# Measuring and supporting students' self-regulated learning in adaptive educational technologies

## FOUNDING: 30 September 2015

### E-CIR SCOPE

Even though the recent influx of tablets with learning technologies in European education is promising, the challenge lies in improving adaptive educational technologies to support students' self-regulated learning. These technologies offer immediate individualized instruction including personalized feedback from real-time data of learner actions and performance. Driven by the emerging field of learning analytics, these technologies seek to tailor learning experiences based on learners' progress through the measurement, collection, analysis and reporting of multi-modal cognitive, metacognitive, affective, and motivational data.

Current adaptive educational technologies focus on students' performance (cognition) to adapt learning materials and largely neglect important aspects, such as students' metacognition, emotion and motivation. However, multimodality online trace data such as log-files, eye gaze behaviours, transpiration, facial expressions of emotions, heart rate and electro-dermal activity can enhance our understanding of students' processes during learning (Azevedo, 2014). For example, eye gaze data reveals the learners' focus at different points of time and is indicative of the level of cognitive load (van Meeuwen et al., 2014). Measurement of transpiration, heart rate and skin galvanic conductivity reveals emotional reactions (McCraty et al., 1995). More specifically, combining multi-modal data can reveal both cognitive and affective states of the learner and can detect arousal levels and the valence of emotional reactions (Azevedo, 2015). In a learning situation, students are confronted with a variety of cognitive challenges (e.g. lack of prior knowledge, task difficulty) which can result in emotional reactions (e.g. frustration, boredom). Therefore, it is important to develop our understanding of multimodal data that unobtrusively capture cognitive, metacognitive, affective and motivational states of learners over time.

This demands for a concerted interdisciplinary dialogue combining findings from psychology and educational sciences with advances in computer sciences and artificial intelligence. The participants in this E-CIR are leading international researchers who have articulated different emerging perspectives and methodologies to measure cognition, metacognition, motivation and emotions during learning. The participants recognize the need for intensive collaboration to accelerate progress with new interdisciplinary methods to develop more powerful adaptive educational technologies.

To guide our E-CIR, we outline two research questions:

1.  How can we analyze multimodal, trace data from existing adaptive educational technologies using different channels (e.g., verbalization, phsysiology) to measure students' cognitive, metacognitive, emotions and motivation during learning?
2.  How can these measurements be used to enhance current adaptive learning technologies supporting learners' self-regualted learning through visualisation and recommendation tools?

**Dr. Inge Molenaar** has a master degrees in both Cognitive Psychology and International business. She received her PhD in educational sciences at the University of Amsterdam, and currently is an assistant professor at the Learning & Plasticity group of the Behavioural Science Institute at Radboud University Nijmegen. Her main interests are technology empowered innovation in education that facilitate students' talent development. Her research focuses on the application of data from online learning environments, apps and games (learning analytics) in understanding how regulation of learning unfolds over time. Temporal analyses offer a powerful way to make new steps towards innovative learning designs. In this respect, it is relevant to note that Inge Molenaar was a guest editor of a recent special issue in Metacogntion and Learning about the temporal and sequential characteristics of self and socially regulated learning. She is a member of the editorial board of metacognition and learning and has received several grants from the Dutch Science Foundation, the European Union and several national bodies. Relevant for the current project are her research on developing intelligent tutors (Atgentive, EU project) for adaptive scaffolding of self-regulated learning. She (co)supervises various PhD and master projects related to the current proposal.

**Dr. Sanna Järvelä** is a professor in the field of learning and educational technology and a head of the Learning and Educational Technology Research Unit (LET) in the Department of Educational Sciences, University of Oulu. Her main research interest deal with learning processes in TEL, self-regulated learning and CSCL. Järvelä and her research group is internationally well known from theoretical advancement of motivation as a contextual phenomena and of social aspects of self-regulated learning. Her research work has also strong contribution to the process oriented methodological development in the field of learning, collaboration and motivation. Järvelä has been an associate editor of Learning and Instruction (2010-2014) and currently an Editor of Frontline Learning Research and Associate Editor in the ijCSCL, as well as editorial board member in several scientific journals. Järvelä has published more than 90 scientific papers in international refereed journals and about 50 book chapters and three edited books. She has also supervised 11 finalized PhD. She has been a member of Executive Committee of EARLI (2010-2014) and she is currently a member of Oulu University Governing Board. In the Oulu University 2014 Research Assessment Evaluation her research group LET was ranked 5.5/6 in the highest vici category.

