

# Multimodal data to understand students' cognition, metacognition, motivation and emotions in a learning process

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Understanding a learning process – what happens before and after – explains progress or failure of learning.

Unfortunately it is complex.

Järvelä, S., Järvenoja, H., Malmberg, J., Isohätälä, J. & Sobocinski, M. (2016). How do types of interaction and phases of self-regulated learning set a stage for collaborative engagement? *Learning and Instruction* 43, 39-51.



# SRL theory helps to understand the complex process of learning





# What is self-regulated learning?

(Winne & Hadwin, 1998; Zimmerman 2010)

**Active** and proactive learning

**Process** of learning to monitor, evaluate, and regulate (or change) your own

- Thinking
  - Motivation
    - Emotion
      - Behaviour
        - Learning

**Adaptive** process that you develop and refine over time

# Successful collaboration requires...

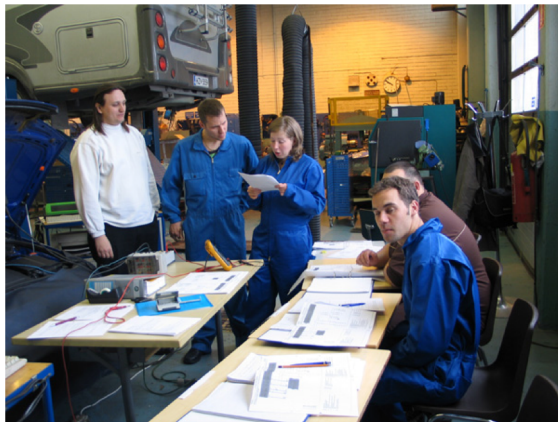


Regulating Oneself



Supporting each other's regulation

Self-regulation  
Co-regulation  
Socially shared regulation



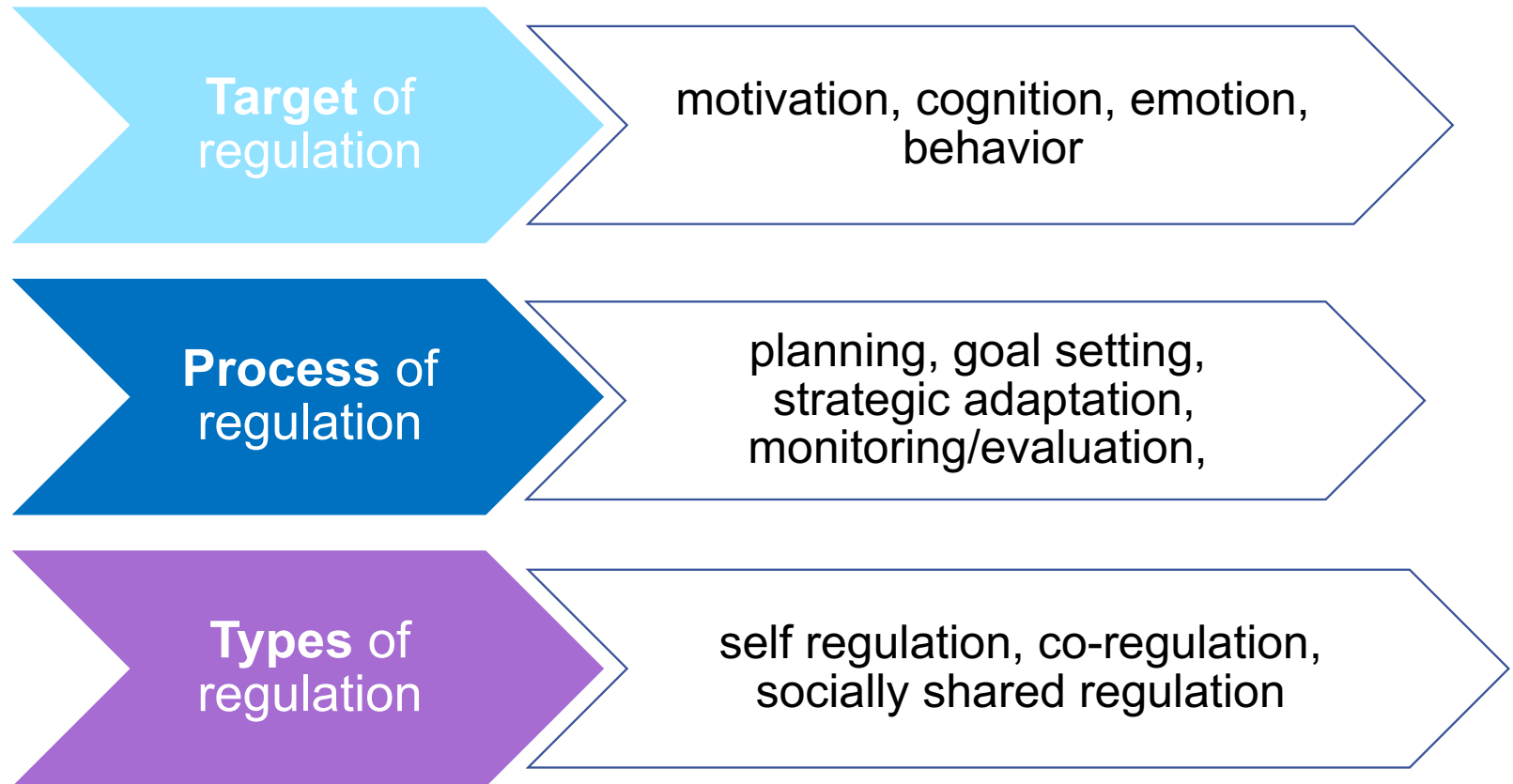
Regulating Together



Järvelä, S. & Hadwin, A. (2013). New Frontiers: Regulating learning in CSCL. *Educational Psychologist*, 48(1), 25-39. ; Hadwin, A. F., Järvelä, S., & Miller, M. (2017). Self-regulation, co-regulation and shared regulation in collaborative learning environments (pp. 83-106). In D. Schunk. & J. Greene. (Eds.). *Handbook of Self-Regulation of Learning and Performance*.



