# SIG 27 CONFERENCE

PROGRAMME AND ABSTRACTS

14-16 DECEMBER 2020

HOSTED BY THE UNIVERSITY OF ANTWERP

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| 14.15-14.45 | Coffee break | Coffee room |
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| | Session 1C | S.003 |
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| 15.30-16.00 | Coffee break | Coffee room |
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| 17.00-19.00 | Venue open for small-group discussions about ad-hoc topics | Lunchroom, Coffee room, Beer garden |
| 19.00-20.00 | Social activity: Beer/wine yoga | Yoga room |

## Tuesday December 15th – day 2

| Time | Session | Gathertown Room |
|---|---|---|
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| 17.00-18.00 | Social activity: Guided meditation | Yoga Room |

## Wednesday December 16th – day 3

| Time | Session | Gathertown Room |
|---|---|---|
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| | Online/distance-based process measures | L.002 |
| | Multimodal data | L.003 |
| | COVID-complain session | L.004 |
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| | Session 2A | S.001 |
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| | Session 3B | S.002 |
| | Session 3C | S.003 |
| 17.00-18.00 | Closing session with drinks | Auditorium |

# Detailed program by day

## Monday December 14th – day 1

### 13.00-13.30 Opening session

Please join us in the Auditorium for the opening session, in which we welcome all attendees and inform you about some practicalities and the social activities.

### 13.30-14.15 Keynote

| Speaker | Chair | Title |
|---|---|---|
| Eco de Geus | Ellen Kok | What wearables will (not) tell us about stress in daily live |

### 14.15-14.45 Coffee break

Join us in the coffee room!

### 14.45-15.30 Parallel session 1

**Session 1A -** No-or-not-so-perfect-data presentation: Self-regulated learning **S.001**

**Chair**: Lucia Mason

**Technical assistance**: Leen Catrysse

| Speaker | Discussant | Title |
|---|---|---|
| Elizabeth Cloude | Leen Catrysse | Self-regulated Learning with Virtual Environments: Challenges for Classroom-based Research |
| Sophie Hall | Megan Wiedbusch | Using keystroke-logging to investigate the effects of dyslexia and planning on writing processes |
| Héctor J. Pijeira-Díaz | Sven De Maeyer | Arousal and cue-utilization during reading metacomprehension |

**Session 1B –** Single paper presentation: Problem-solving **S.002**

**Chair**: Fien Depaepe

**Technical assistance**: Fran Dela Ruelle

| Speaker | Discussant | Title |
|---|---|---|
| Charlotte Larmuseau | Ellen De Bruyne | Multimodal learning analytics to investigate cognitive load during online problem solving |
| Markku Hannula | Stanislav Popelka | Unequally divided visual attention during collaborative problem solving. |
| Enrique Garcia Moreno-Esteva | Ellen Kok | Scanning Signatures: A Model to Represent Gaze Tracking Data |

**Session 1C -** Single paper presentation: Assessing learning with log data **S.003**

**Chair**: Thomas Martens

**Technical assistance**: Margot Chauliac

| Speaker | Discussant | Title |
|---|---|---|
| Stefan Küchemann | Saleh Alrababah | Students' visual and cognitive strategies during physics line-graph problems |
| Hao Wu | Marketa Beitlova | Using Process Data to Cluster Behavioral Patterns in Problem Solving: The Role of Thinking Skills |
| Gyongyver Molnar | Daryn Dever | Analysing Process Data to Make Different Thinking Profiles Visible |

**Session 1D -** No-or-not-so-perfect-data presentation: Teaching and Teacher Education **S.004**

**Chair**: Piet Van den Bossche

**Technical assistance**: Robin Leysen

| Speaker | Discussant | Title |
|---|---|---|
| Saswati Chaudhuri | Tim van Marlen | Teachers´ stress and focus of attention in the classroom: A case study of two Finnish teachers |
| Maaike Grammens | Renske Bouwer | Measuring teachers' synchronous online teaching performance |
| Andy Nguyen | Moritz Niemann | Exploring Regulatory Patterns in Collaborative Learning Using Electrodermal Activity Data |

## 15.30-16.00 Coffee break

Join us in the coffee room!

## 16.00-17.00 Symposia

| **Symposium 1 -** Reading comprehension strategies across different text types | **S.001** |
|---|---|
| **Organizer/chair**: Carolien A. N. Knoop-van Campen<br>**Discussant**: Johanna Kaakinen<br>**Technical assistance**: Robin Leysen | |

| Speaker | Title |
|---|---|
| Leen Catrysse | Gaining more insight into the interplay between cognitive strategies and motivational processes |
| Carolien A. N. Knoop-van Campen | The impact of audio support on reading strategies in students with dyslexia |
| Caroline Leroy | Overt reading strategies and their relation to multiple documents integration |

| **Symposium 2 -** EFG invited symposium: Stress, challenge, threat and biophysiology in educational contexts | **S.002** |
|---|---|
| **Organizer/chair**: Lars-Erik Malmberg<br>**Discussant**: Ulrich Dettweiler<br>**Technical assistance**: Fran Dela Ruelle | |

| Speaker | Title |
|---|---|
| Libera Ylenia Mastromatteo | Physiological Responses During a Cognitive and Social Stress Task |
| Anna-Liisa Jõgi | Teachers' stress and daily affect – combining psychophysiological and experience sampling methods |
| Monika Donker | A Physiological Challenge/Threat Approach to Teacher-Student Interaction |

| **Symposium 3 -** Enhancing Measurement of SRL with Multiple Trace Data and advanced Methods | **S.003** |
|---|---|
| **Organizer/chair**: Inge Molenaar<br>**Discussant**: David Gijbels<br>**Technical assistance**: Margot Chauliac | |

| Speaker | Title |
|---|---|
| Roger Azevedo | Using Multimodal Trace Data to Understand the Interactions between Self-Regulatory Processes |
| Yizhou Fan | To what extent can multi-channel trace data improve the measurement of SRL processes |
| Joep van der Graaf | Online Measurement of Self-Regulated Learning with Instrumentation Tools and Eye-tracking |

## 17.00-19.00 Venue open for small-group discussions about ad-hoc topics

No sessions are planned for this time slot, but the conference venue is open. You can meet new or old acquaintances in the coffee room, lunch rooms and beer garden for small-group discussions.

## 19.00-20.00 Social activity: Beer/wine yoga

During this social activity we combine one of our greatest vices with a virtue. The concept will be simple, you will move through a series of yoga poses under the guidance of a teacher while enjoying a nice beer or wine. Beer yoga is a yoga hybrid, created in America around 2013, in which participants practice yoga at breweries or taprooms, drinking beer during or after asana practice. It has since spread to other countries. Alcohol has been used during yoga rituals since classical times.

Necessities for this activity are:

- Comfortable or stretchy clothing.
- A silent room or a good headset.
- A yoga mat, soft floor or a soft blanked/towel to use as a mat.
- Beer (ideally in a can or bottle), wine or any other tasty beverage of your choice.

Join us in the Yoga room in Gather Town!

## Tuesday December 15th – day 2

### 12.00-13.00 Topic Lunches

Join the conversation in one of the topic lunches! Discussions are not moderated, but you can be sure that you meet people with a similar interest in one of those rooms.

- L001: Collaborative learning
- L002: Emotion and motivation
- L003: Self-regulated learning
- L004: Technology-enhanced learning and learning analytics

### 13.00-14.00 Symposia

| **Symposium 4 -** Cognitive and emotional arousal during task performance: contrasting and discussing three set-ups | **S.001** |
|---|---|
| **Organizer/chair**: Marjaana Puurtinen<br>**Discussant**: Inge Molenaar<br>**Technical assistance**: Fran Dela Ruelle | |

| Speaker | Title |
|---|---|
| Natalia Chitalkina | Cognitive arousal during music and pseudocode reading: Evidence from eye-movement parameters |
| Muhterem Dindar | Tapping metacognitive experiences with physiological arousal during collaborative problem solving |

| **Symposium 5 -** SIG 27 JURE Symposium: Combining Self-Reports with Online Measurements in the Educational Context | **S.002** |
|---|---|
| **Organizer/chair**: Sonia Zaccoletti<br>**Discussant**: Cindy Paans<br>**Technical assistance**: Oleg Cherman | |

| Speaker | Title |
|---|---|
| Monika Donker | Observer-, Student-, and Teacher-Perspectives: Do They Agree and Predict Emotions? |
| Margot Chauliac | Self-Reports Scrutinized: Eye-tracking Sheds Light on the Internal Consistency of Questionnaires |
| Florence Van Meenen | How Do Students Cognitively Process and Use Peer Feedback? An Eye-Tracking Study |

| **Symposium 6 -** EFG invited symposium: Bridging between keystrokes and mental processes | **S.003** |
|---|---|
| **Organizer/chair**: Rianne Conijn<br>**Discussant**: Sven de Maeyer<br>**Technical assistance**: Eleni Goris | |

| Speaker | Title |
|---|---|
| Veerle Baaijen | Interpreting keystroke logs of writing behaviour |
| Jens Roeser | Analysing interkey intervals: Beyond means, medians and pause frequencies |
| Rianne Conijn | Automated extraction of revisions during writing |

## 14.00-14.15 Coffee break

Join us in the coffee room!

## 14.15-15.45 Interactive poster session

Please visit the posters and engage in a discussion with the presenters.

| Poster board | Author | Title | Accepted type |
|---|---|---|---|
| 1 | Ann-Sophie Grub | Process-based measurement of professional vision of (prospective) teachers: a systematic review | Peer-reviewed poster |
| 2 | Stanislav Popelka | Combining a pen tablet and eye-tracking to analyse calculations procedure in Physics | Peer-reviewed poster |
| 3 | Carolien A. N. Knoop-van Campen | I see what you did there: adaptive support with eye movement displays | Peer-reviewed poster |
| 4 | Mandy Klatt | Expert and novice teachers managing classroom disturbances: First findings from a pilot study in the lab | Peer-reviewed poster |
| 5 | Ellen De Bruyne | Evidence informed development of an online Learning Analytics (LA) dashboard for successful learning | Peer-reviewed poster |
| 6 | Kristin Altmeyer | Using Smartpen Features to Predict Elementary School Children's Performance in Sketching Tasks | Peer-reviewed poster |
| 7 | Sebastian Becker | Mobile eye tracking for the diagnosis of learning difficulties in student experiments | Peer-reviewed poster |
| 8 | Marijn Gijsen | The Complexity of Comparative Judgement: Looking Decision Accuracy and Task Familiarity in The Eyes | Peer-reviewed poster |
| 9 | Irina Rets | What if 'eye' find it too difficult? English non-native speakers' response to text simplification | Peer-reviewed poster |
| 10 | Corinne Wyss | Exploring teacher educators' and student teachers' "professional vision" with eye-tracking | Peer-reviewed poster |
| 11 | Saskia Schreiter | Eye-Tracking for investigating teachers' diagnostic judgments from a process-view | Non-reviewed poster |
| 12 | Luisa Lauer | Comparing Augmented-Reality-Technologies in a Learning Scenario on Electrics for Primary Education | Non-reviewed poster |
| 13 | Christian M. Starcke | Educational videos - Thesis circles for replications | Non-reviewed poster |
| 14 | Eeva Haataja | Students' joint visual attention to teacher gestures in collaborative mathematical problem solving | Non-reviewed poster |

## 15.45-16.15 Coffee break

Join us in the coffee room!

