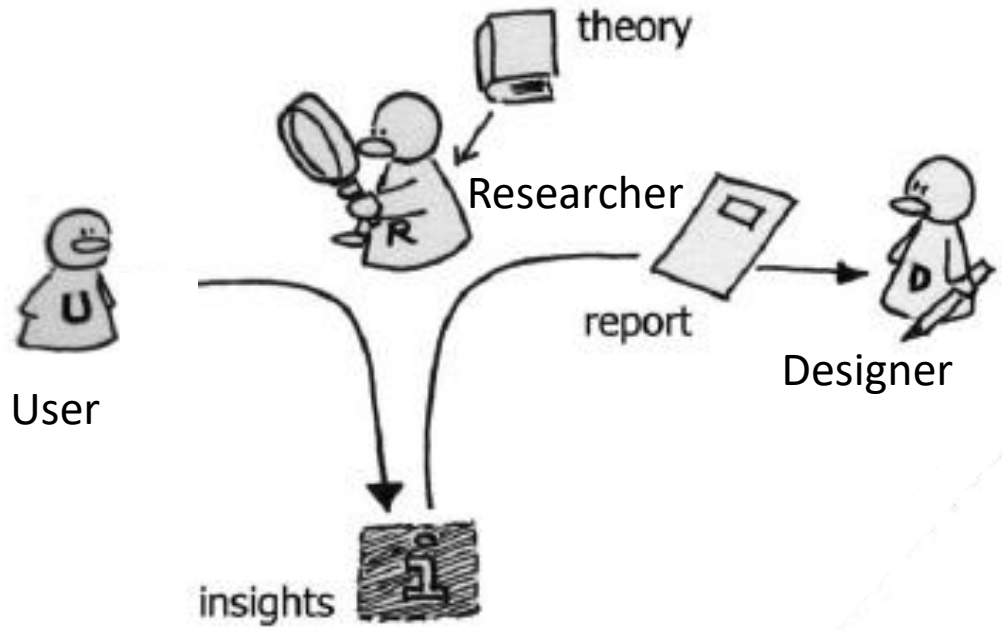
User-centred design



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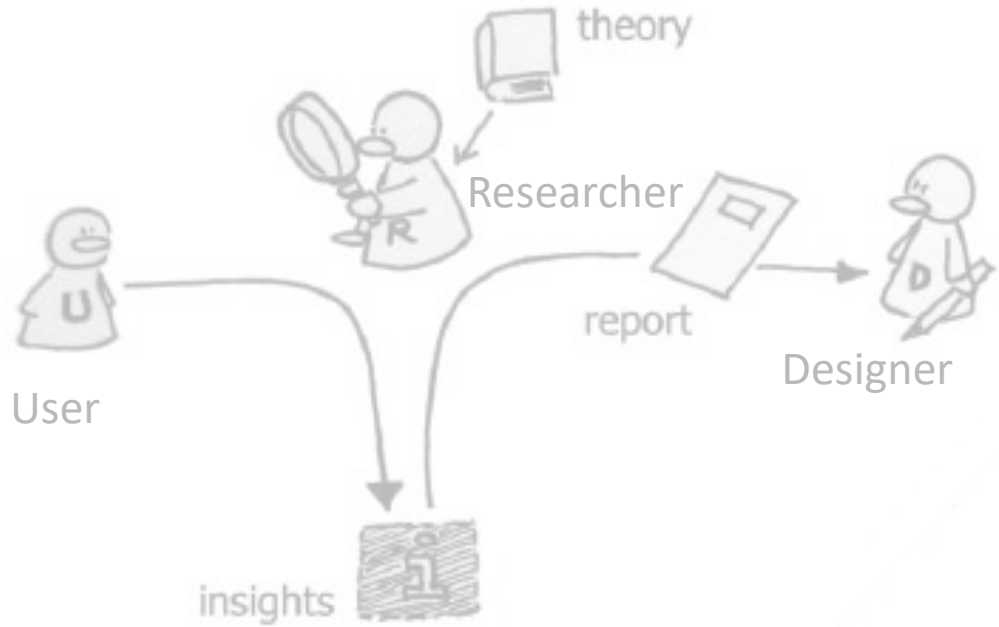
An emancipatory perspective for Learning Analytics?

“Learners are not to be seen as passive beneficiaries of a superior control entity. With respect to software adaptations, if Learning Analytics has to play a role, it should be limited to one of awareness and recommendation.”

Tchounikine, Pierre. (2019). Learners’ agency and CSCL technologies: towards an emancipatory perspective. *International Journal of Computer-Supported Collaborative Learning*, 14(2).

User-centred design



Co-creation (co-design)

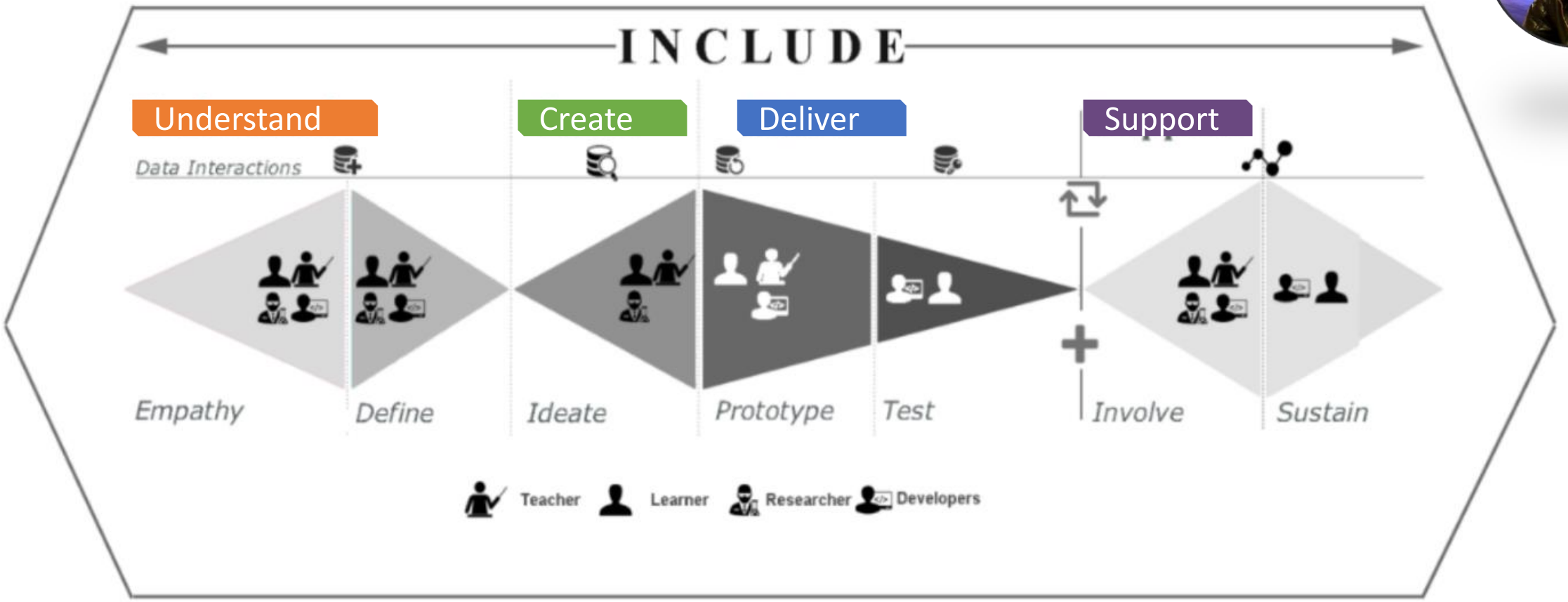
Sanders, E. B. N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design*, *4*(1), 5-18.

“**Human-centred design** is concerned less with assuring that artifacts work as intended (by their producers, designers, or other cultural authorities) than with **enabling many individual or cultural conceptions to unfold into uninterrupted interfaces with technology**.”

Klaus Krippendorff

Krippendorff, K. 2004, Intrinsic motivation and human-centred design, Theoretic Issues in Ergonomics Science, Vol. 5, No. 1, pp 43-72.

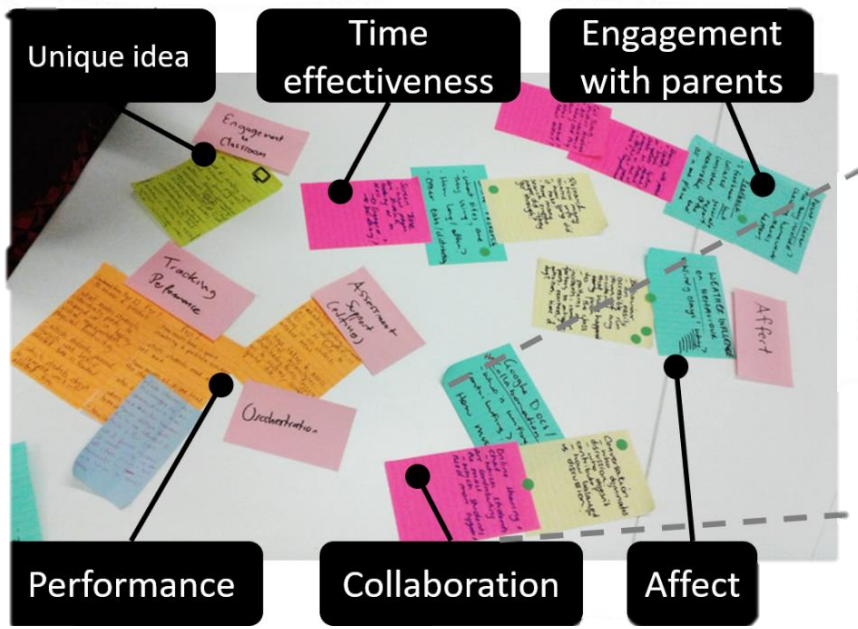
Design Thinking in Learning Analytics



Prieto-Alvarez, C. G., Martinez-Maldonado, R., and Anderson, T. (2018). Co-designing learning analytics tools with learners. In J. M. Lodge, J. C. Horvath, and L. Corrin (Eds.), Learning Analytics in the Classroom (93-110).

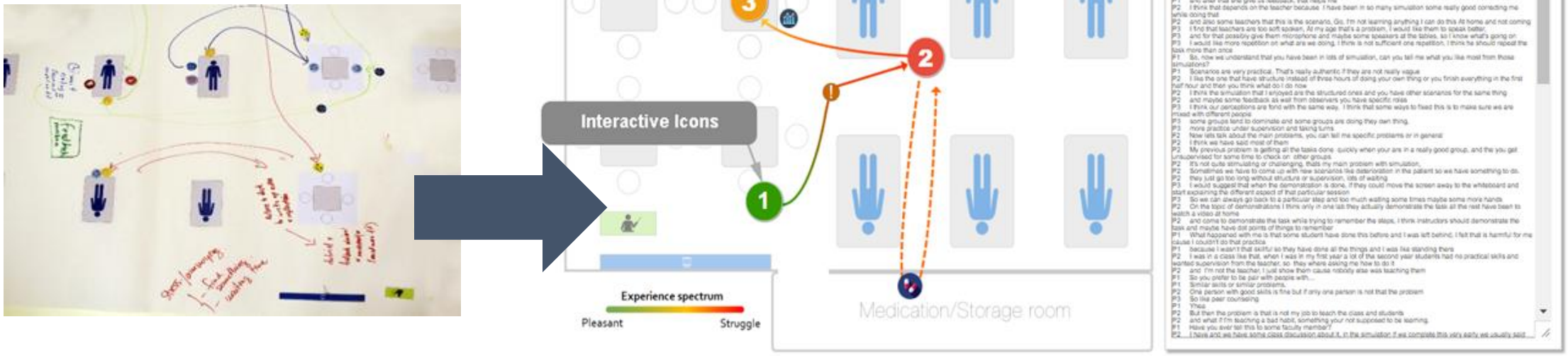
Understand

"*What aspects of the classroom or the learning activity happening in the classroom you would like to make more visible?*"



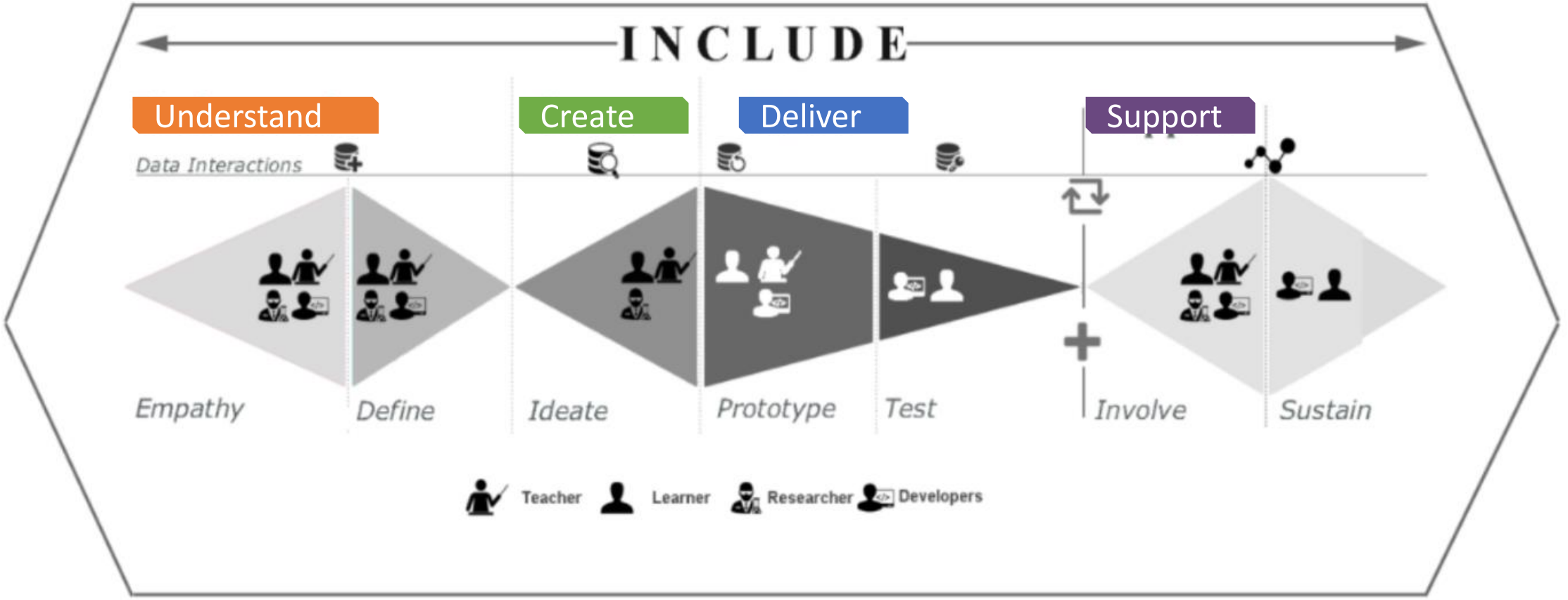
Understand

Learner-data journey mapping



Prieto-Alvarez, C. G., Martinez-Maldonado, R., & Shum, S. B. (2018, December). Mapping learner-data journeys: evolution of a visual co-design tool. In *Proc. OzCHI'18*.

