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Invited Talk, Computer-Human Adapted Interaction Research Group

# Towards Collaboration Translucence: Giving Meaning to Multimodal Group Data

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*Extended version
of CHI 2019 talk*

# Towards Collaboration Translucence:
# Giving Meaning to Multimodal Group Data

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**Figure 1: Multimodal analytics in healthcare scenarios: in a simulation-controlled room (left) and in the classroom (right).**

# OUR CONTEXT:
# HIGH PERFORMANCE TEAMWORK in NURSING

Simulation wards are used in universities and hospitals

Up to 6 teams in action at once at UTS

1 instructor

"Analytically cloaked": no data amenable to computational analysis, to inform debriefs immediately after exercises

# SIMULATION DEBRIEFS COULD BE IMPROVED

**Co-design methods** were used to gain insights from students and educators about running and performing simulation exercises

What were educators' fantasy "superpowers"?

At what points would students value data-driven feedback?

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. *Australian Conference on Human-Computer Interaction, OZCHI 2018*, Melbourne, pp.205-214. https://doi.org/10.1145/3292147.3292168

# SIMULATION DEBRIEFS COULD BE IMPROVED

Student: "Tutors have a big class so they can't supervise everyone at the same time. It's hard for them to give feedback to every student"

# SIMULATION DEBRIEFS COULD BE IMPROVED

*Student: "Time is against us and we don't have enough time for debriefing. Limited time needs a clear direction. Otherwise you're just going to get many different feelings coming back at you"*

# SIMULATION DEBRIEFS COULD BE IMPROVED

*Student: "I think that a better feedback would give me perspective, because when you are in the simulation you can't see where you're positioned, you can't see how you're talking"*

# SIMULATION DEBRIEFS COULD BE IMPROVED

Instructor: "omniscience" to see what's going in every team, in parallel, in detail

Instructor: "Capturing students' body positioning, or movement, would help them visualize the whole activity, to complete the picture."

# INSPIRATION: "SOCIAL TRANSLUCENCE"

Tom Erickson et al. (CHI'99) on the challenge of providing missing social cues in online platforms

## Translucence ≠ Transparency

In f-f social spaces/places, we use translucence to disclose specific information at an appropriate fidelity, as with frosted glass doors and windows.

**Visibility** of socially significant information
**Awareness** of others' presence or actions
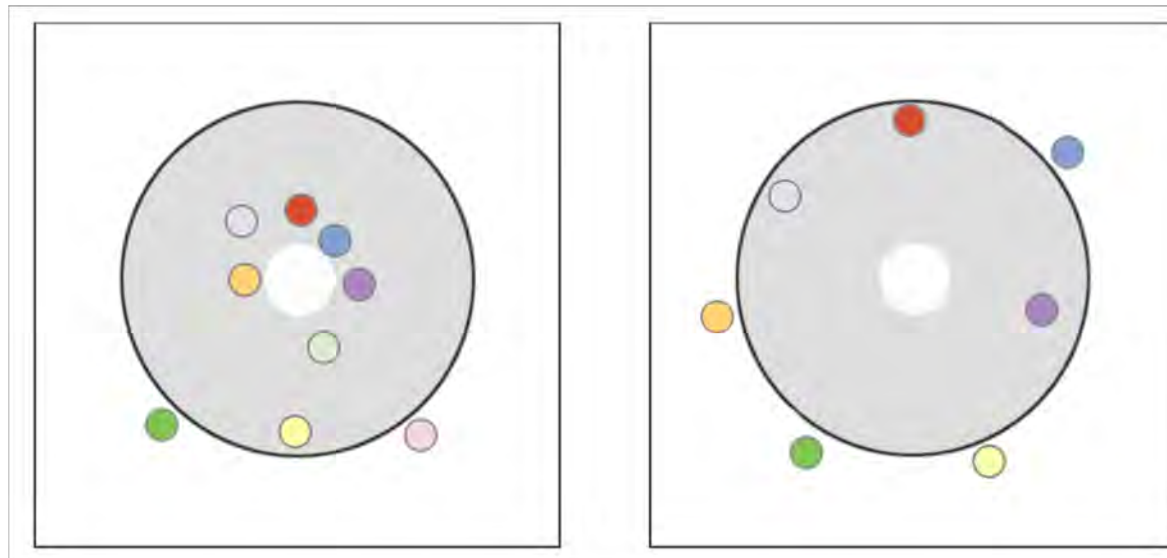**Accountability** of people's own visible actions



H. Schnädelbach and D. Kirk, *People, Personal Data and the Built Environment* (Springer Series in Adaptive Environments). Springer International Publishing, 2018.

Erickson, T., Smith, D. N., Kellogg, W. A., Laff, M., Richards, J. T., & Bradner, E. (1999). Socially translucent systems: social proxies, persistent conversation, and the design of "babble". In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 72-79). ACM.

# GROUP CHAT PROXY

A visualization indicating at a glance an important aspect of the history, or current state, of an online social space
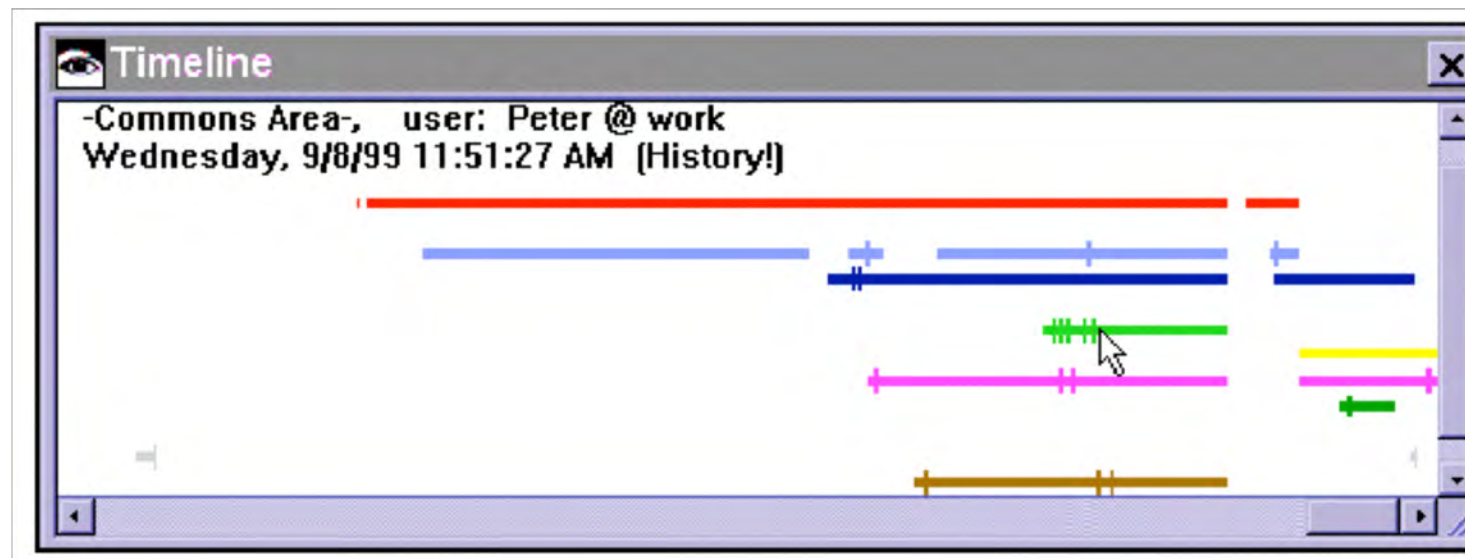


Figure 2. A social proxy for a group chat in the Babble system:
(a) an active chat          (b) after chat has ceased.

Erickson, Thomas. (2009). 'Social' systems: Designing digital systems that support social intelligence. *AI & Society*, 23. 147-166. 10.1007/s00146-007-0140-3.

# CHATROOM PROXY

A visualization indicating at a glance an important aspect of the history, or current state, of an online social space

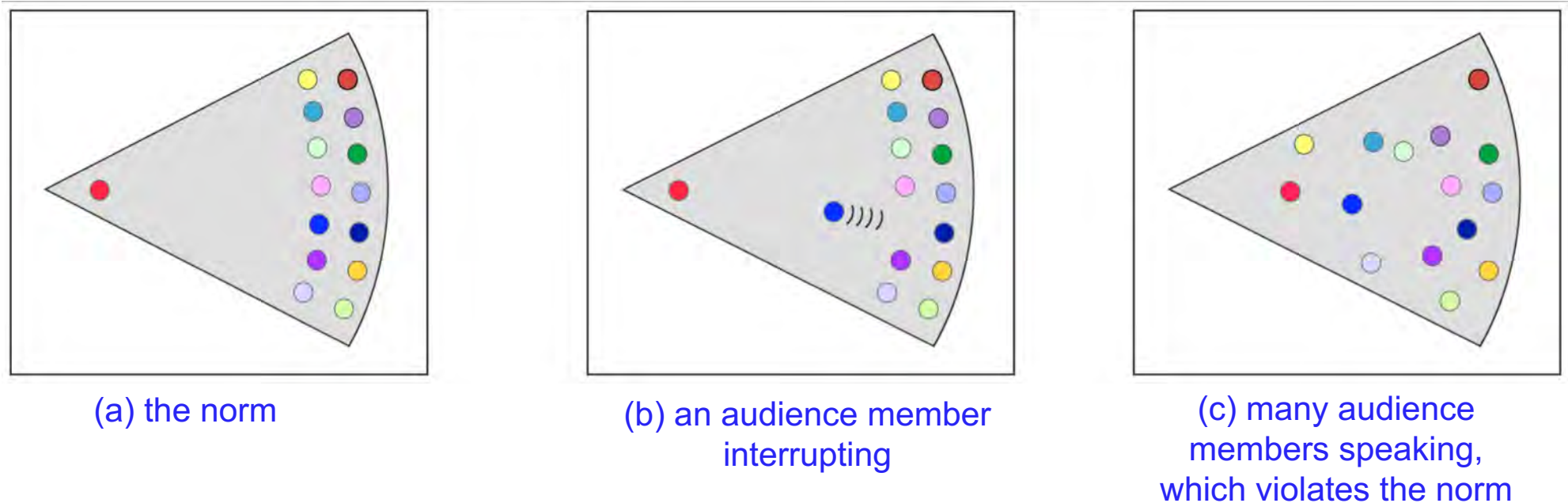Figure 3. The timeline proxy shows users' presence in the chat room as flat lines and their posts as blips, thus showing activity over time.



Erickson, Thomas. (2009). 'Social' systems: Designing digital systems that support social intelligence. *AI & Society,* 23. 147-166. 10.1007/s00146-007-0140-3.

# ONLINE LECTURE PROXY

A visualization indicating at a glance an important aspect of the history, or current state, of an online social space

Figure 4. Three instances of the lecture proxy



(a) the norm

(b) an audience member interrupting

(c) many audience members speaking, which violates the norm

Erickson, Thomas. (2009). 'Social' systems: Designing digital systems that support social intelligence. *AI & Society,* 23. 147-166. 10.1007/s00146-007-0140-3.