## 16.15-17.00 Keynote

| Speaker | Chair | Title |
|---|---|---|
| Johanna Kaakinen | Leen Catrysse | The dynamics of reader engagement: evidence from concurrent recordings of postural and eye movements |

## 17.00-18.00 Social activity: Guided meditation

Tired after a long online conference day? In this social activity we engage in a group meditation led by a guide. The guide will instruct you to relax specific muscles in the body until they are comfortable, and will then lead you through mental images and visualizations, often of healing light or the dissipation of past wrongs. The purpose is to achieve mental, emotional and physical healing and stress relief. According to Dr. Jon Kabat-Zinn, molecular biologist, professor, and researcher at the University of Massachusetts Medical School, those who practice meditation shift the levels of brain activity from the active, stress-housing right-frontal cortex to the more stable left-frontal cortex. Meditation will literally soothe the parts of the brain that keep you wanting to always go, go, go.

Necessities for this activity are:

- Comfortable or stretchy clothing.
- A silent room or a good headset.
- Optionally a yoga mat

Join us in the Yoga room!

## Wednesday December 16th – day 3

### 12.00-13.00 Topic Lunches

Join the conversation in one of the topic lunches! Discussions are not moderated, but you can be sure that you meet people with a similar interest in one of those rooms.

- L001: Eye Tracking
- L002: Online/distance-based process measures.
  *In this room, discuss all distance-based solutions for collecting process measure-data. For example, web-cam based eye-tracking, online log data collection, face recognition etc.*
- L003: Multimodal data
- L004: COVID-complain session
  *This is a session with a wink. Discuss how the pandemic has impacted your research in this session.*

### 13.00-14.00 Parallel session 2

**Session 2A -** No-or-not-so-perfect-data presentation: Instructional design **S.001**
**Chair**: David Gijbels
**Technical assistance**: Tinne van Menxel

| Speaker | Discussant | Title |
|---|---|---|
| Stanislav Popelka | Tobias Deribo | Eye-tracking testing of learners work with graphs in Physics |
| Tim van Marlen | Antje Meier | The Effects of Task Complexity on Learner's Gaze Behaviour when Observing Live Modeling Examples |
| Christian Scharinger | Dirk Tempelaar | Promises and pitfalls of using neurophysiology to study the effects of pictorial seductive details |

**Session 2B** - Single paper presentation: Learning with maps and graphs **S.002**
**Chair**: Saskia Schreiter
**Technical assistance**: Robin Leysen

| Speaker | Discussant | Title |
|---|---|---|
| Ellen Kok | Sophie Hall | Re-viewing performance: Showing eye-tracking data as prompt to look back on learning processes |
| Lonneke Boels | Eva Rexigel | Secondary school students' gaze paths when interpreting graphs: an analysis with machine learning. |
| Marketa Beitlova | Saswati Chaudhuri | School atlas eye-tracking experiment – comparison of students and their teacher |

**Session 2C** - Single paper presentation: Technology-enhanced learning **S.003**
**Chair**: Tamara van Gog
**Technical assistance**: Eleni Goris

| Speaker | Discussant | Title |
|---|---|---|
| Daryn Dever | Charlotte Larmuseau | Understanding Learners' Metacognitive Processes Over Time in Intelligent Tutoring Systems |
| Mark Torrance | Christian Mayer | Eye tracking as a tool for understanding writing processes and supporting learning to write |
| Moritz Niemann | Tiina Törmänen | Online Measurement of Affect during Learning using EEG |

**Session 2D** - Single paper presentation: Higher education **S.004**
**Chair**: Vincent Donche
**Technical assistance**: Oleg Cherman

| Speaker | Discussant | Title |
|---|---|---|
| Renske Bouwer | Stefan Küchemann | The eye-mind of processing feedback: Unravelling how students use feedback for revision |
| Saleh Alrababah | Markku Hannula | The Efficacy of Students' Problem-Solving Strategies in Higher Education in Jordan:Log File Analyses |
| Carolin Hahnel | Hao Wu | Automated and controlled processes in comprehending multiple documents |

## 14.00-14.15 Coffee break

Join us in the coffee room!

## 14.15-15.00 Keynote

| Speaker | Chair | Title |
|---|---|---|
| Inge Molenaar | David Gijbels | Where Learning Analytics and Artificial Intelligence Meet to understand Online Learning Processes |

## 15.00-15.15 Coffee break

Join us in the coffee room!

## 15.15-15.45 Business meeting

All attendees are invited to join the SIG 27 business meeting. During the business meeting we will discuss the SIG invited symposium at EARLI 2021, the election of a new SIG 27 coordinator who will be installed during EARLI 2021 and updates from the EARLI policy council. In addition, we want to discuss which SIG 27 activities might help you with your research during the Covid-19 crisis. Our slides will be available before the meeting on Blackboard, so we have more time for interaction during the meeting.

## 15.45-16.15 Coffee break

Join us in the coffee room!

## 16.15-17.00 Parallel session 3

**Session 3A -** No-or-not-so-perfect-data presentation: Eye-tracking **S.001**
**Chair**: David Gijbels
**Technical assistance**: Lies Appels

| Speaker | Discussant | Title |
|---|---|---|
| Antje Meier | Ellen Kok | Mobile gaze-tracking study: How photography influences attention on mathematically relevant targets |
| Christian Mayer | Andy Nguyen | Analysing problem-solving processes in a computer-based office simulation using eye tracking |
| Eva Rexigel | Enrique Garcia Moreno-Esteva | Students visual behavior during problem-solving of electrical circuits |

**Session 3B** - Single paper presentation: Motivational, Social and Affective Processes **S.002**
**Chair**: Sanna Järvelä
**Technical assistance**: Robin Leysen

| Speaker | Discussant | Title |
|---|---|---|
| Tobias Deribo | Elizabeth Cloude | Is Filtering Rapid Guesses Enough? A model-based comparison of multiple treatment approaches |
| Dirk Tempelaar | Christian Scharinger | Online measures of learning engagement: patterns in time and relationships with off-line measures |
| Tiina Törmänen | Héctor J. Pijeira-Díaz | Combining video and EDA data to explore emotional states and regulation in collaborative learning |

**Session 3C** - No-or-not-so-perfect-data presentation: Learning analytics and technology-enhanced learning **S.003**
**Chair**: Liesje Coertjens
**Technical assistance**: Eleni Goris

| Speaker | Discussant | Title |
|---|---|---|
| Megan Wiedbusch | Gyongyver Molnar | Are Online Behaviors Enough? Scientific Reasoning and Performance during Game-based Learning |
| Sven De Maeyer | Lonneke Boels | Choosing in comparative judgement: how to model eye-gazing data? |
| Wannes Heirman | Carolin Hahnel | Identifying learning analytics dashboards preferences through focus groups in higher education |

### 17.00-18.00 Closing session with drinks

Grab a drink! We'll be closing the conference together. In this session, we will evaluate the conference and congratulate the winner of the social activity. After that, we raise the glass together.

# Abstracts

## Keynotes

### Keynote 1 - What wearables will (not) tell us about stress in daily life

**Eco de Geus (Vrije Universiteit, Amsterdam, Netherlands)**

Stress-related health conditions form a major public health burden and a threat to economic competitiveness. Currently, almost the entire body of knowledge on stress derives from studies using artificial laboratory stressors or animal models. The impact of stress on humans in ecologically meaningful settings, like the classroom, remain largely uncharted because stress responses in daily life, measured at sufficiently long time scales, have not been linked to their longer-term effects on mental and physical health. A current dilemma facing daily-life stress researchers is the choice between highly reliable tools for valid measures with poor user-acceptance and tolerability versus less reliable tools for measures with low validity but that have excellent user-acceptance and tolerability. I illustrate this dilemma using heart rate variability recording as an example.
To elicit discussion, I will take the stand that imperfect technology is just a temporary problem for daily-life stress research. The true Achilles' heel is the poor conceptualization of the daily-life stress exposure and incomplete understanding of the temporal dynamics between stress exposure and the emotional, physiological, cognitive and behavioural stress responses. To advance the science of stress, innovative technology and methodology is needed that combines smartphone based self-report, passive sensing, and wearables to simultaneously assess contextual factors and the multicomponent stress responses in daily-life.

### Keynote 2 - The dynamics of reader engagement: evidence from concurrent recordings of postural and eye movements

**Johanna Kaakinen (University of Turku, Finland)**

Current theories of text comprehension assume that the reading context and the task the reader has in mind guides the selection and processing of text information (e.g., Rouet et al., 2017). According to the *dynamic engagement hypothesis* (Kaakinen & Hyönä, 2014), the allocation of readers' attention and memory resources fluctuate during the course of reading. In this talk, I will present data from two studies utilizing a novel methodological combination of concurrent recordings of postural and eye movements to study reader engagement. Study 1 examined reading of a multiple-page expository text presented on a computer screen (Kaakinen et al., 2018), whereas in Study 2 an expository text was presented on a hand-held device (Ballenghein et al., 2020). The novel methodological combination of concurrent postural and eye movement recordings proved to be successful in revealing how readers embody the cognitive demands of a reading task. The findings indicate that there are two types of task-induced engagement processes during reading: transient changes reflected in readers' eye movements, and sustained changes across the whole text reflected in postural sway. However, the results imply that the sustained changes depend on the reading context: reading on a hand-held device invites different engagement processes than reading on a computer screen. The results have implications to the current theories of text comprehension by demonstrating the dynamic nature of reader engagement and by showing how the reading context and task impact the allocation of attention and memory resources during reading.