Design Thinking in Learning Analytics



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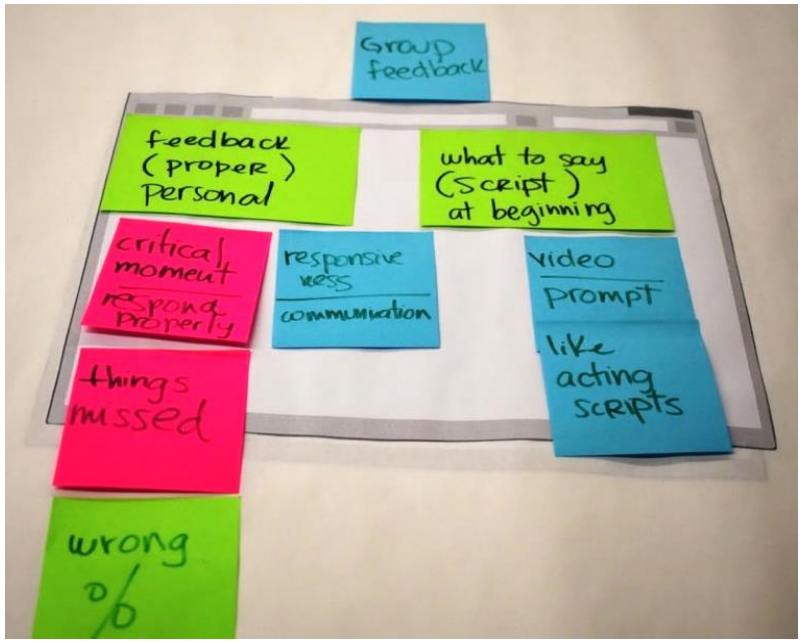
Co-design techniques to elicit student and educator perspectives

(e.g. “Teacher Superpowers”, and “Learning/Data Journey mapping” *)

Teachers

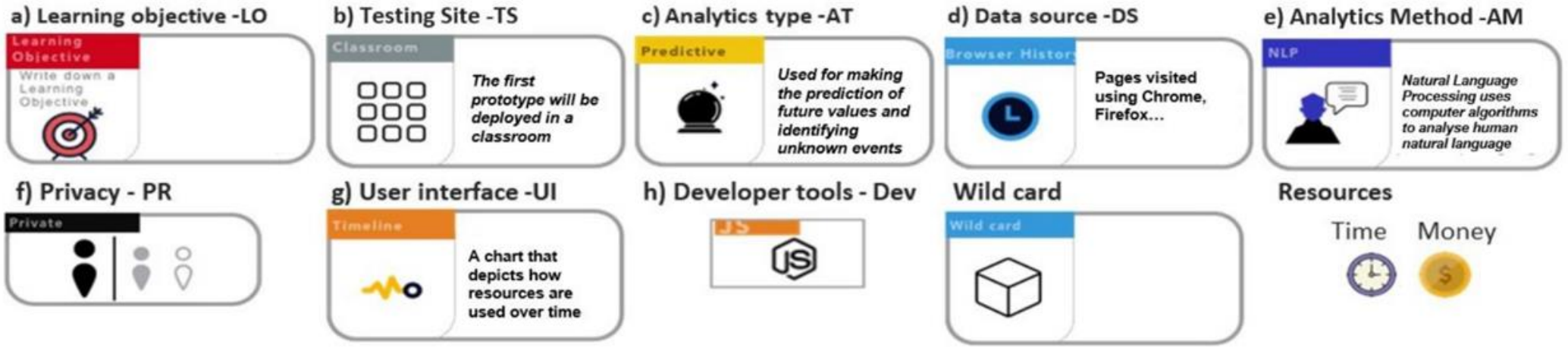
Students



* Prieto-Alvarez, C. G., Anderson, T., Martinez-Maldonado, R., and Buckingham Shum, S. (2018). Mapping Learner/Data Journeys: Evolution of a Visual Co-Design Tool. *Proc. Australian Conference on Human-Computer Interaction*, Melbourne, (ACM, NY), pp.205-214. https://doi.org/10.1145/3292147.3292168

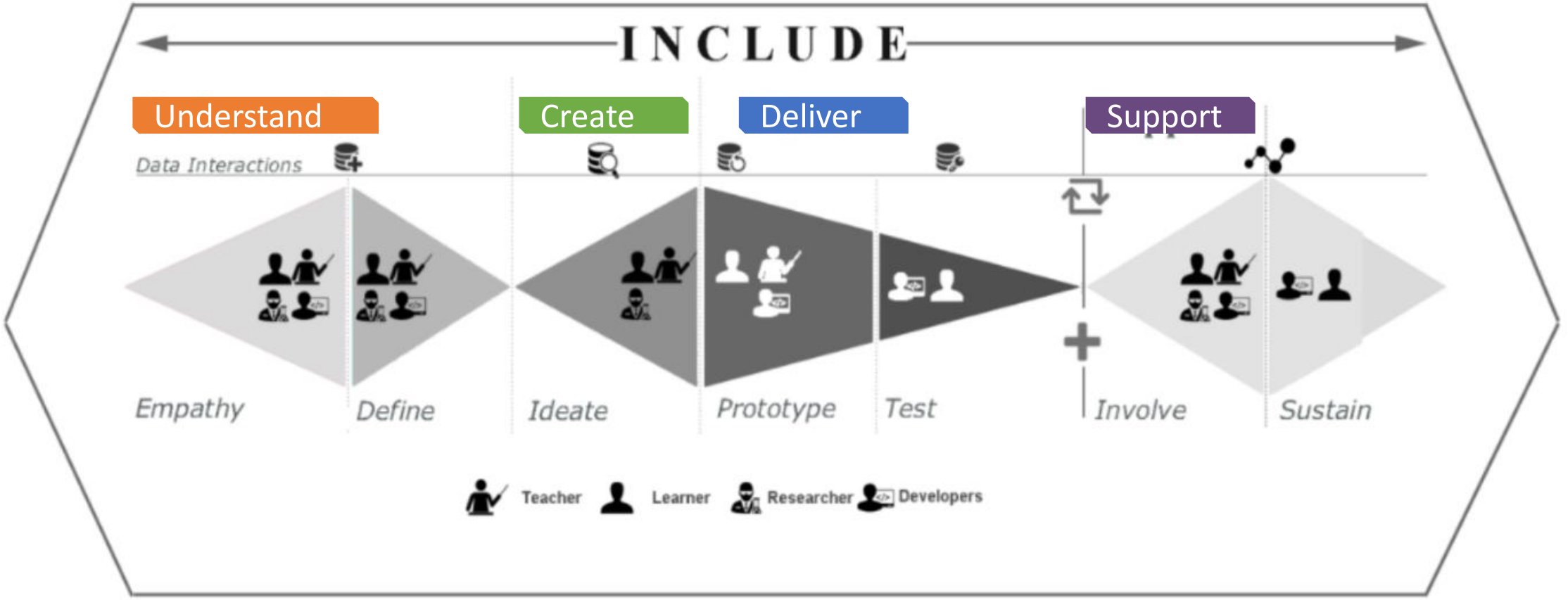
Create

LA-Deck: LA design cards



Alvarez, C. P., Martinez-Maldonado, R., & Shum, S. B. (2020, March). LA-DECK: A card-based learning analytics co-design tool. In *Proc. LAK'20*

Design Thinking (link) in Learning Analytics



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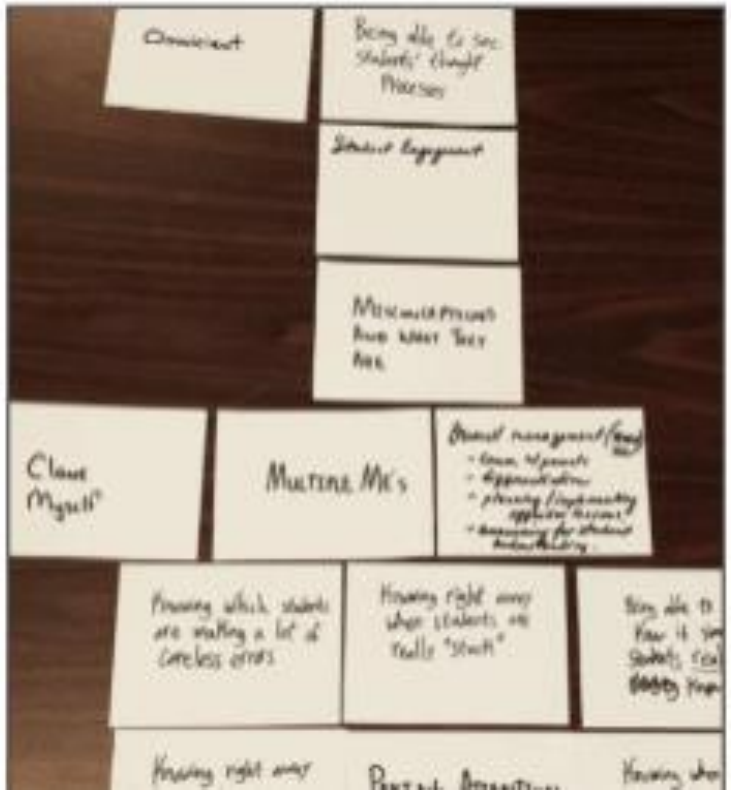
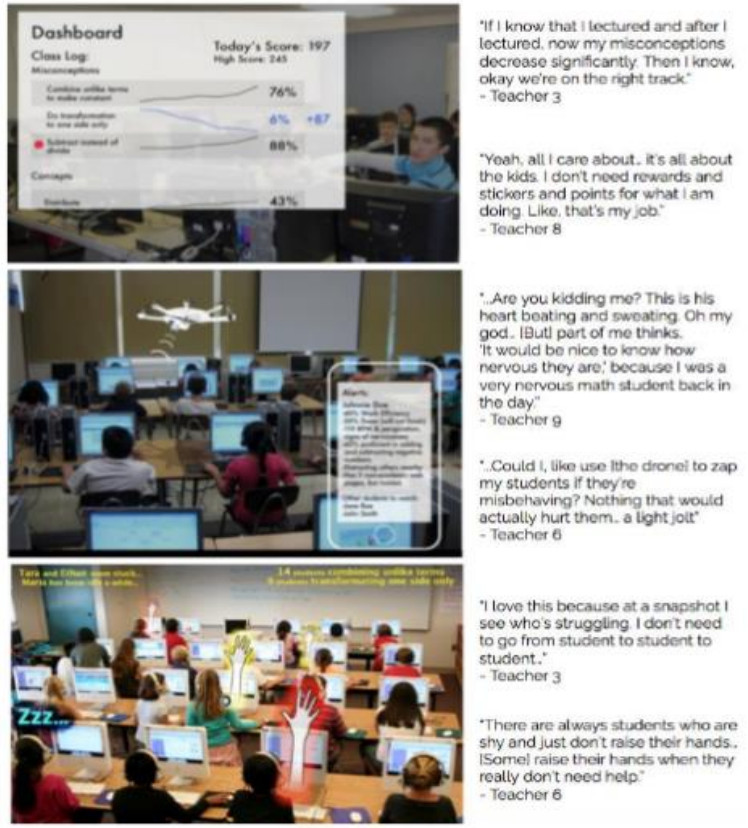
Deliver

JOURNAL OF LEARNING ANALYTICS
SOLAR SOCIETY for LEARNING ANALYTICS RESEARCH
Volume 6(2), 27–52. http://dx.doi.org/10.18608/jla.2019.62.3

Co-Designing a Real-Time Classroom Orchestration Tool to Support Teacher–AI Complementarity

Kenneth Holstein,[1] Bruce M. McLaren,[2] and Vincent Aleven[3]





"If I know that I lectured and after I lectured, now my misconceptions decrease significantly. Then I know, okay we're on the right track."
- Teacher 3

"Yeah, all I care about.. it's all about the kids. I don't need rewards and stickers and points for what I am doing. Like, that's my job."
- Teacher 8

"...Are you kidding me? This is his heart beating and sweating. Oh my god.. [But] part of me thinks, 'It would be nice to know how nervous they are,' because I was a very nervous math student back in the day."
- Teacher 9

"...Could I, like use [the drone] to zap my students if they're misbehaving? Nothing that would actually hurt them.. a light jolt"
- Teacher 6

"I love this because at a snapshot I see who's struggling. I don't need to go from student to student to student.."
- Teacher 3

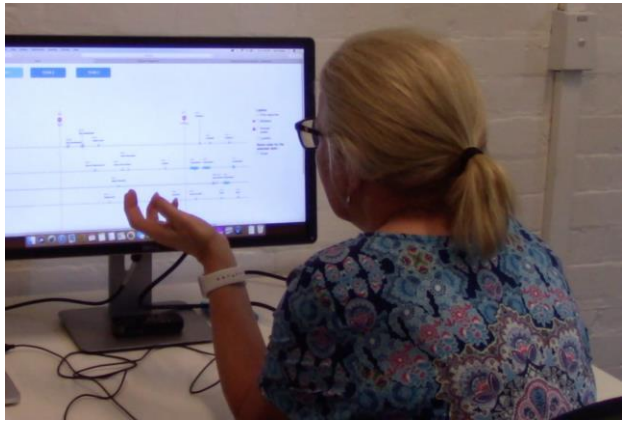
"There are always students who are shy and just don't raise their hands.. [Some] raise their hands when they really don't need help."
- Teacher 6

