I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During my fellowship, I had the opportunity to conduct several experiments and to write papers (see next section) based on the data collected from these experiments. Following experiments were conducted to understand the relation between the physiological and interaction, multimodal data (Eye-tracking, EEG, blood volume pressure, heart rate, electrodermal activity, facial features, keystrokes, audio data) and the performance of the learners in the given specific task:


Apart from the above-mentioned experiments, I have participated in numerous formal and informal discussions with colleagues at the Computer Science Department at NTNU, which I consider very helpful in not only designing and analysing the experiment but also in progressing my professional and personal paths.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Published Journals

This paper describes a promising methodology for studying co-located groups: mobile eye-trackers. We provide a comprehensive description of our data collection and analysis processes so that other researchers can take
advantage of this cutting-edge technology. Data were collected in a controlled experiment where 27 student dyads (N = 54) interacted with a Tangible User Interface. They first had to define some design principles for optimizing a warehouse layout by analyzing a set of Contrasting Cases, and build a small-scale layout based on those principles. The contributions of this paper are that: 1) we replicated prior research showing that levels of Joint Visual Attention (JVA) are correlated with collaboration quality across all groups; 2) we then qualitatively analyzed two dyads with high levels of JVA and show that it can hide a free-rider effect (Salomon and Globerson 1989); 3) in conducting this analysis, we additionally developed a new visualization (augmented cross-recurrence graphs) that allows researchers to distinguish between high JVA groups that have balanced and unbalanced levels of participations; 4) finally, we generalized this effect to the entire sample and found a significant negative correlation between dyads’ learning gains and unbalanced levels of participation (as computed from the eye-tracking data). We conclude by discussing implications for automatically analyzing students’ interactions using dual eye-trackers.


The pedagogical modelling of everyday classroom practice is an interesting kind of evidence, both for educational research and teachers' own professional development. This paper explores the usage of wearable sensors and machine learning techniques to automatically extract orchestration graphs (teaching activities and their social plane over time) on a dataset of 12 classroom sessions enacted by two different teachers in different classroom settings. The dataset included mobile eye-tracking as well as audiovisual and accelerometry data from sensors worn by the teacher. We evaluated both time-independent and time-aware models, achieving median F1 scores of about 0.7–0.8 on leave-one-session-out k-fold cross-validation. Although these results show the feasibility of this approach, they also highlight the need for larger datasets, recorded in a wider variety of classroom settings, to provide automated tagging of classroom practice that can be used in everyday practice across multiple teachers.


Orchestration load is the effort a teacher spends in coordinating multiple activities and learning processes. It has been proposed as a construct to evaluate the usability of learning technologies at the classroom level, in the same way that cognitive load is used as a measure of usability at the individual level. However, so far this notion has remained abstract. In order to ground orchestration load in empirical evidence and study it in a more systematic and detailed manner, we propose a method to quantify it, based on physiological data (concretely, mobile eye-tracking measures), along with human-coded behavioral data. This paper presents the results of applying this method to four exploratory case studies, where four teachers orchestrated technology-enhanced face-to-face lessons with primary, secondary school, and university students. The data from these studies provide a first validation of this method in different conditions, and illustrate how it can be used to understand the effect of different classroom factors on orchestration load. From these studies, we also extract empirical insights about classroom orchestration using technology.


Computational thinking and coding for children are attracting increasing attention. There are several efforts around the globe to implement coding frameworks for children, and there is a need to develop an empirical knowledge base of methods and tools. One major problem for integrating study results into a common body of knowledge is the relatively limited measurements applied, and the relation of the widely used self-reporting methods with more objective measurements, such as biophysical ones. In this study, eye-tracking activity was used to measure children’s learning and activity indicators. The goal of the study is to utilize eye-tracking to understand children’s activity while they learn how to code and to investigate any potential association between children’s attitudes and their gaze. In this contribution, we designed an experiment with 44 children (between 8 and 17 years old) who participated in a full-day construction-based coding activity. We recorded their gaze while they were working and captured their attitudes in relation to their learning, excitement and intention. The results showed a significant relation between children’s attitudes (what they think about coding) and their gaze patterns (how they behaved during coding). Eye-tracking data provide initial insights into the behaviour of children, for example if children have difficulty in extracting information or fail to accomplish an expected task. Therefore, further studies need to be conducted to shed additional light on children’s experience and learning during coding.

We analyse eye-tracking data to understand how people collaborate. Our dataset consists of time series of measurements for eye movements, such as spatial entropy, calculated for each subject during an experiment when several pairs of participants collaborate to accomplish a task. We observe that pairs with high collaboration quality obtain their highest values of concentration (or equivalently lowest values of spatial entropy) occurring simultaneously. In this paper, we propose a flexible model that describes the tail dependence structure between two subjects’ entropy when the pair is collaborating. More generally, we develop a generalized additive model (GAM) framework for tail dependence coefficients in the presence of covariates. As for any GAM-type model, the methodology can be used to predict collaboration quality or to explore how joint concentration depends on other cognitive operations and varies over time.

Published Conferences

Submitted
1. Coding activities for children: Coupling eye-tracking with qualitative data to investigate gender differences (Accepted with minor revisions) Computers in Human Behaviour Papavlasopoulou, S., Sharma K., Giannakos, M.
2. Utilising interactive surfaces to enhance learning, collaboration and engagement: Insights from learners’ gaze (Under review Round 2) Journal of Computer Supported Collaborative learning Sharma. K, Leftheriotis I., Giannakos M.

Work in progress
1. Building Pipelines for Educational Data: Using AI and Multimodal Analytics to Explain Learning in Adaptive Self-Assessment (British Journal of Educational Technology)
3. An fsQCA approach to explain learners (IEEE Transactions on Learning Technologies)
5. Gaze-Driven Design to Enhance Learning Experience: Advancing the Intermediate-Level Knowledge Basis (Transactions on Computer Human Interaction)
6. Teaching How to Look: Displaying Teacher’s Gaze in MOOC Style Videos (Journal of Computer Assisted Learning)
7. A New Lens for Looking at MOOC Data to Predict Student Performance (Journal of Internet and Higher Education)

III – ATTENDED SEMINARS, WORKSHOPS, CONFERENCES
1. FabLearn, Trondheim, Norway, 18th June 2018.

IV – RESEARCH EXCHANGE PROGRAMME (REP)
For my REP, I chose to go to the “Centrum Wiskunde and Informatica” (CWI) Amsterdam. At CWI I visited the Distributed and Interactive Systems group led by Dr. Pablo Cesar. There I had detailed meetings with Dr. Cesar and his team, especially with Dr. Abdallah El Ali. I also gave a talk about my research titled “Looking through versus Looking at: Exploring gaze patterns while problem solving”. We have planned one collaborative experiment with multimodal sensors and capturing the affective state of the learners in individual and collaborative settings. The main research questions to be answered using this experiment are:
1. Can we profile learners based on individual physiological patterns?
2. Do specific individual physiological patterns correlate with the personality factors given by Big 5 traits? Can we predict those traits from physiological data?

The planned task is to require learners watch a video individually and then collaboratively create a concept map about what they learned in the video lecture. The findings of this experiment are planned to be submitted in the International journal of Mobile, Wearable, and Ubiquitous Technology mid next year.