## Researching regulation presumes understanding:





Today, considering SRL in social context forces the field to search alternative ways to evidence the phenomena, because single methodological solution is not enough to **reach the metacognitive, cyclical adaptation to the temporal progress of collaboration.**



As a learning scientist, we face serious **methodological problems** because the learner's cognition, motivation, and emotion are neither visible for the researcher to study it, nor for learners so that they are able to regulate those processes to learn effectively.





## Our aim

1. Investigate regulatory processes in authentic collaborative learning situations
2. Explore what multimodal data can tell us about critical SRL processes
3. Develop scaffolds and support for SSRL in CSCL



## The studies

**(A) 15 year old high school students (N=36) working in collaborative groups of three students for an inquiry “Design a healthy breakfast” (one 75 min lesson)**

**(B) 16 year old high school students (N=43) working in advanced physics collaborative learning tasks (20 x 75 min lessons)**



# Our multimodal data collection



# Multichannel data collection

360-degree video capture + audio

EdX logdata, questionnaires, evaluation forms, student products

Mobile eye tracking

Empatica E3 multisensor devices that track student EDA and heart rate

# Why?

1

Subjective and objective data markers

2

Complement with different data channels

3

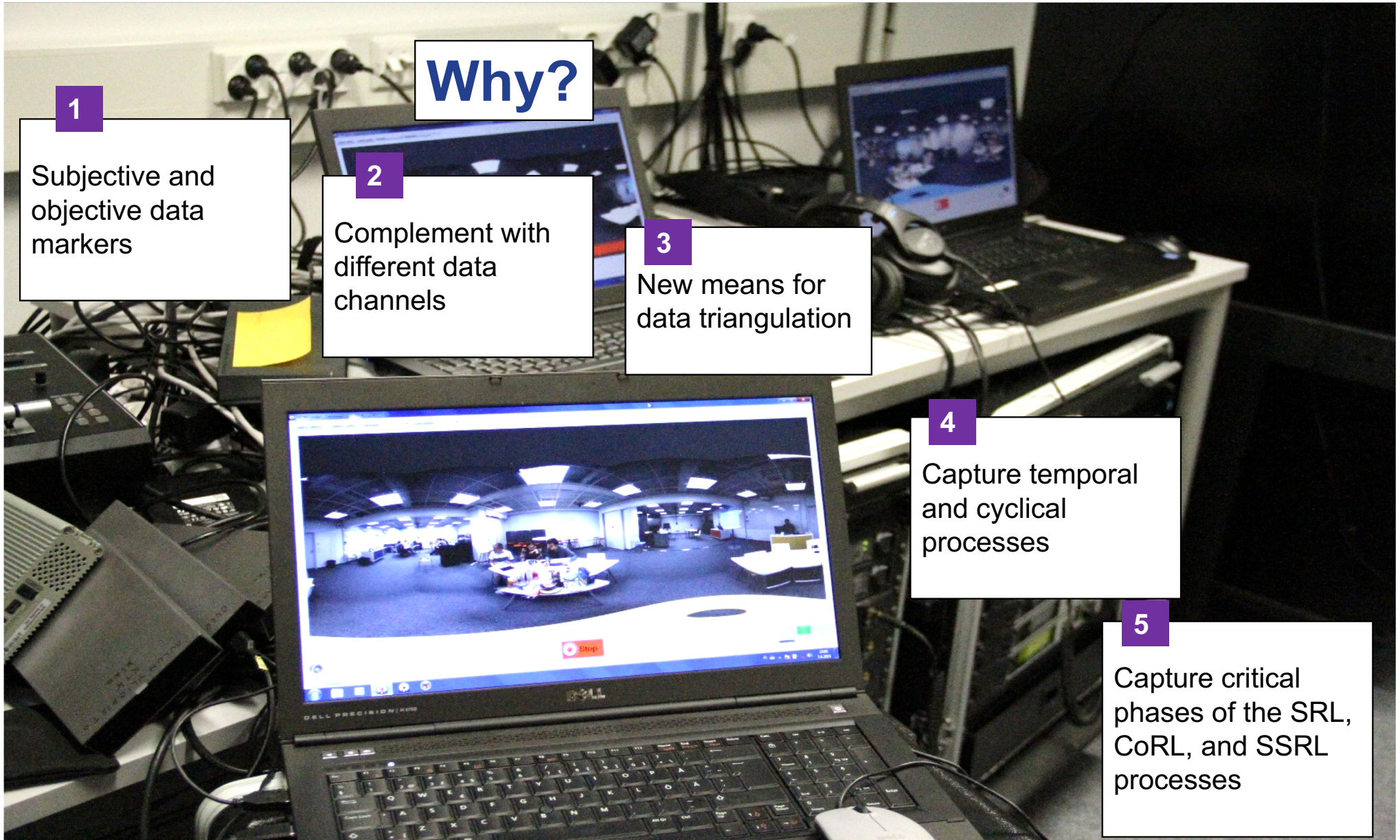
New means for data triangulation

4

Capture temporal and cyclical processes

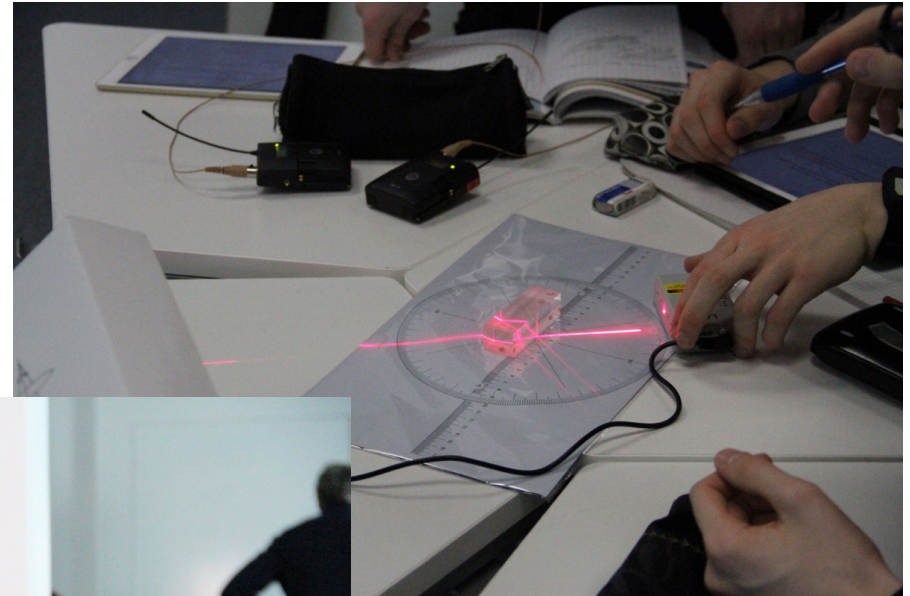
5

Capture critical phases of the SRL, CoRL, and SSRL processes





# BUT, big data don't tell all – if not contextualized, where the learning actually takes place





## Data about individuals



## ...and individuals interacting as a group





# Mobile EYE TRACKING

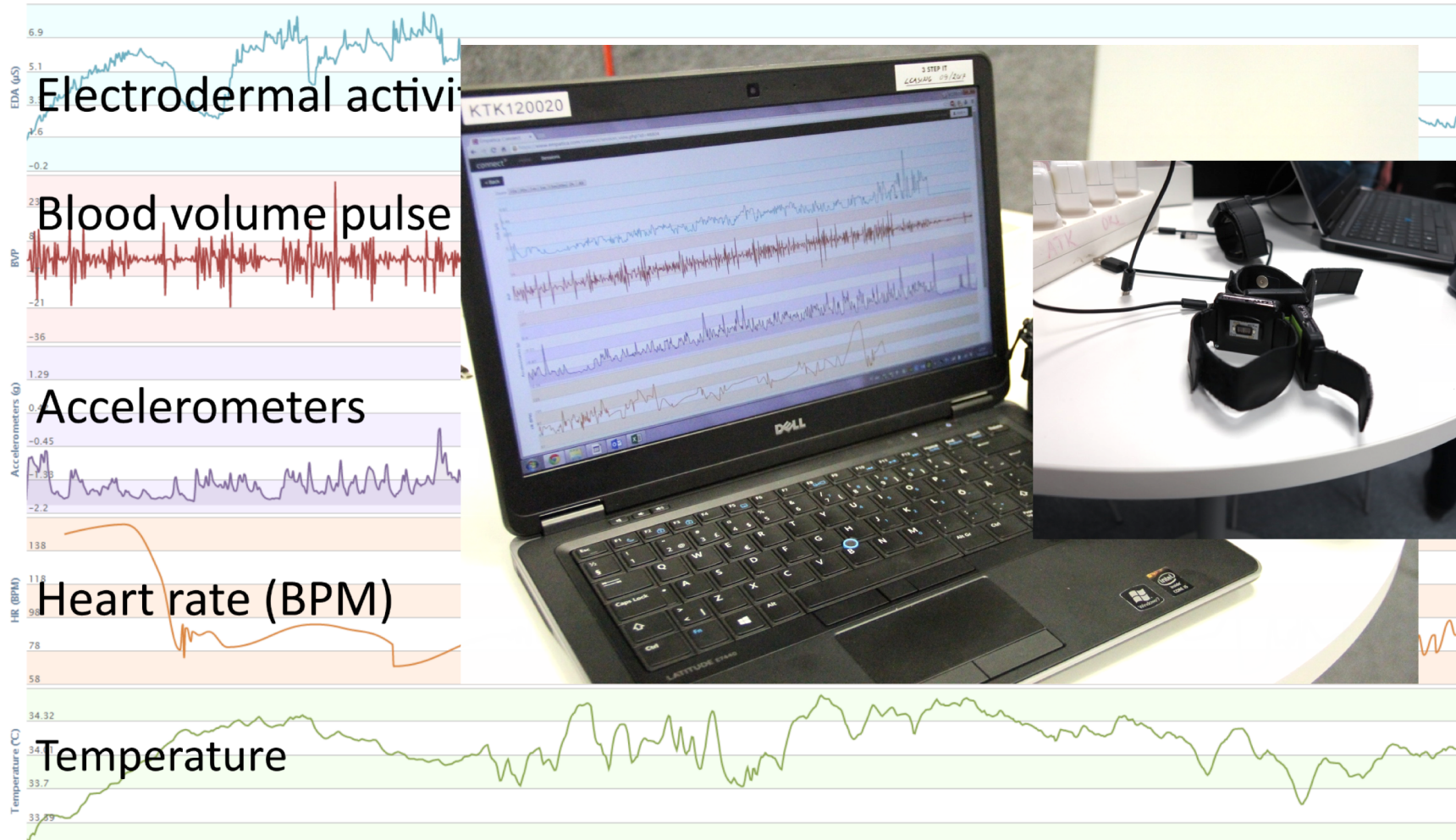
– Areas of interests and focus of attention