## Keynote 3 - Where Learning Analytics and Artificial Intelligence Meet to understand Online Learning Processes.

**Dr. Inge Molenaar (Radboud University, Netherlands)**

The combination of technologies increasingly gaining more data and intelligence plus the trend of one device per student, quickly furthers the integration of technology in education. This allows for increased opportunities to collect data from learners during learning. The aim of our research is to reveal how learning processes unfold over time using this data. In this effort, we thrive to better understand learning, and in my case specifically regulation of learning. **Detection** of data with multimodal data streams and **diagnosis** of process data during learning have a central position in our research. Emphasizing the practical orientation of our research, we translate these insights into new interventions to support students. Interventions to en**act** new insights can take the form of extracted analytics (dashboards) and embedded analytics (algorithms). Learning Analytics and Artificial Intelligence play an role in **detecting**, **diagnosing** and **acting** on online process data. This supports advanced understanding of learning processes, but also leads to challenges in our field:

1. Detection and synchronization of multiple data streams is a complex process.
2. Diagnosis, annotation and interpretation of learner data is challenging.
3. Acting upon novel insights making them actionable for learners is difficult.

In this keynote, I will illustrate how to make progress on these challenges and I will extract attention points for our future research agenda.

## Symposia

### Symposium 1 - Reading comprehension strategies across different text types

**Organizer: Carolien A. N. Knoop-van Campen (Radboud University, Netherlands)**
**Discussant: Johanna Kaakinen (University of Turku, Finland)**

Abstract: To read efficiently, readers have to regulate their reading by using reading comprehension strategies. Especially in task-based reading assignments the use of reading strategies can support readers in improving processing different types of texts and attain academic success. However, it is by no means clear how people extract information from these different types of text, and whether more or less optimal strategies can be distinguished. In this symposium, we will address these questions. By examining reading comprehension strategies from different perspectives, we shed light on universal aspects of reading strategies, and search for overarching theoretical and practical implications. There are various text types: linear texts (straightforward presentation of written text), multimedia texts (written text accompanied by other media), and multiple documents from various sources. Eye tracking can be used to assess reading patterns (within one text) and reveal readers' navigation through a text, log files can indicate how readers combine information from different documents. In this symposium, speakers from four different countries are involved. Leen Catrysse will present her work on reading strategies in linear texts. Carolien Knoop-van will continue with a presentation of multimedia learning environments. In both presentations, reading comprehension strategies were measured with eye tracking. Caroline Leroy will present her research on multiple documents' integrated understanding, using log files to assess reading strategies. Professor Johanna Kaakinen will address the overarching framework of the universality of reading strategies across different text types as well as the implications of the presented research for science and education.

#### *Presentation 1: Gaining more insight into the interplay between cognitive strategies and motivational processes*

**Leen Catrysse, Margot Chauliac, David Gijbels, Vincent Donche (University of Antwerp, Belgium)**

In this study, we used eye-tracking to gain a deeper understanding of interplay between cognitive (i.e. depth of processing, prior knowledge) and motivational processes (i.e. topic interest) during online text comprehension of standard expository and refutation texts. The sample for this study consisted of 92 academic bachelor students in Social Sciences who participated in a one-hour eye-tracking study. Mixed effects models were used to analyze the eye movement data. The results show that the refutation text facilitates reading, more specifically topic-introducing sentences are read faster in the refutation text than in the standard expository text. The analysis reveals that prior knowledge is crucial for the facilitating effect, the higher someone's prior knowledge is, the quicker the refutation text is processed compared to the standard expository text. More prior knowledge does not necessarily facilitate the reading process of a standard expository text. The analysis of eye movements revealed an elaboration effect as well. This elaboration effect is related to the processing strategy one is using and not to the type of text one is processing (refutation vs. expository text). When a student is using more deep processing strategies, topic medial sentences are processed more deeply during reading. Students with a higher prior knowledge show better learning outcomes for both the standard expository and refutation text. Moreover, students applying deep processing strategies show better learning outcomes for the refutation text compared to the standard expository text.

*Presentation 2: The impact of audio support on reading strategies in students with dyslexia*
**Carolien A. N. Knoop-van Campen, Eliane Segers, Ludo Verhoeven (Radboud University, Netherlands)**

Students with dyslexia often receive audio support to compensate for their reading problems. This may support students' reading, however it is unclear how it may impact students' use of reading strategies. Especially in task-based reading, using reading strategies is important to go efficiently through the material. Not only do students with dyslexia use fewer reading strategies, audio support also guides readers from beginning to end through a text, possibly hindering the use of reading strategies. To understand how exactly audio support affects reading strategies in students with dyslexia, we provided reading comprehension tasks with and without audio support to secondary school students with and without dyslexia. Data collection is ongoing until February 2020. Present results are based on the first pool of participants (14 dyslexia, 10 controls). Students received task-based reading assignments which elicited intensive reading strategies (summarizing) or searching strategies (open ended questions and statement questions). Audio support (narration) could be paused and replayed. Gaze patterns (recorded with SMI-RED500) were automatically coded based on weighted fixation times per AoI as intensive or searching reading strategies. As expected, summarizing questions elicited more intensive reading strategies than the open ended and statement questions. Also, audio support in students with dyslexia led to more intensive reading strategies when answering open ended questions. These preliminary results seem to indicate that audio support affects reading strategies of students with dyslexia towards more intensive reading strategies. During the presentation, the link between reading strategies and reading comprehension scores will be discussed.

*Presentation 3: Overt reading strategies and their relation to multiple documents integration*
**Caroline Leroy, Yvonne Kammerer, Peter Gerjets (Leibniz Institut für Wissensmedien, Germany)**

Despite its importance, many readers face difficulties when required to construct an integrated understanding of a complex issue from multiple documents. A complex interplay between the reading context, reading actions, and the resulting integrated understanding has been suggested previously. In order to investigate this interplay in more detail, we assessed readers' integrated understanding of six partly conflicting documents when reading them in one of two reading contexts, and investigated how their overt reading strategies (i.e., reading actions) in the respective reading context were related to their integrated understanding. Specifically, documents were presented sequentially (i.e., only one document was visible at a time) or simultaneously (i.e., all documents were visible at the same time) on a large multi-touch table. Notably, in the simultaneous reading context, documents could be arranged freely (i.e., dragged and zoomed), but not so in the sequential reading context. Readers' overt reading strategies were assessed in the number of revisits to previously read documents in the sequential, and in whether participants had grouped consistent documents during reading in the simultaneous reading context. Readers' integrated understanding was assessed in the number of cross-document information connections in essays written after reading as well as in a source-content matching score. While there was no difference in any of these two measures of readers' integrated understanding between the two reading contexts, the present results indicate a relationship between participants' reading strategies and their integrated understanding in both reading contexts. Findings will be discussed at the conference.

## Symposium 2 – EFG invited symposium: Stress, challenge, threat and biophysiology in educational contexts

**Organizer: Lars-Erik Malmberg (University of Oxford, UK)**
**Discussant: Ulrich Dettweiler (University of Stavanger, Norway)**

In order to enhance our knowledge on the association between stressful situations in educational contexts and biophysiological correlates, we present findings from one experimental study and two real-time studies. Heart-rate variability, cortisol and heart-rate were used as bio-markers of stress, challenge and threat. The findings are promising for our understanding of associations between (1) students' experience of a cognitively and socially stressful tasks and cardiac response, (2) real-time emotions (experience sampling) and salivary cortisol, and (3) real-time challenge and threats (cardiac output) and teachers' emotions in the classroom. The findings have implications for classroom practices that support and promote students' self-regulation and prevent teacher burnout.

### *Presentation 1: Physiological Responses During a Cognitive and Social Stress Task*

**Libera Ylenia Mastromatteo, Sonia Zaccoletti, Sara Scrimin, Lucia Mason (University of Padova, Italy)**

This study aimed to investigate children's physiological response and regulation when involved in a cognitive and social stress task similar to the ones experienced at school. Moreover, we investigated the direct and interactive effects of environmental and individual factors on children's physiological response to the task. Stressful experiences are very common at school, and particularly in the first years of primary school, it is therefore worth understanding which factors are relevant in the regulatory process to support students with effective interventions. One hundred and sixteen children were interviewed on student-teacher relationship and their electrocardiogram was registered at rest and during a 2-minutes cognitive and social stress task. Children also reported their emotional perception of the task in terms of both valence and arousal. Results demonstrated a significant increase in heart rate from tonic to phasic state and a decrease in heart rate variability (HRV). The subjective perception of the task was directly associated with children's physiological response to the cognitive and social task in terms of HRV. Regression analysis revealed that children's autonomic response to stress was affected by the interaction between the physiological disposition to self-regulate (tonic HRV) and the emotional valence and arousal of having to perform a complex cognitive task, as well as by the interaction between student-teacher relationship and the emotional valence of being observed while doing it. The study suggests that dispositional self-regulation and positive feelings associated with the task play a relevant role in the way students react to a stressor.

### *Presentation 2: Teachers' stress and daily affect – combining psychophysiological experience sampling methods*

**Anna-Liisa Jõgi, Eija Pakarinen, Marja-Kristiina Lerkkanen (University of Jyväskylä, Finland)**

The regulation of teachers' physiological stress and affect have recently come into focus of researchers and practitioners. The current study explores teachers' situational physiological stress, positive and negative affect during schooldays, as well as relations between changes in stress and affect. We investigated physiological stress and self-reported affect of 49 classroom teachers. Salivary cortisol was collected six times a day during two consecutive days as a physiological stress indicator. Teachers reported their affect (Positive and Negative Affect Schedule; PANAS) four times a day via online experience-sampling survey. We expected positive affect to be related to lower physiological stress and negative affect to higher cortisol levels. First, we faced methodological issues of merging two time-variant datasets and the lack of variability in negative affect scale. Higher positive affect tended to be related to lower cortisol levels before afternoon. Interrelations between changes in situational positive affect and changes in salivary cortisol level might depend on the time of the day due to the cortisol diurnal cycle. We discuss data merging and result interpretation challenges educational

researchers face when combining psychophysiological and experience sampling methods. Despite these challenges we believe that integrating psychophysiological and online measures opens up new possibilities for understanding relations between teachers' affect and stress in order to prevent teacher burnout.

*Presentation 3: A Physiological Challenge/Threat Approach to Teacher-Student Interaction*

**Monika Donker[1], Tamara Van Gog[1], Daan Scheepers[2], Nora Mcintyre[3], Mariska Hove[1], Tim Mainhard[1] ([1]Utrecht University, Netherlands, [2]University of Leiden, Netherlands, [3]University of Sheffield, UK)**

According to the biopsychosocial model, feeling that one has the resources to handle an incident's demands results in a relative challenge physiological response (i.e., increase in cardiac output), thereby enabling the body to efficiently marshal the energy needed to cope with such critical incidents (instead of a decrease in cardiac output, i.e., threat). The present study explored whether and how the connection between teachers' interpersonal behavior during critical incidents in the classroom and their emotional outcomes may depend on their challenge/threat physiological response during the incident as well as their average behavior during that lesson. Physiological responses of 80 teachers in secondary education were measured during one lesson. Critical incidents were operationalized as occurring when a teacher's heart rate was two standard deviations above their lesson baseline, indicating personal relevance. Teachers' interpersonal behavior was coded in terms of teacher agency (i.e., dominance, power, or social influence) and communion (i.e., friendliness, affection, or warmth). Teachers differed largely in their interpersonal behavior during critical incidents. Physiological responses seemed especially relevant for teachers with a low baseline agency level during a lesson. Of the low-baseline-agency teachers who showed a challenge physiological response those who decreased their agency during a critical incident reported lower levels of positive emotions after the lesson. Of the low-baseline-agency teachers showing a threat physiological response, those who decreased in agency reported lower levels of negative emotions. Physiological measures of challenge/threat during teaching might help to explain teachers' lesson-focused emotions, and could be used in designing personalized interventions for teachers.

