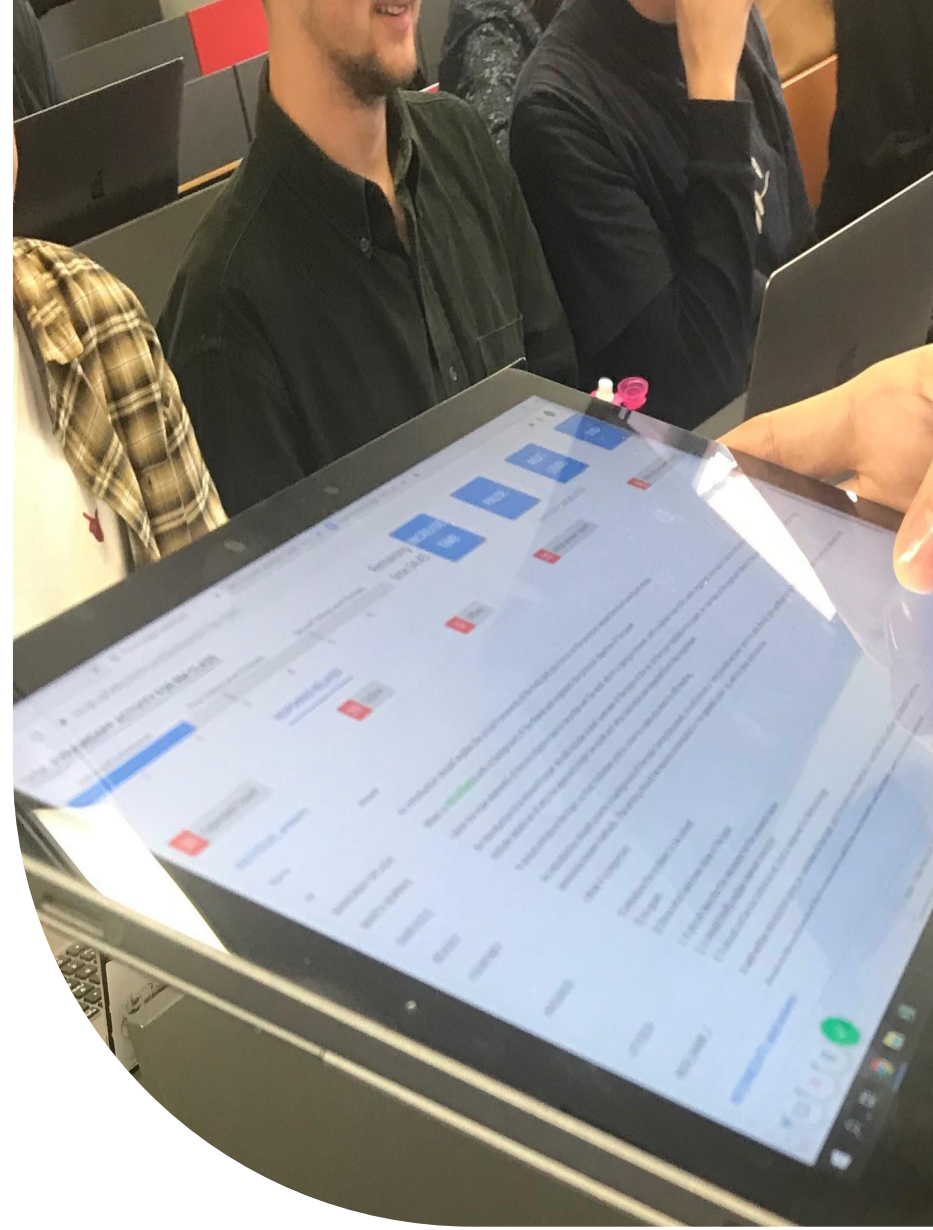


Collaborative Learning Scripts and Learning Analytics

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EXCELENCIA
MARÍA
DE MAEZTU

Introduction

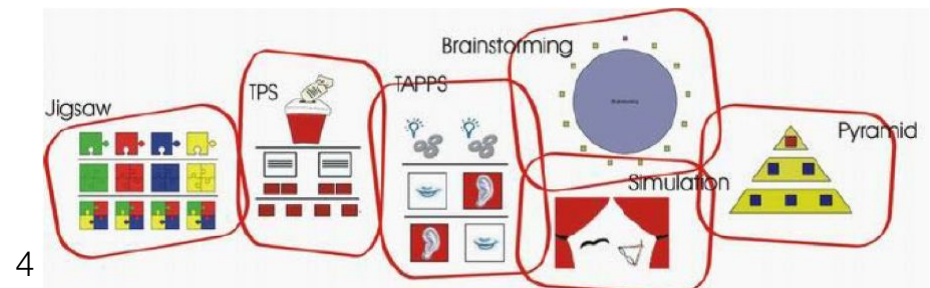
➤ Computer-Supported Collaborative Learning (CSCL)

- How people can **learn together** / collaboratively with the help of **computers**
[Dillenbourg 1999]
- One major concern: productive interactions rarely occur in spontaneous collaboration
[Dillenbourg and Tchounikine 2007; Kobbe et al. 2007]
- Aims to contribute with **mechanisms** and **technologies** that support the creation of beneficial collaborative learning situations
 - Monitor and intervene as required [Soller, Martínez- Monés, Jermann, & Muehlenbrock, 2005]
 - Provide a set of instructions to guide collaboration - **CSCL Scripts** [Dillenbourg 1999]



Introduction

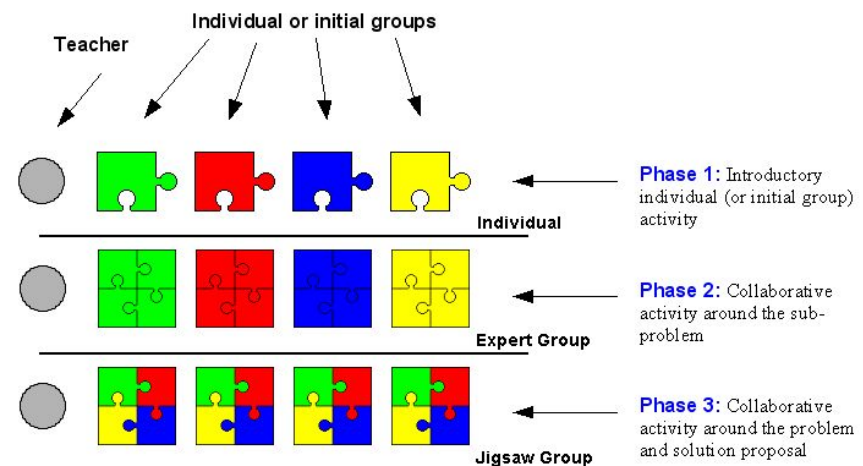
- Micro-scripts : emphasize on individual learner's actions with finer granularity [Dillenbourg & Tchounikine, 2007; Kobbe et al. 2007]
 - e.g., construction of arguments or argumentation sequences [Weinberger et al. 2005]
- Macro-scripts : deals with the organization of coarser-granularity activity flows [Dillenbourg & Tchounikine, 2007; Kobbe et al. 2007]
 - e.g., Phases of the activity flow, description of groups, roles
- Collaborative Learning Flow Patterns (CLFPs) [Hernández-Leo et al. 2007]
 - Examples of macros-scripts, reflect best practices
 - Repetitively used macro scripts [Hernández-Leo et al. 2007]



CLFP Examples (1)

➤ Jigsaw CLFP

- Students face resolution of a complex problem/task that can be easily divided into sections or independent sub-problems [Hernández-Leo et al. 2008]
 - Individual phase: study the given task individually
 - Expert groups: students who studied the same task work together
 - Jigsaw groups: students who have studied different tasks are grouped together



CLFP Examples (2)

➤ Pyramid/Snowball pattern

- Students face resolution of a complex problem/task, usually without a concrete solution, whose resolution implies the achievement of gradual consensus among all the participants [Hernández-Leo et al. 2008]
 - Propose initial solutions
 - Agreed solutions are shared with peers
 - Growing collaborations