# SENSORS – physiological reactions





# LOG DATA (EdX)

– strategic task enactment

Checking the dashboard

Navigating through the course

Watching an instructional video



username	event_type	time
AleksiK	seq_goto	2016-03-26 11:36:06.304367
NikoK	/dashboard	2016-03-27 14:02:25.343951
Tatuj	seq_goto	2016-03-27 19:55:36.231206
Tatuj	seq_goto	2016-03-27 19:55:43.317112
NikoK	/dashboard	2016-03-28 09:31:43.106506
NikoK	/dashboard	2016-03-28 09:42:40.563449
NikoK	/dashboard	2016-03-28 09:42:42.318640
NikoK	/logout	2016-03-28 09:42:46.912533
JoelM	seq_next	2016-02-23 13:28:25.715418
JoelM	seq_goto	2016-02-23 13:28:29.506735
JoelM	seq_goto	2016-02-23 13:28:39.272139
JoelM	seq_goto	2016-02-23 13:28:42.639985
JoelM	seq_goto	2016-02-23 13:29:29.799360
JoelM	seq_goto	2016-02-23 13:29:32.823067
JoelM	load_video	2016-02-23 13:29:33.964559
JoelM	seq_goto	2016-02-23 13:34:21.994600
JoelM	seq_goto	2016-02-23 13:35:18.978750
JoelM	seq_goto	2016-02-23 13:35:22.336114
JoelM	seq_goto	2016-02-23 13:35:24.907074
JoelM	seq_goto	2016-02-23 13:35:38.444851
JoelM	seq_goto	2016-02-23 13:35:40.648030
JoelM	seq_goto	2016-02-23 13:35:42.964417
JoelM	seq_goto	2016-02-23 13:35:45.030024
JoelM	seq_goto	2016-02-23 13:35:47.319700



# ON-LINE EVALUATION FORMS & retrospective dashboards

Meidän ryhmän tilanne



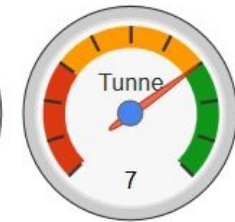
Our  
group



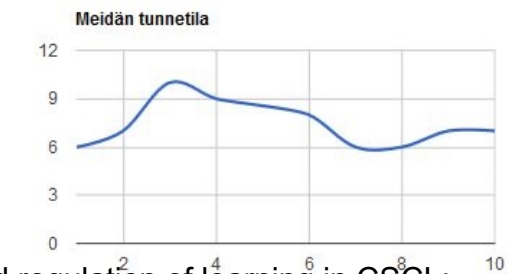
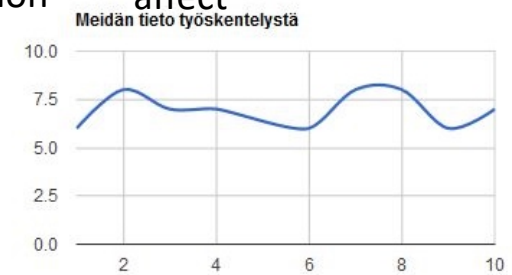
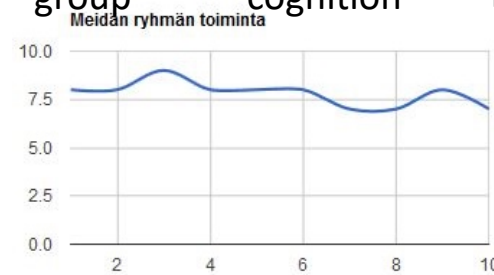
Our  
cognition