Deliver

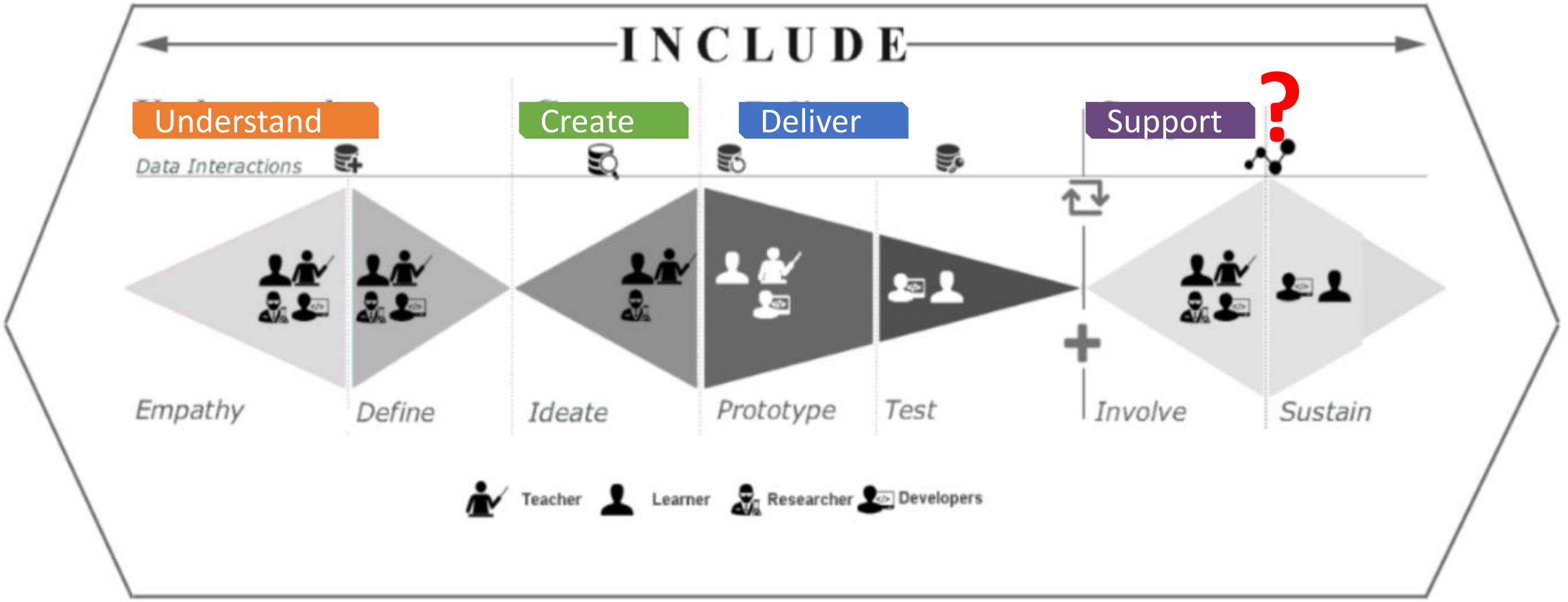
Testing the same prototypes with

Students

Teachers



Design Thinking in Learning Analytics



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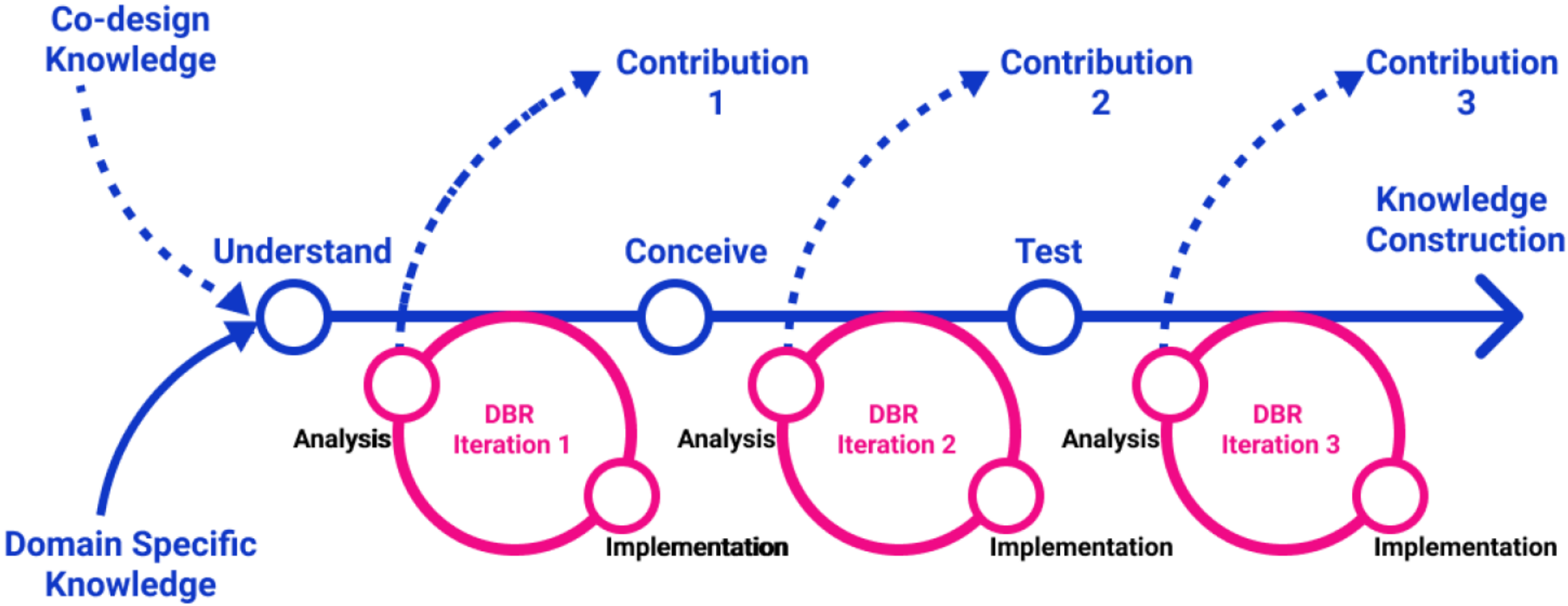
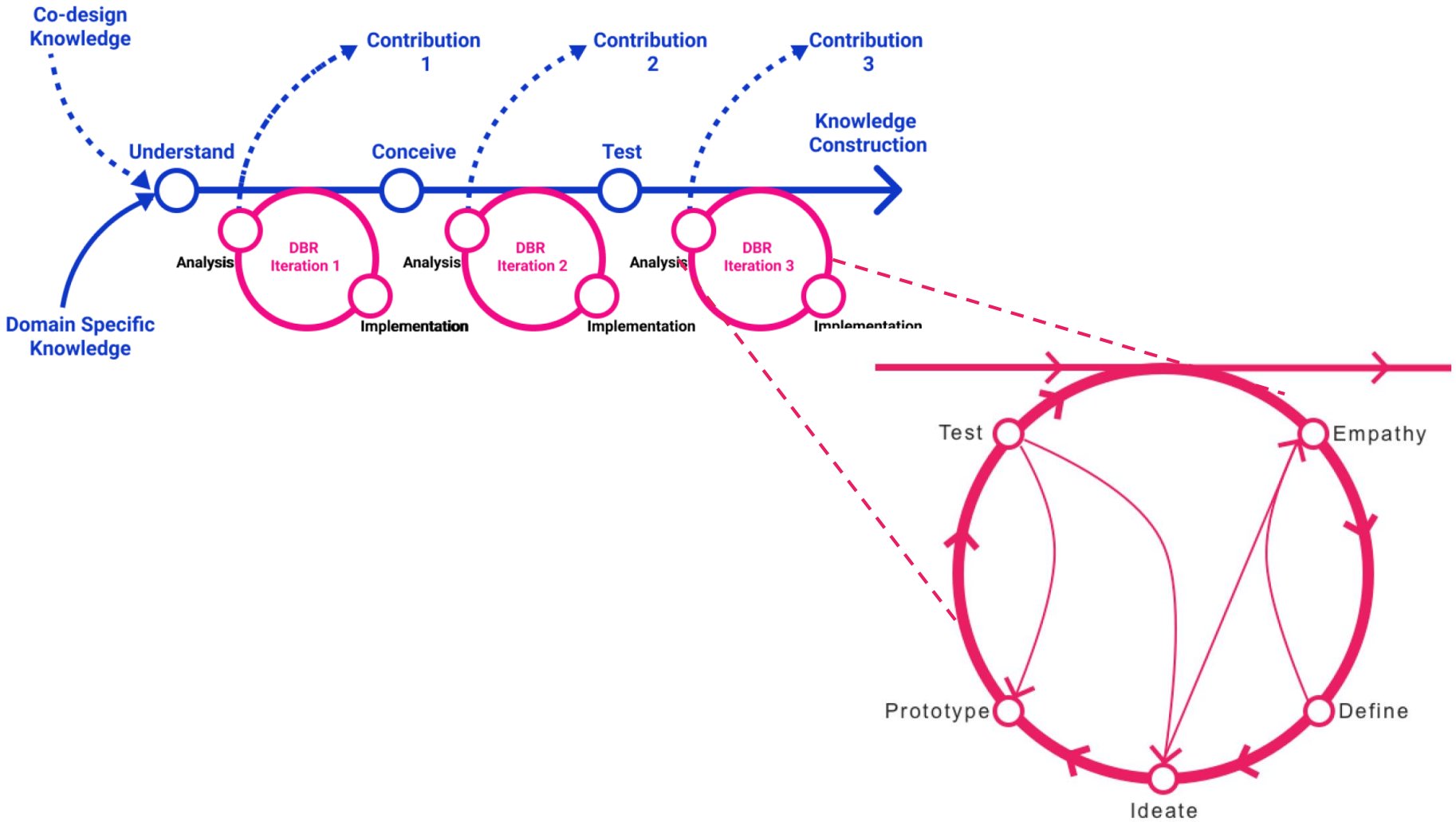
What about DBR?

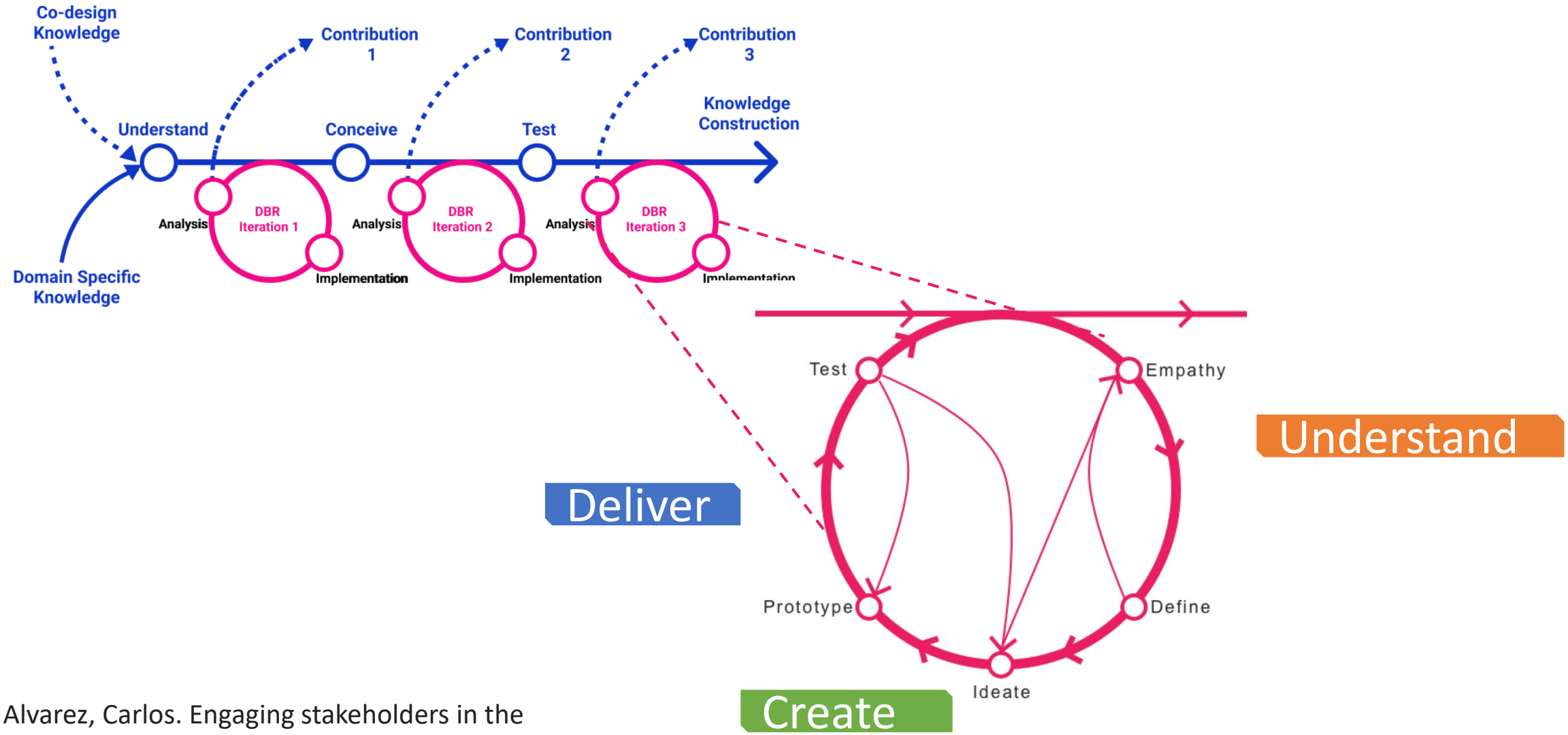


DBR + Design thinking



Prieto Alvarez, Carlos. Engaging stakeholders in the learning analytics design process. PhD Thesis

DBR + Design thinking



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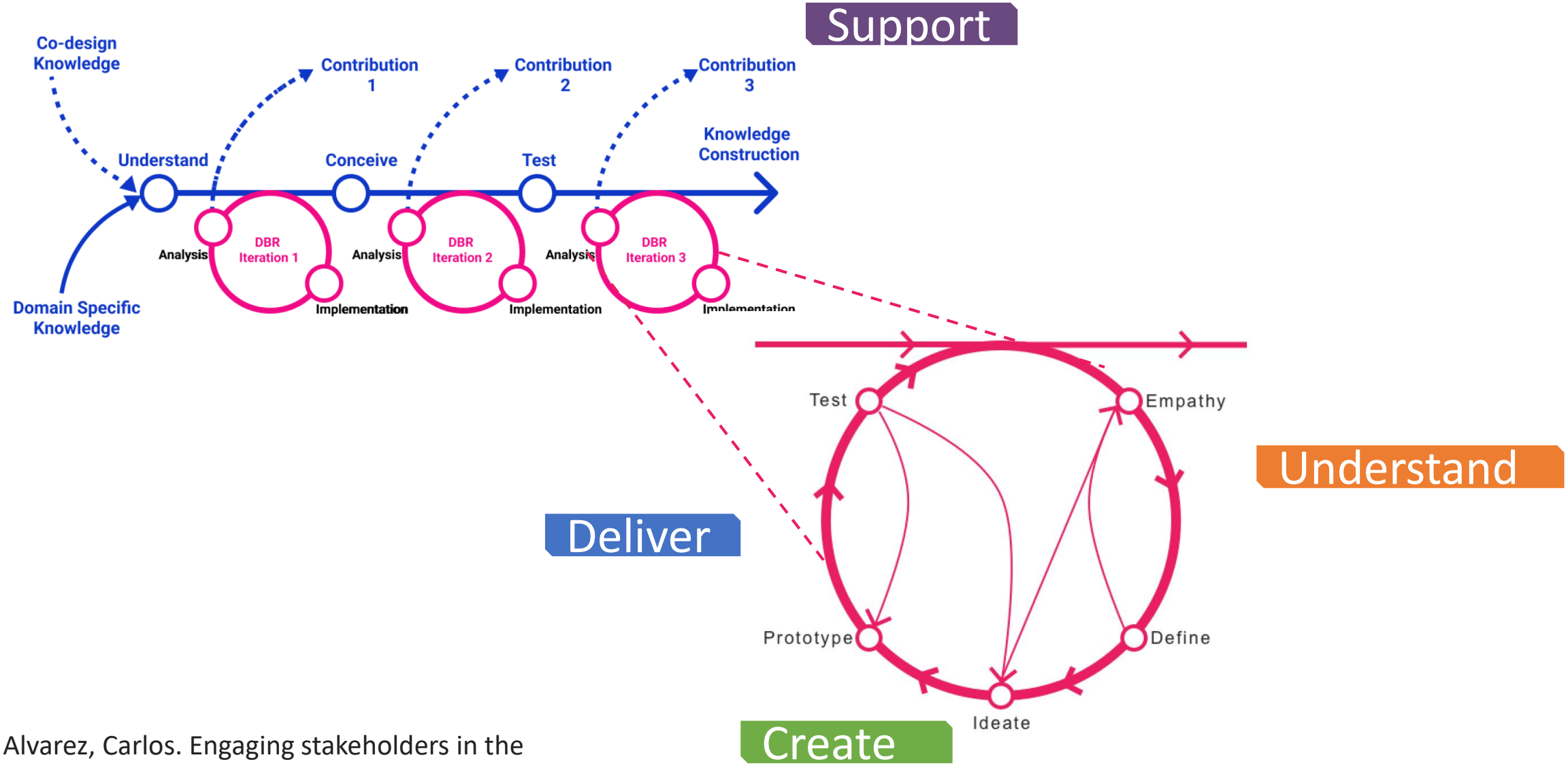

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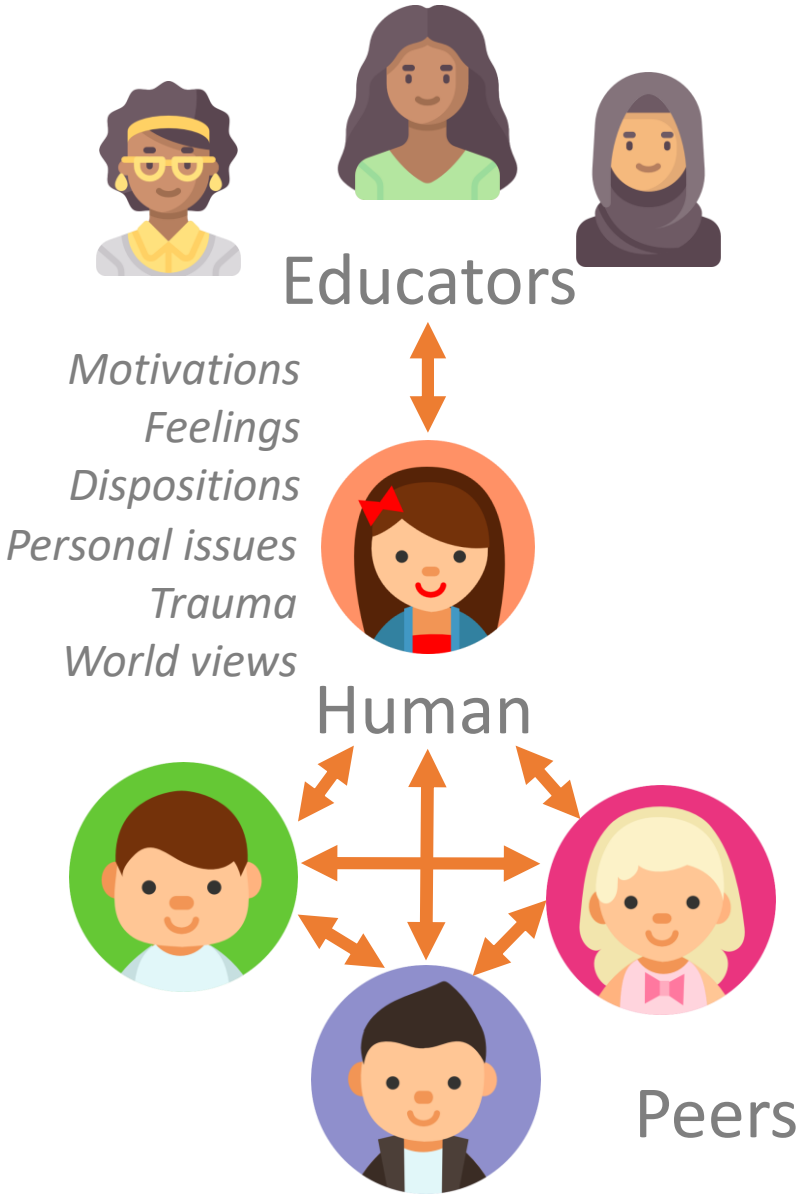
Outline

- ❑ Human centredness
- ❑ Multimodality
- ❑ Storytelling

The real Learning Analytics situation



<<Interaction>>

Multimodality in Learning Analytics

"Multimodal data is used in recognition of the plurality of ways that students may demonstrate or communicate knowledge, interests and intent"