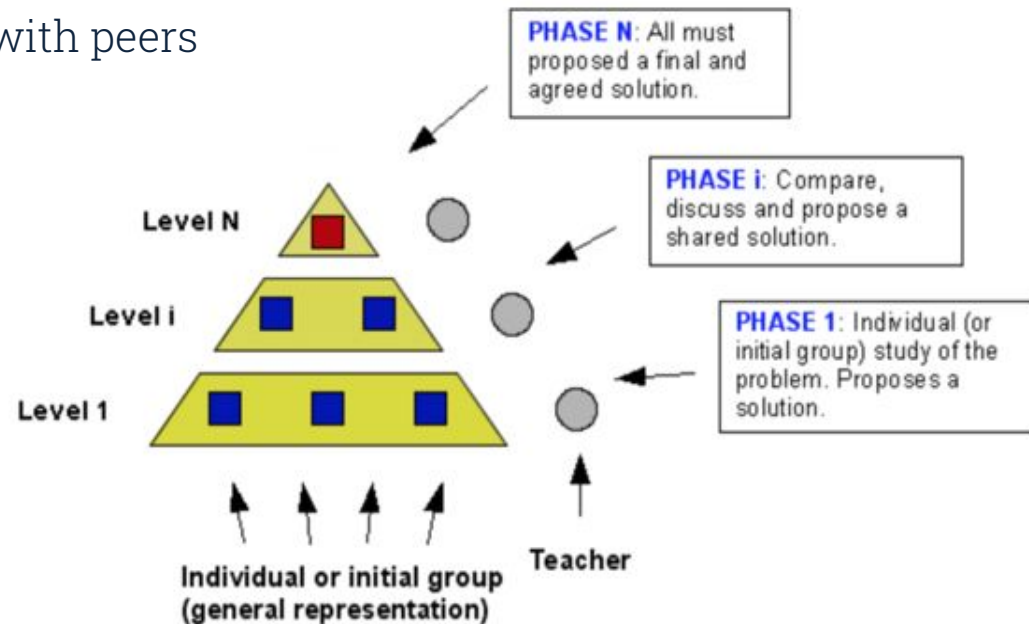


Fig. 2. Pyramid CLFP

Orchestration

- “How a teacher manages, in real time, **multi-layered** activities in a **multi-constraints** context” [Dillenbourg, 2013, p. 1]
 - Individual, group and class level activities
 - Curriculum, assessment, time, energy, space and safety constraints
- **Teacher-centrism** is a key feature
- Teachers as not the one of a *guide on the side* but rather as a **conductor**, who manages and drives the whole activity in a productive direction [Dillenbourg, 2013]
 - Monitoring the situation
 - Deciding what adaptations are necessary
 - Performing adaptations

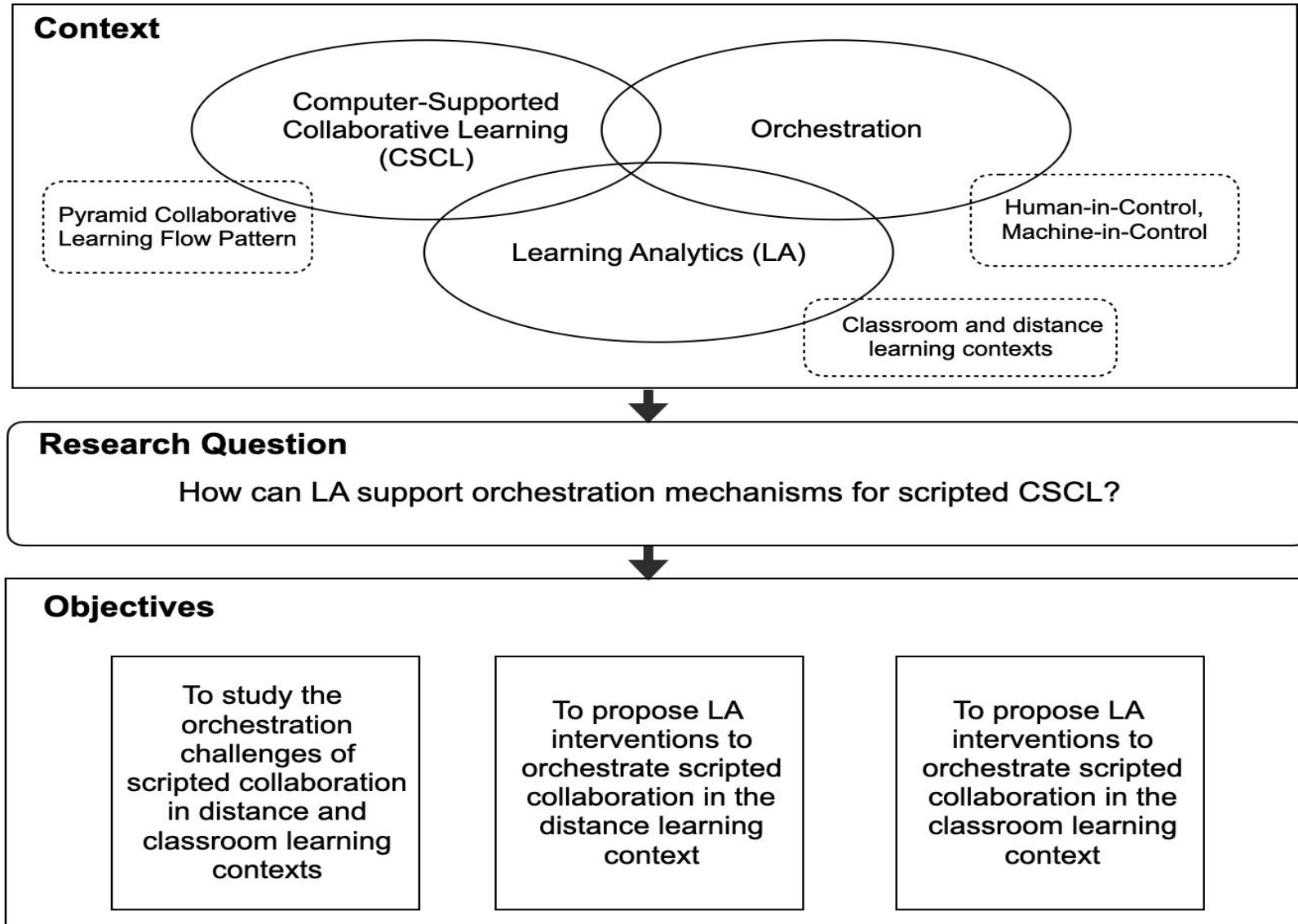


Learning Analytics (LA)

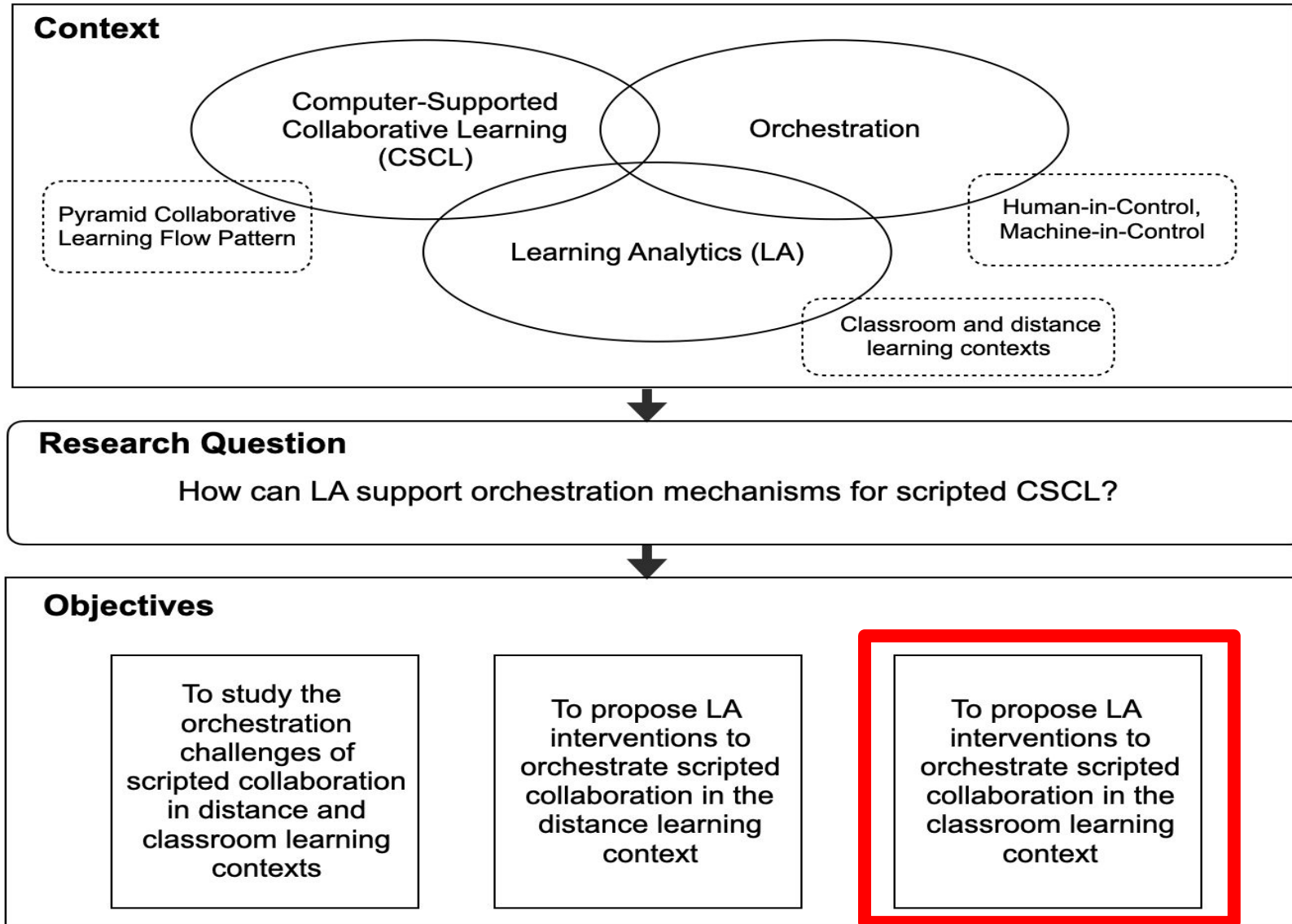
- “Measurement, collection, analysis and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environment in which it occurs” [Siemens and Gašević, 2012]
 - Influenced by a wide range of disciplines, e.g., learning sciences, machine learning, data mining, information visualisation and psychology [Sclater, Peasgood, & Mullan, 2016].
- Offers opportunities :
 - To heighten students’ awareness of their own learning outcomes [Dawson, 2006; Coffrin et al, 2014]
 - To enhance teaching practices [Dyckhoff, 2013]
- CACL provides opportunities for LA with vast amount of digital data traces collected
- Capturing, analyzing and visualizing such data traces in real-time facilitates to obtain a deeper understanding of how collaboration evolves over time [Rodríguez-Triana, 2015]