## Symposium 3 – Enhancing Measurement of SRL with Multiple Trace Data and Advanced Methods

**Organizer: Inge Molenaar (Radboud University, Netherlands)**
**Discussant: David Gijbels (University of Antwerp, Belgium)**

The measurement of SRL is a much debated and still largely unresolved issue (Greene & Azevedo, 2010). The positioning of SRL as event-based construct has shifted attention from offline to online methods (Veenman et al., 2006). Offline measures are less reliable and do not provided insights into how SRL processes evolve over time (Molenaar & Järvelä, 2014). The application of multiple data channels has been articulated as a great promise for the measurement of SRL (Azevedo, Taub, & Mudrick, 2018). This symposium combines three contributions that focus on measuring students' SRL with multiple data channels in the context of higher education. These papers contribute to the state of the art addressing the interactions between the SRL processes and multiple data channels applying new analysis methods to triangulate different data-streams. The first paper outlies how multimodal trace data are collected in different advanced technologies and how this has contributed to our ability to measure SRL. The second paper study demonstrates how log files enriched with peripheral data and eye tracking enhance measurement of SRL processes. In this contribution a new method to analyze logs and enriched logs is outlined. The third paper shows how instrumentation tools, such as highlighting and note taking, further improve the measurement of SRL. To conclude, this symposium makes a significant contribution to the current debate about how self-regulated learning can be measured applying multiple data channels driving towards improved methods to support students to regulate their learning during learning, problem solving, and reasoning across learning contexts.

### *Presentation 1: Using Multimodal Trace Data to Understand the Interactions between Self-Regulatory Processes*

**Roger Azevedo[1], Elizabeth Cloude[1], Megan Wiedbusch[1], Daryn Dever[1], Franz Wortha[2], James Lester[3], Eunice Jang[4], Michelle Taub[1] ([1]University of Central Florida, US, [2]Eberhard Karls University Tubingen, Germany, [3]North Carolina State University, US, [4]University of Toronto, Canada)**

Multimodal multichannel trace data on learners' cognitive, affective, metacognitive, and motivational (CAMM) processes enhance our understanding of the temporal dynamic nature of self-regulated learning (SRL) with advanced learning technologies (ALTs) such as immersive environments, intelligent tutoring systems (ITSs), serious games, and hypermedia. Despite advances in using multimodal multichannel data, researchers continue to experience significant challenges such as temporally aligning data and accurately inferring about SRL processes, understanding how serial vs. parallel SRL processes deploy in real-time, and developing valid measures, methods, and sensors to capture these processes. In this presentation, we highlight the strengths and challenges on empirical research with various ALTs of which range from ITSs and serious games to immersive virtual systems. After describing our general methodological approach in collecting rich multimodal multichannel trace data of CAMM processes during learning (e.g., eye tracking, facial expressions of emotion), we will focus on the challenges involved in using multimodal to understand how SRL processes interact during learning with various ALTs. Specifically, we will present and discuss the methodological, analytical, and pedagogical challenges associated with measuring, understanding, and inferring SRL processes by using examples from multichannel, multimodal data (e.g., log files, eye tracking, facial expressions of emotions, physiological data, and screen recordings of learner-system interactions) collected from several studies with middle-school and undergraduate students as they learned about various STEM topics using MetaTutor, Crystal Island, and an immersive virtual reality system, and medical professionals diagnosing medical cases with a hypermedia system.

### *Presentation 2: To what extent can multi-channel trace data improve the measurement of SRL processes*

**Yizhou Fan[1], Lyn Lim[2], Joep van der Graaf[3], Jonathan Kilgour[1], Katharina Engelmann[2], Johanna Moore[1], Dragan Gasevic[4], Inge Molenaar[3] ([1]University of Edinburgh, UK, [2]Technical University of Munich, Germany, [3]Radboud University Nijmegen, Netherlands, [4]Monash University, Australia)**

To advance research understanding of and facilitate learners' self-regulated learning (SRL) processes, we need to develop novel approaches to measurement and integration of multi-channel data that are used for the study of SRL. Recent advances in new data-capturing devices allow researchers to go beyond simple navigational log data to multi-channel data that simultaneously trace a range of cognitive processes in more nuanced ways, e.g. eye-movement tracking and brain activation. However, it is still under-investigated what multi-channel data can reveal about SRL processes, and to what extent multi-channel trace data can improve the measurement of micro-level SRL processes. Hence, we conducted a study that aimed at addressing this problem by enhancing log data with other peripheral data such as mouse movement, mouse click, keyboard stroke, and more interestingly, and eye tracking data. In this paper, we present the preliminary findings of a lab study(N=25) that aimed to compare the utility of three data channels (navigation log, enhanced log with mouse and keyboard trace, and log+eye tracking data). The comparison was done using a process mining method to show the SRL process maps and differences detected from these three data channels. Our results show that the joint log and eye tracking data and enhanced log data provided richer information about the SRL process than navigation log data alone, and thus, greatly improved the granularity of measurement of SRL process patterns. In order to further validate the value of joining eye-tracking and log data, future work will include the use of think-aloud data.

### *Presentation 3: Online Measurement of Self-Regulated Learning with Instrumentation Tools and Eye-tracking*

**Joep van der Graaf[1], Lyn Lim[2], Yizhou Fan[3], Katharina Engelmann[2], Maria Bannert[2], Dragan Gasevic[3], Inge Molenaar[1] ([1]Radboud University Nijmegen, Netherlands, [2]Technical University of Munich, Germany, [3]University of Edinburgh, UK)**

Self-regulated learning (SRL) theory defines learning as a goal-oriented process, in which students make conscious choices working toward learning goals, reasoning on and combining new information. So far, the field of SRL has been struggling with measurement of SRL processes. In Flora-Study 2, we added eye tracking and multiple instrumentation tools to enrich log data and improve measurement of SRL. Thirty (to be extended to 45) university students from Nijmegen participated. Their task was to write a vision-essay about education in 2035 using informative text. Instrumentation tools were a planner, a timer, a note-taking/highlighting function, a search function, and a hybrid read-write mode of the essay, where the screen was shared between the text and the essay. Monitoring activities, measured with think aloud, were frequent when learners used the timer. High cognitive activities, such as organization of information, occurred during highlighting and essay writing. Eye-tracking results showed that monitoring was associated with larger distance between subsequent fixations compared to reading, indicating global processing. The hybrid mode of the essay was linked to more switches (subsequent fixations on the text and the essay) compared to the read or write mode. By embedding additional tools in the learning environment several SRL processes that are hard to detected in log data can be revealed. Eye-tracking may improve mapping of SRL in log data based on the analysis of fixation patterns and transitions in fixations. Hence instrumentation tools and eye-tracking could be valuable additions to improve online-measurement of SRL.

## Symposium 4 – Cognitive and emotional arousal during task performance: contrasting and discussing three set-ups

**Organizer: Marjaana Puurtinen (University of Turku, Finland)**
**Discussant: Inge Molenaar (Radboud University, Netherlands)**

This symposium aims at strengthening the methodological grounds for the study of cognitive and emotional arousal during task performance. Arousal measures are considered important indicators of underlying cognitive and/or emotional processes, and the use of them is booming in educational research. However, despite the common interests, scholars in this field tend to approach the matter from diverse methodological frameworks. The differences, and the challenges faced with often complex set-ups, are rarely explicitly explored, contrasted, and discussed. For one, some set-ups make it difficult to differentiate what is actually being measured: cognitive challenges with the task itself, or emotions related to partaking in them, or the interaction of these two factors. For another, different physiological signals are applied for somewhat the same purpose, but these measures reflect arousal differently and have different temporal characteristics in terms of when potential arousal effects appear. In this symposium, we will bring these issues to the front by inviting authors with at first glance differing research topics, namely music- and code reading, team interaction and collaborative learning, to present and discuss their approach toward what is common to all three: the study of arousal, the challenges they have faced, and their solutions for overcoming them. The focused discussion and contrasting of studies as well as exchange of ideas is a necessary step in the search for increasing methodological coherence in the use of these measures in learning research. Additionally, the symposium bridges eye-tracking and collaborative learning research through the joint interest in arousal measures.

### *Presentation 1: Cognitive arousal during music and pseudocode reading: Evidence from eye-movement parameters*

**Natalia Chitalkina[1], Marjaana Puurtinen[1], Roman Bednarik[2], Hans Gruber[3] ([1]University of Turku, Finland, [2]University of Eastern Finland, Finland, [3]University of Regensburg, Germany)**

During music and code reading unexpected changes in familiar music and code notation induce local changes in cognitive arousal due to violation of readers' predictive models. Inserting challenging sections into otherwise familiar, to-be-read material allows the measuring of such immediate arousal effects and eye tracking provides promising measures, such as pupil dilation and fixation parameters, for their study. In two eye-tracking studies we investigated how experienced participants dealt with unexpected changes either in familiar music or algorithms. The results of our music-reading study revealed that increase in cognitive arousal was reflected in first-pass fixation duration, pupil-size and eye-time span parameters. The preliminary results of the pseudocode reading study will be presented at the conference. Our line of research facilitates the development of research practices by comparing and contrasting two different reading tasks that differ especially in terms of the temporal aspects of the reading task, while also aiming to contribute to the improvement of pedagogical training in the fields of music and programming. The submission will contribute to the symposium through its discussion of the advantages and challenges of highly structured, domain-specific task designs in the study of cognitive arousal.

### *Presentation 2: Tapping metacognitive experiences with physiological arousal during collaborative problem solving*

**Muhterem Dindar, Sanna Järvelä, Eetu Haataja (University of Oulu, Finland)**

Metacognitive experiences are the concurrent feelings and judgements that arise during an ongoing learning task. Judgement of confidence, estimates of mental effort, perceived task difficulty, task interest and emotions have been considered as the prominent metacognitive experiences in the literature. An essential feature of metacognitive experiences is that they are temporal, and unfold in relation to the learners' interaction within a learning context. A current challenge in metacognition research is to capture real-time alterations in metacognitive experiences. In light of this challenge, this empirical study investigates the temporal characteristics of metacognitive experiences in a collaborative problem solving (CPS) situation in which participants worked together in groups of three

in a computer-based collaborative problem simulation. The study utilized electrodermal activity and situated-self reports to capture metacognitive experiences. The current research provides insight into the temporality of metacognitive experiences in CPS and discusses the challenges in measuring metacognitive experiences with electrodermal activity data.