Our  
motivation



Our  
affect

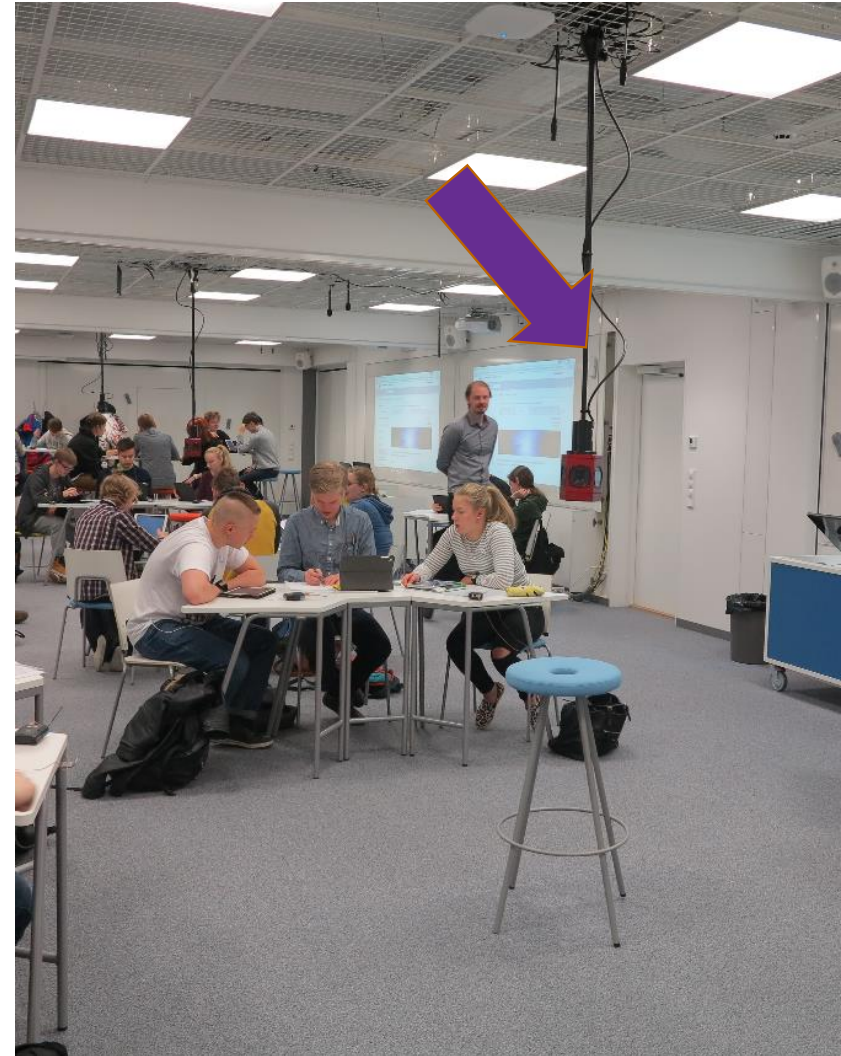


Järvelä, S. , Kirschner, P. A., Hadwin, A., Järvenoja, H., Malmberg, J. Miller, M. & Laru, J. (2016).<sup>19</sup> Socially shared regulation of learning in CSCL: Understanding and prompting individual- and group-level shared regulatory activities. *International Journal of Computer Supported Collaborative Learning* 11(3). 263-280.



# 360 ° VIDEODATA

– learning "in action"





# Data troubles



## All resulting **BIG & COMPLEX** data:

101 hours of video,  
266 216 000 data points of  
physiological data,  
236 000 EdX log events...



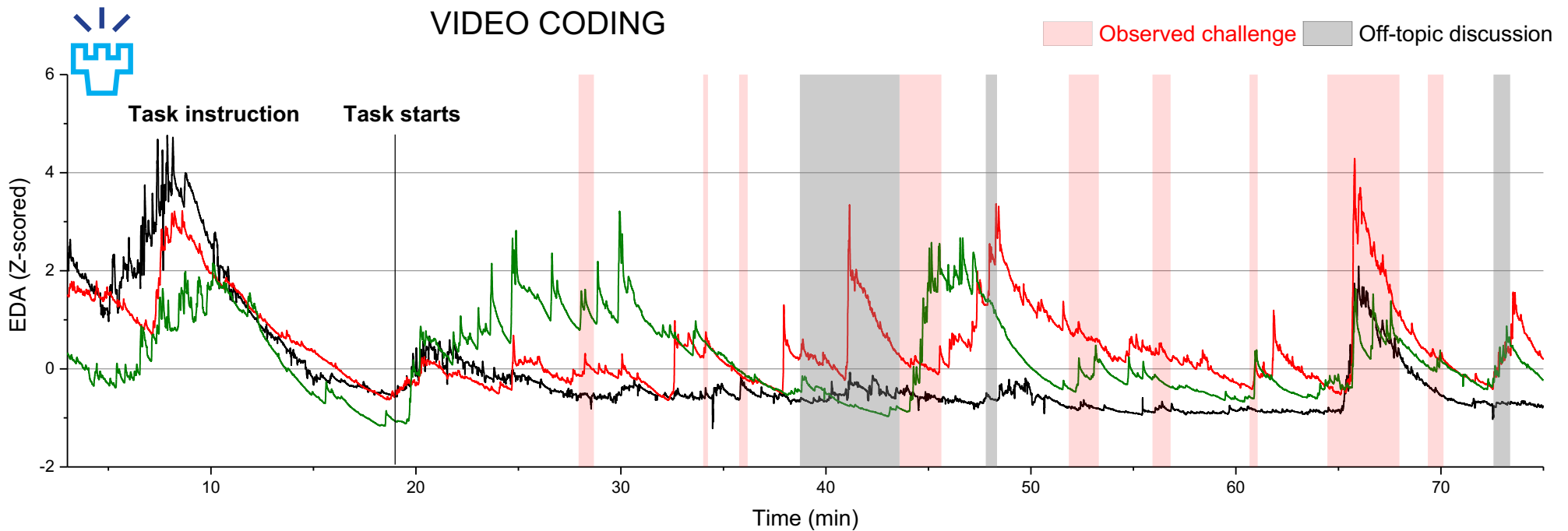
### **GRAPHICAL USER INTERFACE VISUALIZING COMPLEX DATA**

Collaboration with LA, data-mining  
and signal processing experts

(Alikhani, I., Juuso, I., & Seppänen, T. 2017)