Research Question & Objectives



Research Question & Objectives



Teachers' Adaptation of CSCL Scripts in the Classroom

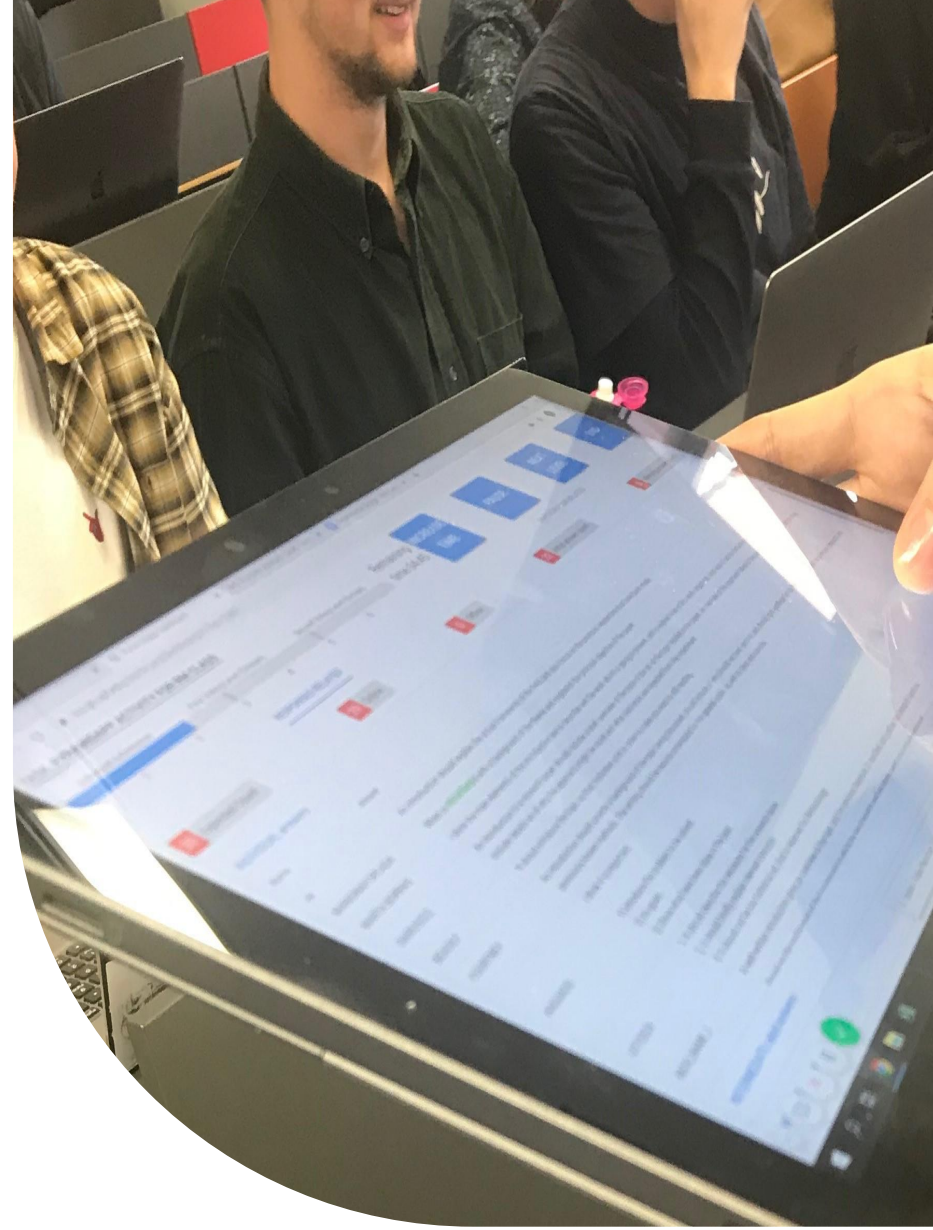
Supportive Technologies and Learning Analytics

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Study Context

- **LA Dashboards:** Single displays that aggregate different indicators about learner(s), learning process(es) and/or learning context(s) into one or multiple visualisations [Schwendimann et al., 2016]

Guiding support [Sollar et al., 2005]

Mirroring

- Present information
- Interpretation is upto the teacher

Alerting

- Present information & alerts
- Alerts highlight critical moments

Advising

- Present information & alerts
- Alerts highlight critical moments
- Provide further advice to take actions
- e.g., different ways to support students

[van Leeuwen et al., 2019]

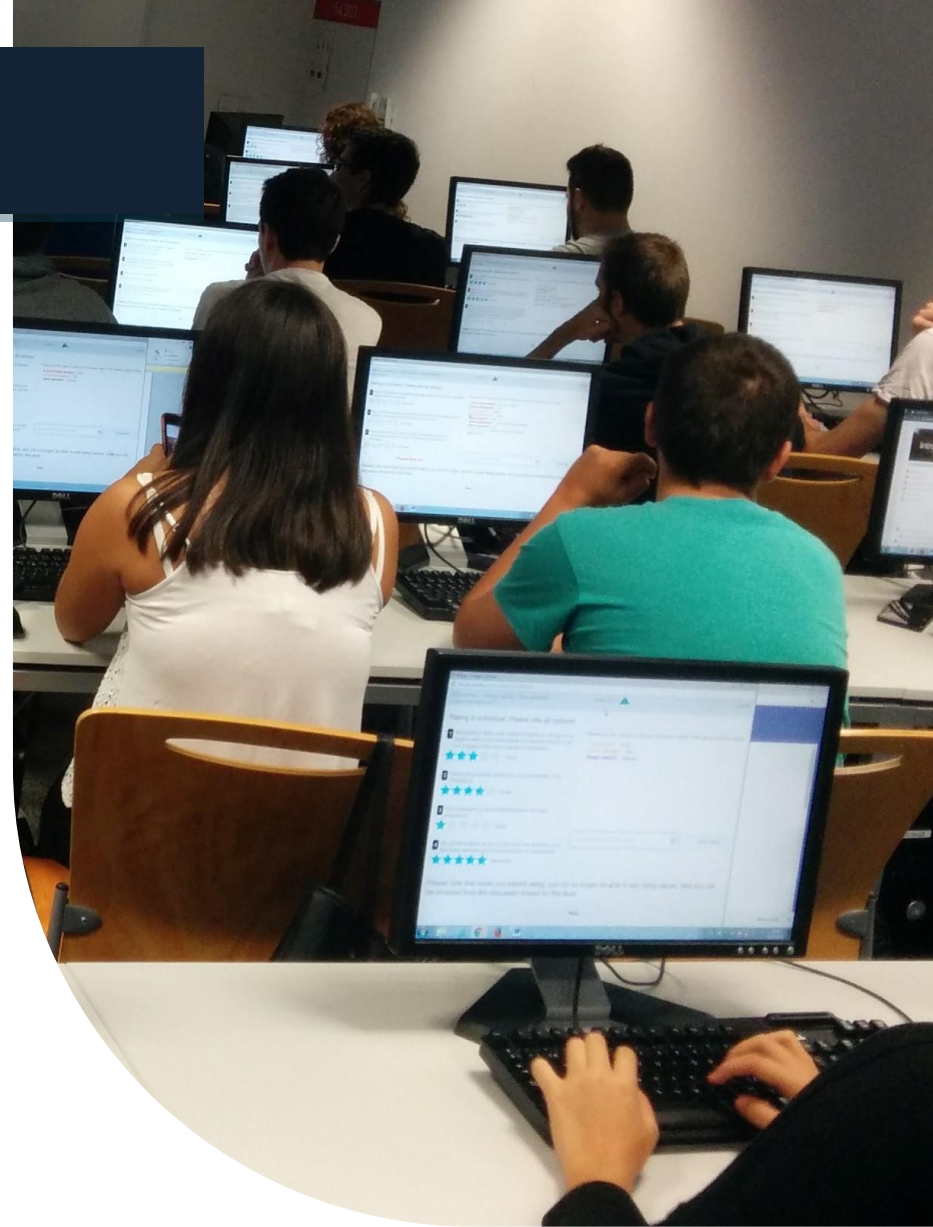
Related work

- Teachers **ability to act** given **different amounts of interpretational aids** in teacher-facing dashboards in **authentic CSCL situations** have not been fully explored yet [van Leeuwen *et al.*, 2019, Martinez-Maldonado 2019]
- Essential to understand how teachers make dashboard information actionable [Wise and Jung 2019]
- Facilitates to propose design guidelines for impactful solutions [Martinez-Maldonado 2019]

How do mirroring and guiding supports influence the orchestration actions of the teachers?