# TRANSLUCENCE PROXIES FOR COLLOCATED COLLABORATION?

Team simulations can be cognitively and emotionally intense

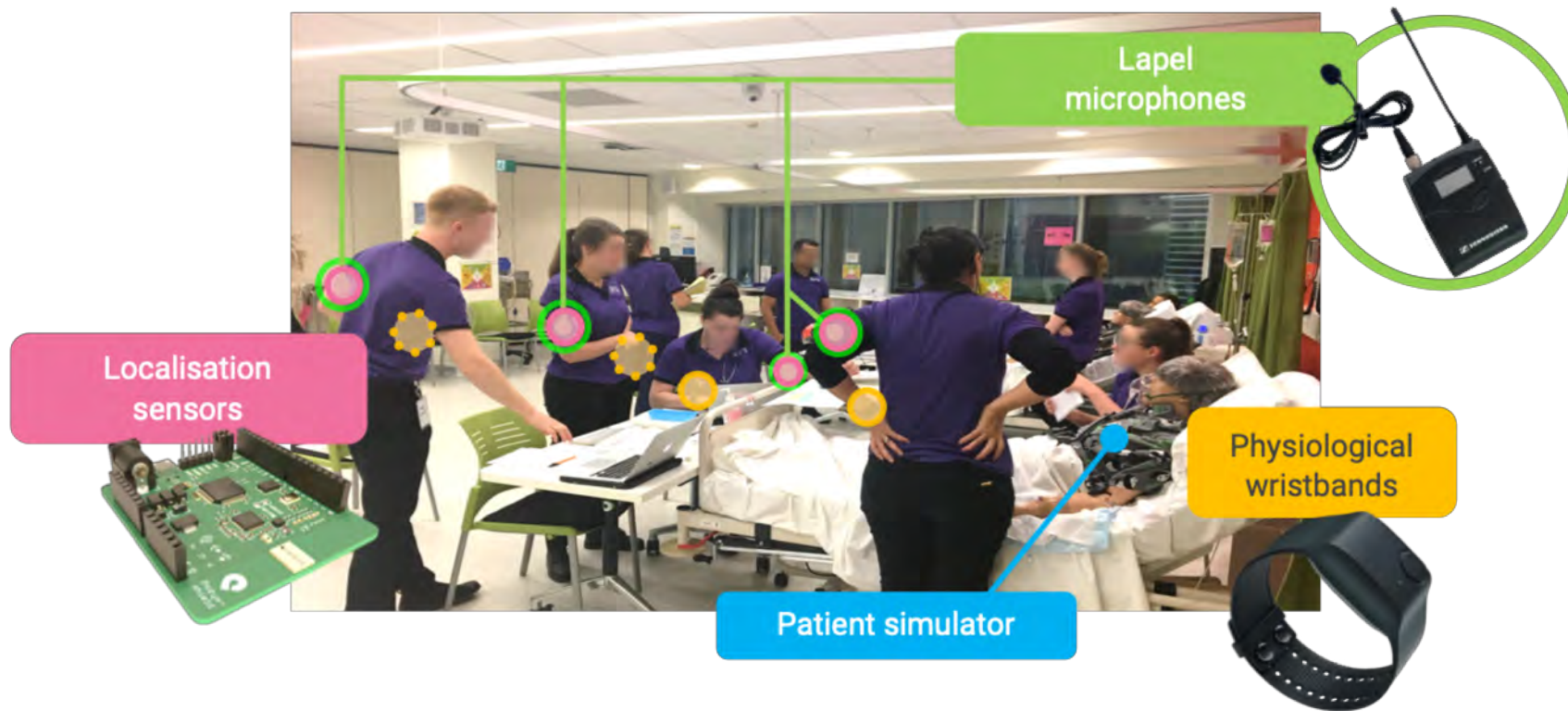There's too much going on to see it all, or remember it all

Inspired by Social Translucence proxies, could we devise visual proxies for collocated collaboration?

# THE ANALYTICS CHALLENGE:
# SENSE AND CAPTURE ACTIVITY



Localisation sensors

Physiological wristbands
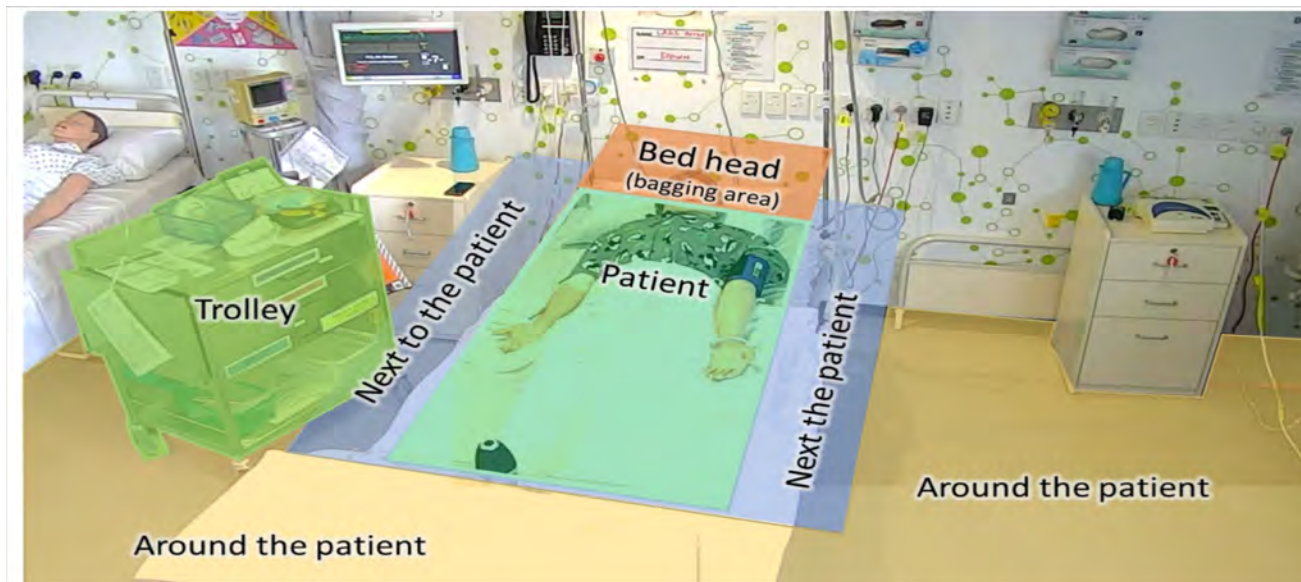
Microphone array

Patient simulator
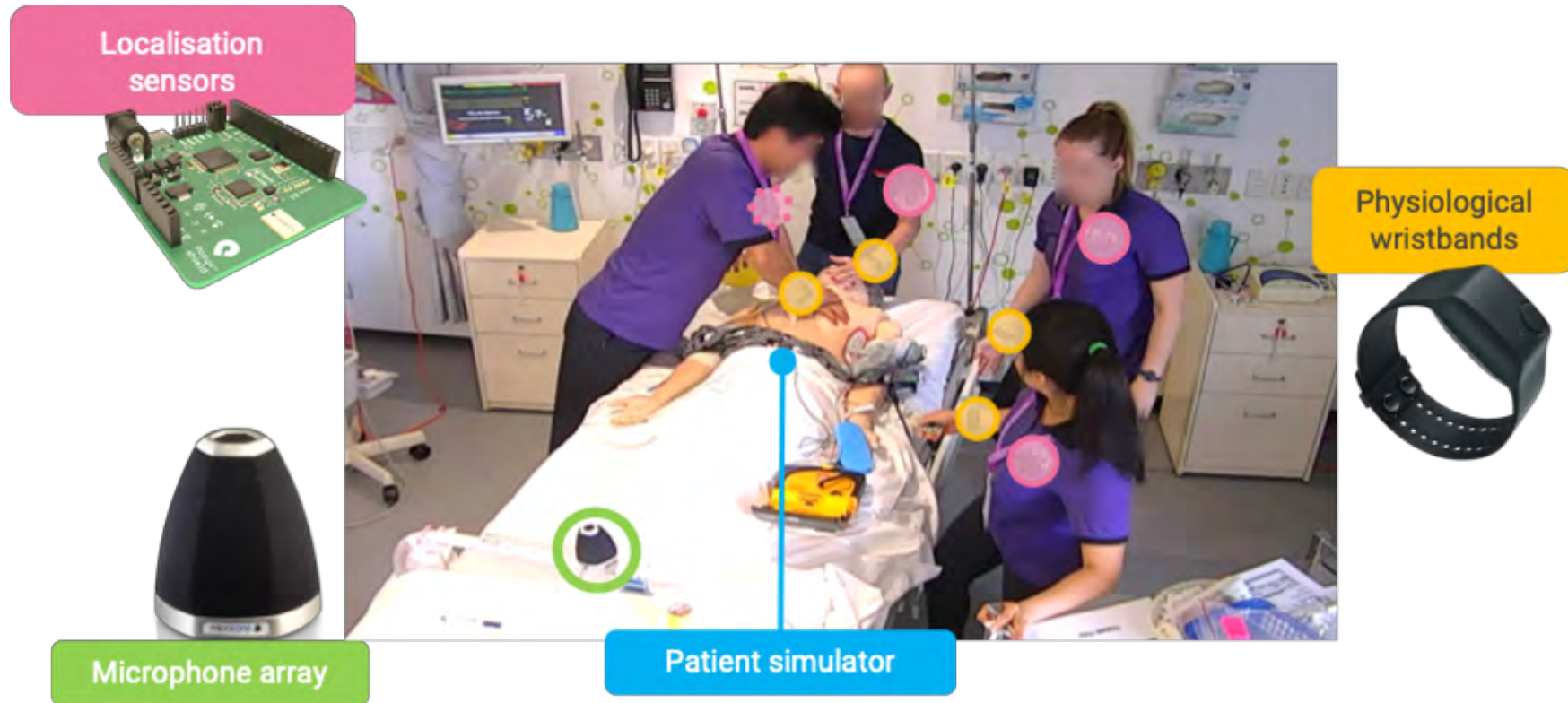
# THE ANALYTICS CHALLENGE:
# SENSE AND CAPTURE ACTIVITY

# THE ANALYTICS CHALLENGE: MODELLING THE SEMANTICS OF LOCATION

Clinical expertise informed the modelling of 5 meaningful zones for positional data



i) **the patient's bed** for cases where nurses are located on top of or very close to the patient

ii) **next to patient** for cases where nurses are either side of bed

iii) **around the patient** for cases where nurses are 1.5 to 3 metres away

iv) **bed head** where nurses commonly stand to clear the airway during CPR

v) **trolley area** where nurses access medication or equipment

# KEY FEATURES OF COLLOCATED COLLABORATION:

**ACAD: Activity-Centred Analysis & Design framework**

**The SET —** physical and digital space and objects; input devices, screens, software, material tools, furniture
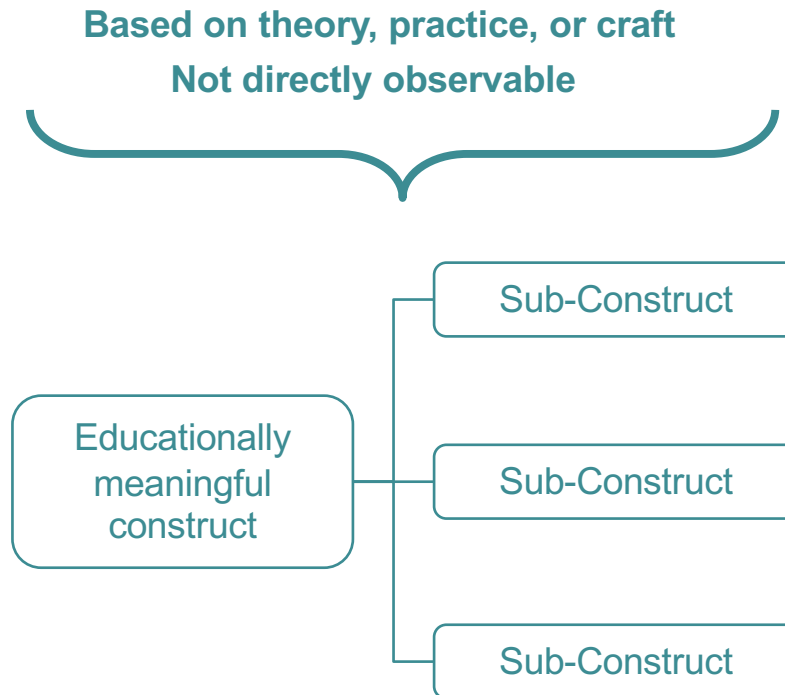
**The EPISTEMIC TASKS** — implicit and explicit knowledge oriented elements that shape the participants' tasks and working methods