## Symposium 5 – SIG 27 JURE Symposium: Combining Self-Reports with Online Measurements in the Educational Context

**Organizer: Sonia Zaccoletti (University of Padova, Italy)**
**Discussant: Cindy Paans (Radboud University, Netherlands)**

Self-reports have been widely used in psychological sciences, including in the educational research. However, their use is much debated in the literature, as they are subject to many weaknesses, such as time consumption, social desirability, and limited reliability of the responses assigned by respondents. Moreover, one's own perspective is not always associated with the responses given by external observers. In order to overcome the limitations of these subjective measures, the use of process measurement would be relevant. Eye movements, for instance, are process measures that can shed more light on the participant's behavior with more objective data available. In this regard, the present symposium aims to discuss the relation and/or added value of process measures on self-reports. Three junior researchers from two different countries are involved. In Study 1, Monika Donker (Utrecht University, the Netherlands) compares process measures of observed behavior with teacher and student self-reports and highlights the importance of using self-report measurements, especially in the case of emotions. However, Study 1 shows the difficulties in the use of self-reports, since it is a subjective measure that makes the overlap of different perspectives challenging. In line with Study 1, in Study 2 Margot Chauliac (University of Antwerp, Belgium) shows that self-reports are useful, but that eye-movements serve as a promising tool to gain more insight into self-reports. In Study 3, Florence Van Meenen (Université catholique de Louvain, Belgium) adds extra proof that eye-tracking supports self-report measurements or at least makes subjective measurements more objective.

### *Presentation 1: Observer-, Student-, and Teacher-Perspectives: Do They Agree and Predict Emotions?*

**Monika Donker (Utrecht University, Netherlands)**

Teacher behavior in class has often been claimed as important antecedent of both teacher and student emotions. However, empirical evidence regarding teacher emotions is scarce, and studies on student emotions relied on student ratings of both teacher behavior and emotions, which could lead to common-method or same-rater bias. Using other perspectives on teacher behavior, such as external observation or teacher reports, have been proposed but it is not clear to what extent external observation, student ratings, and teacher self-reports of interpersonal teacher behavior overlap. Moreover, the three perspectives will likely have different associations with emotional outcomes, but this is hard to investigate with the currently available statistical techniques, which is why we introduced a novel statistical, regression-based technique to calculate the shared and unique variance of the three perspectives in explaining teacher and student emotions. We used data of 80 secondary education teachers and one group of their students. Teacher behavior was scored in terms of Agency (i.e., dominance, power, or social influence) and Communion (i.e., friendliness, affection, or warmth). The perspectives showed medium to high correlations, except for the observer and teacher perspective on communion, which did not overlap. Especially for student emotions, teacher communion was a better predictor than agency. Student ratings and teacher self-reports of teacher behavior were the best predictors of student and teacher emotions, respectively. This cannot only be attributed to common-method bias, because the overlap with the other perspectives also explained part of the variance in emotions.

### *Presentation 2: Self-Reports Scrutinized: Eye-tracking Sheds Light on the Internal Consistency of Questionnaires*

**Margot Chauliac (University of Antwerp, Belgium)**

Despite the fact that self-report questionnaires are widely used, researchers argue whether responses to these types of questionnaires are indeed reliable representations of the respondent's thoughts and beliefs. In order to provide more insight into the quality of questionnaire data, our study aims to gain an understanding of the processes that impact the completion of self-report questionnaires. To this end, we explore the process of completing a questionnaire by monitoring the eye tracking data of 75 students in higher education. We hereby examine the relation between eye movement measures and the level of internal consistency demonstrated in the responses to the questionnaire. We also investigated the intermediating role of personal factors such interest in the text about which the questionnaire handles as well as the working memory capacity of the respondent.

### *Presentation 3: How Do Students Cognitively Process and Use Peer Feedback? An EyeTracking Study*

**Florence Van Meenen, Nicolas Masson and Liesje Coertjens (Université catholique de Louvain, Belgium)**

Eye tracking research on the cognitive processing and use of peer feedback by the students is scarce. The limited set of studies that have been conducted on the topic indicate that higher education students struggle with this. Moreover, the limited set of studies show a substantial shortcoming: only one peer provided feedback, which contrasts with most peer feedback exercises in which multiple students give feedback. To address this shortcoming, the present project discerns the following research questions: (1) Which attention patterns are effective? And (2) Are there statistically significant differences between the use of feedback with and without contradictions? Sixty medical education students will be invited to (1) read an essay written by a fictional student, (2) read feedback provided by 2 fictional peers with and without contradiction, (3) revise the essay, (4) execute a distraction task and (5) a feedback recall exercise. Different kinds of feedback will be used: higher or lower level of feedback and suggestive or directive feedback. Students' eye movements will be measured with an eye tracker during these tasks. To discern which attention patterns are effective, recall and revision performances will enable us to determine which students have used effective cognitive processing strategies and which have used ineffective cognitive processing strategies. Hence, we will discern the effective and ineffective eye movements using a Mann-Whitney U test. To answer the research question on statistically significant differences between the use of feedback with and without contradictions, a multivariate analysis of variance [MANOVA] will be carried out.

## Symposium 6 – EFG invited symposium: Bridging between keystrokes and mental processes

**Organizer: Rianne Conijn (Tilburg University, Netherlands)**
**Discussant: Sven de Maeyer (University of Antwerpen, Belgium)**

EFG4 invited symposium: In most classroom environments, teachers are not able to systematically monitor the development of students' writing skills and in particular of those that struggle. Keystroke logging has been increasingly used as an online measurement to provide insight in an individual's writing process. Real-time keystroke data offer potential for automatic extraction of important diagnostic information, thus providing an earlier and precise identification of writing difficulties. This has the potential to provide information about different stages at which an individual might fail to write text; e.g., creating a syntactic structure or accessing lexical items from memory. To unveil this potential, appropriate computational and statistical tools are needed. In this symposium, we will discuss novel and sophisticated approaches to the analysis of keystroke data and contrast these to the standard treatment in the field. In particular, we will focus on process disfluency and non-linearity. A growing amount of literature shows that both disfluency and non-linearity can provide insight into the cognitive processes involved in writing, and hence writing difficulties. For example, process disfluency indicates situations in which the time to initiate a text specific feature (letters, words, sentences) is longer than might be expected if the writer was merely preparing finger movements. Non-linearity, on the other hand, refers to situations in which a writer moves away from the point of utterance. In three talks we will address how we can use computational and statistical tools to bridge between the complexity of the keystroke data and the underlying cognitive processes.

### *Presentation 1: Interpreting keystroke logs of writing behaviour*

**Veerle Baaijen[1], David Galbraith[2] ([1]University of Groningen, Netherlands, [2]University of Southampton, UK)**

Keystroke logs provide a moment-by-moment record of behaviour during writing, but on their own, the features that are recorded do not provide direct information about the underlying mental processes responsible for the behaviour. Furthermore, the correlational nature of the data provided by keystroke logs make it difficult to infer causal relationships between variables. This presentation will discuss some of the analytic procedures that we have used to improve the interpretability of keystroke measures, and then illustrate how composite measures of keystrokes can be used to assess relationships between writing behaviour, text quality and the development of the writer's understanding. The two principal distinctions that we apply in analysing keystrokes are: (i) between linear and non-linear transitions between units, and (ii) between sentence and supra-sentence operations. These distinctions enabled us to construct two composite measures of writing behaviour: (i) a sentence production measure, distinguishing between spontaneous and deliberate sentence production; and (ii) a global linearity measure, distinguishing between linear and recursive sentence production. In an experimental study with undergraduate students, in which the type of planning carried out in advance of writing was manipulated, we found systematic relationships between these measures and both the quality of the text that writers produced and the extent to which they reported developments in their understanding of the topic. We will conclude by discussing how the pure keystroke measures that we used in this experiment could be supplemented with information from eye-tracking and retrospective verbal protocols to further disambiguate these relationships.

### *Presentation 2: Analysing interkey intervals: Beyond means, medians and pause frequencies*

**Jens Roeser[1], Mark Torrance[1], Mariëlle Leijten[2], Sven De Maeyer[2], Luuk Van Waes[2] ([1]Nottingham Trent University, UK, [2]University of Antwerp, Belgium)**

Writing research has made extensive use of keystroke logging. The analysis of these data is typically performed on aggregates (mean, median) of inter-keystroke intervals (IKIs). Data aggregation by-

passes certain statistical problems. However, treating the data in this way gives rise to two basic problems. First, means are poor descriptive data that come from a non-normal distribution. Second, using mean IKI artificially reduces information and potentially adds bias to the estimates.This paper will describe and illustrate two alternative ways of modelling individual IKIs to provide reliable by-participant estimates. We randomly sampled data from 500 participants (age 18-25) from the Dutch subset of the copy-task corpus and compared our analyses for two non-lexical tasks, one that is purely motoric and one cognitively demanding copy task.First, we modelled bigrams as random intercept terms to account for the variance that is associated with bigrams. Second, we modelled IKIs in an autoregressive process. Autoregression models estimate an additional parameter that captures the extent to which each IKI can be predicted by the IKI preceding it. These approaches were implemented as Bayesian models. We compared the predictive performance of these models. We found a higher predictive performance for the autogression model for the purely motoric task, but not for the cognitively demanding task. For the latter, random intercepts achieved a higher predictive performance. This suggests that the statistical treatment of keystroke data is to some extent task-dependent and not typing general.

*Presentation 3: Automated extraction of revisions during writing*

**Rianne Conijn[1], Emily Dux Speltz[2], Menno van Zaanen[3], Luuk Van Waes[4], Evgeny Chukharev-Hudilainen[2] ([1]Eindhoven University of Technology, Netherlands, [2]Iowa State University, US, [3]South African Centre for Digital Language Resources, South Africa, [4]University of Antwerp, Belgium)**

Revision plays an important role in writing. Although there is no unambigous correlation between revision and text quality, revision has shown to be a determining factor in writers' development, including writers' knowledge about the topic and writing. Moreover, as revisions lead to disfluencies in the writing process, they are crucial in describing writing process dynamics.Keystroke analysis has been used to extract revisions made during writing. Previous approaches include the manual annotation of revisions, building non-linear S-notations, and the automated extraction of backspace keys. However, these approaches are not optimal: manual annotation is time-intensive and the S-notation has proven to be rather vulnarable to construct. The automated extraction of backspace keys is more scalable, but restricted, as this approach does not identify insertions nor the characters typed to replace the deleted text. Therefore, we present a computational approach to automatically extract all revision events from keystroke logs, ranging from simple typos to complex operations during which complete paragraphs are reordered and restructured. Within this approach, the beginning of the revision event is automatically extracted, using a rule-based algorithm. The end of the revision event is identified using machine learning. For this, a dataset of keystrokes from 65 students conducting a writing task was manually annotated on revision end (Krippendorff's alpha = 0.74). In total, 7,120 revision events were annotated. The results showed that revision end could be predicted with a relatively high accuracy. This suggest that computational approaches can be beneficial in providing more detailed measurements of revision in writing.