Methods

- Pyramid pattern based CSCL activities
 - Facilitate students towards a consensus following a Pyramid structure [Hernández-Leo et al., 2010]
- PyramidApp [Manathunga and Hernández-Leo 2018]
 - Individual answer submission phase
 - Group phases
 - Provides a voting mechanism & discussion spaces
- PyramidApp dashboard to orchestrate collaboration
- Six teachers & students in respective classes participated



PyramidApp Dashboard

TASK PYRAMIDAPP ACTIVITY FOR RM CLASS

Individual submission First Voting Level (Groups) Second Voting Level (Groups)

Remaining time 00:00

INCREASE TIME **PAUSE** **NEXT LEVEL** **END**

RESPONSES RELATED PARTICIPATION RELATED

15 Expected Count **0** Online **0** Offline **15** Initial answer count **2** Winning answer count

INDIVIDUAL answers

Names of the students	Answers
[Redacted]	If it provides information about what tools they used and how they find their resources and based on which criteria they decide to go for what tools and resource
[Redacted]	1. Datasets used are indicated, and if they could be publically available it is nice to footnote some links 2. Computational approach well described enough for the reader to follow, but not with an insane amount of details if there is another seminal paper that could be referenced 3. Evaluation methods mentioned.
[Redacted]	it needs to be clear and specific. Needs to give enough details to understand just which methods are used while doing this research. Should be related to study area, meaning not an unrelated method should be used.
[Redacted]	The methodology should describe all the methods that have been used in order to justify the results and also
[Redacted]	It mentions the problem that they want to solve, describe the methodology , describe the instrument of measurement..
[Redacted]	- Explain the dataset - variance, length, general characteristics - Algorithm theory and use of it in the dataset
[Redacted]	Numbered equations Logical ordering (chronological for example) Explicit on all detail Clear and concise Sections if needed Well referenced
[Redacted]	for me it should ask and be able to answer different questions. It should not repeat itself just without any reason, I appreciate the appropriate usage of details

INTERMEDIATE rated answers

WINNING answers

Methods Contd.

➤ Three conditions

- No Dashboard
- Mirroring condition
- Guiding condition
 - Highlighted the requirements for actions
 - Increase duration for script phases
 - Students skipping answer submission
 - No keywords detected in answers



Methods Contd.

TASK PYRAMIDAPP ACTIVITY FOR RM CLASS

Individual submission | First Voting Level (Groups) | Second Voting Level (Groups)

Remaining time 00:00

INCREASE TIME **PAUSE** **NEXT LEVEL** **END**

1 2 3 4 5 6 7 8

RESPONSES RELATED | PARTICIPATION RELATED

17 Expected Count | 0 Online | 0 Offline | 19 Initial answer count | 2 Winning answer count

INCREASE time for rating submission ✕

Increase Time 1 min

2 groups had not finished first-rating level yet!
Select how much time you would like to increase & click "OKAY" to increase time.
Click "CANCEL" to close the alert & proceed!

OKAY **CANCEL**

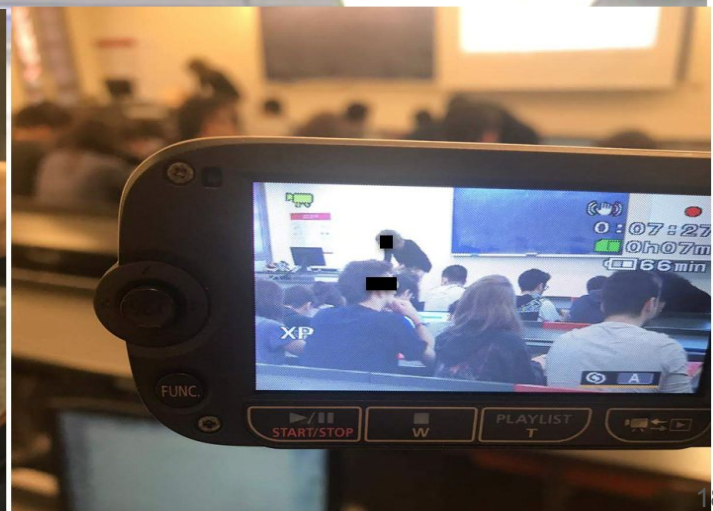
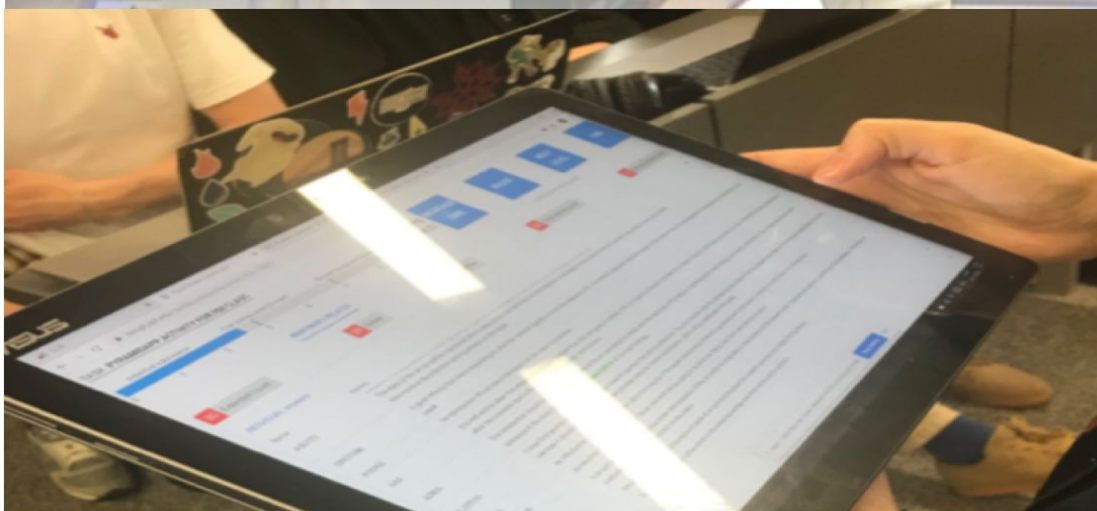
INDIVIDUAL answers

Name	Answer
AMORSI	<ul style="list-style-type: none">- should contextualize the- should have a some of- should provide the auth- should explain paper or- evaluation strategy- should go in some deta
CLOTHILDEB	The introduction should Balance should be found the importance of your own paper. As for any part of a research paper, the introduction should be clear and concise.
GHASEM	If it provide a good explanation to the subject and clear the path it wanna go during the paper and maybe by drwaing the whole idea
HAMIT	Introduction should be compatible with the structure of the article. Reader may want to learn very briefly about input information or ideas, methods that are being used and results that are obtained according to all content of the paper. Introduction should retrieve readers attraction and lead him/her to learn more about the topic. This is, however, come true by using hook sentences, samples from findings etc.

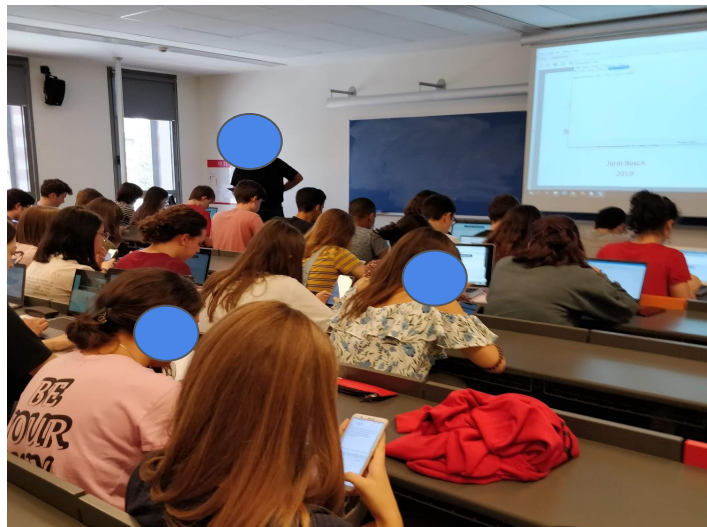
INTERMEDIATE rated answers

WINNING answers

Methods Contd.



Iteration 1 - Results & Conclusions



Ethics Approval

Project: SmartLET-UPF: Learning Analytics to Enhance the Design and Orchestration in Scalable, IoT-Enriched, and Ubiquitous Smart Learning

Principal Investigator: Davinia Hernández

Department: Department of Information and Communication Technologies

CIREP approval number: 129

Date of approval: 09.01.2020

The Institutional Committee for Ethical Review of Projects (CIREP) at Universitat Pompeu Fabra has reviewed the application for ethics approval submitted for the above-mentioned project *SmartLET-UPF: Learning Analytics to Enhance the Design and Orchestration in Scalable, IoT-Enriched, and Ubiquitous Smart Learning* following the procedure described in the CIREP protocol: www.upf.edu/web/cirep/procedure.

CIREP has assessed the project with respect to:

- the internationally accepted *ethical principles in research involving humans*: avoidance of exploitation, fair distribution of benefits and burden, beneficence, respect for persons, respect for human dignity, scientific validity, social value, the rights and interests of research participants;
- personal data protection*, guided by Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

The project has been **approved** by CIREP as it is in compliance of the above-mentioned principles and regulations.