# Multidisciplinary collaboration in multimodal data analysis



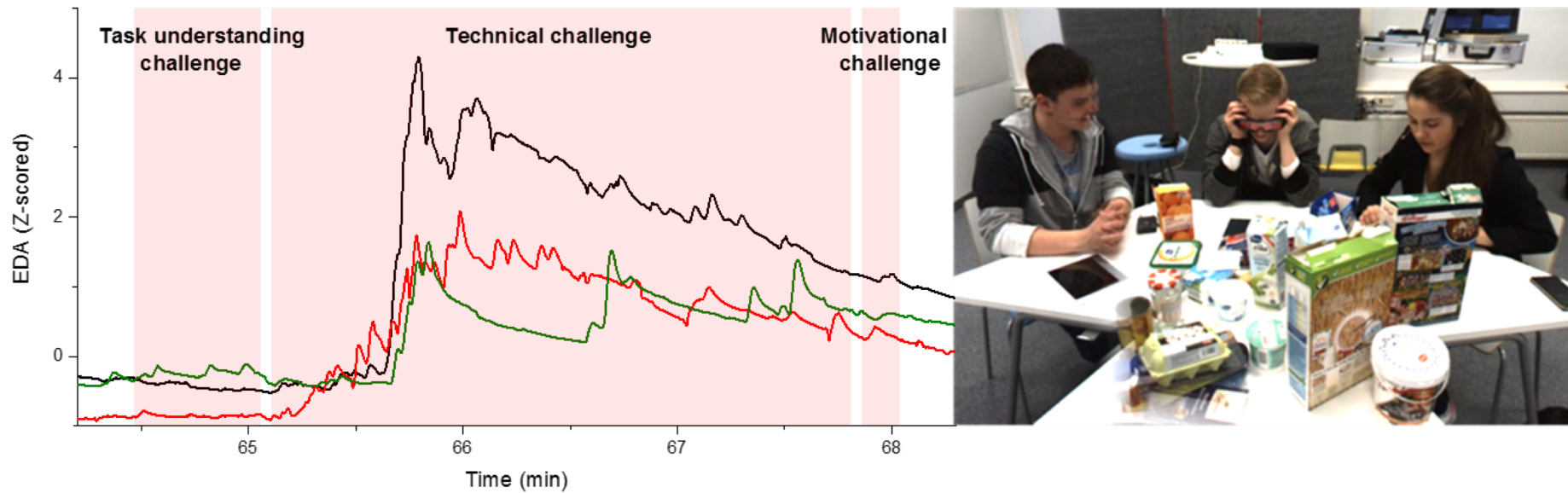
*Example 1.*

“Design a healthy breakfast for a marathon runner” (75 min lesson). Observed challenges and EDA signals in a group of 3 students.





## Synchronized EDA & video



### *Example 2.*

The challenge episode associated with EDA signals of three students.

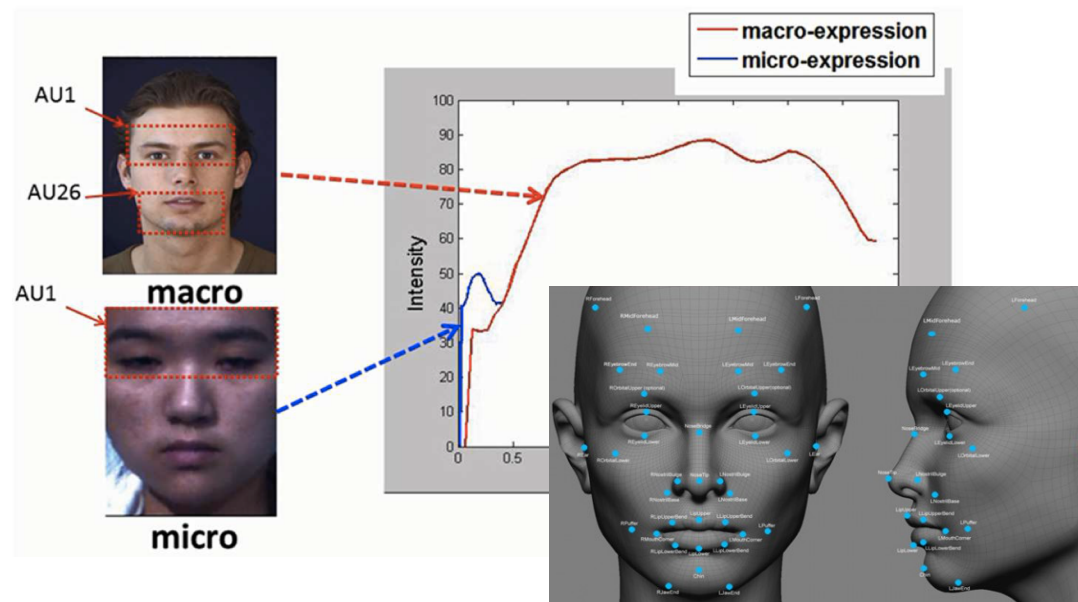
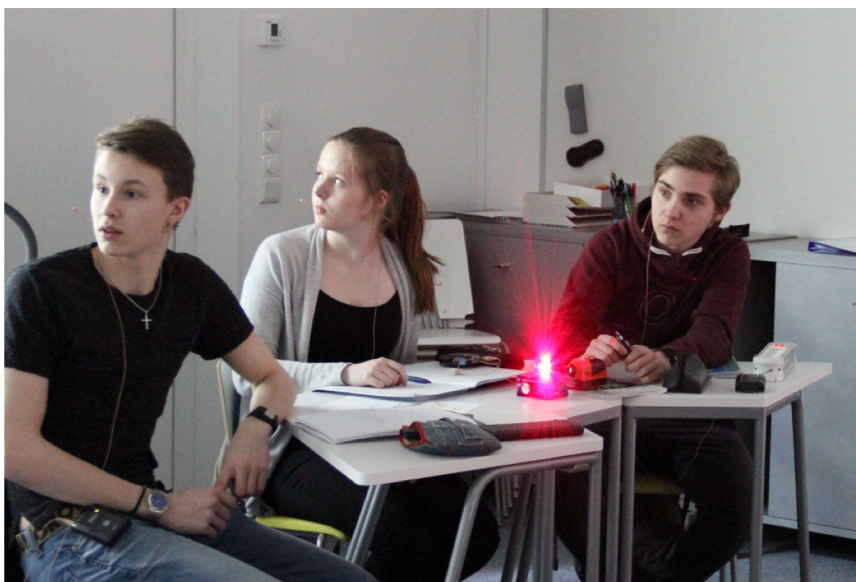
Haataja, E., Malmberg, J. & Järvelä, S. (2017, submitted). Monitoring in collaborative learning: Co-occurrence of observed behavior and physiological synchrony explored



Our next step:

## FACE READING

### Micro-expressions and socially oriented micro-gesture analysis in groups



X. Li, X. Hong, A. Moilanen, X. Huang, T. Pfister, **G. Zhao**, and M. Pietikäinen. Towards Reading Hidden Emotions: A Comparative Study of Spontaneous Micro-expression Spotting and Recognition Methods. IEEE Transactions on Affective Computing, 2017



## Triangulating multiple sources of process data

How to make sense?