**The SOCIAL SITUATION** — the variety of ways in which people might be grouped together (e.g. dyads, trios); scripted or emerging roles; and divisions of labour

**AFFECTIVE RESPONSES** — and extension to ACAD, building on evidence from healthcare simulation research

Martinez-Maldonado, R., Goodyear, P., Kay, J., Thompson, K., and Carvalho, L. (2016) An Actionable Approach to Understand Group Experience in Complex, Multi-surface Spaces. *SIGCHI Conference: Human Factors in Computing Systems, CHI 2016, 2062-2074.* https://doi.org/10.1145/2858036.2858213
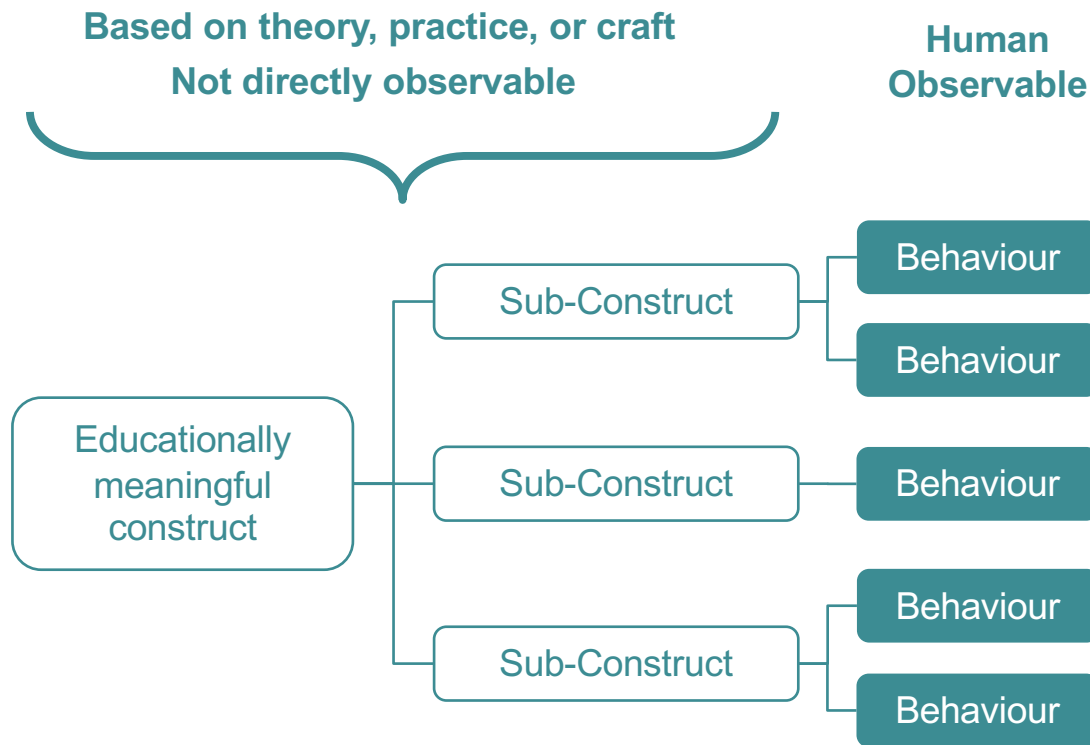
# THE ANALYTICS CHALLENGE:
# MAKING MULTIMODAL STREAMS MEANINGFUL

In the fields of Assessment Science and Learning Analytics, the challenge is to forge principled mappings between the qualities that we want to assess, and behavioural evidence
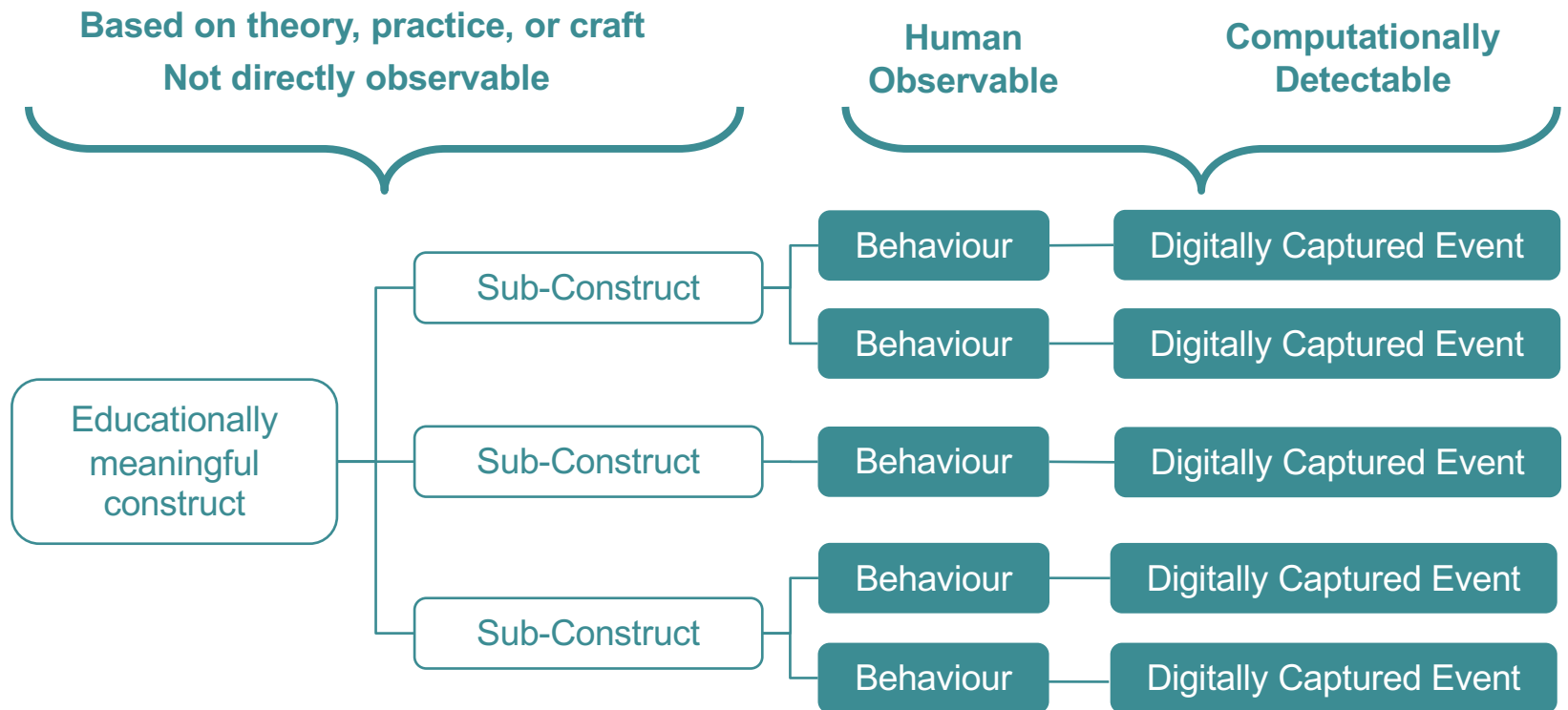
**Based on theory, practice, or craft**
**Not directly observable**