Worsley et al. 2021

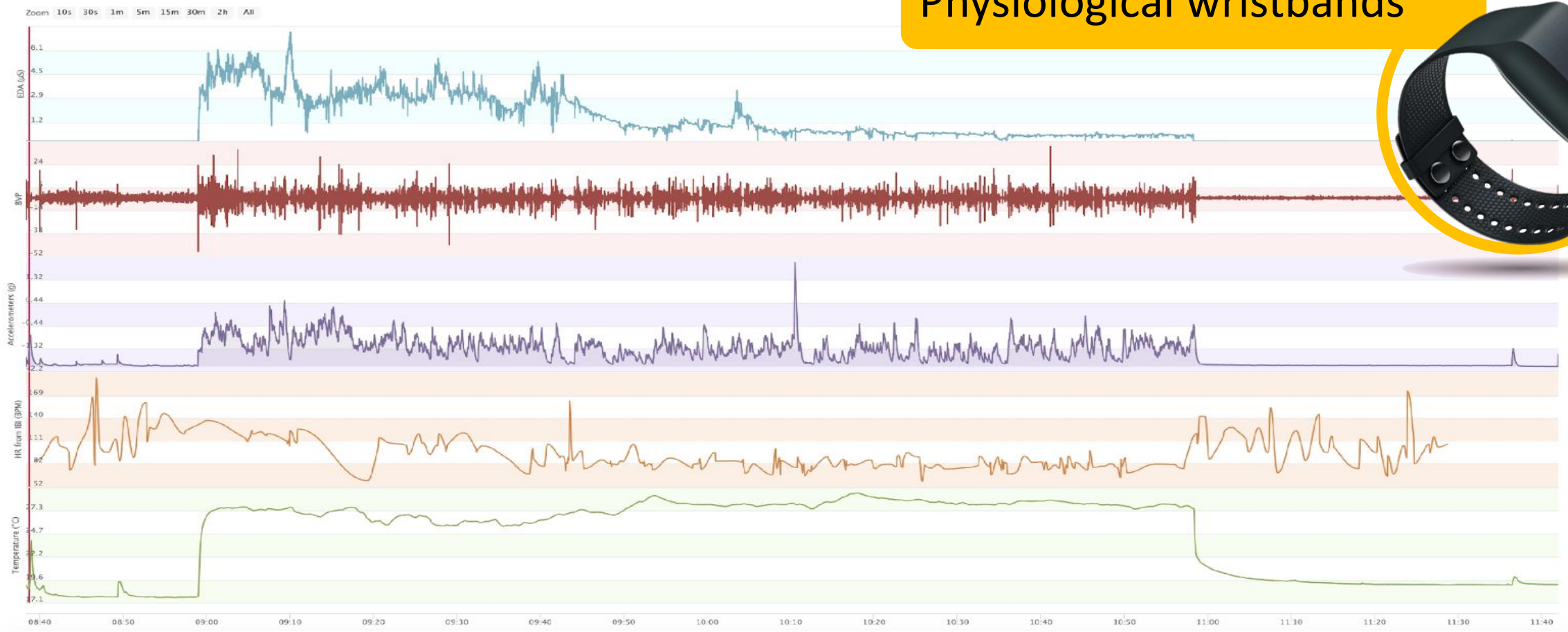
Multimodal learning analytics vision

“The goal of MMLA is to support learning experiences that may be collaborative, hands-on, and face-to-face, **de-emphasizing the computer screen** as the primary form or object of interaction”

Worsley et al. 2021

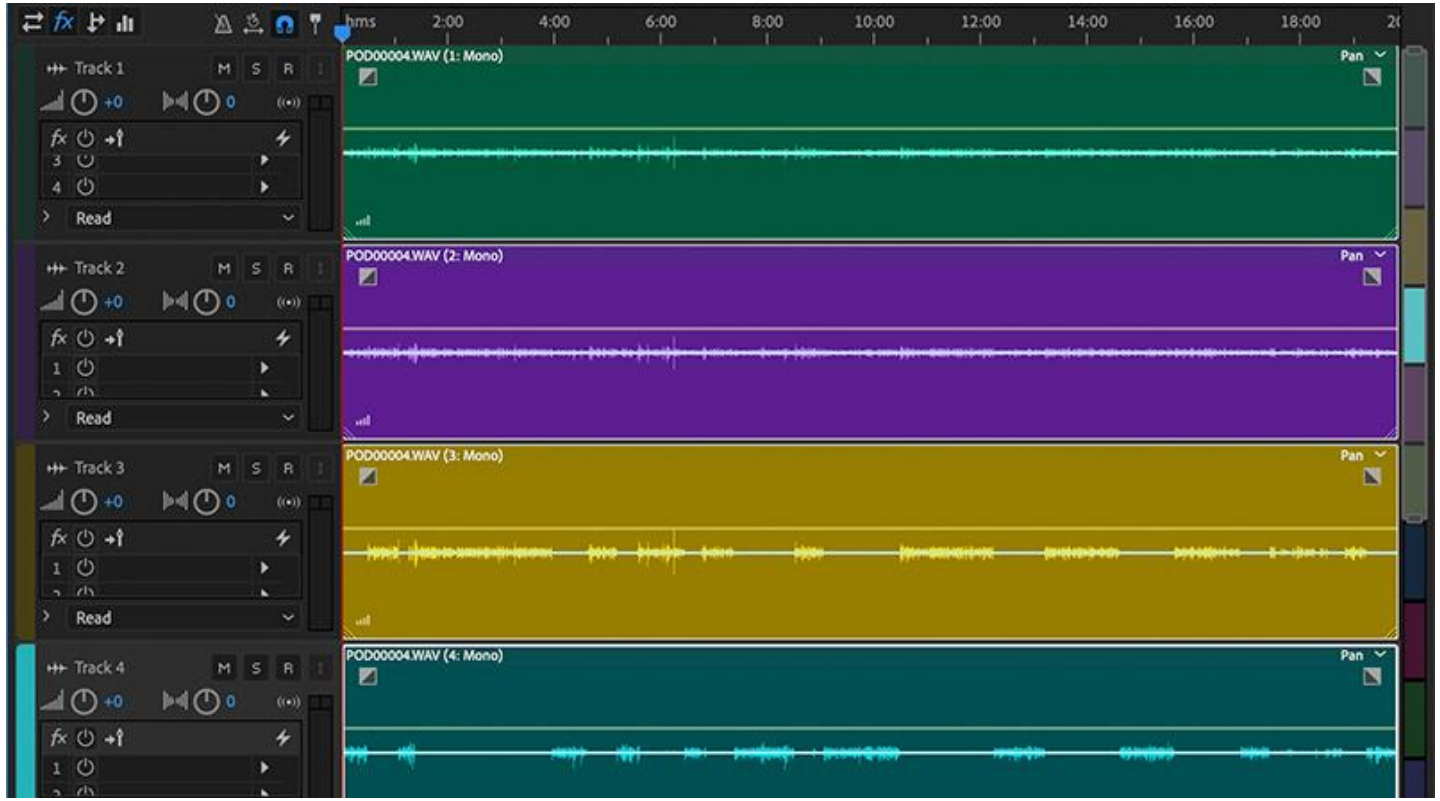
Resulting multi-channel data streams

Physiological wristbands



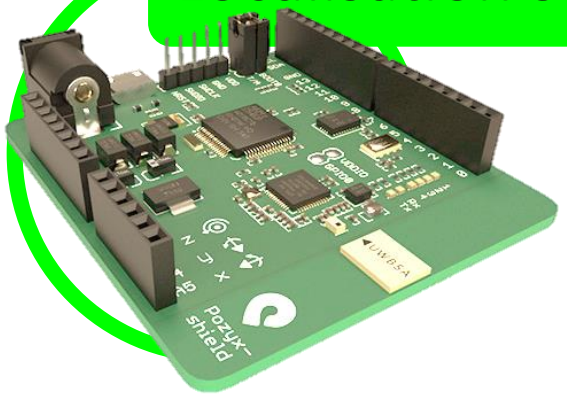
Audio data

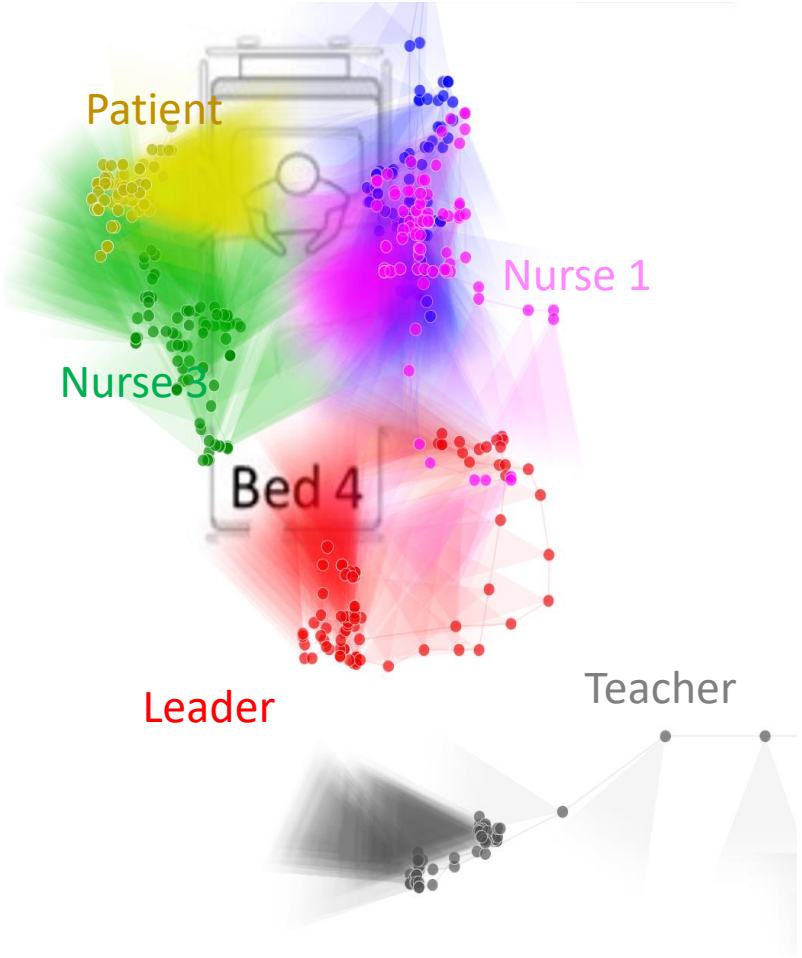
Audio devices


hms
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
Track 1
POD00004.WAV (1: Mono)
Pan
Read
Track 2
POD00004.WAV (2: Mono)
Pan
Read
Track 3
POD00004.WAV (3: Mono)
Pan
Read
Track 4
POD00004.WAV (4: Mono)
Pan

Positioning data

Localisation sensors





2 minute of activity

Action log data

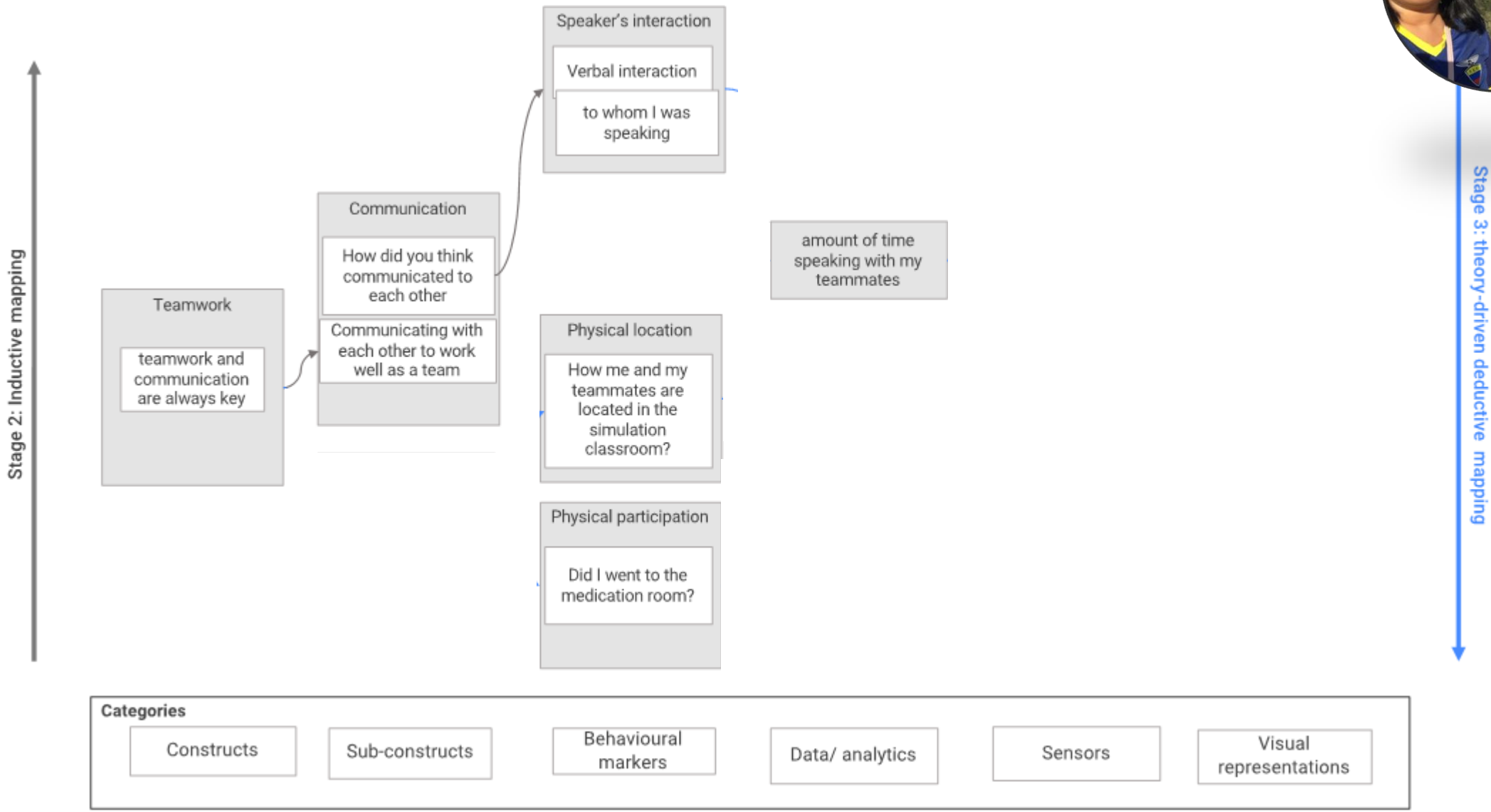
System logs

Observation logs

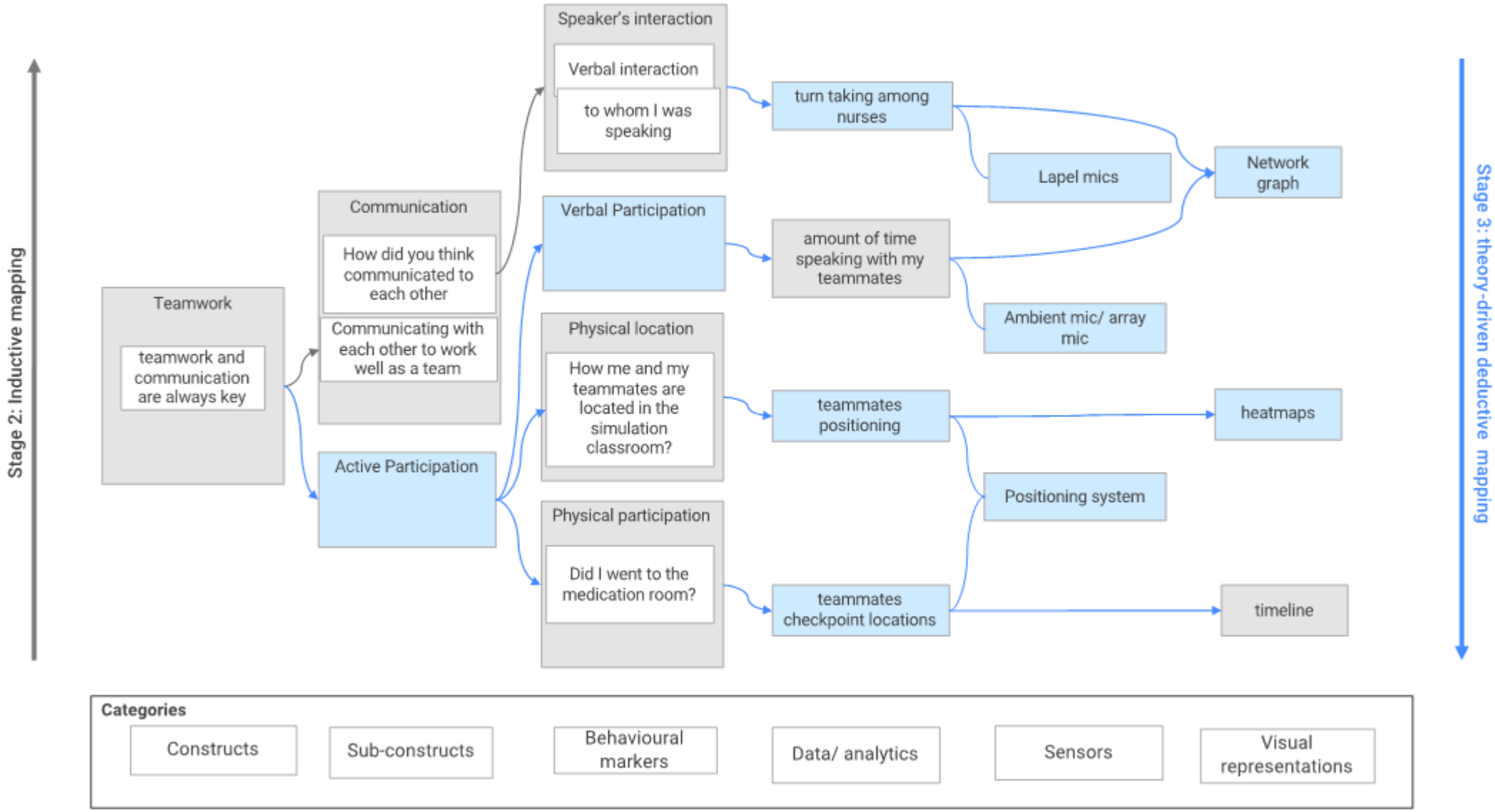
Patient simulator logs

Timestamp	User	Action
00:02	Leader	Connect oximeter
01:00	Nurse 2	Prepare medication
01:20	Nurse 3	Check vital signs
01:55	Leader	Provide medication
02:01	Nurse 2	Connect IV device
02:04	Observer	Log actions
02:32	Nurse 2	Check vital signs