## Single paper presentation

### Parallel session 1B – Problem Solving

*1 Multimodal learning analytics to investigate cognitive load during online problem solving*

**Charlotte Larmuseau[1], Fien Depaepe[2], Jan Cornelis[3], Lugi Lancieri[1], Piet Desmet[2] ([1]Université de Lille, France, [2]KU Leuven, Belgium, [3]Imec, Belgium)**

High cognitive load has a negative impact on the problem solving process. To have insight into cognitive load during complex problem solving, this study aims at measuring cognitive load through physiological data. According to Cognitive Load Theory, cognitive load can be both intrinsic (level of complexity) and extraneous (provision of support). Therefore, the current study experimentally manipulated the intrinsic and the extraneous load by developing four sets of exercises in the field of probability calculations in statistics: (1) high complex with hints, (2) low complex with hints, (3) high complex without hints and (4) low complex without hints. The study had a within-subject-design in which 67 students solved the sets in a randomized order. Self-reported mental effort after problem solving is combined with measures of physiological data during problem solving, namely, galvanic skin response (GSR), skin temperature (ST), heart rate (HR) and heart rate variability (HRV). Firstly, this study examined differences between the four conditions in view of the physiological data. Secondly, it investigates how much variance of self-reported mental effort and task performance can be explained by physiological data. Finally, it aims at investigating which features of physiological data can be used to detect cognitive load. Results reveal significant differences between the four conditions in terms of HR and ST. Moreover results reveal that HR and ST significantly predicted self-reported mental effort and ST was a significant predictor for task performance. Finally, the slope of ST seems to play a major role in detecting and therefore predicting cognitive load.

*2 Unequally divided visual attention during collaborative problem solving*

**Markku Hannula[1], Enrique Garcia Moreno-Esteva[1], Miika Toivanen[2], Einat Heyd-Metzuyanim[3], Eeva Haataja[1] ([1]University of Helsinki, Finland, [2]SeeTrue Technologies, Finland, [3]The Technion Israel Institute of Technology, Israel)**

One challenge in eye-tracking research is the synthesizing of the information-rich data in an easily digestible form. Especially the temporal aspect of a perceptual process is often lost. In this study we use “scanning sequences”, a novel method developed in our team to make synthetical descriptions of students’ gaze behavior, in the context of collaborative problem solving. Our research question is: When students work as a group, what differences in their visual behavior we can observe? The data for three volunteering students was collected during a grade nine mathematics lesson in Finland, when they solved a non-routine geometry problem as a group. We used self-made mobile gaze trackers. Dwell targets were annotated manually. The temporal sequences of dwells were synthesized into nine graphs representing three students’ different scanning behaviour in three five-minute segments. The images show how students s1 and s2 focus on each other, largely ignoring s3 and s4. We see also some differences between the three students’ temporal sequences. The results show that the scanning signature is an efficient way to describe the individual characteristics in visual behaviour.

## Parallel session 1C – Assessing Learning with log data

### *1 Students' visual and cognitive strategies during physics line-graph problems*

**Stefan Küchemann, Sebastian Becker, Pascal Klein, Jochen Kuhn (TU Kaiserslautern, Germany)**

Line-graphs are important formats to measure conceptual knowledge in general – especially in physics. Previous work by Beichner already demonstrated that students exhibit specific difficulties when working with graphs. Among these difficulties are, for instance, the slope-height confusion and a variable confusion, pointing out the complexity of the physics context when applying mathematical procedures. To study these difficulties, he developed a test, the Test of Understanding of Graphs in Kinematics (TUG-K) (Beichner, 1993). Despite the wide use of this test, little is known about learners' visual and cognitive processes and strategies during solving problems with line graphs. In this work, we used a large gaze-data set of 115 high-school students and 62 first-semester engineering students who solved the TUG-K. Applying machine-learning on different gaze-based metrics, the eye-tracking data reveals insights into specific visual strategies during solving of quantitative slope and area problems. Specifically, students with correct answers allocate more visual attention in conceptually relevant areas along the graph and the axes tick labels and perform more transitions between these areas when applying the slope concept, and, additionally when applying the area concept, they focus on areas below the graph. Furthermore, we report retrospective think aloud and interview data being uniquely able to link the visual and the cognitive strategy. Apart from advances in the field of physics education, the results provide a guide for a selective combination of eye-tracking metrics and machine learning approaches for the optimization of gaze-based adaptive learning environments.

### *2 Using Process Data to Cluster Behavioral Patterns in Problem Solving: The Role of Thinking Skills*

**Hao Wu, Gyongyver Molnar (University of Szeged, Hungary)**

Dynamic problem solving (DPS) is considered one of the most important skills for successful learning. In order to explore the nature of DPS, this study aims to investigating the role of inductive reasoning (IR) and combinatorial reasoning (CR) in the problem-solving process by students using statistically distinguishable exploration strategies in DPS environment. The sample was drawn from a group of Hungarian university students (N=1,343). The tests were delivered by an online assessment platform eDia. Latent class analyses were employed to seek students whose problem-solving strategies showed similar patterns. Three qualitatively different class profiles were identified: (1) 80.9% of the students were proficient strategy users, (2) 10.4% of the students were rapid learners, and (3) 8.7% of the students were slow learners. Structure equation modeling results showed rapid learners used their CR skills (β=.378), slow learners used their IR skills (β=.387), while proficient strategy users used both of the skills (CR: β=.115, IR: β=.429) in the knowledge acquisition phase of DPS. To sum up, the analysis discovered Hungarian university students' problem-solving behaviours in the aspect of exploration strategy in DPS environment, and detected several remarkable differences in terms of the use of thinking skills between students with different exploration strategies.

### *3 Analysing Process Data to Make Different Thinking Profiles Visible*

**Gyongyver Molnar (University of Szeged, Hungary)**

This study uses log file analysis to empirically test the different behaviour and strategy usage of first-year university students and make the differences in their thinking visible while they solve dynamic problems developed with the MicroDyn approach. The sample for the study was drawn from first-year university students (N=1682). All the interactive problems were administered online via the eDia platform. Latent class analysis was employed to find students whose thinking strategies show similar patterns. The internal consistency of the test based on the recoded log data and the exploration

behaviour of the students was high (Cronbach's α=.94). Result showed that the use of a theoretically effective exploration strategy does not always result in high performance, a correct solution requires something more. Three qualitatively different class profiles were identified at university level: (1) proficient strategy users who consistently employed optimal exploration strategies; (2) rapid learners who started out as low-to-intermediate performers, showed a rapid learning curve, and, by the end of the test, approached the high level of exploration behaviour of the proficient explorers; (3) intermediate performers on the easiest problems, but low performers on complex ones. The tested four process indicators proved to be non-invariant over the different latent profiles, that is, it is not enough to run analyses on sample level, there are big differences in the role of the number of executed manipulations, time-on-task, type of thinking and type of strategy applied on actual problem-solving achievement between students belonging to the different thinking profiles.

## Parallel session 2B – Learning with maps and graphs

### *1 Re-viewing performance: Showing eye-tracking data as prompt to look back on learning processes*

**Ellen Kok, Olle Hormann, Jeroen Rou, Evi van Saase, Marieke van der Schaaf, Liesbeth Kester, Tamara Van Gog (Utrecht University, Netherlands)**

Monitoring learning processes is difficult, but crucial for effective regulation of study behavior (Nelson & Nahrens, 1990; Zimmerman, 2002). Visualizations of participants' viewing behavior as recorded with eye-tracking apparatus, so-called gaze displays, can serve as prompts for participants to remember and evaluate learning processes (Kostons, van Gog, & Paas, 2009). However, it is yet unknown if this helps to improve monitoring accuracy. In this study, we investigate the effectiveness of gaze displays as prompts to review learning processes while learning map reading. It is hypothesized that participants who see gaze displays during reviewing have a higher monitoring accuracy and increase in posttest performance than participants who review based on just a screen recording. Sixteen male and 50 female students (Mage 23.1 years, SD=3.73) were randomly assigned to the gaze-display or control condition. Maps were accompanied by written descriptions of location and destination, and participants had to choose where to head next (left, right, ahead, back). After watching an instruction video, they practiced on five maps and reviewed their performance while thinking aloud, either prompted by a screen recording (control condition) or a screen recording with gaze display. Before and after reviewing, participants estimated the number of correctly solved tasks and finally made a five-item posttest. Gaze displays did not improve monitoring accuracy and post-test performance. In fact, participants started to underestimate their performance as a result of reviewing in both conditions. Analysis of verbal data collected during the review phase is in progress and might shed light on these findings.

### *2 Secondary school students' gaze paths when interpreting graphs: an analysis with machine learning*

**Lonneke Boels[1], Enrique Garcia Moreno-Esteva[2], Arthur Bakker[1], Paul Drijvers[1] ([1]Utrecht University, Netherlands, [2]University of Helsinki, Finland)**

Can students' eye-tracking data be used to automatically identify their strategy and predict their answer? If so, automated online feedback could be provided during a graph interpretation task. Automated answer prediction can be done with machine learning software. The difficulty of machine learning is that this is a black-box process that does not reveal how it predicts. We therefore developed a grey-box method that predicts students' answers based on students' gaze data and gives insight in students' problem solving strategies. We do this within the theoretical framework of gaze data as evidence of conceptual actions (Chumamenko, Shvarts, Budanov, 2014). Fifty students (age 15–19) were placed in front of a Tobii XII-60 eye-tracker and asked questions that required interpreting graphs. Based on the gaze data, machine learning software predicted whether students answered correctly (84% accuracy) showing that it is possible to predict students' answers based on their gazes and therefore worth constructing a new model that gives insight into students' strategies. This grey-box model was informed by previous research (Boels et al., 2018). For this model we divided the gazes into vertical (correct strategy) and horizontal (incorrect strategy) eye movements. Our model predicts with the same accuracy as the black-box machine learning but with the benefit of providing insight into a key parameter that helps predict answer correctness. The results of this research can be used in the development of online student feedback systems based on students' gaze patterns. Our method is an addition to the toolbox of eye-tracking research.