**Dr. Maria Bannert** research area is educational psychology with a focus on instructional media. Current research activities comprise issues the analysis of self-regulated individual and group learning processes and their instructional support by means of ICT. In particular, she is investigating meta-cognitive and motivational-volitional support measures in order to improve student's self-regulated learning and problem solving. One focus is the assessment of SRL-processes by multi-dimensional online-measures (e.g. think-aloud data, logfiles, and recently eye-tracking and physiological data) and their temporal analysis to develop further SRL theories and instructional support. She has extensive teaching and research experience and is responsible for a number of research and developmental projects. Besides, she is a consultant in e-learning projects and involved in a number of research and R&D projects. She has published about 80 scientific articles, written seven books and co-edited six books and special issues. She was Assistant Editor of Learning & Instruction (2002-2003) and is currently on the editorial board of Metacognition and Learning and Research and Practice in Technology Enhanced Learning. She held the chair in Educational Media at the Chemnitz University of Technology from 2005-2011. Since 2011, she holds the chair in Instructional Media at the University of Wuerzburg, Germany.

**Dr. Roger Azevedo** is a Professor of Psychology in the area of Human Factors and Applied Cognition and Associated faculty in the Department of Computer Science at North Carolina State University. His research examines the role of cognitive, affective, metacognitive, and motivational (CAMM) self-regulatory processes with advanced learning technologies. His overarching research goal is to understand the complex interactions between humans and intelligent systems by using interdisciplinary methods to measure and analyse CAMM processes and their impact on learning, performance, and transfer. To accomplish this goal, he conducts laboratory, classroom, and in-situ studies and collects multi-channel data to develop models of human-computer interaction; examines the nature of temporally unfolding self- and other-regulatory processes (e.g., human-artificial agents); and, designs intelligent learning systems to detect, track, model, and foster learners self-regulatory processes. He has published over 200 peer-reviewed papers, chapters, and refereed conference proceedings in the areas of educational, learning, cognitive, and computational sciences. He is the editor of the Metacognition and Learning journal and also serves on the editorial board of several top-tiered learning science journals. He is also serves as a senior program committee member of several international conferences (e.g., International Conference on AI in Education, Intelligent Tutoring Systems). His research is funded by the National Science Foundation and the Institute of Education Sciences. He is a fellow of the American Psychological Association and the recipient of the prestigious Early Faculty Career Award from the National Science Foundation.

**Dr. Dragan Gasevic** is a Professor and Chair in Learning Analytics and Informatics in the Schools of Education and Informatics at the University of Edinburgh. His research centres on the development of methods for measurement and enhancement of self-regulated and social learning processes based on the use of digital traces of learners' interaction with technology. Funded by granting agencies and industry in Australia, Canada, Europe, and USA, he is a recipient of several best paper awards at the major international conferences in learning technology. The award-winning work of his team on the LOCO-Analytics software is considered one of the pioneering contributions in the growing area of learning analytics. Recently, he has founded ProSolo Technologies Inc that develops a software solution for tracking, evaluating, and recognizing competences gained through self-directed learning and social interactions. Committed to the development of international research community, Dragan had a pleasure to serve as a founding program co-chair of the International Conference on Learning Analytics & Knowledge (LAK) in 2011 and 2012 and the Learning Analytics Summer Institute (LASI) in 2013 and 2014. Currently serving as a founding editor of the Journal of Learning Analytics and the general chair of LAK 2016, Dragan is a (co-)author of numerous research papers and books and a frequent keynote speaker.


Hendrik Drachsler

Jonna Malmberg

Christoph Sonnenberg

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Michelle Taub

Nicholas Mudrick

## E-CIR MEETINGS

- ❑ August 2019 (Aachen, DE)  EARLI 2019 conference
- ❑ February 2019 online
- ❑ 13t[h] April 2018, (New York,  USA) prior to AREA meeting
- ❑ 26th August 2018 (Zurich, CH) prior to SIG MC meeting
- ❑ 1 August 2017 (Tampere, Finland) *EARLI Conference*
- ❑ 30 May – 31 May  2017 (Edinburgh, United Kingdom)
- ❑ 13 March 2017 (Vancouver, Canada) *Learning Analystics and Knowledge Conference*
- ❑ 22 August 2016 (Nijmegen, The Netherlands)
- ❑ 13 - 14 January 2016 (Leuven, Belgium)

## Annual report:

**Report 2016**

**Report 2017**

**Report 2018**

**Report 2019**

**Report 2020**