Inductive step with teachers



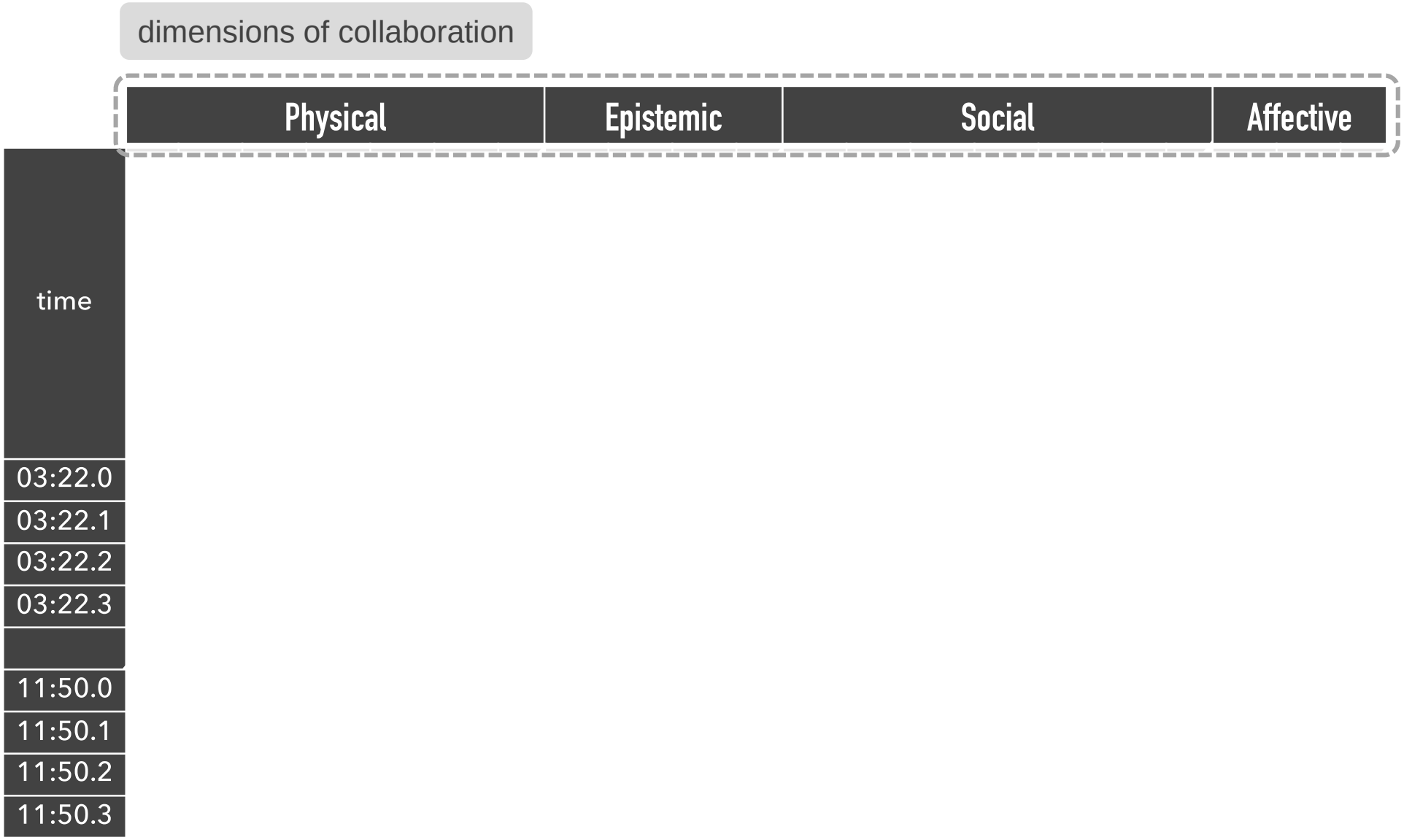
Deductive step: filling the holes from theory



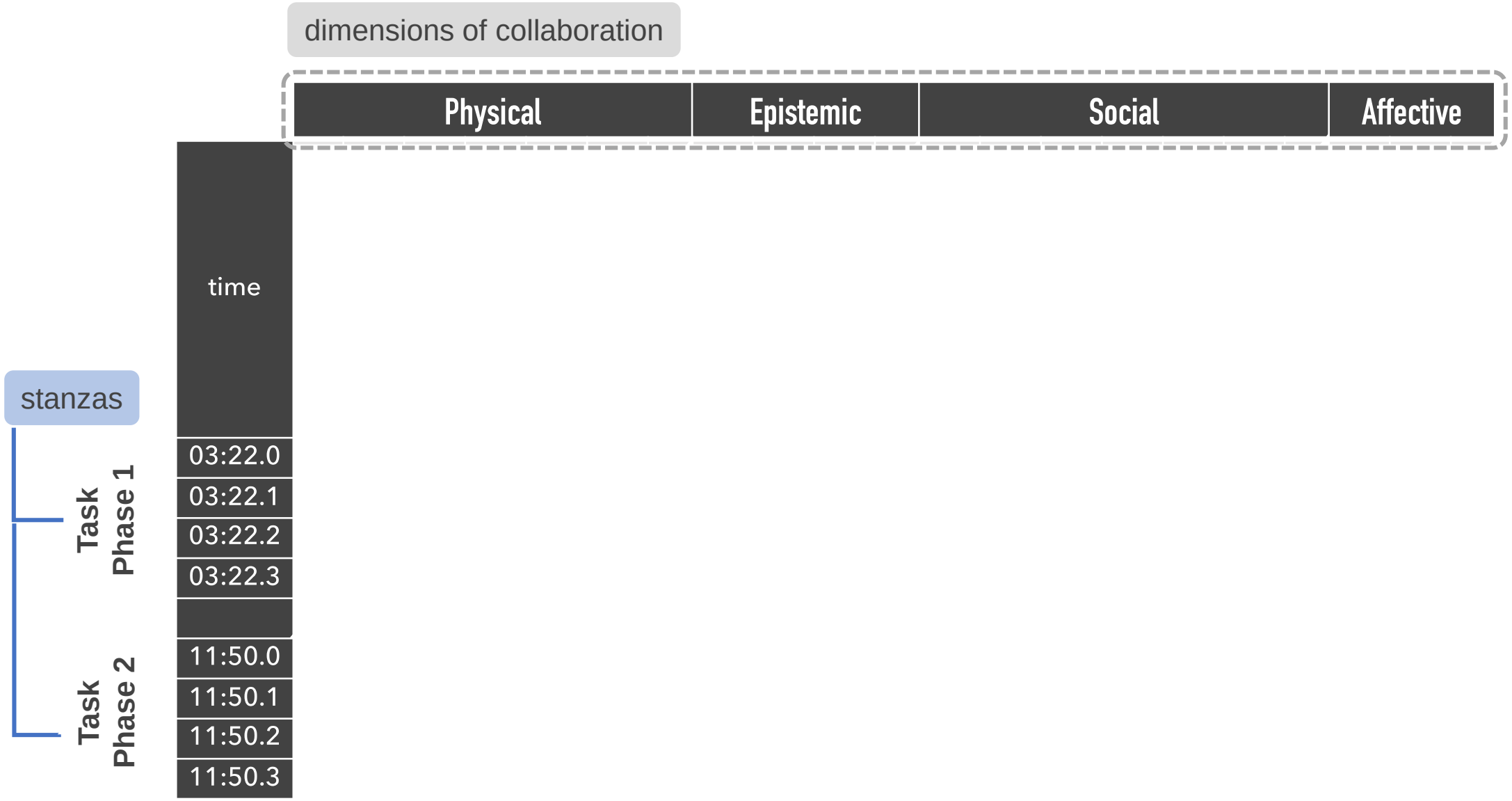
Multimodal Matrix: overview

Echeverria, V. 2020 Designing Feedback for Collocated Teams using Multimodal Learning Analytics. PhD thesis