- **Triangulation involves matching process data resulting from different channels based on the time-stamped information related to each data source** (D'Mello, Dieterle, Duckworth, 2017).
- **Different channels to the learning process to capture the dynamic, context- and time-sensitive nature of regulation** (Zusho, 2017).
- **Testing and experimentation with different combinations of data** (Roll & Winne, 2015)
- **Validating data obtained from different data channels** (Ochoa, 2017)



## What multimodal data can tell us this far?

- Regulation seems to be critical **in progress** of collaborative learning (Isohätälä et al., 2016), and thus, contributing to the results of collaborative learning (Järvelä et al., 2016).
- Evidence from **patterns and temporal progress** in students' strategic actions in different tasks (Malmberg, J., Järvenoja, H., & Järvelä, S. 2013).
- **Capturing temporal and sequential patterns of self-, co- and socially shared regulation in the context of collaborative learning** (Malmberg, J., Järvelä, S. & Järvenoja, H. (2017).
- **Concordance of self-report data and physiological synchrony among the collaborating students** (Dindar, Malmberg, Järvelä, Haataja & Kirschner, 2017).



# Why multimodal data & LA can help?



Reveal complexity and range of cognitive and non-cognitive processes



Adaptation, temporality, cyclical processes, tendencies, patterns

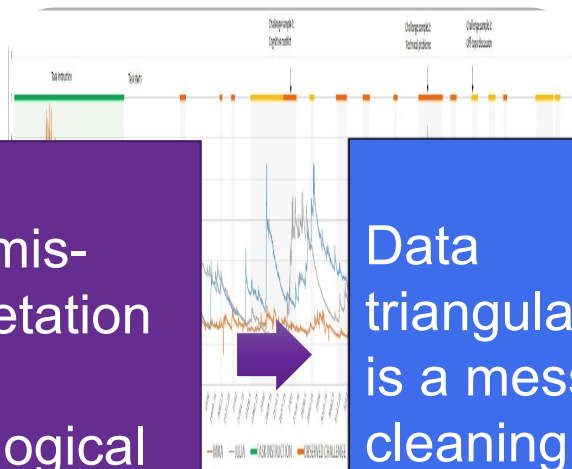


Bigger the data  
- stronger the evidence



# Where do we need to struggle more?

Over-/mis-interpretation of physiological data



Data triangulation is a mess-cleaning the data



Sampling rates of each technique and data granularity

Minimize the **costs** of multimodal data collection and handling



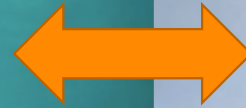
# Future perspectives





Smart thinking and  
creativity

Sensitive  
communication



Adaptive support

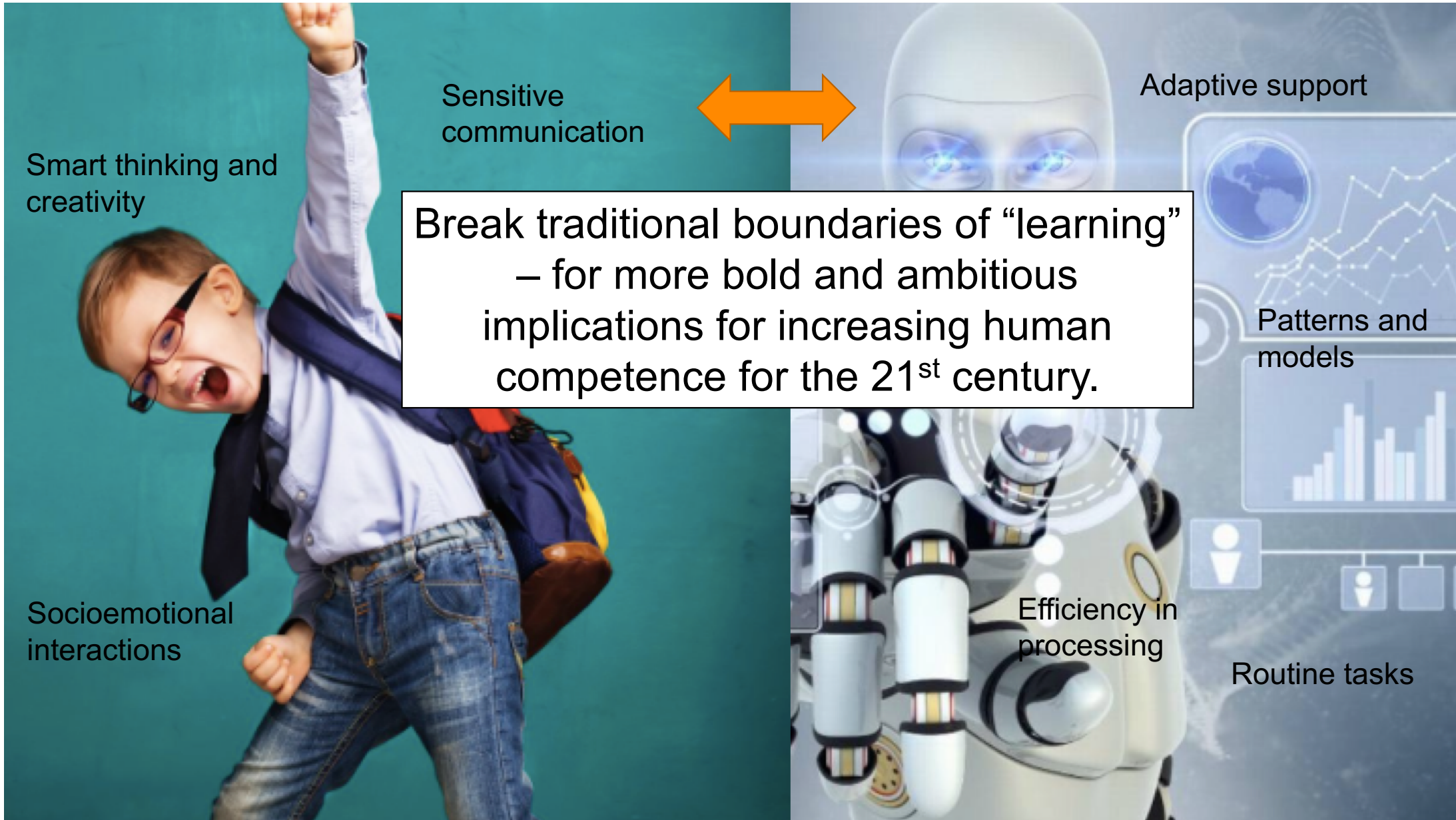
Break traditional boundaries of “learning”  
– for more bold and ambitious  
implications for increasing human  
competence for the 21<sup>st</sup> century.