*3 School atlas eye-tracking experiment – comparison of students and their teacher*

**Marketa Beitlova, Stanislac Popelka (Palacký University Olomouc, Czech Republic)**

The contribution describes the geographic eye-tracking experiment conducted in the classroom. The aim of the experiment was to analyse the way how grammar school students in the third year read maps in school atlas of the world. Ten different tasks on the thematic maps of the world were solved by 30 students. The maps were derived from the most commonly used school world atlas in the Czech Republic and contain especially choropleth maps and diagram maps. The tasks were focused on finding specific thematic content in the map. For example, the students had to mark countries where import exceeds export. For that, they need to understand the legend, find correct diagrams on the map and mark the countries with a mouse click. The correctness of student's answers was analysed together with the eye-movement data. The results showed that students had problems with some cartographic methods. For example, they were not able to derive values from the legend of the proportional pie-chart map. Beside the recording of 30 students, the eye-movements of their teacher solving the same tasks were recorded. The aim of this procedure was to compare student's strategy with the strategy of their teacher. For that, the developed tool ScanGraph has been used, as well as the well-known multi-match algorithm. The results showed that the teacher had an absolutely different strategy for task solving. The answers of the teacher were solved on the basis of previous knowledge, not according to the map.

## Parallel session 2C – Technology-enhance learning

### *1 Understanding Learners' Metacognitive Processes over Time in Intelligent Tutoring Systems*

**Daryn Dever[1], Franz Wortha[2], Roger Azevedo[1] ([1]University of Central Florida, US, [2]Eberhart Karls University Tübingen, Germany)**

Learners can metacognitively monitor their self-regulatory processes in intelligent tutoring systems (ITSs) by engaging in judgements of learning (JOLs), feelings of knowing (FOKs), and content evaluations (CEs). By capturing these processes through log files, researchers are able to examine learners' ability to effectively utilize metacognitive processes as they try to understand and learn the information presented within the ITS. As such, this study utilizes log files to identify changes in duration of learners' self-initiated metacognitive processes over time. Undergraduate students (n=81) were split between two conditions (control and experimental) where participants in the experimental condition were prompted by pedagogical agents to engage in metacognitive processes and provided feedback on their performance while the control condition did not receive prompts or feedback. Analyses found no differences in proportional learning gains (PLGs) between the two conditions. Results indicated that condition and time on task did not influence the duration participants spent on FOKs and CEs. However, participants in the experimental condition spent more time engaging in JOLs than those in the control condition. Additionally, the duration on JOLs were greater in the first 25% of time on task than the last 25% of time. These findings have implications for using log files to track fluctuations in learners' metacognitive processes over time and how scaffolding these processes can be used in design implications for intelligent tutoring systems.

### *2 Eye tracking as a tool for understanding writing processes and supporting learning to write*

**Mark Torrance[1], Evgeny Chukharev-Hudilainen[2] ([1]Nottingham Trent University, UK, [2]Iowa State University, US)**

Writers composing text – writing essays, papers, this abstract – do not produce keystrokes at regular intervals. The period between keypresses varies considerably. This variation is patterned, and dependent both on characteristics of the writer and where they are within their text. Appropriate analysis of this pattern has potential to give insight into the cognitive processes, and therefore the state-of-learning, of the writer. However, keystroke times alone are ambiguous. For example, a writer who pauses before writing a sentence may be doing one or both of thinking about what to write next and checking back over what they have just written. Knowing where the writer was looked during this pause, if processed appropriately, provides this information. Processing eye tracking data from writers' gaze on the text that they are writing is made difficult because, unlike reading researcher-provided text, areas of interest (words) move around as the text scrolls, wraps and is edited. We will first describe two software solutions that automatically extract the text of the word (sentence, paragraph) that the writer is fixating. We will then present selected findings from three studies, two published and one in progress, that explore reading-during-writing behaviour using these methods, including comparison of native speakers with students writing in a language that they are learning (Ns = 10, 24, and 39). Finally, we will describe a method (and a case-study evaluation) that uses visualizations of key and eye data to help university students understand and then adapt their writing behaviours.

### *3 Online Measurement of Affect during Learning using EEG*

**Moritz Niemann[1], Uwe Dick[2], Thomas Martens[1] ([1]Medical School Hamburg, Germany, [2]Leuphana University of Lüneburg, Germany)**

Learning situations are rich with affective states such as confusion, frustration, boredom, and curiosity. A good teacher will adapt their teaching to a student's current affective state. Intelligent

Tutoring Systems (ITS) attempt to imitate the adaptive behavior of a good teacher in order to increase learning outcomes. How to best teach an ITS to recognize affective states is an open research question. In the present study, we created a model that allows the detection of a learner's affective states during learning from brain activity (Electroencephalography; EEG) in an automated manner. Subjects completed an introductory programming course for the Python programming language while EEG was recorded. Reviewing their own learning session on video afterwards, they self-reported on their affective states as they had occurred during learning (Retrospective Affect Judgment Protocol) every 15 seconds. EEG data was segmented into 15s epochs, and each segment was labeled with an affective self-report. A multinomial logistic regression classifier was trained on this data using 10-fold cross-validation and was able to predict affective states significantly better than a baseline model. With this research we show that EEG can be used to distinguish between naturally occurring affective states during learning, without the need to experimentally induce them. A caveat of this non-experimental design is that we cannot neatly distinguish between emotion and cognition in the EEG. The affective states observed here are mixture states of both emotion and cognition.

### *4 Scanning Signatures: A Model to Represent Gaze Tracking Data*

**Enrique Garcia Moreno-Esteva, Anttoni Kervinen, Markku Hannula, Anna Uitto (University of Helsinki, Finland)**

We discuss how a network (graph theoretical) model can be used to analyze gaze tracking data coming from a preliminary experiment carried out in a biodiversity education research project. We discuss the network model (consisting of a simple directed graph with weighted vertices and edges and an arc ordering) which is used to represent the gaze tracking data in a way that is meaningful to study students' biodiversity observations. Our network model can be thought of as scanning signature of how a subject visually scans a scene. We provide a couple of examples of how it can be used to investigate the personal identification processes of a biologist and non-biologist when they are carrying out a task concerning the observation of species-specific characteristics of two bird species in the context of biology education research. We suggest that a scanning signature can be effectively used to compare the competencies of different persons and groups of people when they are making observations on specific areas of interests.

## Parallel session 2D – Higher education

### *1 The eye-mind of processing feedback: Unravelling how students use feedback for revision*

**Renske Bouwer, Kim Dirkx (Open University, Netherlands)**

Feedback is one of the most powerful instructional tools for writing. But how do students process and use teacher feedback to improve their writing? In two studies we investigated these processes for university students using a combination of eye tracking, thinking aloud, and keystroke logging measures. The first study explored how sixteen premaster students read and use the feedback for revision while thinking aloud. Results showed that students read all the feedback, but often in a rather linear way and without critically rereading one's own text. Only half of the feedback was used for revision. The probability of revising was unrelated to students' feedback reading strategy or the focus of feedback, but students were five times more likely to revise if the feedback was provided in a facilitative rather than a directive way. Similar results were obtained in a follow-up experimental study, in which 47 students received a written paper of average quality with feedback that was provided either as comments (condition 1) or as a combination of comments and in-text changes (condition 2). Results showed that even though all feedback is read, not all feedback is also used for revision. Students' revisions were predominantly at the surface level of the text. The probability on meaning-level revisions was increased for facilitative feedback. Together, by integrating online and offline process measures, these two studies provide novel insights on how students process teacher feedback and use it for revision. Implications of the findings for effective feedback will be discussed.

### *2 The Efficacy of Students' Problem-Solving Strategies in Higher Education in Jordan: Log File Analysis*

**Saleh Alrababah, Hao Wu, Gyongyver Molnar (University of Szeged, Hungary)**

Education must prepare students for jobs that have not even been imagined and to solve problems that have not been identified, to succeed in the 21st century. These expectations have shaped higher education, especially the desired outcomes, which resulted in novel assessment needs. Dynamic problem-solving (DPS) has become an important educational achievement indicator with two components: knowledge acquisition and knowledge application. The purpose of the study is to perform log file analyses to map the exploration strategies of Jordanian students. The participants were undergraduate students (Average age=21.50, SD: 3.03, N=195, Boys= 22.1% Girls= 58.5% missing= 19.5%) from two Jordanian universities. DPS was measured with the MicroDYN approach. The items have been adapted to Arabic language. The tests were administered via the eDia platform, data collection lasted 45 minutes. Analyses of process data were performed to detect the impact of exploration strategy use. The internal consistency of the DPS tests was high (Cronbach`s alpha=.83). The test proved to be hard for the students (M=16.8%; SD=16.7%-point). Log file analyses indicated that the use of a theoretically effective strategy did not always lead to high performance. Using latent class analyses on the process data, we identified three qualitatively different class profiles: 49.3% of students belonged to the proficient strategy users, 21.8% proved to be intermediate explorers and 28.9% were low performers regarding the use of successful exploration strategy. The pilot study confirmed that computer-based assessment is reliable and its advantages can be exploited in Jordan at university level.

### *3 Automated and controlled processes in comprehending multiple documents*

**Carolin Hahnel[1], Frank Goldhammer[1], Ulf Kroehne[1], Jorge Klagges[1], Nina Mahlow[2], Cordula Artelt[2], Cornelia Schoor[3] ([1]DIPF Leibniz Institute for Research and Information in Education, Germany, [2]Leibniz Institute for Educational Trajectories, Germany, [3]University of Bamberg, Germany)**

The study aims at investigating the nature of automated and controlled cognitive processes that take place when university students read and comprehend multiple documents. We assessed the performance and log data of 508 students dealing with two sets of multiple documents (i.e., two or three documents with up to 11 items addressing comprehension across documents). Process indicators were derived from students' interactions with the documents and comprised their processing time, the number of switches between documents as indication of corroboration, and students' visits to source information as indication of sourcing. Based on regression-based analyses, we examined the relationship of students' probability to solve the multiple document items correctly and their process behavior together with their reading speed and skills in memory updating and reading comprehension. The results show that an elaborate comprehension of multiple documents requires proficient reading comprehension skill, but students also benefited from efficient low-level reading components and, in easier items, from higher skill in memory updating. Skilled readers were also in a better position to adopt a more strategic approach to dealing with multiple documents, as shown by the positive prediction of students' engagement in corroboration and sourcing behavior through reading comprehension. A more complex pattern was observed for the prediction of processing time. Finally, the results indicate that, although multiple document tasks can be better accomplished by experienced readers, students can still achieve a deep understanding if they invest time, take a strategic approach, and learn how to deal with multiple documents.