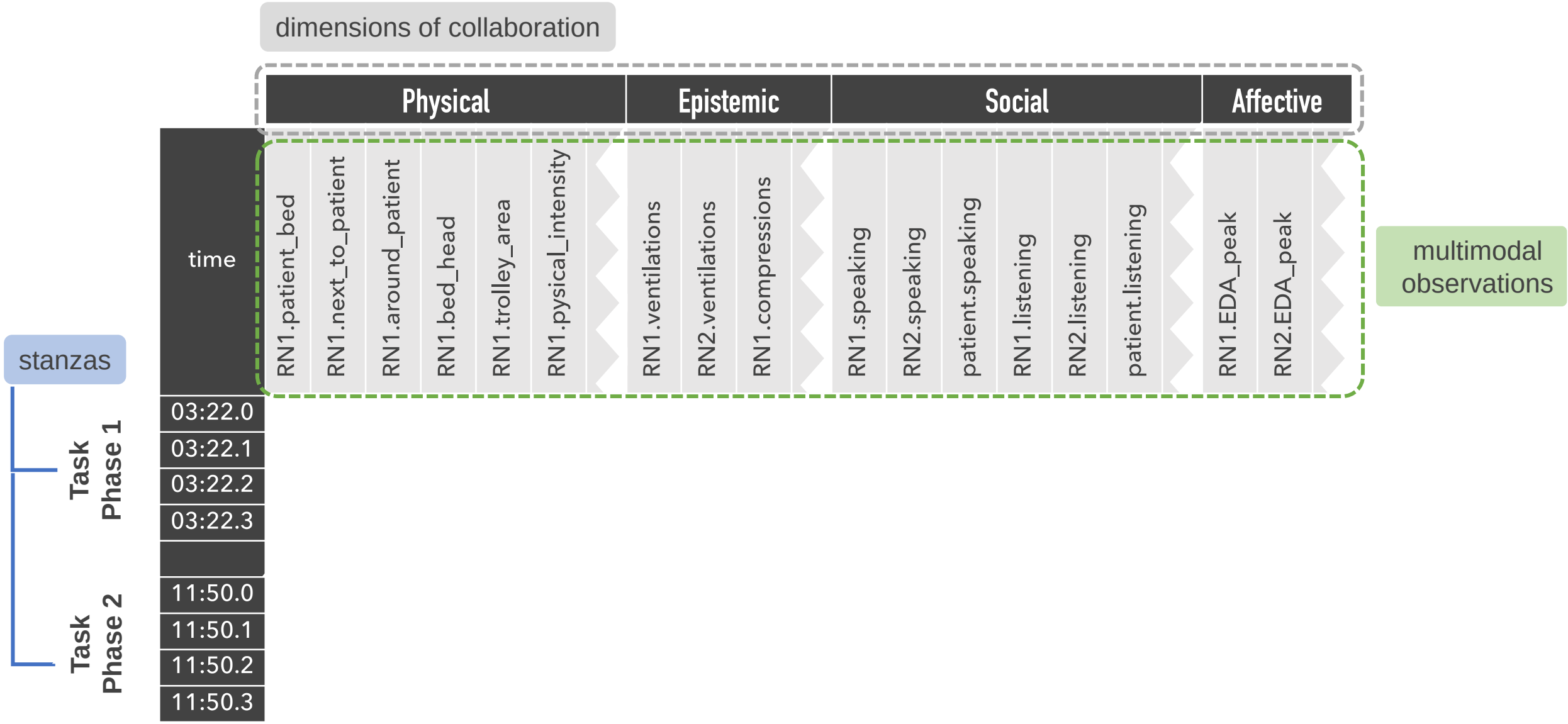
Multimodal Matrix: overview



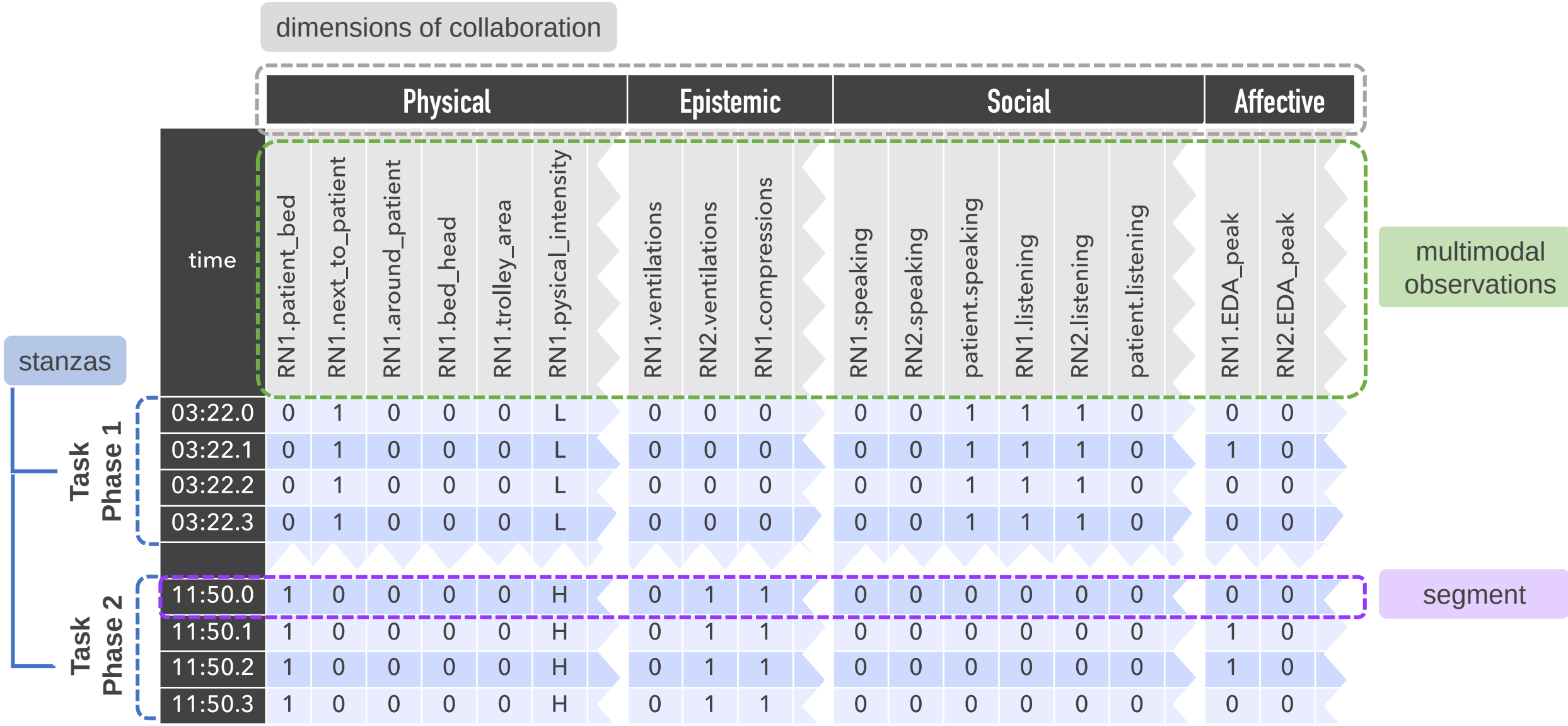
Multimodal Matrix: overview



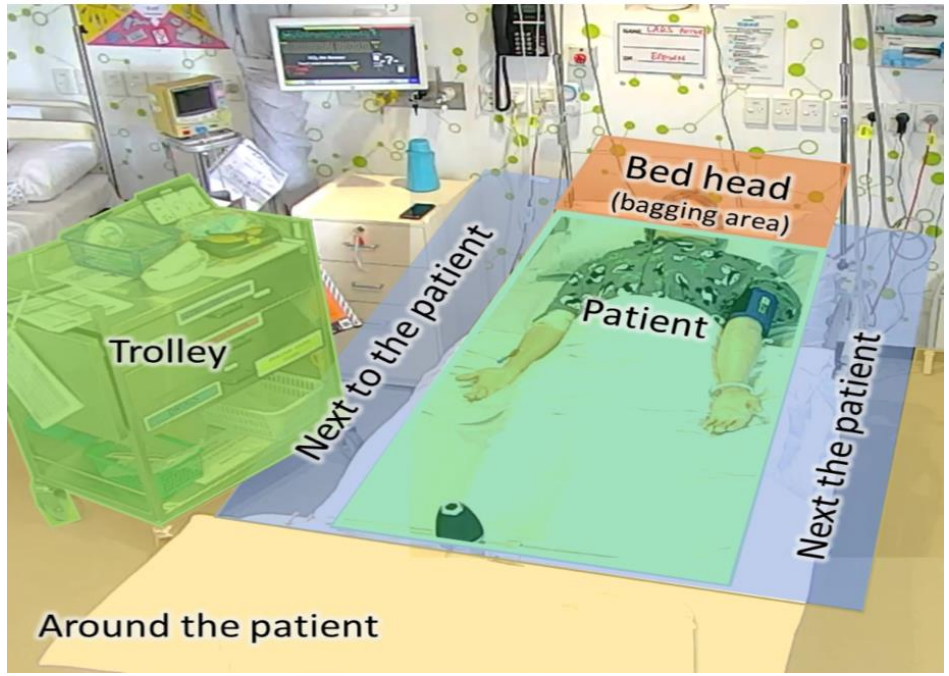
Multimodal Matrix: overview



Multimodal Matrix: overview



Mapping from positional Codes to digital codes in the Multimodal Matrix

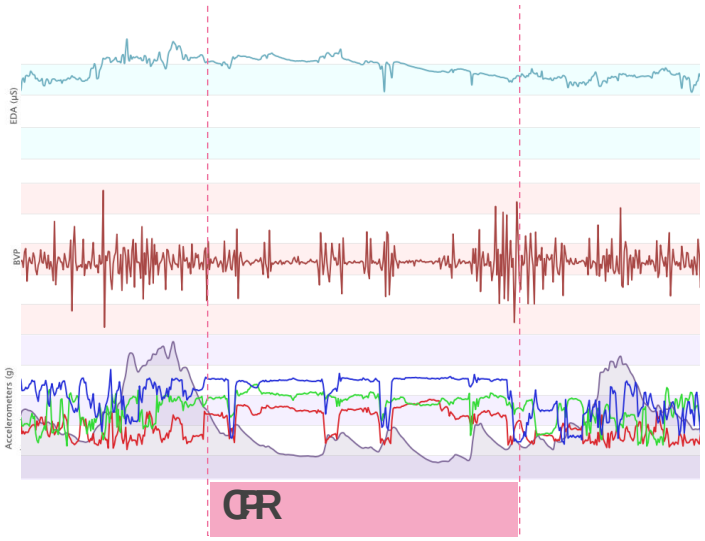


Machine coding

	Physical				
time	RN1.patient_bed	RN1.next_to_patient	RN1.around_patient	RN1.bed_head	RN1.trolley_area
03:22.0	0	1	0	0	0
03:22.1	0	1	0	0	0
03:22.2	0	1	0	0	0
03:22.3	0	1	0	0	0
11:50.0	1	0	0	0	0
11:50.1	1	0	0	0	0
11:50.2	1	0	0	0	0
11:50.3	1	0	0	0	0

Classifying raw accelerometer data

→ low/medium/high physical activity

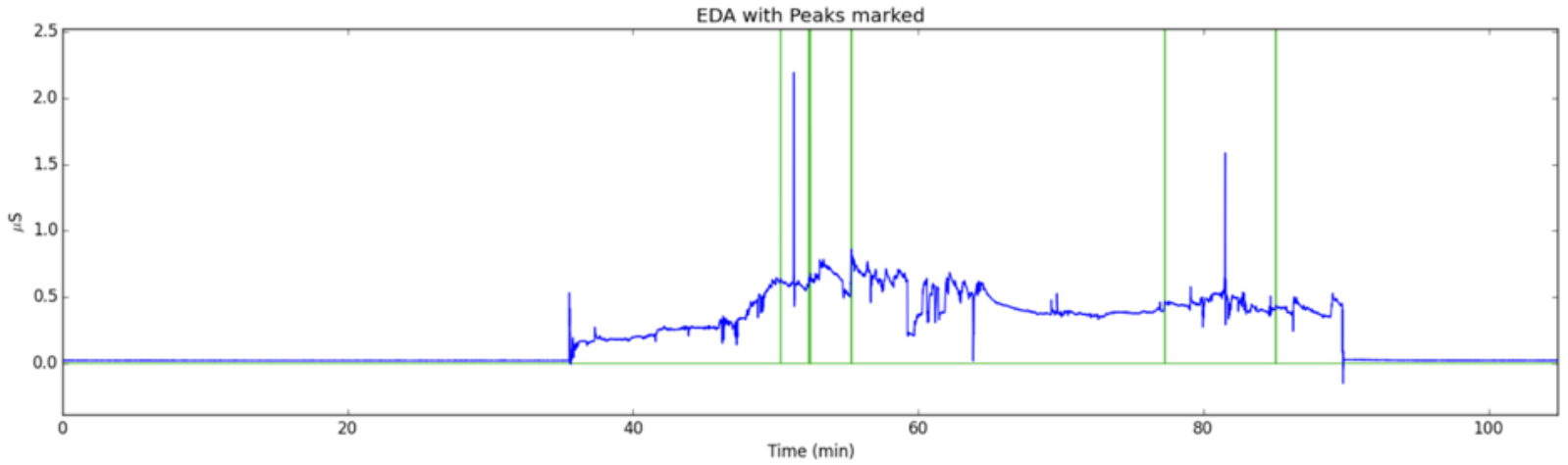


high-level of physical activity

Machine coding

Physical	
time	RN1.pysical_intensity
03:22.0	L
03:22.1	L
03:22.2	L
03:22.3	L
11:50.0	H
11:50.1	H
11:50.2	H
11:50.3	H

Thresholding raw EDA traces to focus on what's interesting: EDA peaks + low physical activity

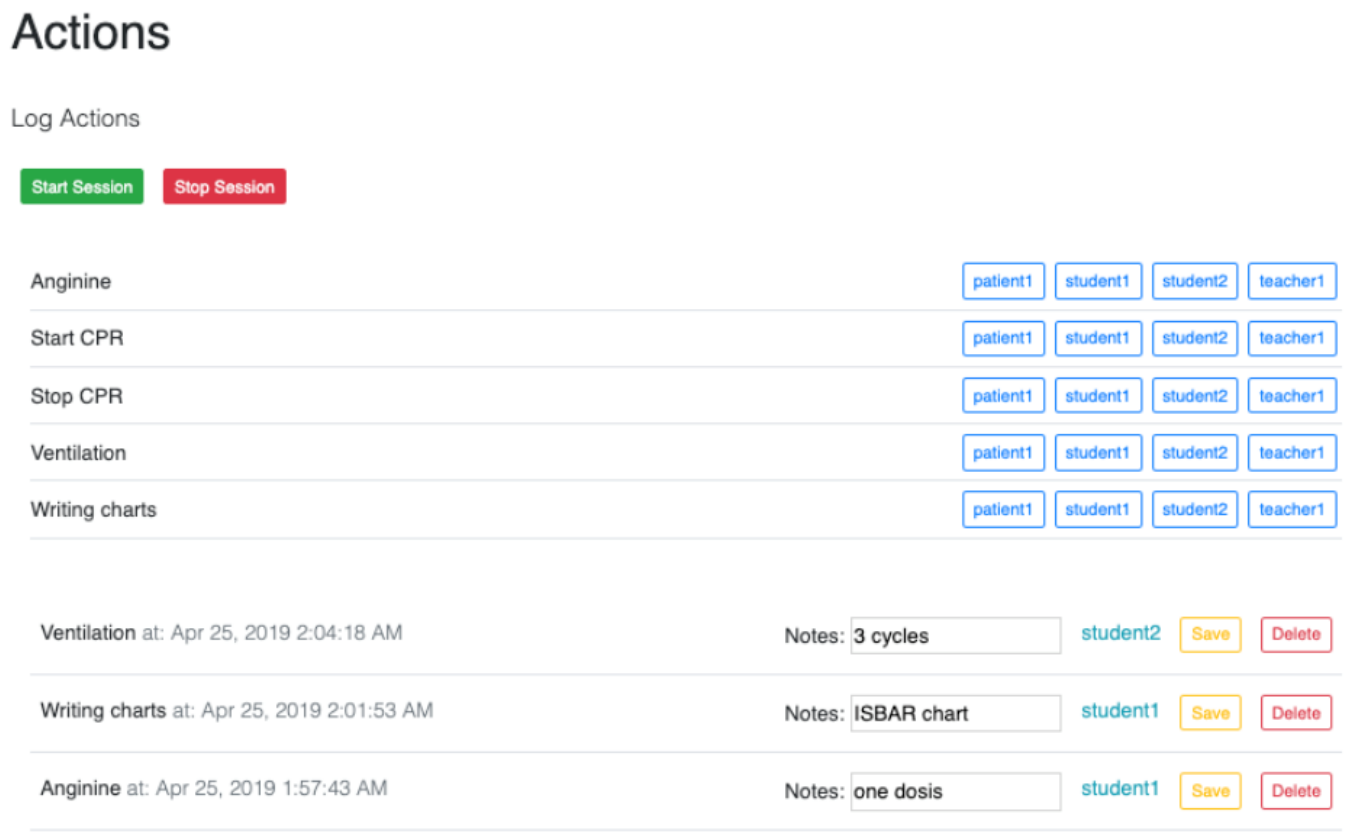


Machine coding

Affective	
RN1.EDA_peak	RN2.EDA_peak
0	0
1	0
0	0
0	0
0	0
1	0
1	0
0	0

Observers (e.g. researchers or students)

use a tablet-based annotation tool to log key actions



Human coding

Epistemic		
RN1.ventilations	RN2.ventilations	RN1.compressions
0	0	0
0	0	0
0	0	0
0	0	0
0	1	1
0	1	1
0	1	1
0	1	1

Working towards automatically identifying

who is speaking and listening/sec.

Machine coding

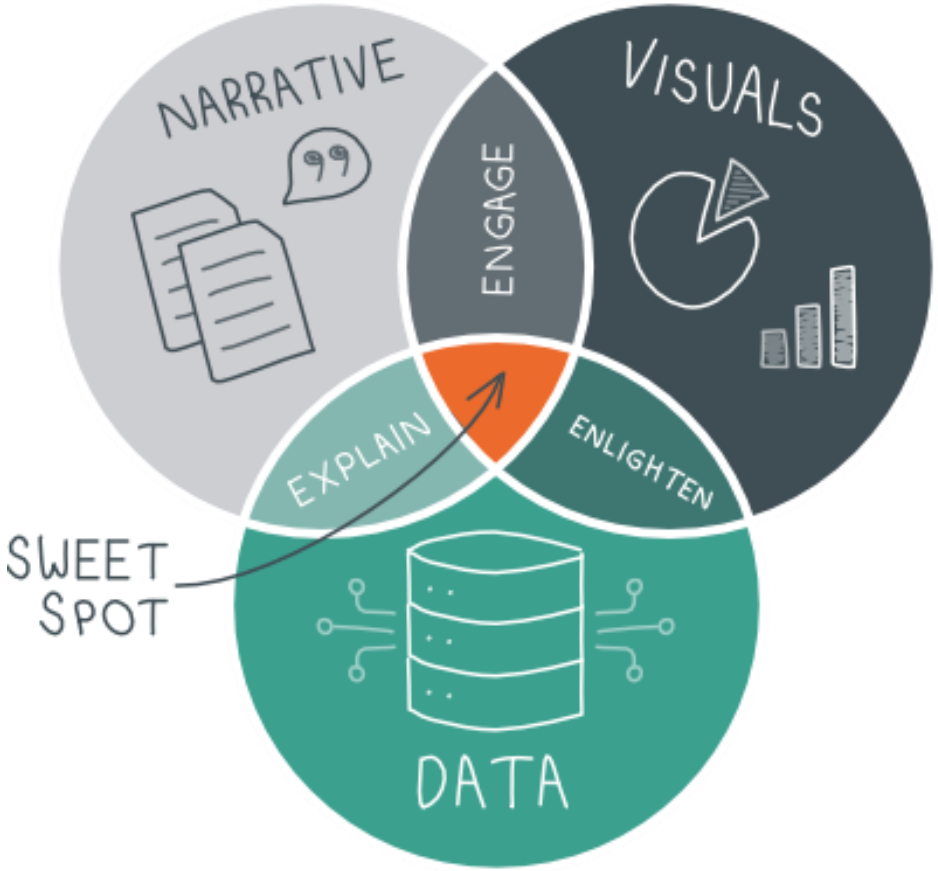
Social					
RN1.speaking	RN2.speaking	patient.speaking	RN1.listening	RN2.listening	patient.listening
0	0	1	1	1	0
0	0	1	1	1	0
0	0	1	1	1	0
0	0	1	1	1	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

Outline

- ❑ Human centredness
- ❑ Multimodality
- ❑ Storytelling

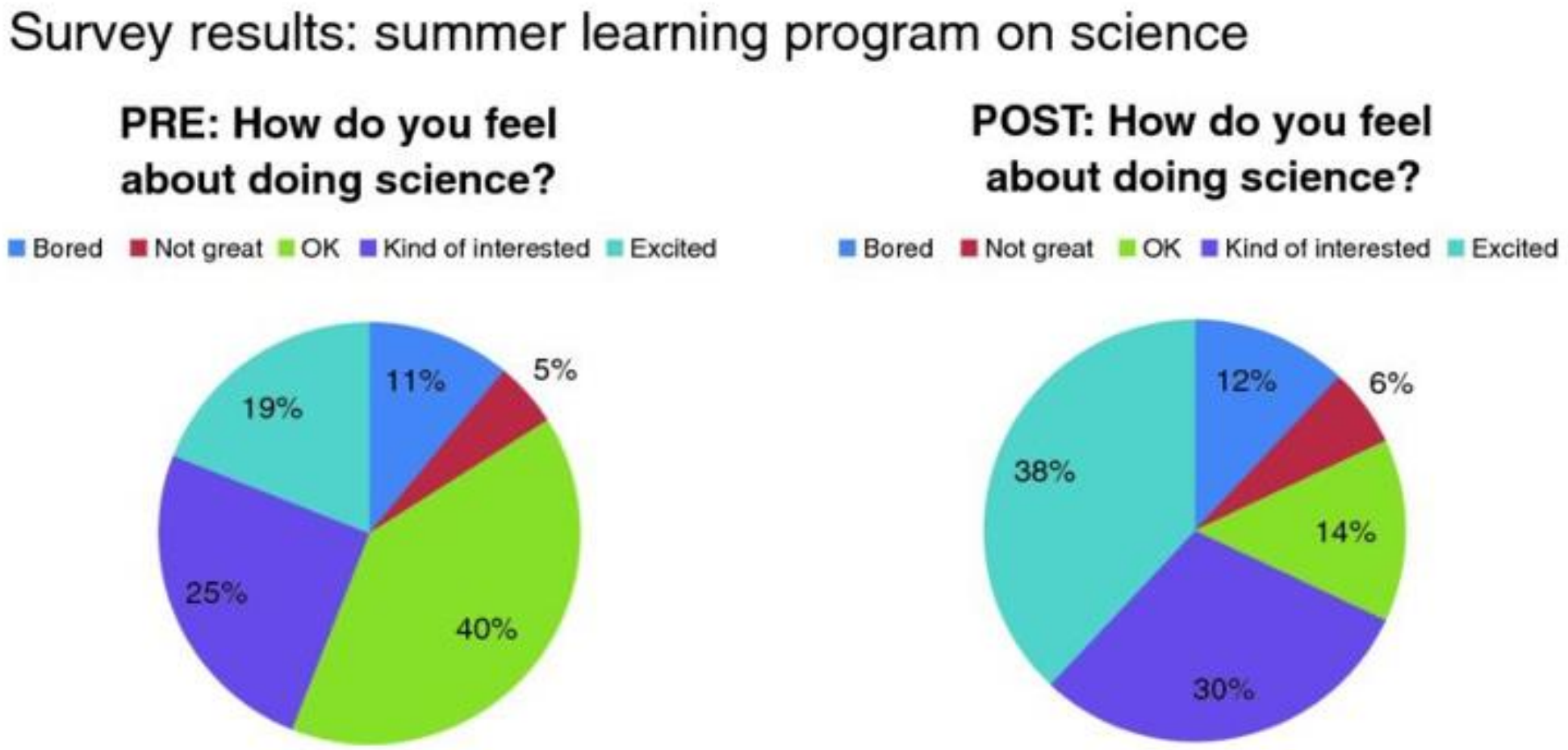
What is data storytelling?