Patterns and  
models

Socioemotional  
interactions

Efficiency in  
processing

Routine tasks





# Thank you!

[www.slamproject.org](http://www.slamproject.org)

[www.oulu.fi/let](http://www.oulu.fi/let)

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@LET\_Oulu



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## Recent related SLAM publications:



Järvelä, S. & Hadwin, A. (2013). New Frontiers: Regulating learning in CSCL. *Educational Psychologist*, 48(1), 25-39. DOI:10.1080/00461520.2012.748006

Järvelä, S., Kirschner, P. A., Panadero, E., Malmberg, J., Phielix, C., Jaspers, J., Koivuniemi, M., & Järvenoja, H. (2015). Enhancing Socially Shared Regulation in Collaborative Learning Groups: Designing for CSCL Regulation Tools. *Educational Technology Research and Development*, 63, 1, 125-142. DOI: 10.1007/s11423-014-9358-1

Järvenoja, H., Järvelä, S. & Malmberg, J. (2015). Understanding the process of motivational, emotional and cognitive regulation in learning situations. *Educational Psychologist*, 50(3), 204-219.

Järvelä, S., Malmberg, J. & Koivuniemi, M. (2016). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learning and Instruction*, 42, 1-11. DOI: 10.1016/j.learninstruc.2015.10.006

Järvelä, S., Järvenoja, H., Malmberg, J., Isohätälä, J. & Sobocinski, M. (2016). How do types of interaction and phases of self-regulated learning set a stage for collaborative engagement? *Learning and Instruction* 43, 39-51. doi:10.1016/j.learninstruc.2016.01.005

Pijeira-Díaz, H. J., Drachsler, H., Järvelä, S., & Kirschner, P. A. (2016). Investigating collaborative learning success with physiological coupling indices based on electrodermal activity. *Proceedings of the Sixth International Conference on Learning Analytics and Knowledge*. ACM. doi: 10.1145/1235

Järvelä, S., Kirschner, P. A., Hadwin, A., Järvenoja, H., Malmberg, J. Miller, M. & Laru, J. (2016). Socially shared regulation of learning in CSCL: Understanding and prompting individual- and group-level shared regulatory activities. *International Journal of Computer Supported Collaborative Learning* 11(3), 263-280. doi:10.1007/s11412-016-9238-2

Malmberg, J., Järvelä, S. & Järvenoja, H. (2017, in press). Capturing temporal and sequential patterns of self-, co- and socially shared regulation in the context of collaborative learning. *Contemporary Journal of Educational Psychology*

Sobocinski, M., Malmberg, J. & Järvelä, S. (2016). Exploring temporal sequences of regulatory phases and associated interaction types in collaborative learning tasks. *Metacognition and Learning*. doi:10.1007/s11409-016-9167-5

Malmberg, J., Järvelä, S., Holappa, J., Haataja, E., & Siipo, A. (2016). *Going beyond what is visible –What physiological measures can reveal about regulated learning in the context of collaborative learning*. Submitted

Hadwin, A. F., Järvelä, S., & Miller, M. (2017). Self-regulation, co-regulation and shared regulation in collaborative learning environments. In D. Schunk, & J. Greene, (Eds.). *Handbook of Self-Regulation of Learning and Performance* (2<sup>nd</sup> Ed.). New York, NY: Routledge.

Järvelä, S., Hadwin, A.F., Malmberg, J. & Miller, M. (2017). Contemporary Perspectives of Regulated Learning in Collaboration. In F. Fischer, C.E. Hmelo-Silver, Reimann, P. & S. R. Goldman (Eds.). *Handbook of the Learning Sciences*. Taylor & Francis.



1. Why understanding a learning process – not only a product of learning - is important?
2. How various technologies can both support learners, but also be used as a data collection tool?