Sub-Construct

Educationally meaningful construct

Sub-Construct

Sub-Construct

# THE ANALYTICS CHALLENGE:
# MAKING MULTIMODAL STREAMS MEANINGFUL

In the fields of Assessment Science and Learning Analytics, the challenge is to forge principled mappings between the qualities that we want to assess, and behavioural evidence
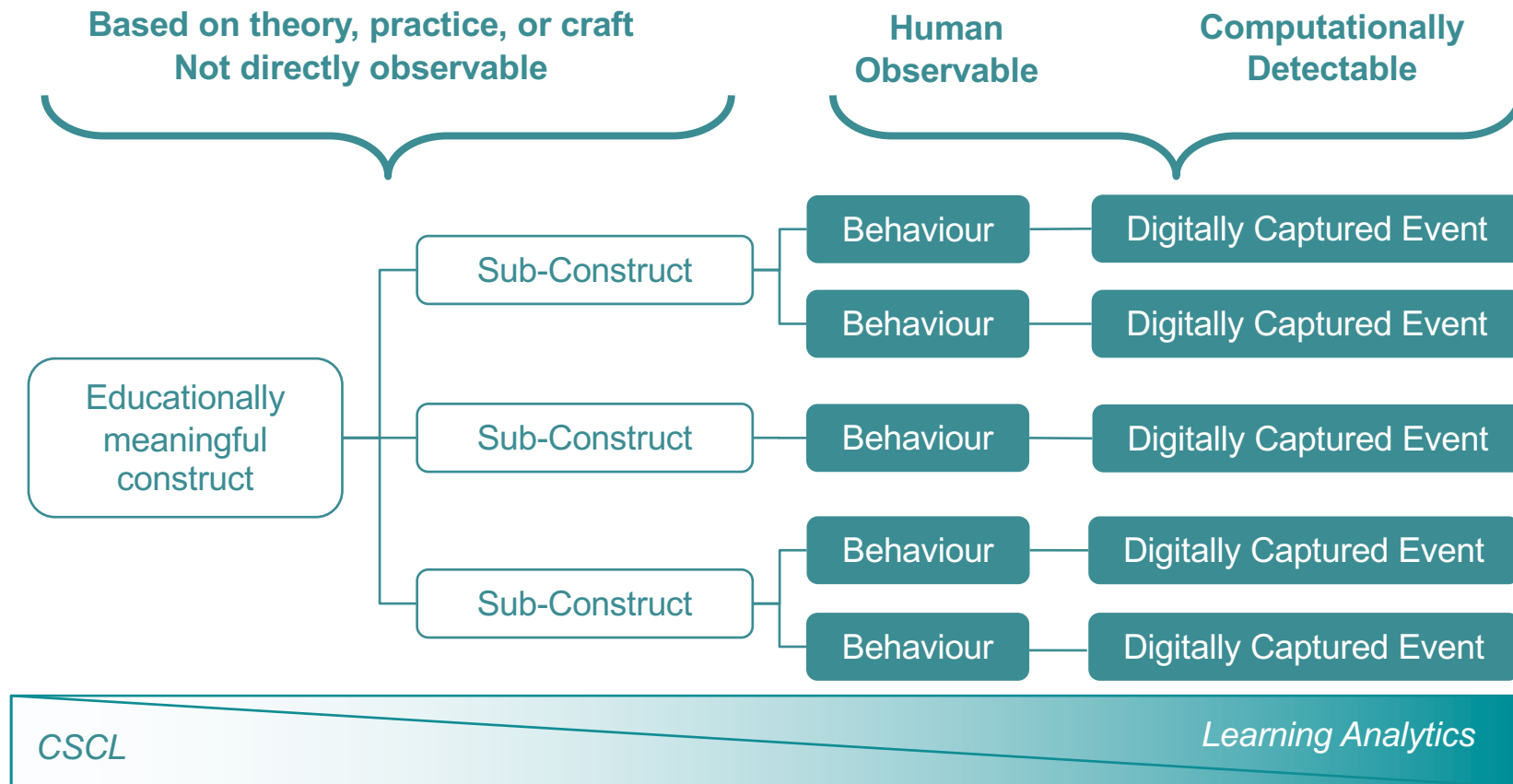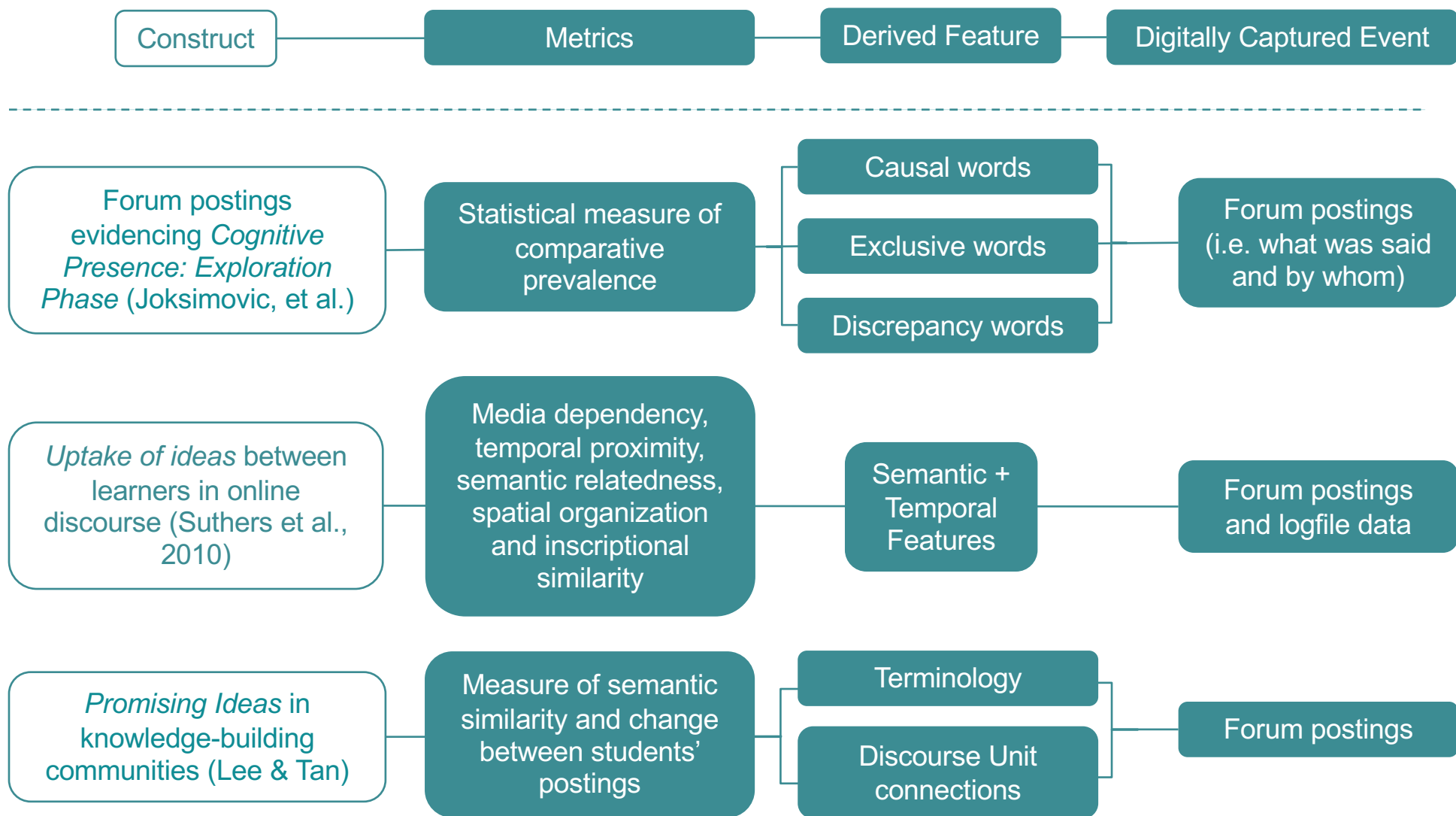
**Based on theory, practice, or craft**
**Not directly observable**

**Human Observable**

Educationally meaningful construct

Sub-Construct — Behaviour
Sub-Construct — Behaviour

Sub-Construct — Behaviour

Sub-Construct — Behaviour
Sub-Construct — Behaviour

# THE ANALYTICS CHALLENGE: MAKING MULTIMODAL STREAMS MEANINGFUL

In the fields of Assessment Science and Learning Analytics, the challenge is to forge principled mappings between the qualities that we want to assess, and behavioural evidence, as detected by sensors

# THE ANALYTICS CHALLENGE:
# MAKING MULTIMODAL STREAMS MEANINGFUL



**Based on theory, practice, or craft Not directly observable**  ·  **Human Observable**  ·  **Computationally Detectable**

Educationally meaningful construct

- Sub-Construct
  - Behaviour → Digitally Captured Event
  - Behaviour → Digitally Captured Event
- Sub-Construct
  - Behaviour → Digitally Captured Event
- Sub-Construct
  - Behaviour → Digitally Captured Event
  - Behaviour → Digitally Captured Event

*CSCL* ——————————————————— *Learning Analytics*

Wise, A., Knight, S. & Buckingham Shum, S. (In Press). Collaborative Learning Analytics. *International Handbook of Computer-Supported Collaborative Learning.* Springer.

Construct — Metrics — Derived Feature — Digitally Captured Event

Wise, A., Knight, S. & Buckingham Shum, S. (In Press). Collaborative Learning Analytics. *International Handbook of Computer-Supported Collaborative Learning.* Springer.

**Construct** — **Metrics** — **Derived Feature** — **Digitally Captured Event**

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Forum postings evidencing *Cognitive Presence: Exploration Phase* (Joksimovic, et al.) — Statistical measure of comparative prevalence — Causal words / Exclusive words / Discrepancy words — Forum postings (i.e. what was said and by whom)

*Uptake of ideas* between learners in online discourse (Suthers et al., 2010) — Media dependency, temporal proximity, semantic relatedness, spatial organization and inscriptional similarity — Semantic + Temporal Features — Forum postings and logfile data

*Promising Ideas* in knowledge-building communities (Lee & Tan) — Measure of semantic similarity and change between students' postings — Terminology / Discourse Unit connections — Forum postings

Wise, A., Knight, S. & Buckingham Shum, S. (In Press). Collaborative Learning Analytics. *International Handbook of Computer-Supported Collaborative Learning.* Springer.

# THE ANALYTICS CHALLENGE:
# Making multimodal streams meaningful

From multimodal logs to higher-order constructs:

Curriculum outcomes

**1** **Patient-centred care**

**&**

**2** **Teamwork**

# THE ANALYTICS CHALLENGE:
# Making multimodal streams meaningful

From multimodal logs to higher-order constructs:

Curriculum outcomes

Constructs for collaborative activity
(from ACAD Framework)

**1** **Patient-centred care**
**&**
**2** **Teamwork**

- Physical
- Epistemic
- Social
- Affective

# THE ANALYTICS CHALLENGE:
## Making multimodal streams meaningful

From multimodal logs to higher-order constructs:

Curriculum outcomes

Constructs for collaborative activity
(from ACAD Framework)

**1** **Patient-centred care**
&
**2** **Teamwork**

Physical
- Embodied strategies
- Proximity to patient/objects
- Intensity of physical activity

Epistemic
- Actions and procedures

Social
- Communication with patient
- Teamwork communication

Affective
- Changes in emotional arousal

# THE ANALYTICS CHALLENGE:
## Making multimodal streams meaningful

From multimodal logs to higher-order constructs:

**Curriculum outcomes**

**Constructs for collaborative activity (from ACAD Framework)**

**Multimodal data sources**

1 **Patient-centred care**
&
2 **Teamwork**

Physical
- Embodied strategies ← Presence in meaningful zones
- Proximity to patient/objects ← Distance to the patient and the trolley
- Intensity of physical activity ← Wrist acceleration intensity

Epistemic
- Actions and procedures ← Actions registered by the manikin
  - Critical procedures
  - Interactions with objects

Social
- Communication with patient ← # and length of utterances by the patient
- Teamwork communication ← # and length of utterances by nurses

Affective
- Changes in emotional arousal ← Electrodermal activity peaks

# THE MULTIMODAL MATRIX:
## Combining data sources to operationalise constructs

| Dimensions of collaboration | | | |
|---|---|---|---|
| Physical | Epistemic | Social | Affective |

# THE MULTIMODAL MATRIX:
## Combining data sources to operationalise constructs



| Dimensions of collaboration | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Physical | | | | Epistemic | | | Social | | Affective | |
| Time | RN1_next | RN1_patient | RN1_intensity | .... | Check_pulse | CPR | .... | RN1_talking | Patient_talking | .... | EDA peak | .... |

Multimodal observations

# THE MULTIMODAL MATRIX:
## Combining data sources to operationalise constructs

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## Combining data sources to operationalise constructs

# THE MULTIMODAL MATRIX:
## Combining data sources to operationalise constructs



| Stanzas | | Time | Physical | | | | Epistemic | | | Social | | | Affective | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RN1_next | RN1_patient | RN1_intensity | .... | Check_pulse | CPR | .... | RN1_talking | Patient_talking | .... | EDA peak | .... |
| Phase 1 | | 00:01 | 1 | 0 | low | | 0 | 0 | | 0 | 1 | | 0 | |
| | | 00:02 | 1 | 0 | low | | 1 | 0 | | 0 | 1 | | 0 | |
| | | 00:03 | 1 | 0 | low | | 1 | 0 | | 1 | 0 | | 0 Segment | |
| | | 00:04 .... | 1 | 0 | low | | 1 | 0 | | 1 | 0 | | 0 | |
| Phase 2 | | 12:23 | 0 | 1 | high | | 0 | 1 | | 1 | 0 | | 0 | |
| | | 12:24 | 0 | 1 | high | | 0 | 1 | | 0 | 0 | | 1 | |
| | | 12:25 | 0 | 1 | high | | 0 | 1 | | 1 | 0 | | 1 | |
| | | 12:26 | 0 | 1 | moderate | | 0 | 0 | | 0 | 0 | | 0 | |
| | | .... | | | | | | | | | | | | |

Dimensions of collaboration

Multimodal observations

Modelling decisions: how to map data type(s) to constructs          Segments can be added by machines or humans

# N.B. "Quantitative Ethnography" (Shaffer, 2017)

An emerging community committed to harmonising quantitative and qualitative methodologies to analyse (large scale) human activity data



Society for Learning Analytics Research
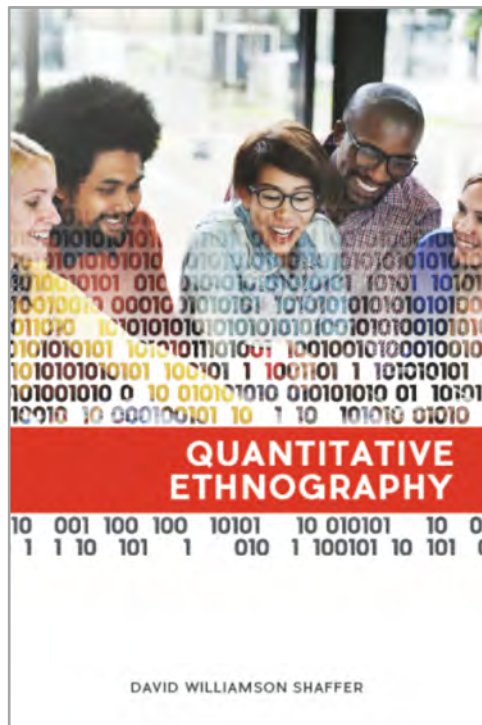
LAK18 Keynote Address

# The quant/qual distinction has dissolved.
# Each has methods to enrich the other

"In the age of Big Data, we have an opportunity to expand the tools of ethnography — and history, and literary analysis, and philosophy, and any discipline that analyzes meaning — by using statistical techniques not to supplant grounded understanding, but to expand it. To use additional warrants to support the stories that we tell about the things people do, and reasons they do them."