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Enric Vallduví
CIREP President
Institutional Committee for Ethical Review of Projects
Research Service
Ciutadella Campus
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08005 Barcelona
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Coding Scheme

- Initially 19 codes
- Refined later to include only the observable behaviours
- Two researchers coded the dataset (Cohen's kappa = 0.96, $p < 0.005$)

Code	Definition
Teacher Individual Interaction	Teacher responds/answer to specific questions raised by individual students (unidirectional)
Teacher Class Interaction	This code captures the bidirectional interactions between teachers and the whole class. Examples: <ul style="list-style-type: none">- Surveying- Giving directions- Debriefing- Criticizing
Announcements to Class	Teacher makes announcements to the class regarding: <ul style="list-style-type: none">- Time availability- Phase transitions of the script- Student participation in the activity
Teacher Perception	This includes the following two behaviors: <ul style="list-style-type: none">- Teacher is looking at individual student devices (e.g., mobile or desktop monitors)- Teacher is looking at the task projection

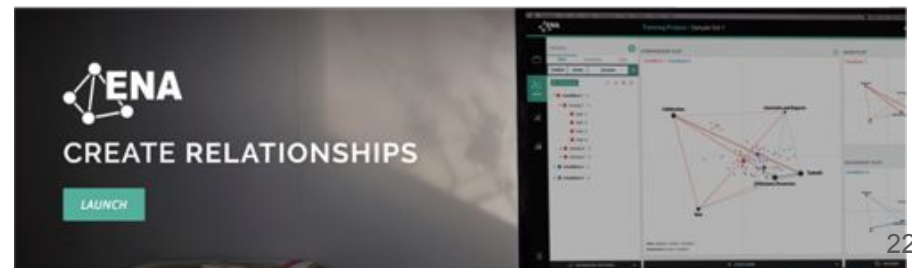
Coding Scheme Contd.

Code	Definition
Check Responses Tab	<p>This code summarises the following actions by the teacher within the <i>Responses</i> Tab of the Dashboard:</p> <ul style="list-style-type: none"> - Scrolling answers received from individual students - Scrolling highly rated answers at the group level - Checking other statistics presented in the "Response Tab" (e.g.online & offline counts, number of answers etc.)
Check Participation Tab	<p>This code summarises the following actions by the teacher within the <i>Participation</i> Tab of the Dashboard:</p> <ul style="list-style-type: none"> - Checking information related to satisfactory and unsatisfactory voting participation of groups - Opening a particular group box and scrolling the chat messages posted by the students - Opening a particular group box and checking the names of the group members
Dashboard Interventions	<p>This code summarises the following dashboard interventions by the teacher:</p> <ul style="list-style-type: none"> - Posting messages to groups - Use of <i>Next Level</i> control - Use of <i>Increase time</i> control - Use of <i>End</i> button to end the collaborative learning activity before reaching the end of planned time - Use of <i>Pause</i> button to pause the script

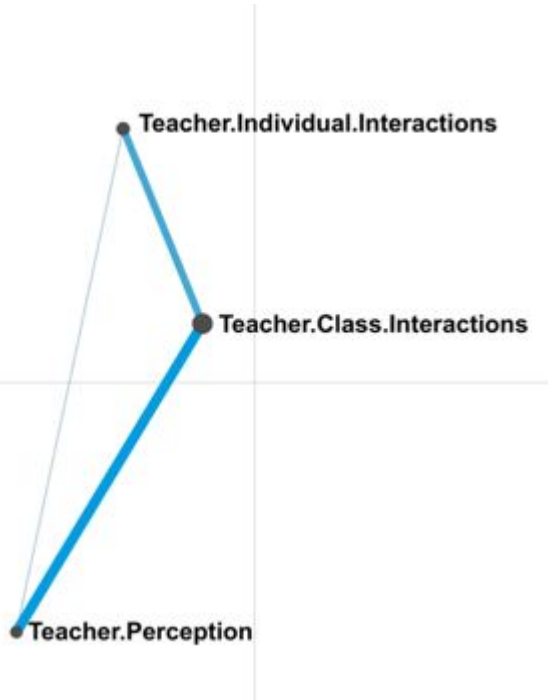
Epistemic Network Analysis (ENA)

- Coded data was modeled using ENA techniques
- ENA [Shaffer 2018]
 - Quantifies the connections among codes in discourse data
 - Visualises the structure of connections using dynamic network models
 - Takes into account the temporality in discourse data
 - Alleviates limitations in frequency-based measures, i.e., coding-and-counting [Saint et al. 2020; Csanadi et al. 2018, Reimann,2009].
- ENA is appropriate for our modeling task:
 - Takes into account the temporality of teachers actions
 - Provide insights into how different actions relate to one another
 - Visualisation of the structure of co-occurrences facilitate identifying action patterns
 - Allow to quantitatively compare the action differences between different conditions

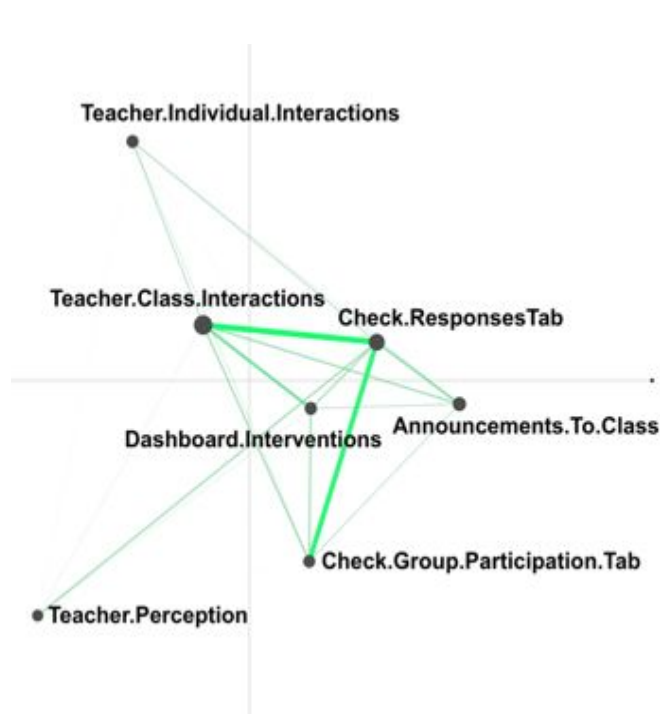
www.epistemicnetwork.org



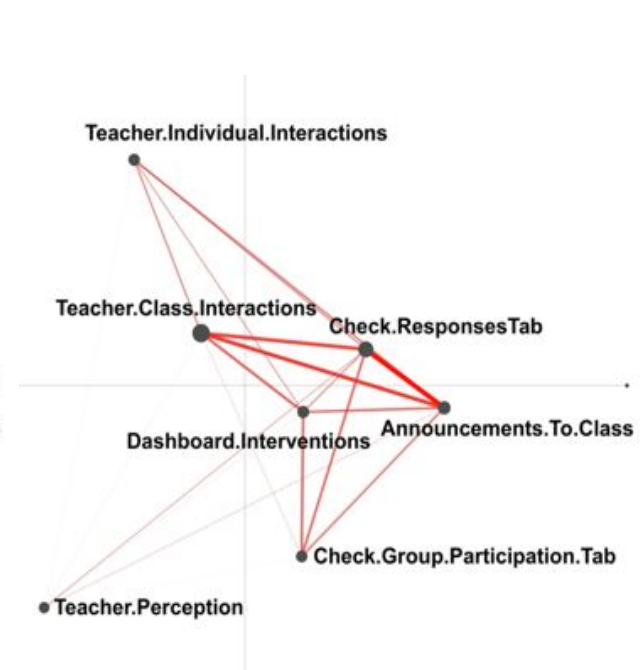
ENA Analysis - Results



No Dashboard Condition



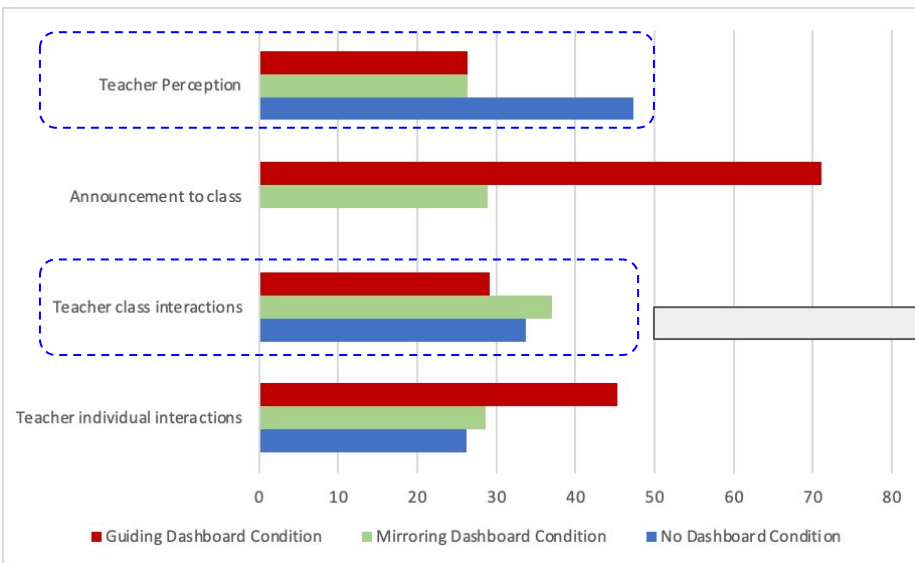
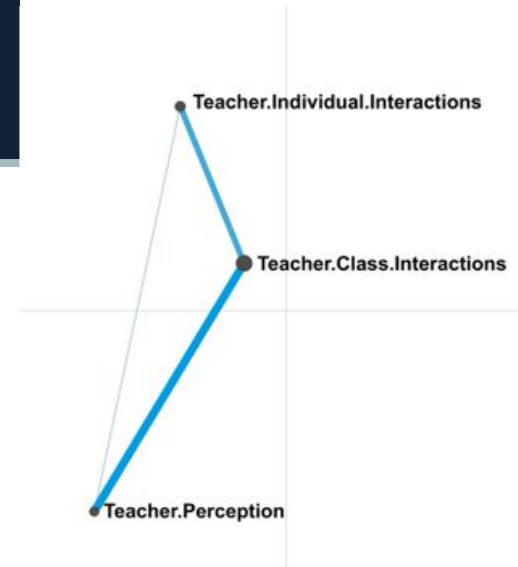
Mirroring Condition