An information compression technique for communicating insights to an audience through the combination of data, visuals, and narrative



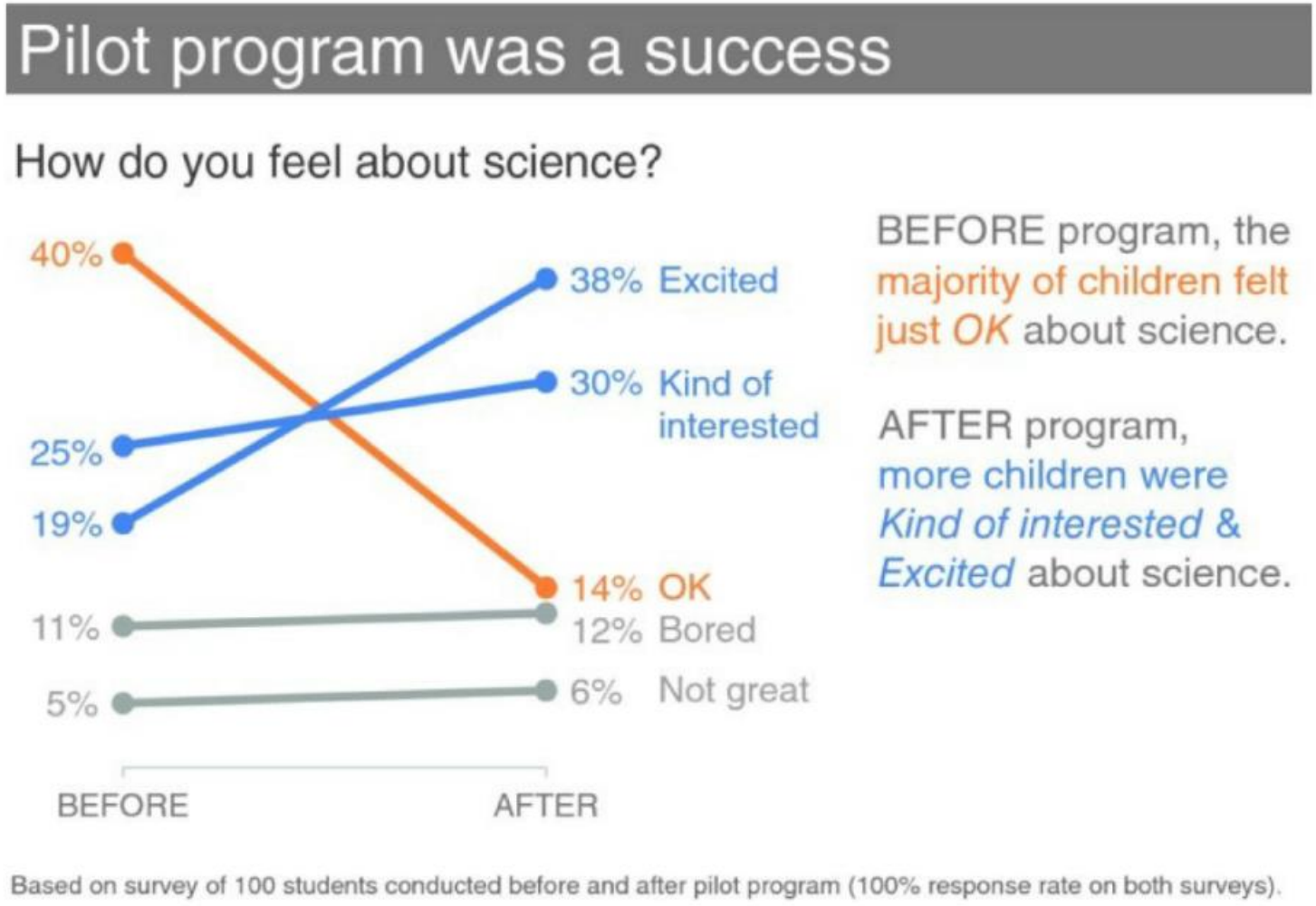
Brent Dykes. 2015. Data storytelling: What it is and how it can be used to effectively communicate analysis results. Applied Marketing Analytics. 1, 4, 299-313.

We want to move from this…..

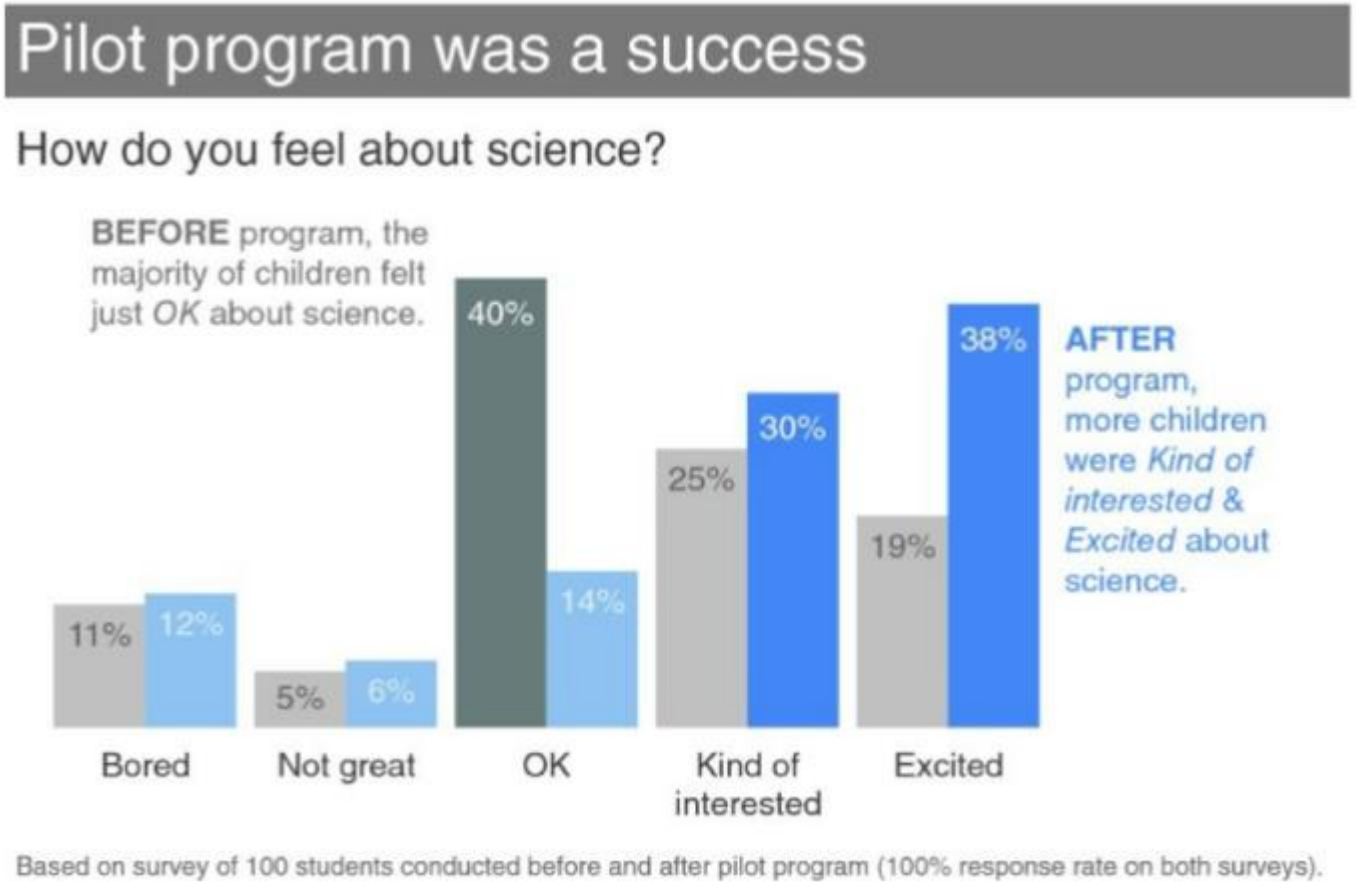


Example from: Knaflic, C. N. (2015). *Storytelling with data: A data visualization guide for business professionals*. John Wiley & Sons.

…towards data stories like this…



… or this one…

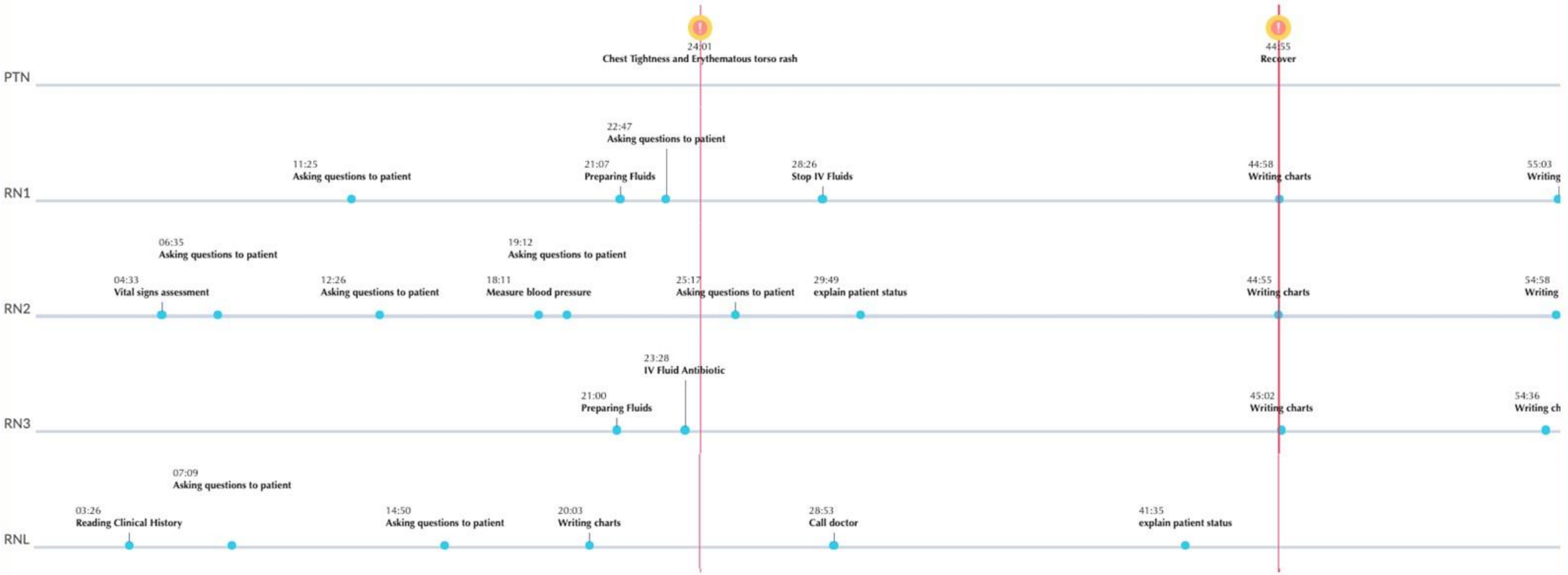

Pilot program was a success
How do you feel about science?
BEFORE program, the majority of children felt just OK about science.
40%
14%
11%
12%
5%
6%
25%
30%
19%
38%
AFTER program, more children were Kind of interested & Excited about science.
Bored
Not great
OK
Kind of interested
Excited
Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).

… or identifying the indicators that may be most useful to make decisions…

Layered data storytelling prototype

Put to the test with **nursing students**

Select the critical incidents by clicking on the buttons below



Vital Signs Assessment

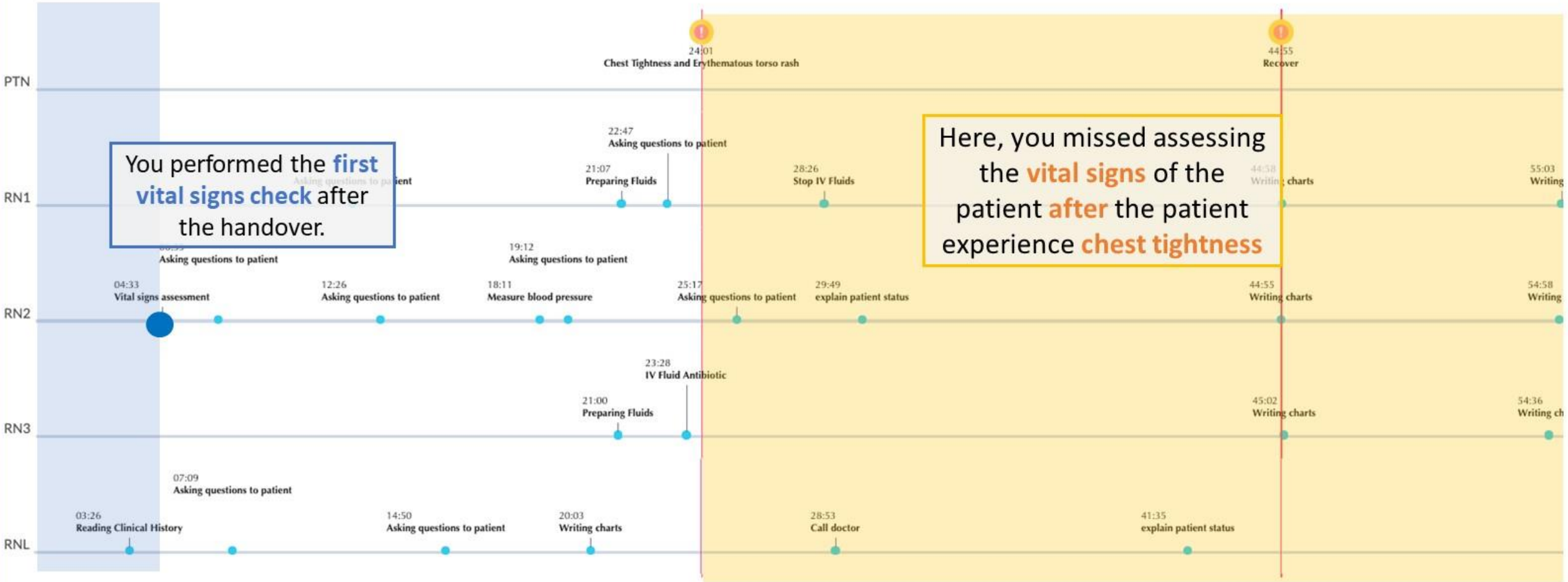
Administer and Stop IV Antibiotic

Perform ECG

Call the doctor

Arousal

After the patient complains of **chest tightness** it is very important to assess his/her vital signs