David Williamson Shaffer, *Quantitative Ethnography*, 2017, p.398

icqe19.org



ICQE 19

SUBMISSIONS     WORKSHOPS     SPEAKERS     SCHEDULE     COMMITTEES     EVENT INFORMATION     REGISTER

International Conference on
Quantitative Ethnography 2019

October 20-22, 2019 Madison, Wisconsin

# THE HCI/FEEDBACK CHALLENGE:
## Making activity visible through proxies
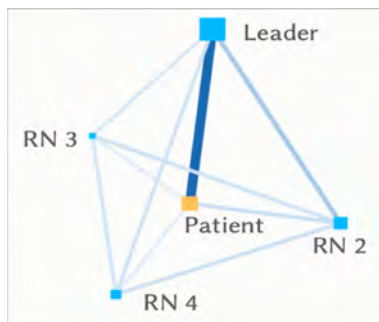


Patient-centred verbal communication, and within nursing team
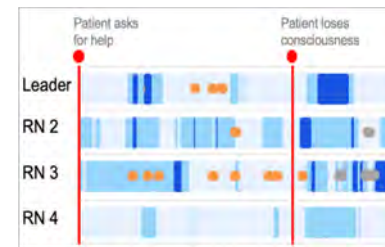


Affective/cognitive arousal via EDA peaks
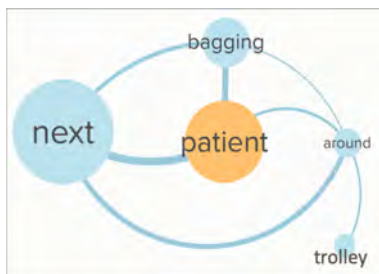


Patient-centred movement around the simulation zones



Critical actions performed by nurses

# COLLABORATION TRANSLUCENCE:
## Proxy for Patient-Centred Verbal Communication

RN =
Registered Nurse

Node size =
frequency of
speaking

Edge thickness =
frequency of
interaction
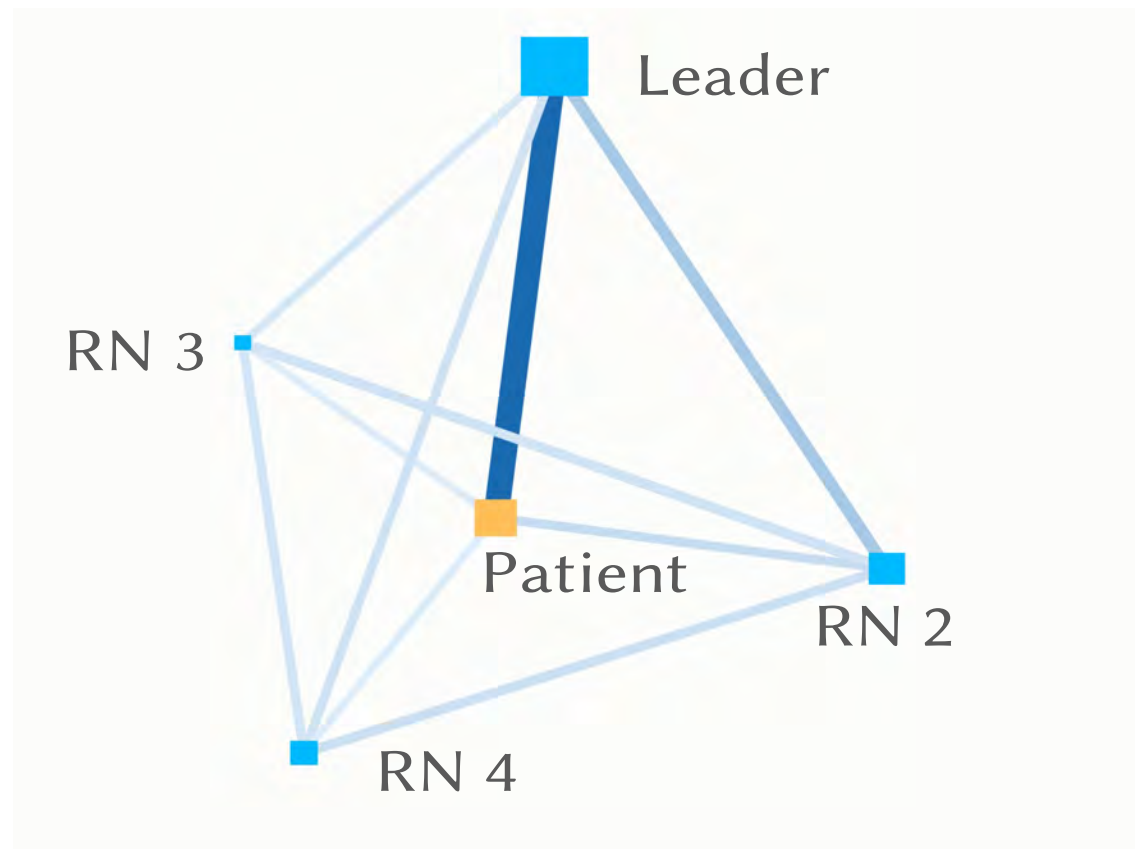
# COLLABORATION TRANSLUCENCE:
## Proxy for Patient-Centred Verbal Communication
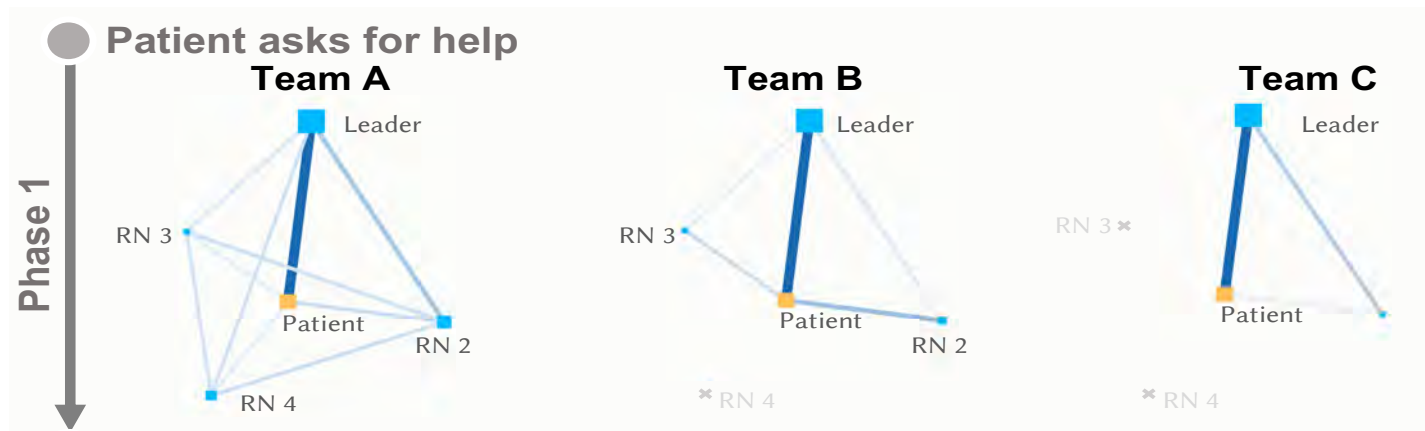
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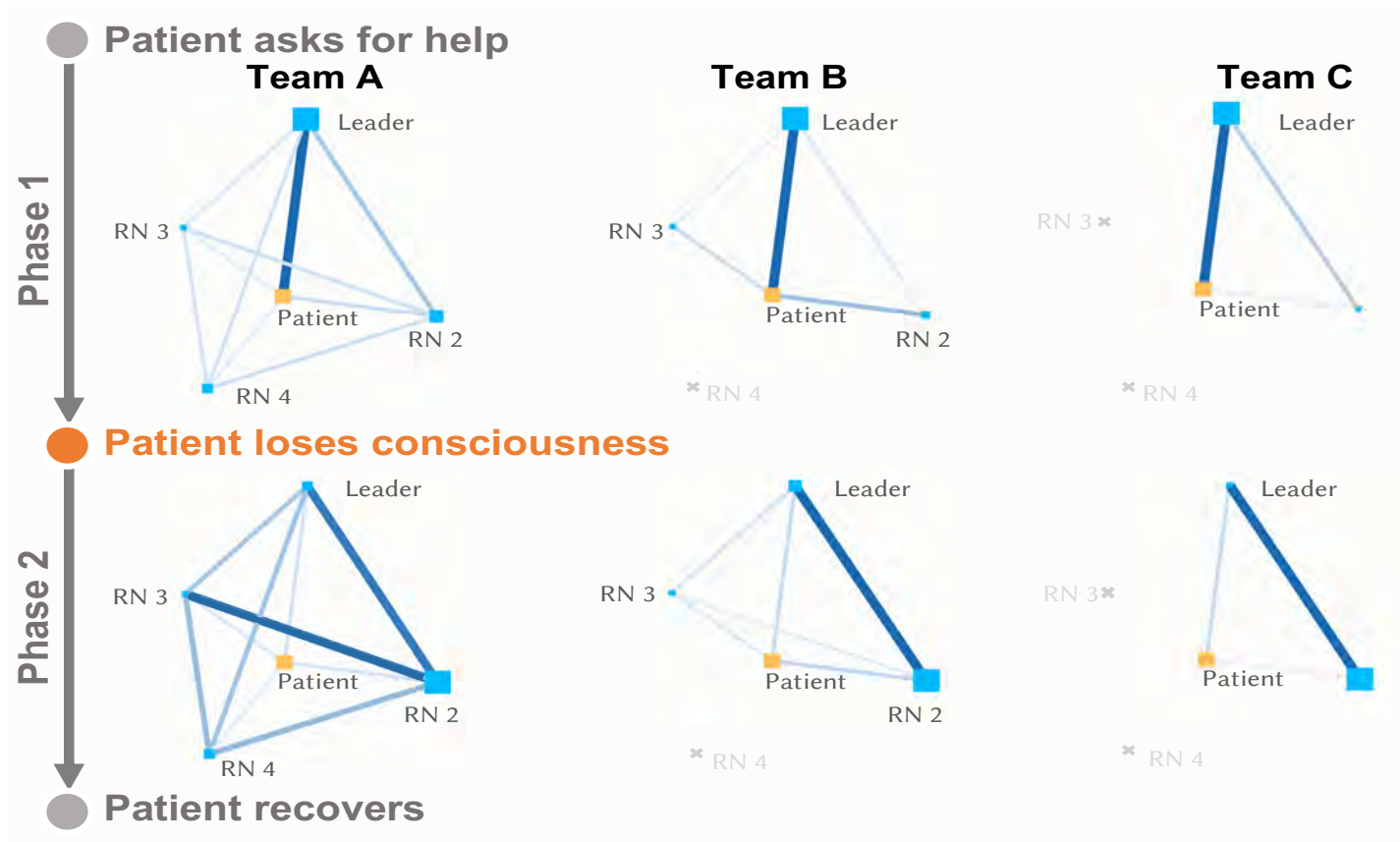
# COLLABORATION TRANSLUCENCE:
# Proxy for Patient-Centred Verbal Communication
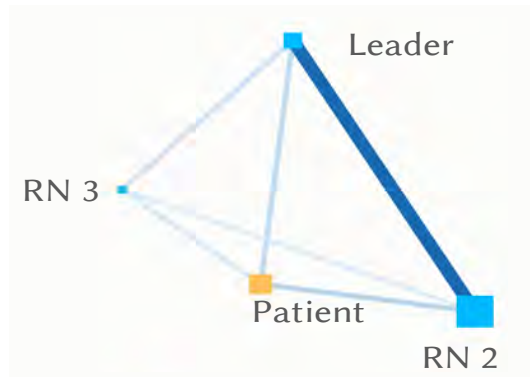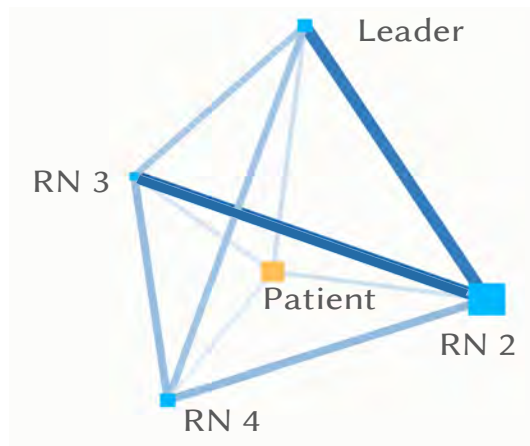