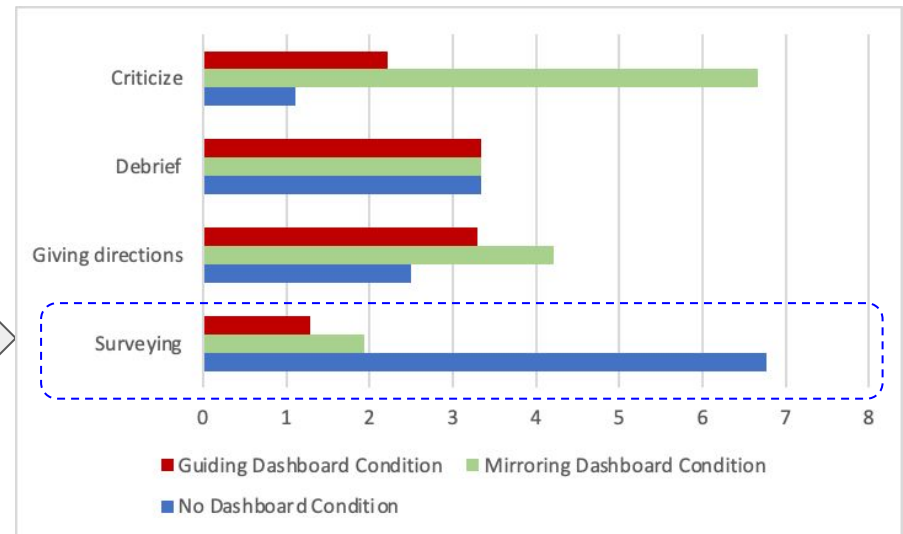
Guiding Condition

Discussion - No Dashboard

- Frequent codes- Teacher perception, class interactions
 - Trying to understand collaboration via surveying
- Absent code - announcements to class
 - Post-activity questionnaire responses:
 - "Very difficult to obtain the whole picture..I was stressed regarding the planned time as some students were taking more time and frustrated for not having means to control the script progressions "*



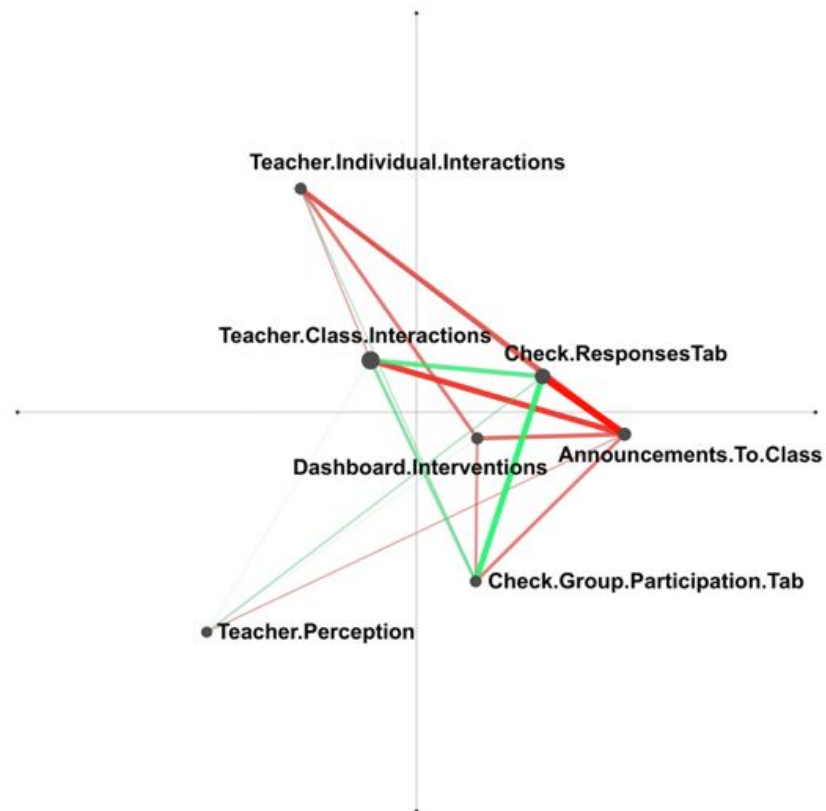
Teachers actions across the three conditions



Teacher Class Interactions Details

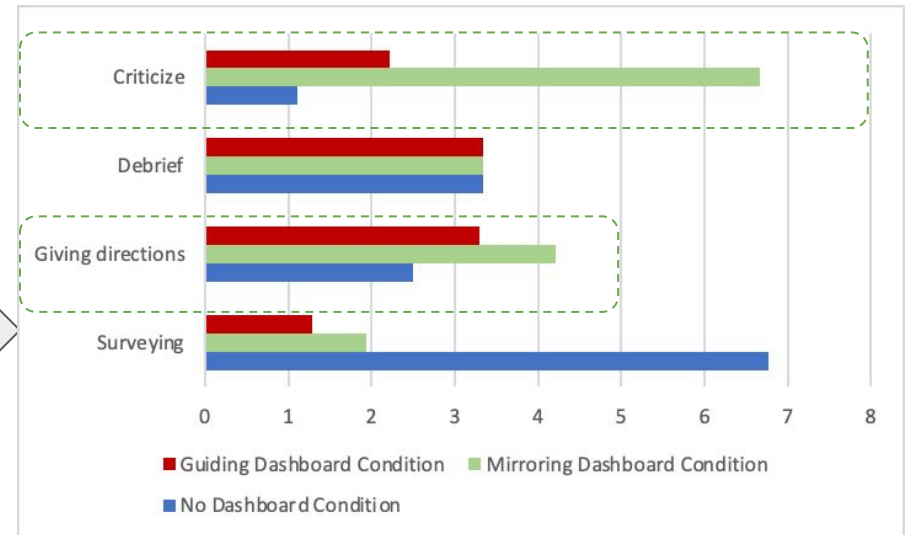
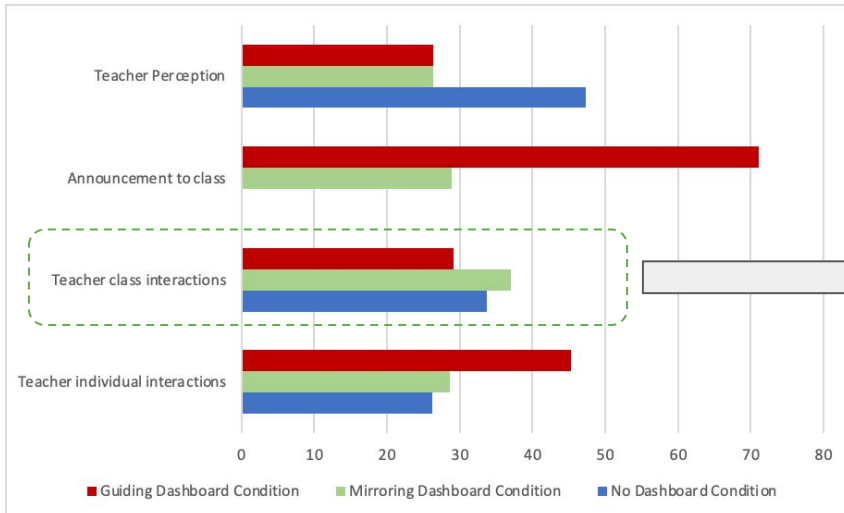
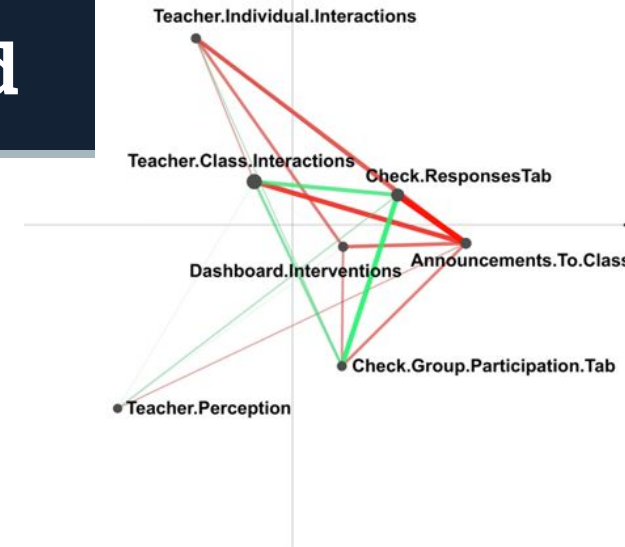
ENA Analysis - Subtracted Network