Vital Signs Assessment

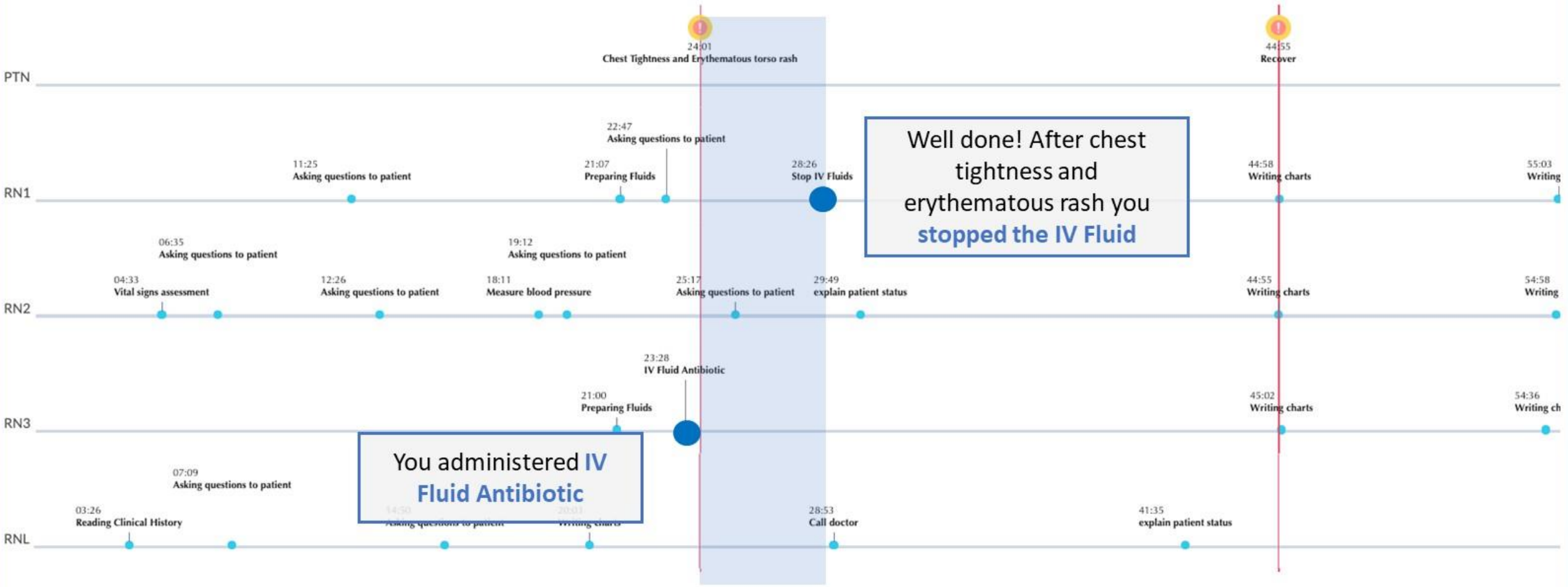
Administer and Stop IV Antibiotic

Perform ECG

Call the doctor

Arousal

RN1 stopped the medication **less than 5 minutes** after patient's adverse reaction



Vital Signs Assessment

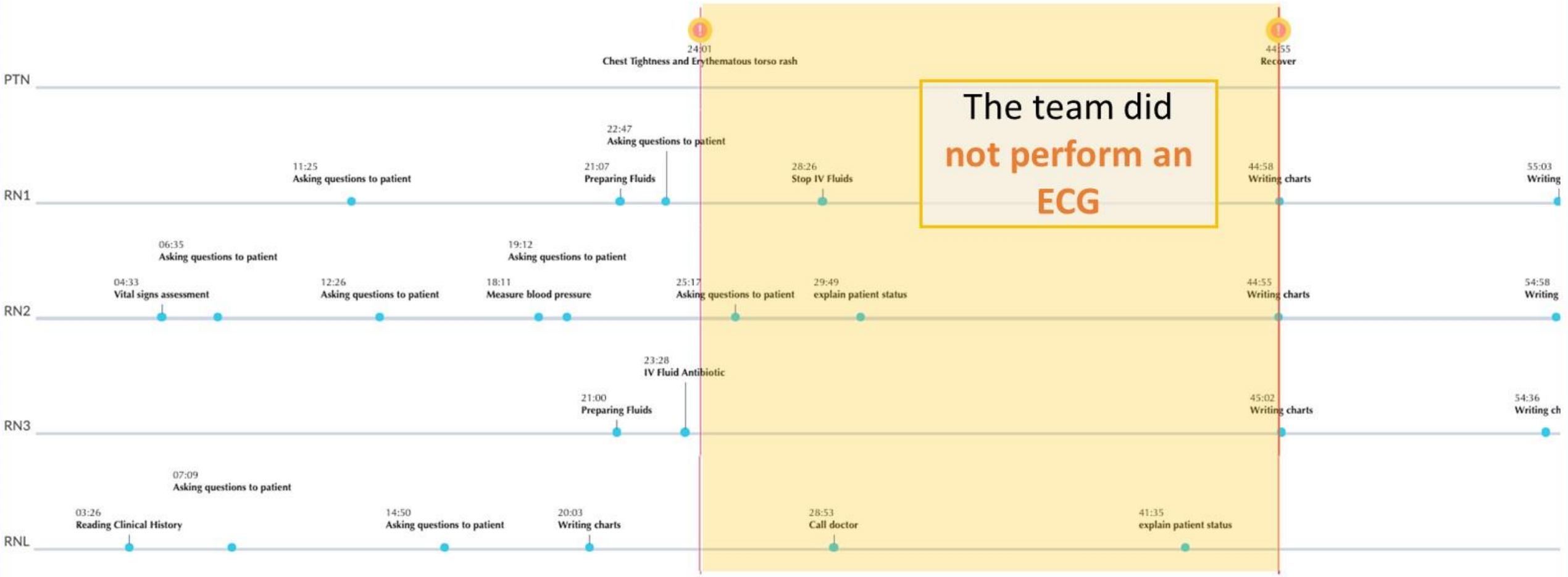
Administer and Stop IV Antibiotic

Perform ECG

Call the doctor

Arousal

It is recommended to **perform an ECG** after the patient complains of chest tightness



Vital Signs Assessment

Administer and Stop IV Antibiotic

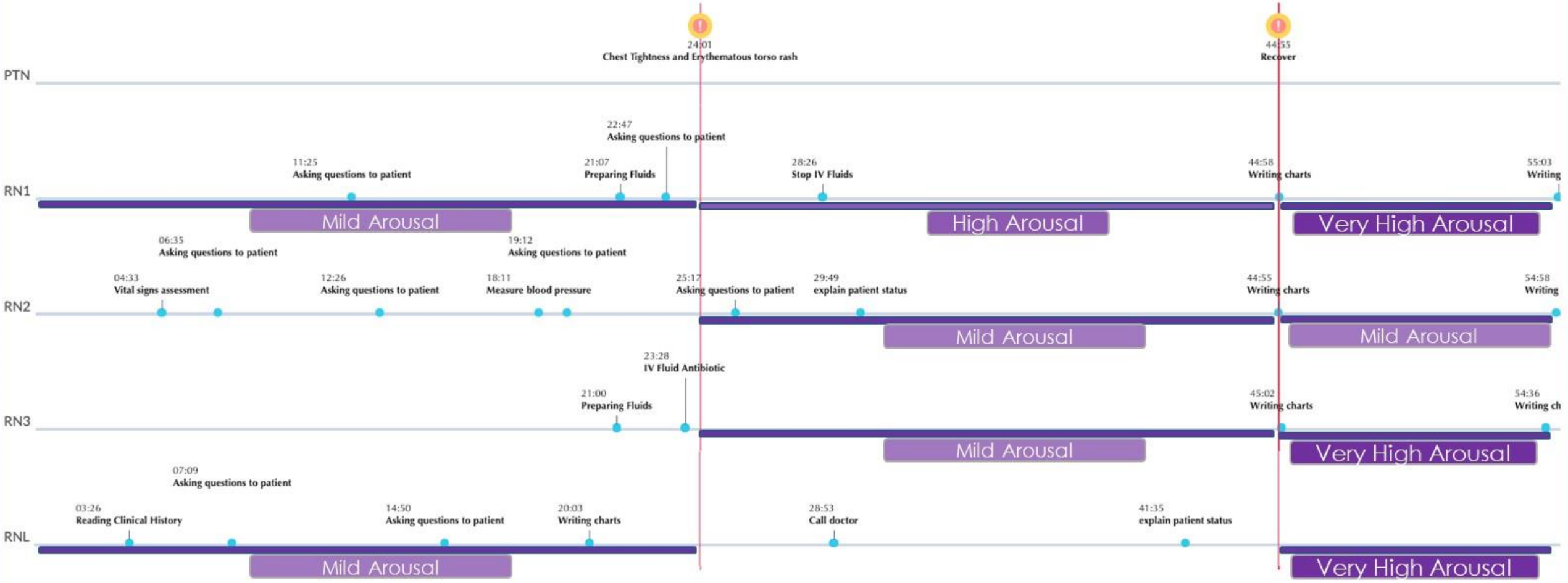
Perform ECG

Call the doctor

Arousal

RN1, **RN3** and **RNL** presented **several arousal peaks** throughout the simulation

RN2 presented a **few arousal peaks**



Vital Signs Assessment

Administer and Stop IV Antibiotic

Perform ECG

Call the doctor

Arousal

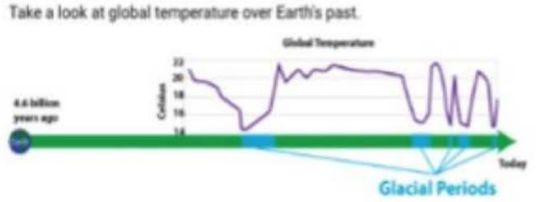
A report as a data storytelling channel

Narrative
+
Visuals

Hello Ms. Kerrington,

I noticed that most of your students completed Step 1.4 which has the maximum number of attempts feature, so I've analyzed the log data from that step.

Learning goal: Step 1.4 targets MS-ESS3-5 and the stability and change CCC. Students need to be able to recognize the scale of the timeline and interpret the graphical data.



Has global temperature in the past always been the same as it is today?

In the past:

- ○ It was ALWAYS THE SAME temperature as today
- ○ It was ALWAYS MUCH COLDER than today
- ○ It was ALWAYS MUCH WARMER than today
- ○ It was BOTH COLDER AND WARMER than today

Here is my analysis (by class period) of the log data of your students' responses. Note: You can find the students associated with the workgroup ID by clicking on the "Manage Students" link in the Teacher Tools.

Answered correctly on the first attempt
- Period 1 - 46% (6/13)
- Period 2 - 79% (11/14)
- Period 3 - 75% (9/12)

How many multiple attempts were needed (by workgroup)?
- 2 attempts were needed by those who didn't answer correctly on the first attempt.

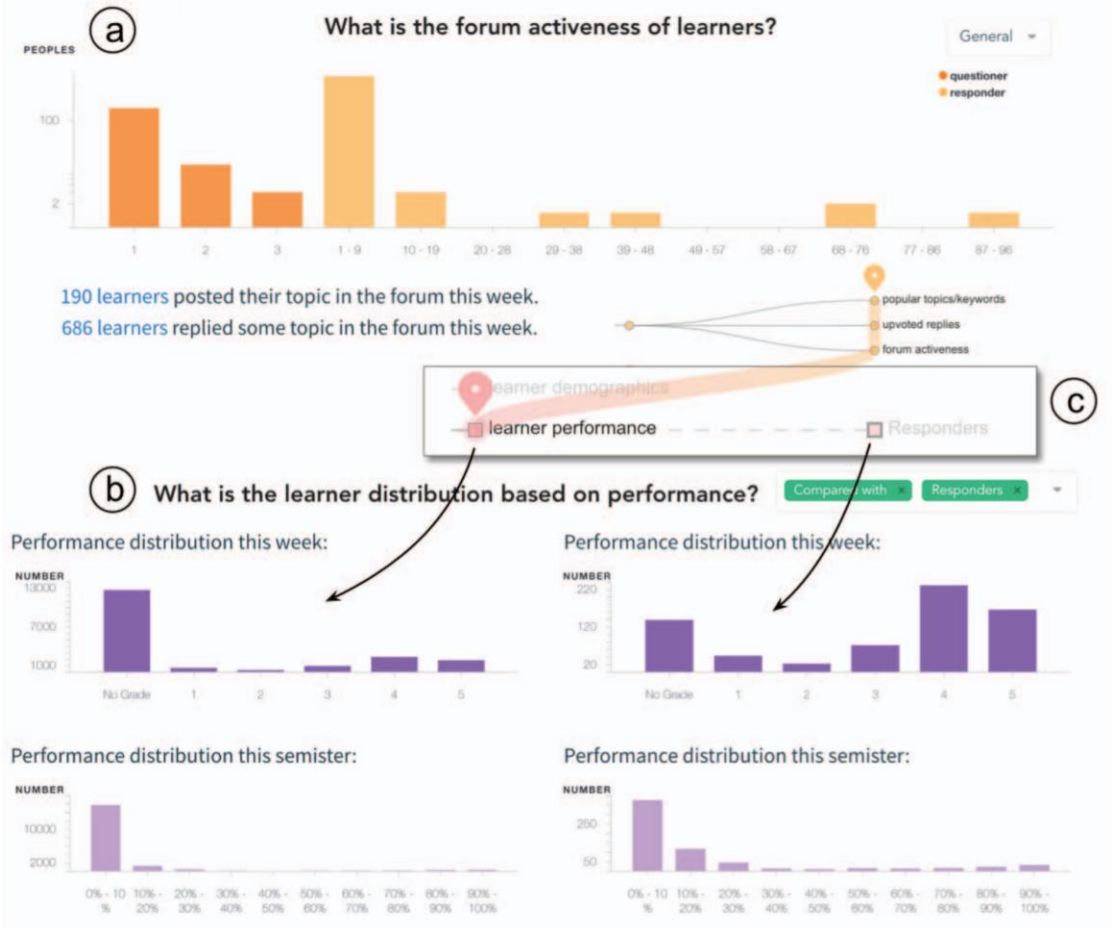
What was the most common incorrect answer on the first attempt?
- Most students chose "It was ALWAYS MUCH COLDER than today"
- Students who followed a different pattern, by period:
  - Period 1
    - 397583, 397597 - It was ALWAYS MUCH WARMER than today, then answered correctly.
  - Period 2
    - 397640 -It was ALWAYS THE SAME temperature as today, then chose the correct answer
  - Period 3 (all followed primary pattern)

Researcher Insight: This suggests that students' prior knowledge that current global temperatures are the highest they have been in recent history is overriding their analysis of the actual data presented in the timeline of Earth's history.

Wiley, K. J., Dimitriadis, Y., Bradford, A., & Linn, M. C. (2020, March). From theory to action: Developing and evaluating learning analytics for learning design. In *Proceedings of the tenth international conference on learning analytics & knowledge* (pp. 569-578).

A navigation slideshow as a data storytelling channel

Visuals
+
Narrative
+
Navigation



Chen, Q., Li, Z., Pong, T. C., & Qu, H. (2019, April). Designing Narrative Slideshows for Learning Analytics. In *2019 IEEE Pacific Visualization Symposium (PacificVis)* (pp. 237-246). IEEE.

Learning Analytics for ‘end-users’:

from Human-centred Design to Multimodal Data Storytelling

Roberto Martinez-Maldonado

Roberto.MartinezMaldonado.net

twitter: @RobertoResearch

MONASH University

Learning Analytics for ~~'end-users':~~ HUMANS,

from Human-centred Design to Multimodal Data Storytelling

Roberto Martinez-Maldonado

Roberto.MartinezMaldonado.net

twitter: @RobertoResearch

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Our Promise to Youth

Take away message 1: Human-centred design

A human-centred approach is critical in the design of any educational technology…

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

Take away message 1: Human-centred design

A human-centred approach is critical in the design of any educational technology…

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

Human

…but even more critical to navigate the disruptions and potential risks triggered by the rapid development of AI, Data Analytics and surveillance tools

Take away message 2: Multimodality

A call for embracing multimodality..

…not with the purpose of adding sensors to the learning spaces but to embrace the complexity of learning and human interaction

Take away message 3: Data Storytelling

"Humans think in **stories** rather than in facts, numbers or equations ….

Yuval Noah Harari

Take away message 3: Data Storytelling

"Humans think in **stories** rather than in facts, numbers or equations ….

…. and **the simpler the story, the better**"

Yuval Noah Harari

Thanks!