Excerpt 1: Nurses in Team A communicating effectively
1.  RN2 ⇨ Leader: Put the head up.
2.  Leader ⇨ RN2: one, two (giving oxygen to the patient)
3.  RN2 ⇨ Everyone: I am going to do one more... twenty-one, twenty-two, twenty-three ... (doing CPR and counting aloud)
4.  RN2 ⇨ RN3: You take the next round please.
5.  RN3 ⇨ RN2: Ok!
6.  Leader ⇨ Everyone: one, two (giving oxygen to the patient)
7.  RN4 ⇨ Everyone: Guys, I am going to start, I am going to do the defib now.

Excerpt 2: Nurses in Team B communicating less effectively
1.  Leader ⇨ RN2: I am going to check the airway.
2.  RN2 ⇨ Leader: ...and I will need this one (pointing to the aging mask) ...so, should I start?
3.  Leader ⇨ RN2: Yes!
4.  RN2 ⇨ RN1: one, two(doing CPR and counting aloud)...twenty-nine, thirty
5.  Leader ⇨ Everyone: one, two (giving oxygen to the patient)

# COLLABORATION TRANSLUCENCE:
## Patient-centred movement

Three different positions from which nurses performed chest compressions:
By the bed (A)　　　　　　Over the patient (B)　　　　　Over the bed (C)



Chest compressions in Phase 2

Team A　　　Team B　　　Team C

Actual chest compression rates per team:
79/min*　　　115/min　　　112/min
*Recommended chest compression rate: 100 to 120/min (American Heart Association)
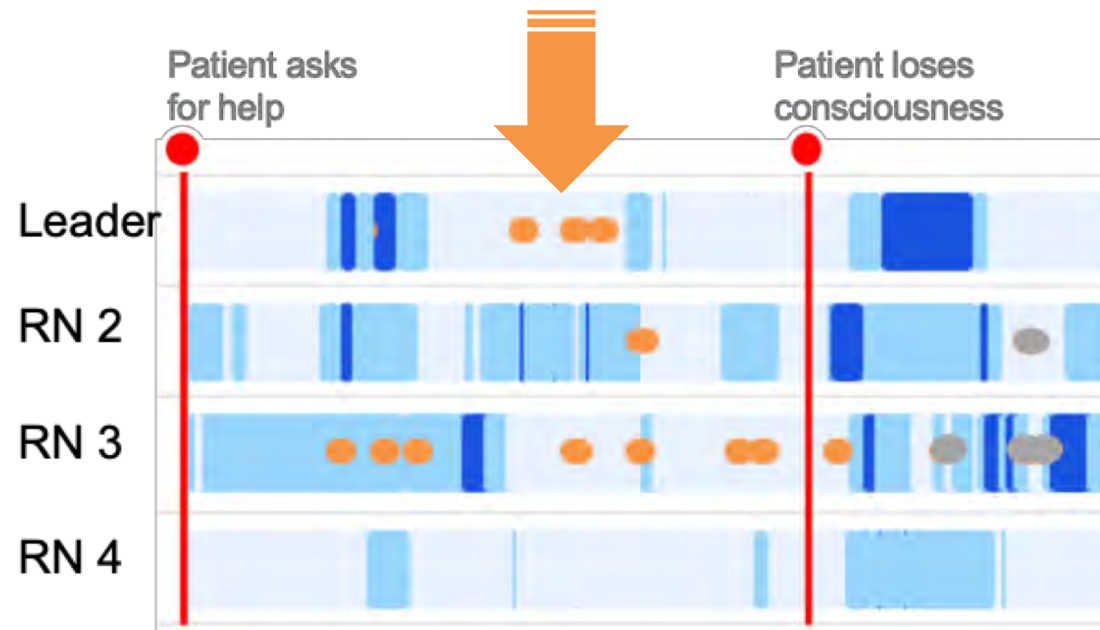
# COLLABORATION TRANSLUCENCE:
## Proxy for Patient-Centred Movement

Each circle represents one zone of interest around the patient's bed, size reflecting relative location, links showing the transitions between zones
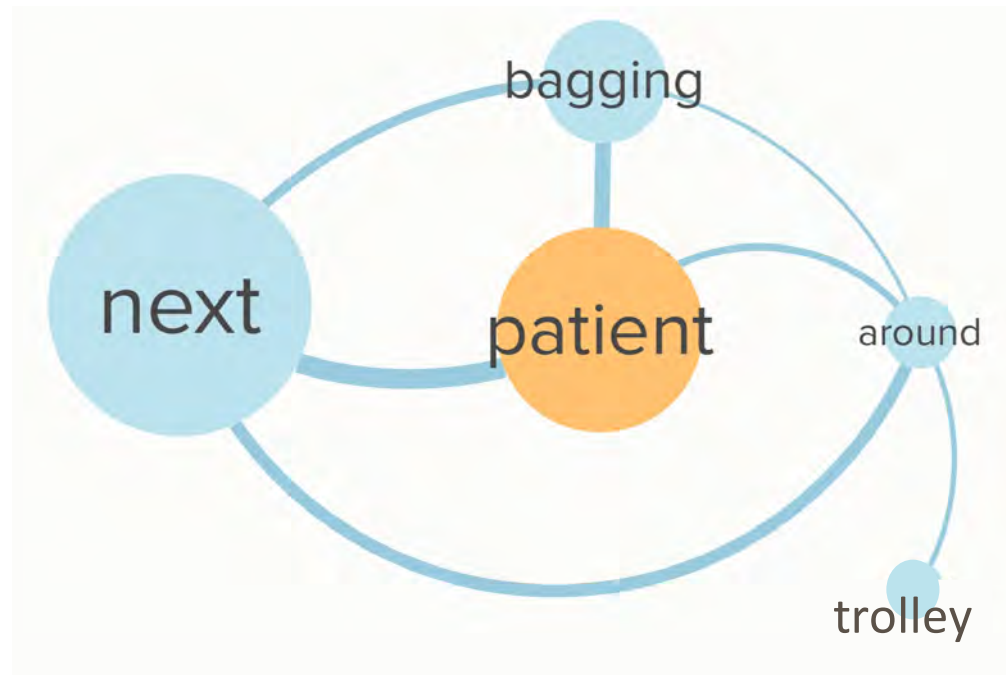
# COLLABORATION TRANSLUCENCE:
## Position and Movement