- Subtracting the mean connection strengths of the two networks
- Each line is coloured to indicate which of the two networks contains the stronger connection



Discussion - Mirroring Dashboard

- More class interactions when compared to the guiding condition
 - Increased teacher class interactions in the forms of giving directions and criticizing lack of participation

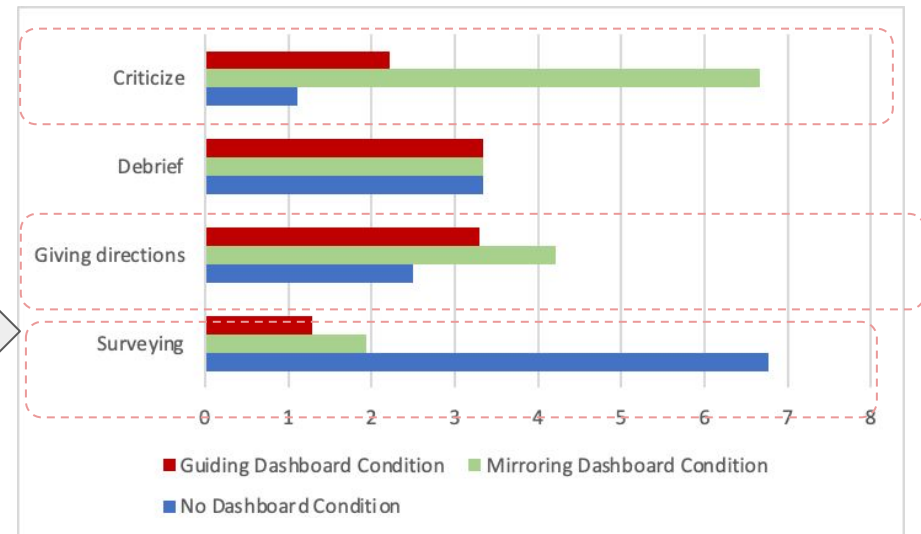
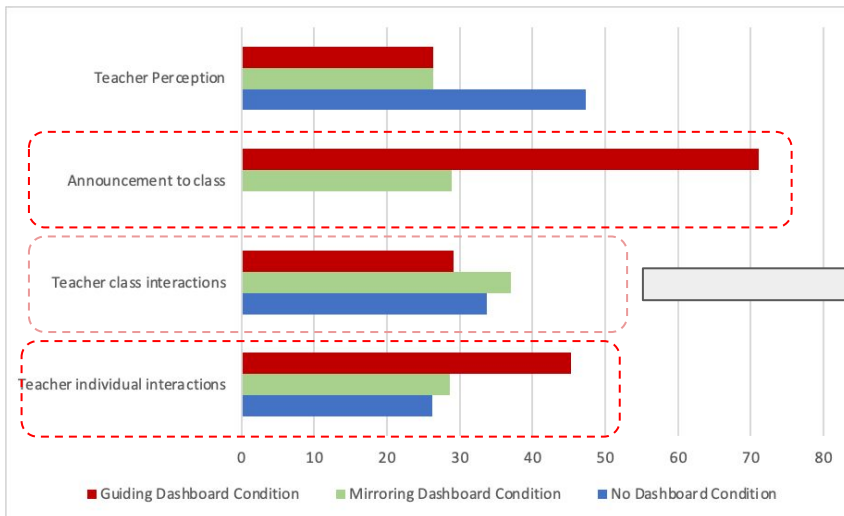
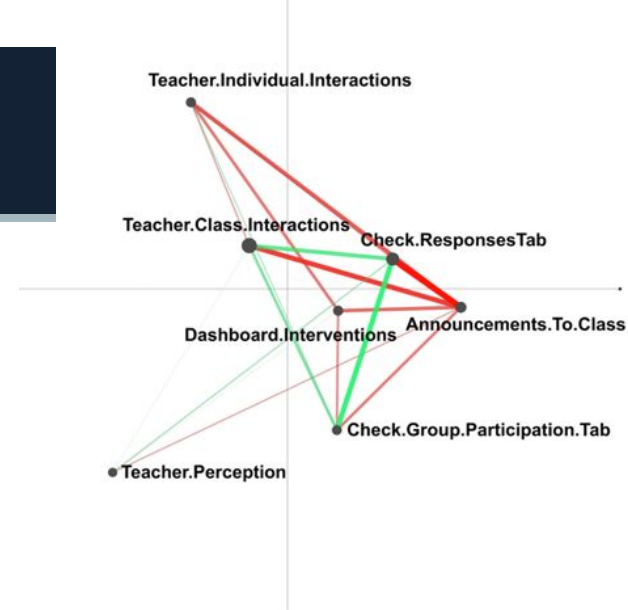


Teachers actions across the three conditions

Teacher Class Interactions Details

Discussion - Guiding Dashboard

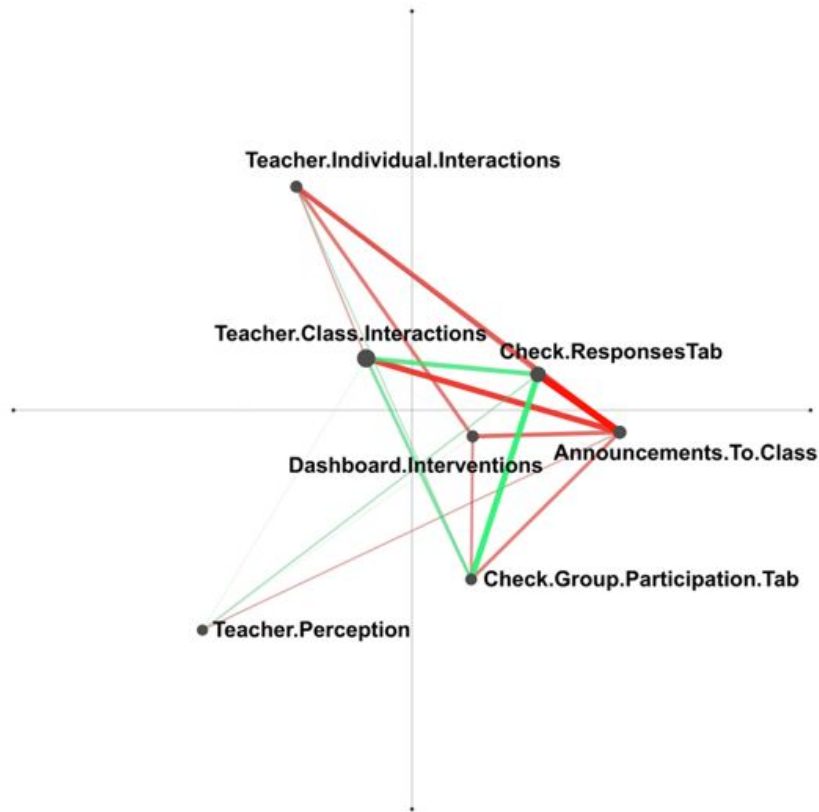
- Less class interactions when compared to the mirroring condition
 - Lack of criticism, surveying and directions
- More individual interactions
- More announcements to the class
- Log data indicated increased targeted interactions at the group level
 - teachers engaged in direct communication with problematic groups by posting messages



Teachers actions across the three conditions

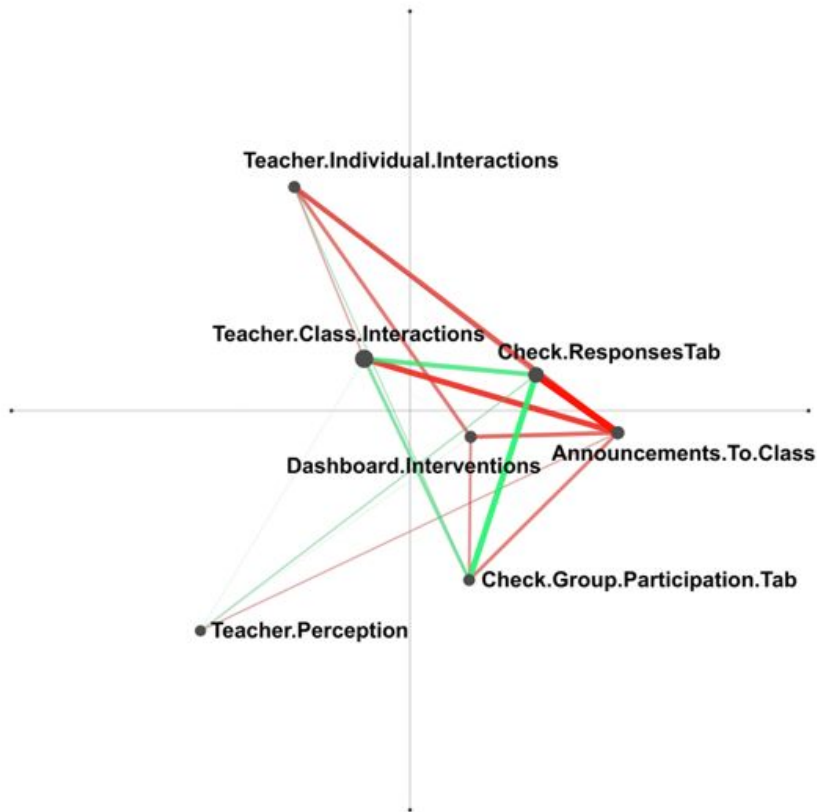
Teacher Class Interactions Details

ENA Analysis Contd.