Each circle represents one zone of interest around the patient's bed, with links showing the transitions among zones.
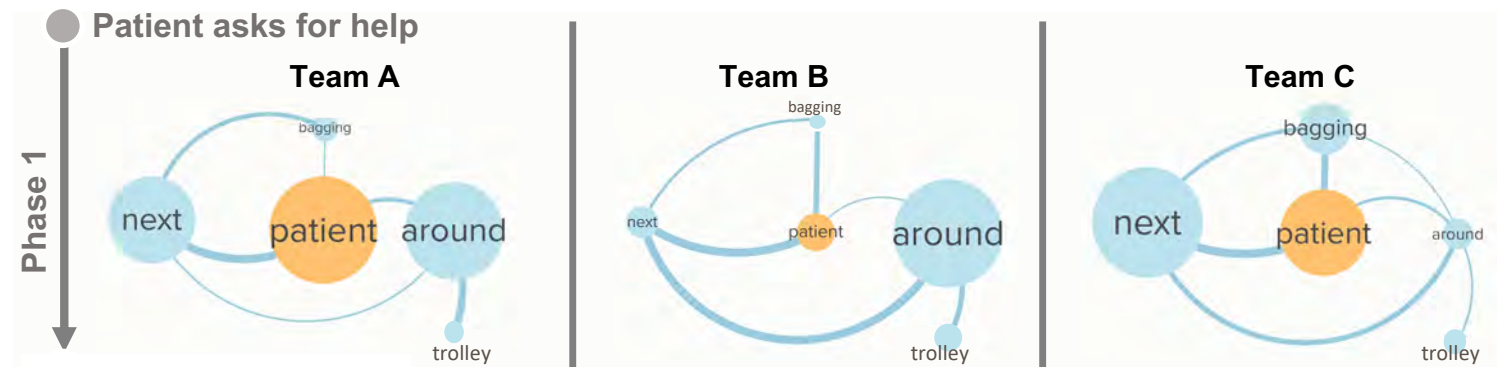
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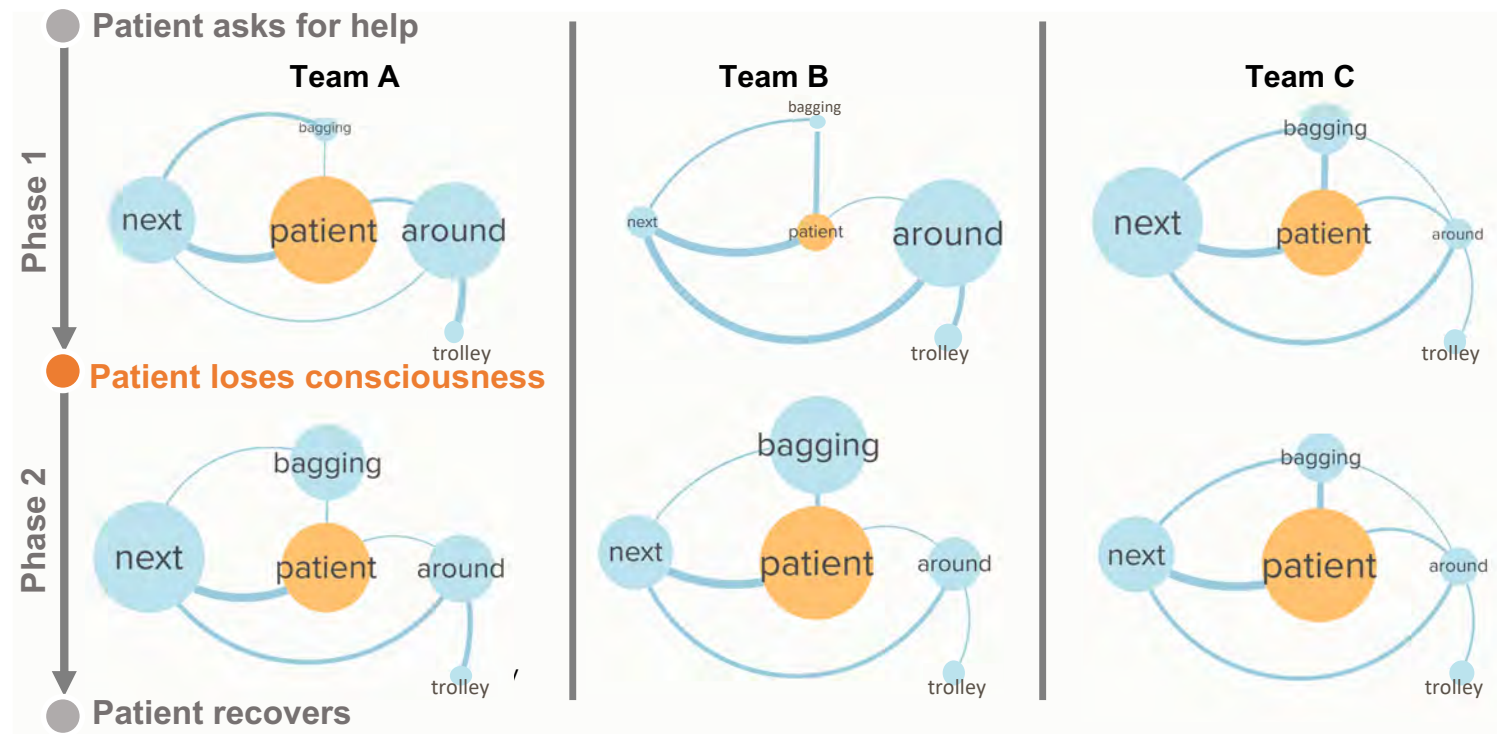
## COLLABORATION TRANSLUCENCE:
## Position and Movement

To assist reflection, the proxies can be compared and contrasted between phases, or within phases across teams, optionally coupled with video
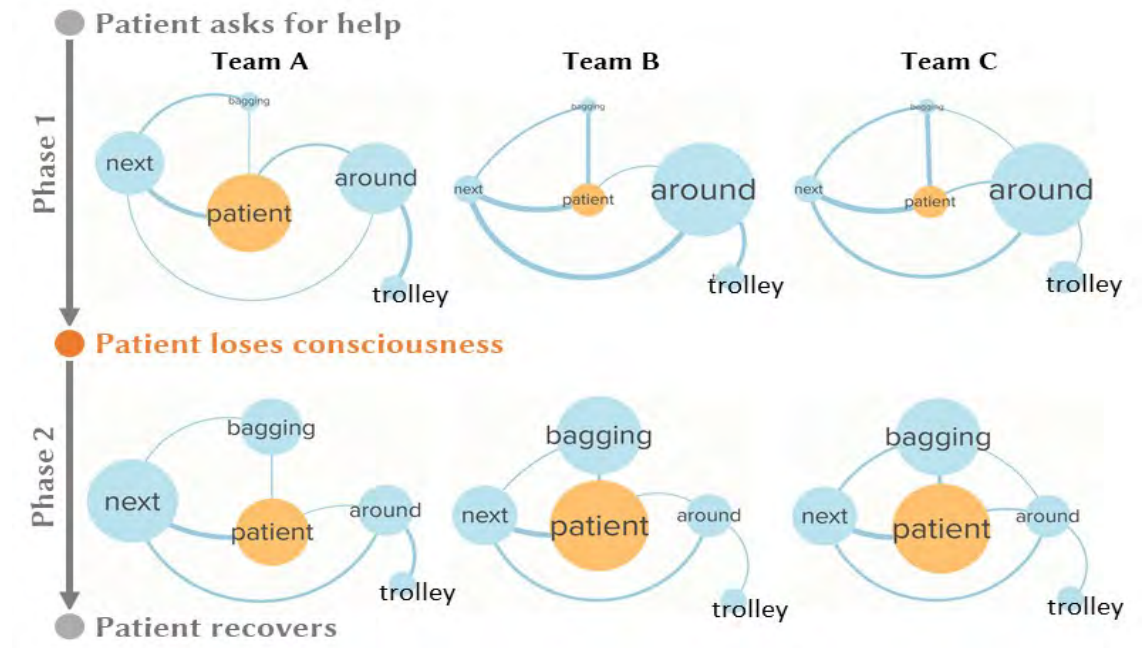


Chest compressions in Phase 2

Actual chest compression rates per team:
79/min*     115/min     112/min

*Recommended chest compression rate: 100 to 120/min (American Heart Association)

# COLLABORATION TRANSLUCENCE:
## Affective response (= stress? engagement?)

Physiological arousal as measured by Electrodermal Activity (EDA) peaks

Focus is on the orange EDA peaks
(during low physical intensity)

physical intensity
(shades of blue)

EDA peaks that may
be caused by
intense physical
activity (grey dots)

Patient asks for help

Patient loses consciousness

Leader

RN 2

RN 3

RN 4

# COLLABORATION TRANSLUCENCE:
## Affective response (= stress? engagement?)

Human analysis of the videos confirmed that both *EDA peaks*, *and their absence*, may signify a range of responses in nurses
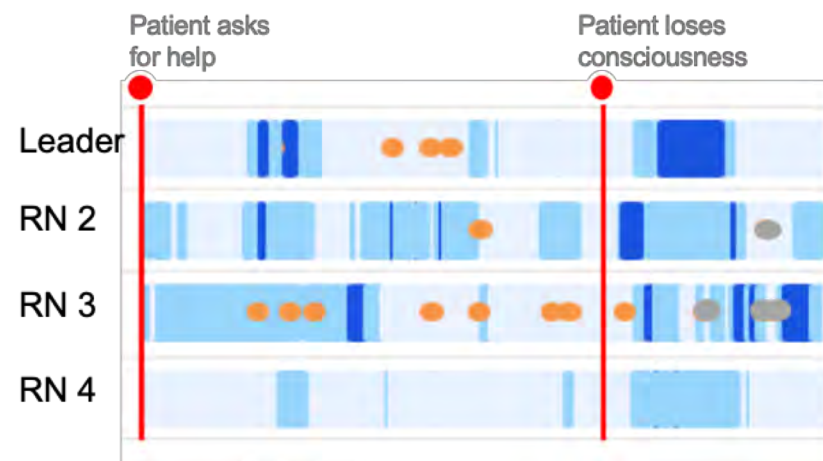
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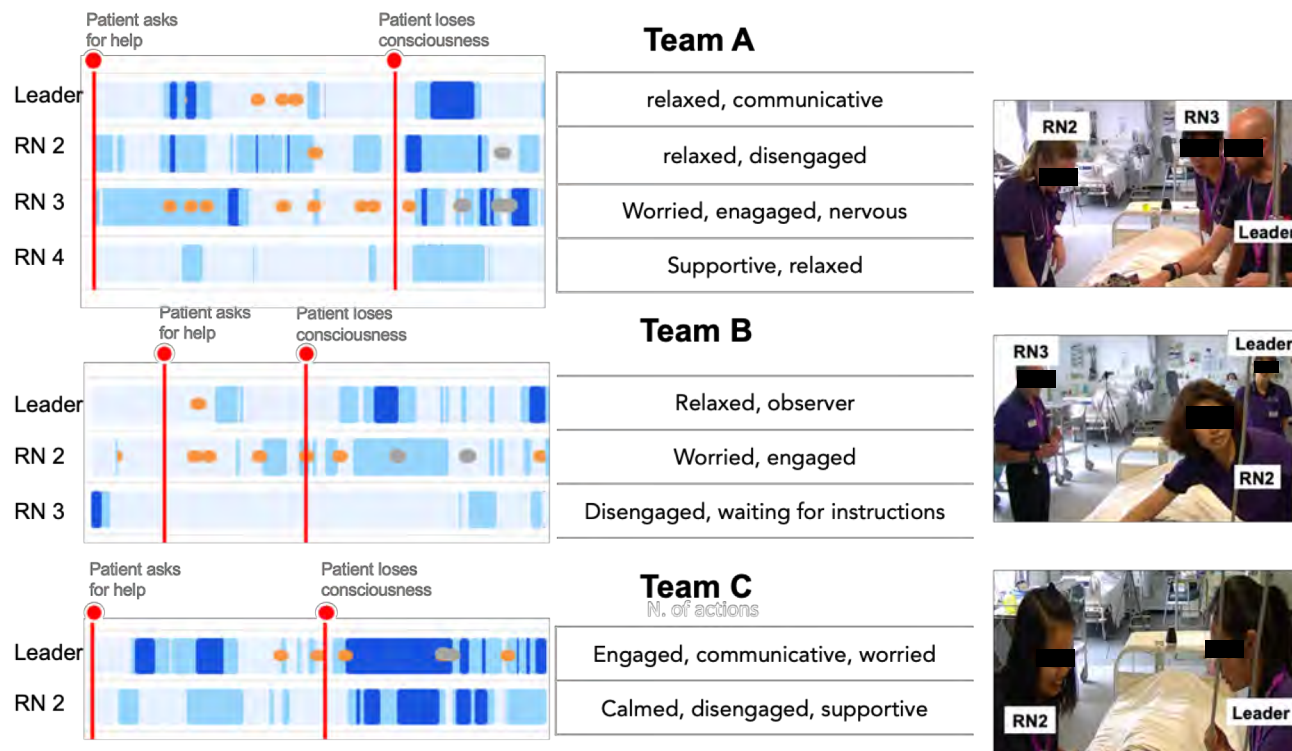
# COLLABORATION TRANSLUCENCE:
## Patient-centred team coordination of tasks
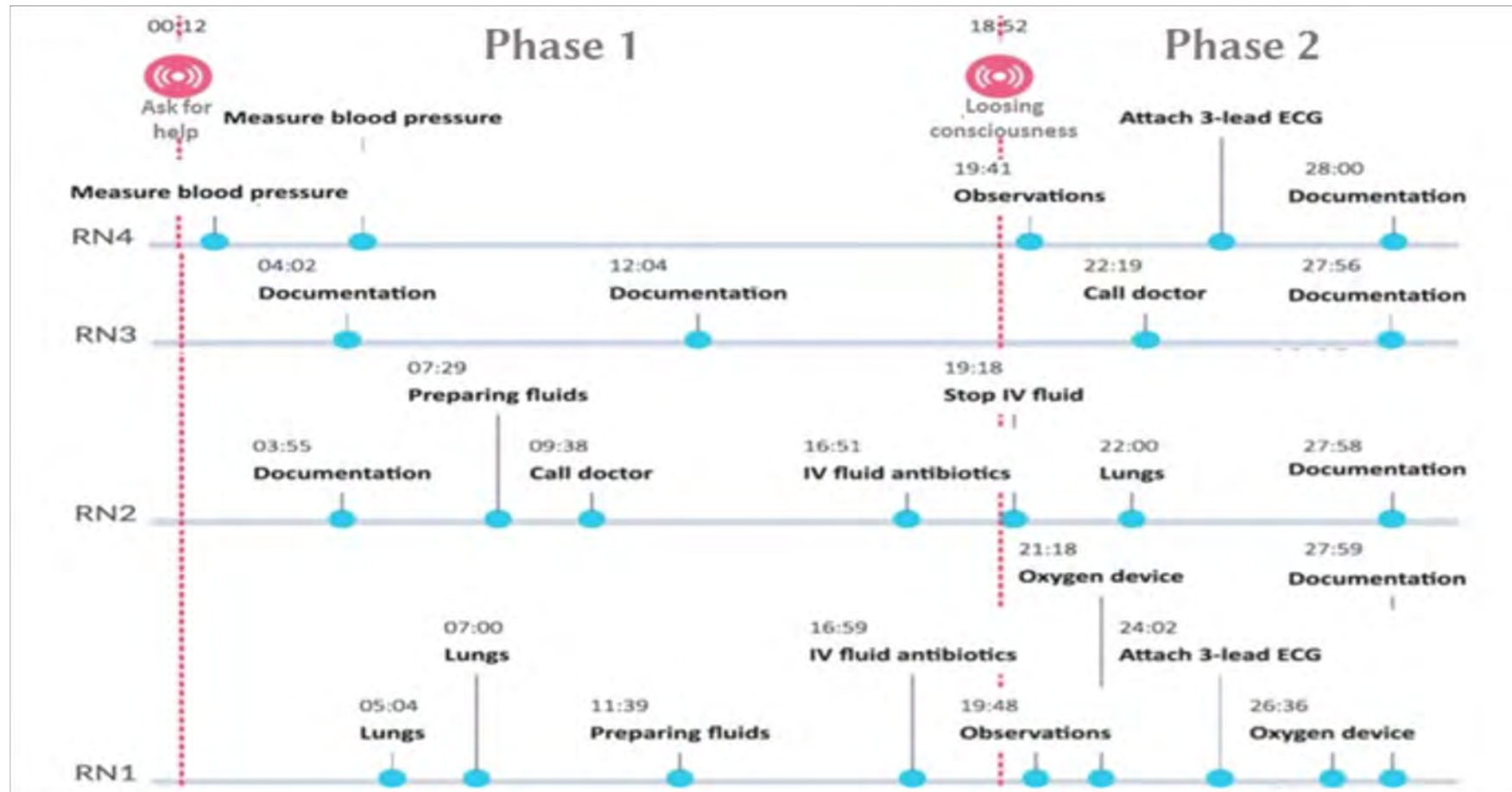
# COLLABORATION TRANSLUCENCE:

## Patient-centred team coordination

### enhanced version using "data storytelling" principles (Echeverria et al. 2018)



Echeverria, V., R. Martinez-Maldonado, R. Granda, K. Chiluiza, C. Conati and S. Buckingham Shum (2018). Driving Data Storytelling from Learning Design. In *Proceedings of the International Conference on Learning Analytics & Knowledge*, LAK'18, 131-140. ACM. https://doi.org/10.1145/3170358.3170380

# COLLABORATION TRANSLUCENCE:
# Patient-centred team coordination (enhanced version)

## Video demo
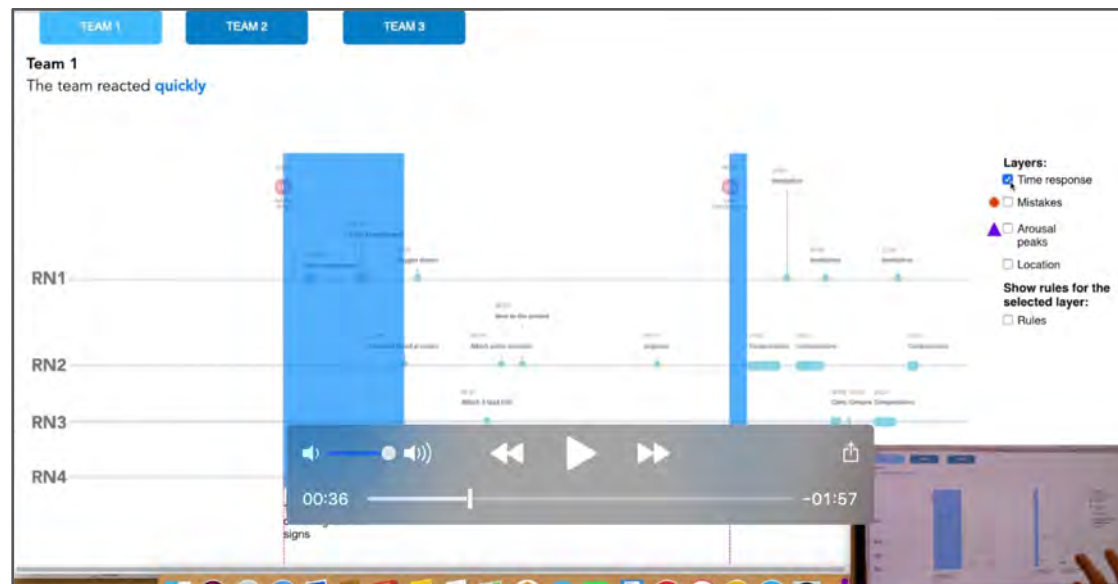
# Student responses were very positive to the Team Timeline

(detailed evaluation being written up)



"…while RN4 and RN2 were doing the fluids I was staying with the patient. It is good to step back and look at what each person was doing, one thing at the same time, I think it shows you how you worked as a team"

"it seems like a lot was done in clumps, you [RN3] were talking to the patient, looking for information while others were doing the observations, that seems practical to me"

# Staff responses were very positive to the Team Timeline
(detailed evaluation being written up)

"… particularly if [students] have no arousal peaks. That for me is a concern. What are you actually...? What's happening? Why are you...? Why weren't you engaging with that? Or what could be...? Yes, I think it's interesting. […] And it's also important because we need to let students understand that that's okay. We actually want them to have a little bit of a stress response in all situations because it does sort of stimulate their thinking and makes [students] aware. It improves [students] awareness." [E5]

# Staff responses were very positive to the Team Timeline
(detailed evaluation being written up)

"So, I am assuming RN1 has called the doctor and then told them to get the resus trolley. But there's no other delegation in here because there are no activities [referring to the actions shown in the timeline]. Nothing being done, it's all reactive, it's not proactive." [E8].

# Staff responses were very positive to the Team Timeline

(detailed evaluation being written up)

"I think it gives [students] something to look at. And show them location, like, for example, if you [team 3] are supposed to be interacting with the patient but you're standing at the end of the foot of the bed, at least you can show [students] that this is where you were and ask them why." [E5]

# Staff responses were very positive to the Team Timeline

(detailed evaluation being written up)

"Unless we show [students] recordings, they won't remember what they actually did. [Using Team-IN] some really would remember exactly how they would do it differently next time" [E5]

"It [Team-IN] would be really helpful for students in terms of a reflection, if you gave them really structured reflection questions and this information, and asked them to reflect on what they were doing, whether it was accurate or not, how they're engaging with the patient and other team members, what they were thinking and feeling at the time, it would be a really valuable tool for deep reflection." [E3]

**Academics' proposed uses of the Team Timeline to prompt student reflection**

**performance** e.g. *"Am I doing a good job? Am I getting things done?"* [E7]

**arousal** e.g. *"Can you talk me through what you were feeling in this moment. Can you tell me what you were thinking at this point?"* [E2]

**actions or mistakes performed** e.g. *"So, let's have a look at these compressions, and as I said, you know, they're too shallow. So, tell me a bit about what depth the compressions need to be at, and have you achieved that? How do you know you're achieving that and the rate of compression?"* [E2]

**Academics' proposed uses of the Team Timeline to prompt student reflection**

**response time** e.g. *"Do you think that that's a definitive time frame to do that in? Or looking at the ABCDEFG algorithm, when would you hope to provide your first shock?"* [E8]

**wrong positioning during the simulation** e.g. *"What were you doing over here? Because you didn't go and get the resus trolley but what took you over here? And then this person stood the most time off to the side and did nothing. And do you think that's a fair way to behave in a team?"* [E8]

**unsafe practice** e.g. *"Is this clinically safe for your patient? Are you performing in a way that's safe for your patient?"* [E5]

# HOW CLOSE TO FULLY AUTOMATED FEEDBACK?
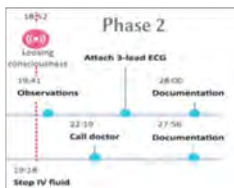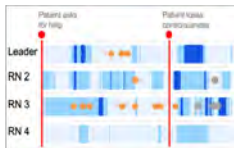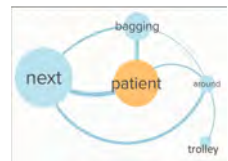
| Collaboration Proxy | Data source | Manual interventions | | Automated |
|---|---|---|---|---|
| **Patient-centred speech interaction** | Audio from video recording | Speech interaction manually annotated | → | Sociograms generated from speech onset/offset logs |
| **Patient-centred movement** | X,Y positions and pre-defined zones using indoor localization | | → | Zone transition networks generated from localisation data |
| **Physical Intensity and Affective reaction** | EDA and accelerometer from Empatica wristband | Wristband data download | → | EDA timelines generated from wristband data |
| **Teamwork Timeline** | Timestamped actions from observation tool | Nursing actions logged by an observer | → | Timelines generated from action logs |

# SUMMARY: A METHODOLOGY TO GENERATE COLLOCATED COLLABORATION ANALYTICS

From teamwork as…

**Ephemeral** activity
(no evidence to inform debriefs)

**Opaque** to computational analysis
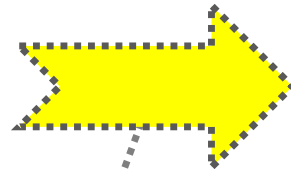
Method to inform the modelling of **quantitative** activity data with **qualitative** insights into what makes it **meaningful**

Sensors generate **persistent** traces

Semi-automated **data fusion and modelling**

"Collaboration Translucence" via **visual proxies**

**Positive feedback** from students and instructors

# POTENTIAL FUTURE TRAJECTORIES…

### TECHNICAL INFRASTRUCTURE

Towards fully automated feedback

Future learning spaces will be configured

### EMPIRICAL STUDIES

Further testing with Health

Expansion to other disciplines

Privacy/ethics

### AFFORDANCES FOR LEARNING

The use of personal replays to review and reflect

Fictional dashboards for teaching