- Announcements To Class
- Guiding condition
 - 54 announcements in total
 - 10 announcements about time
 - 11 about script phase transitions
 - 33 about students activity participation
- Mirroring condition
 - 22 announcements in total
 - 5 announcements about time
 - 10 about script phase transitions
 - 7 about participation.

ENA Analysis Contd.



- Dashboard Interventions
- Guiding Condition
 - Self-directed actions: 21
 - In-response to alerts: 12
- Mirroring Condition
 - Self-directed actions: 16

Conclusions

- Mirroring Condition
 - Mostly engaged in sense- making of the information presented in the dashboard
 - Led to interactions with students at the level of the class
 - Provide directions
 - Criticising lack of participation
 - Post-activity questionnaire responses
 - Concerned on one aspect of collaboration, e.g., quality of students answers, missed chances of reacting to other aspects of the activity, e.g., increasing the duration

“ In occasions I was concentrated on one aspect (e.g. reading their answers) and, even now that I was more familiar with the dashboard, I could not pay attention to other aspects in the dashboard (progress in the participation), so I missed elements to which I could have reacted, like adding more time in some phases”.

Conclusions Contd.

- Guiding Condition
 - Mostly used information to make announcements to the class
 - E.g., time available for collaboration, script progressions, participation
 - More targeted interventions at the individual & group level
 - More interventions
 - Post-activity questionnaire responses:
 - Alerts helped to upfront critical moments reducing the workload
 - Facilitated script redesign according to the needs

"I really felt I was in control. I could concentrate on those elements that interested me more (reading students' answers to identify misconceptions or issues of interest for later discussion). Even if I was not paying attention to activity participation and progression, the dashboard alerted me of critical moments in this respect"

- Reaction to alerts also depend on the constraints of the classroom

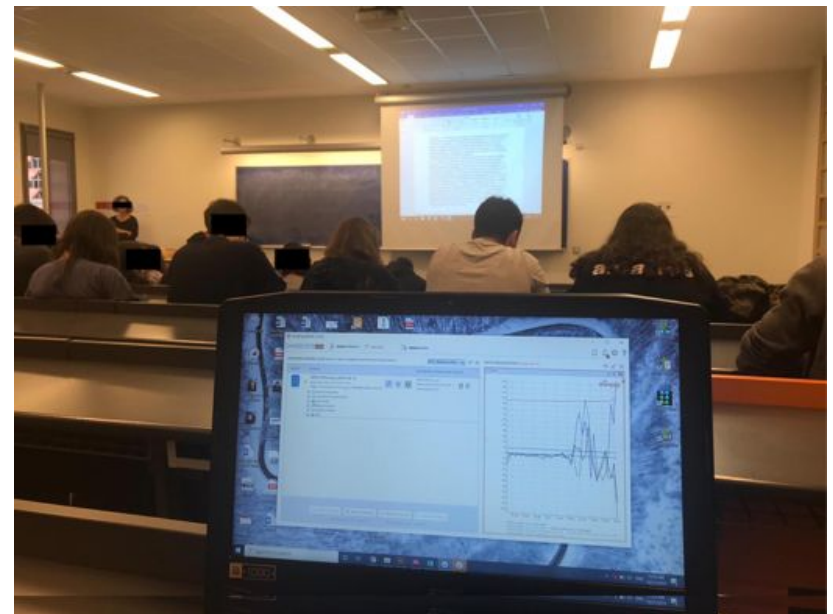
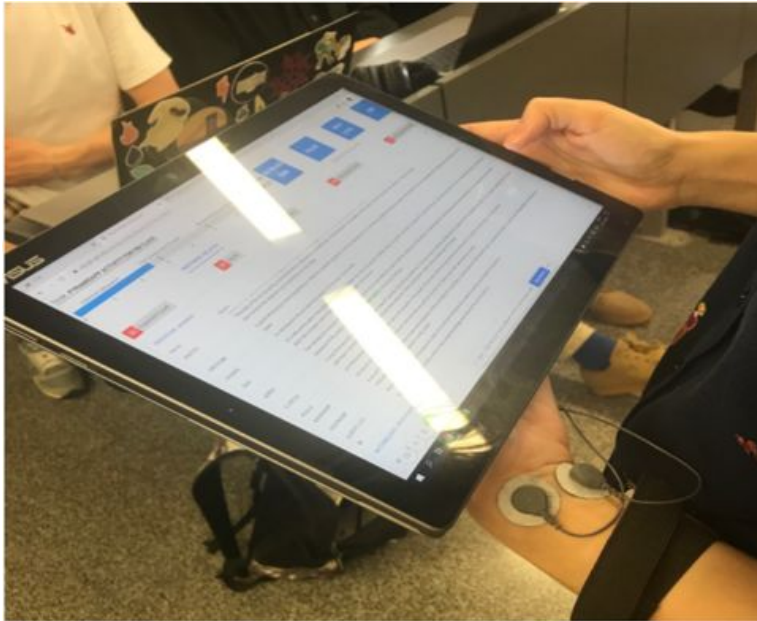
"I decided to react to some of them, depending on other aspects of the context (like the overall time I could use for this activity). It is surprising that this happened to me even in a small group class. So, I guess this would be even more critical in larger classrooms"

- Receiving alerts about known information did not add value

"Sometimes, I was carefully paying attention to dashboard information about activity progression, and I felt the alerts were a bit annoying – as offering information I already knew"

Future work

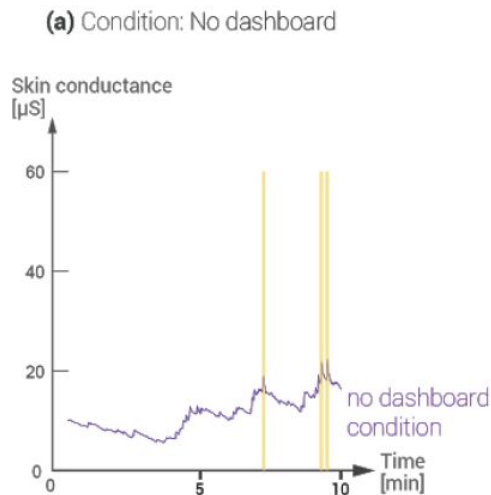
- Perceived cognitive load on average, reflecting the effort of orchestrating collaboration on a scale from 1 to 20 (1 low and 20 high)
 - Guiding dashboard condition: 6.2 (SD=3.27)
 - No dashboard condition: 5.6 (SD=5.54)
 - Mirroring dashboard condition: 5.4 (SD=2.7)



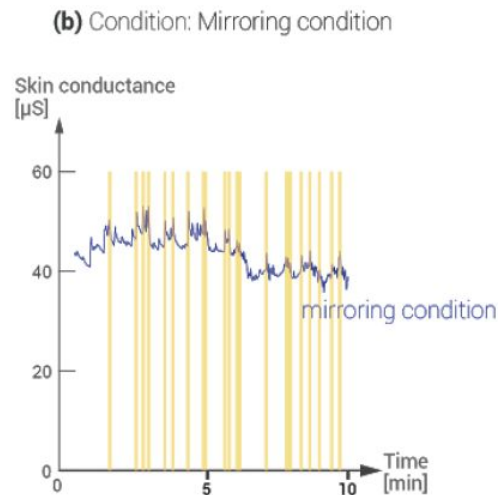
Amarasinghe, I., Hernández-Leo, D., Michos, K., & Vujovic, M. (2020). An actionable orchestration dashboard to enhance collaboration in the classroom. *IEEE Transactions on Learning Technologies*. doi: 10.1109/TLT.2020.3028597 (Early Access)

Future work Contd.

- Novel tracking technologies to measure orchestration load
 - Physiological - EDA (also known as galvanic skin response - GSR) data
 - Presence of peaks (Physiological response) in graphs imply changes in the affective state of the teacher
 - Inferred that the EDA signal shows that arousal which could be related to frustration

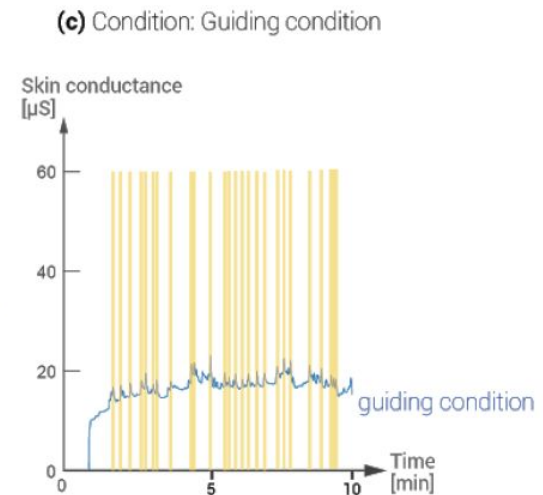


Number of peaks and skin conductivity increases towards the end of the activity



Physiological state changes over time declines towards the end

E.g. thinking and making decisions at the beginnings was demanding at first



More constant state

E.g., Comfortable and in control

References

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