## Parallel session 3B – Motivational, Social and Affective processes

### *1 Is Filtering Rapid Guesses Enough? A model-based comparison of multiple treatment approaches*

**Tobias Deribo, Ulf Kroehne, Frank Goldhammer (DIPF, Leibniz Institute for Research and Information in Education, Germany)**

Increased availability of time information through computer-based assessment enabled new ways to measure test-taking engagement. One of these ways is the distinction of solution- and rapid guessing behavior. Prior research recommended response-level filtering to deal with rapid guesses. Response-level filtering can lead to parameter bias if rapid guessing depends on the measured trait or (un-)observed covariates. Therefore a model based on Mislevy and Wu (1996) was applied. The model enabled us to investigate the assumption of ignorable missing data underlying response-level filtering. Moreover the model allowed to compare different treatment approaches in a single framework through model parameterization. Comparisons were made related to the sensitivity of the ability estimation, model fit and concurrent validity. The study found lower ability test-takers to tend to rapid guess more frequently, indicating a violation of the assumption of ignorable missing data underlying response-level filtering. Further ability estimation seemed sensitive to different treatment approaches. Altogether model-based approaches showed a better model fit and higher concurrent validity compared to response-level filtering. The results can illustrate the need to thoroughly compare specific treatment approaches in terms of the underlying assumptions and the impact on the validity of the interpretation of test-scores.

### *2 Online measures of learning engagement: patterns in time and relationships with off-line measures*

**Dirk Tempelaar (Maastricht University, Netherlands)**

The measurement of learning engagement is a major research theme, both in the learning analytics community and the broader area of educational research. The complexity of conceptualizing as well as operationalizing the construct of engagement generates a wide range of instruments, such as self-report surveys, log data from technology-enhanced learning systems, think-aloud and tests. In this empirical work, we investigate the alignment of behavioural traces of engagement with self-report measures and their impact on academic performance. The unique contribution of this study was the integration of temporal, behavioural, affective, and cognitive dimensions of engagement by combining digital traces at three different learning phases with self-report, formative as well as summative assessments. Using a two-step cluster analysis based on data from 1,027 undergraduate students in a first-year 8-week statistics course, we identified four distinct temporal engagement patterns (i.e. non-active, active before tutorial, active before quiz, and active before exams). Our analysis showed that early engagement (i.e. before tutorial) was significantly associated with course performance and self-report measures, while late engagement patterns had weaker correlations. This study shed further lights on a potential source of heterogeneity and collinearity in engagement measures (i.e. timing of engagement) that should be accounted for in learning analytics model. In order to design effective intervention, it is crucial to consider different profiles of learners based on their engagement patterns as well as the temporal relation between trace data, self-report, and academic performance.

### *3 Combining video and EDA data to explore emotional states and regulation in collaborative learning*

**Tiina Törmänen, Hanna Jarvenoja, Kristiina Mänty (University of Oulo, Finland)**

Social interaction in collaborative learning situations gives rise to various emotions. To maintain favorable socio-emotional grounds for committed learning and collaboration, group members need to be able to manage these emotions. The theory suggests that favorable conditions for collaboration

are built up in interaction between group members and shaped during socially shared emotion regulation activities. However, how individual group members' emotions are related to the actual activation of group level emotion regulation and, further, to their participation in collaboration, is still unclear. This study aims to explore the interplay between students' situational emotional states and actualized emotion regulation behavior during collaborative learning. The participants were 12-year-old students (N = 31, 10 groups) performing a collaborative science task. Students' situational emotional states were determined based on their emotional valence (video) and physiological activation (electrodermal activity). Actualized group level emotion regulation and participation in collaborative learning activities were observed from the video data. Results revealed that students' emotional states were related with their actualized regulatory behavior. Students with positive de-activating emotional state were more likely to initiate regulatory activities within the group, and in turn, students with negative emotional conditions were more likely to be targets for regulation. The results also imply that emotion regulation activated within the group did not inevitably shape the group members' emotional states as such. However, it may influence on their participation in further collaborative learning activities.

## No-or-not-so-perfect-data presentation

### Parallel session 1A – Self-regulated learning

*1 Self-regulated Learning with Virtual Environments: Challenges for Classroom-based Research*

**Elizabeth Cloude, Roger Azevedo (University of Central Florida, US)**

Studies have found that using self-regulated learning (SRL) processes with advanced learning technologies contribute to improved academic performance. Yet, gaps in research exist as studies have not been extended this work to virtual learning environments (VLEs). Since VLEs offer benefits most traditional ALTs do not such as immersion and presence in a variety of novel contexts, it is critical to assess how dynamic, immersive, and embodied elements of VLEs impact SRL and performance. As such, we examined 37 high school students SRL process use and performance over time in a science classroom. In our presentation, we will discuss the issues related to conducting a study in a science classroom to capture, analyze, and understand SRL processes as they temporally unfolded during learning about photosynthesis with a VLE while collecting multiple data channels such as think-alouds and self-report questionnaires. Specifically, we will focus on discussing issues related to conducting research in classrooms such as methodological and analytical issues. For instance, are think-aloud protocols ideal methods for capturing SRL during learning with VLEs for measuring extraneous cognitive load, detecting metacognitive processes, and assessing embodied cognitive strategies? What are ways we can map multimodal data to assumptions from contemporary SRL models for scaffolding SRL during learning with VLEs, etc. How to deal with missing online trace data from students over different time points, and which imputation techniques are ideal for maximizing information which also satisfies peer-reviews for scholarly publication? We will discuss challenges associated with publishing when using not-so-perfect data.

*2 Using keystroke-logging to investigate the effects of dyslexia and planning on writing processes*

**Sophie Hall (University of Southampton, UK)**

This presentation will focus on keystroke logging as a tool to assess the relationships between the processes involved in writing with text quality and knowledge development, or 'discovery' (Baaijen & Galbraith, 2018). Data collection for this project is ongoing, so the talk will focus on how keystrokes are analysed in relation to text quality and the development of the writer's understanding, highlighting issues that can arise when using keystroke logging as a tool for examining writing processes. This quasi-experimental study was designed to explore the effect of planning on text quality and the writer's subjective understanding for dyslexic and non-dyslexic undergraduates. 120 participants were randomly allocated to one of two planning conditions: (i) outline planning, in which students were asked to plan and write a well-formed essay; (ii) rough drafting, in which students were asked to write a rough draft of an essay with relaxed writing constraints and without an outline. Keystrokes were logged throughout the 30-minute writing period. Writers were asked to rate their subjective understanding of the topic before and after writing, and two judges will rate the quality of the final text. Composite measures derived from the keystroke logs, including pause bursts and revisions, will be used to assess the relationships between writing processes, text quality, and discovery. It is anticipated that the full analysis will be restricted to the non-dyslexic sample, but the presentation may include a discussion of the dyslexic sample.

*3 Arousal and cue-utilization during reading metacomprehension*

**Héctor J. Pijeira-Díaz (Maastricht University, Netherlands)**

Increasingly across educational levels, students need to learn from expository texts in a variety of subjects, making reading comprehension an important part of their learning. Students judge their comprehension (i.e., metacomprehension) based on cues, some of which are more diagnostic or predictive than others about their actual learning. The importance of metacomprehension is that it likely guides the contents student decide to restudy, which ultimately influences their learning and exam scores. Unfortunately, students' metacomprehension accuracy (i.e., the correlation between metacomprehension judgements and actual exam scores) is typically rather low (r = .27), which has been ascribed to inappropriate cue-utilization. Therefore, interventions are needed to support students in their metacognitive judgments. Concurrently, the range of cue-utilization (and subsequent performance) can be modulated by the level of arousal (i.e., physiological activation). In this proposal, we argue for the consideration of (at least two) arousal roles in text metacomprehension, namely 1) as a cue in its own right, owing to connections to cognition (e.g., attention) and affect (e.g., anxiety); and 2) as a cue-utilization modulator. Moreover, we propose to test arousal regulation interventions in this context. Methodologically, arousal can be conveniently measured via increasingly available wearable sensors (e.g., wristbands), which facilitate in-the-wild, continuous, objective and online measures during reading comprehension. This proposal aims to present to and discuss with the audience this theoretical perspective bridging reading metacomprehension research and arousal theory through the cue-utilization framework. Related empirical research, as well as experiment designs, materials and analyses are also to be discussed.

## Parallel session 1D – Teaching and Teacher Education

*1 Teachers' stress and focus of attention in the classroom: A case study of two Finnish teachers*
**Saswati Chaudhuri, Marja-Kristiina Lerkkanen, Eija Pakarinen, Heli Muhonen (University of Jyväskylä, Finland)**

The present study is first of a kind to investigate teacher stress and their focus of attention using eye tracking in authentic classroom situations. Firstly, aim of this study was to examine the extent to which teachers´ perceived stress could be associated with their focus of attention in the classroom. Secondly, to study how teachers with more and less perceived stress distribute their focus of attention in the classroom. A case study design was followed where in two teachers teaching Grade 1 were identified based on their self-reported stress scores from a larger data pool. Teacher 1 had higher than average stress score in all domains of Bergen Burnout Inventory whereas Teacher 2 had lower than average stress scores. Eye tracking was used to study teachers´ focus of attention in an authentic classroom situation using Tobii pro glasses 2. Eye-tracking video recordings were coded using coding criteria. Using total fixation durations, gini-coefficients were calculated to examine the variation in distribution of focus of attention among targets in the classroom. A positive significant relationship was found between perceived inadequacy and focus of attention. Both teachers in the study showed higher focus of attention on students in the spring. Additionally, teacher with more stress gave reduced individual attention on students in both fall and spring. However, teacher with less stress gave more individual attention to students in the fall. Further investigation of this topic is required using a larger sample to study how teachers´ focus of attention may vary with stress.

*2 Measuring teachers' synchronous online teaching performance*
**Maaike Grammens, Bram De Wever, Ruben Vanderlinde (Ghent University, Belgium)**

As a growing number of educational institutions and organisations are offering online learning programs, more and more teachers need professionalization and support to successfully master this new way of teaching. This is especially true for synchronous online learning, in which the teacher and the learners interact with each other online at the same time through video, chat and whiteboard modalities. In a previous systematic review study, we identified the competences and roles needed to teach a small group of students synchronous online through a virtual classroom. Currently, we want to map to which extent teachers already master these synchronous online learning (SOL) competences and present a holistic view of their current dispositions and behaviour. Building on the conceptual model of Blömeke et al. (2015), combined with the conceptual framework of professional vision (Sherin, 2001), our aim is to get a holistic view on the SOL competences of virtual classroom teachers by applying different ways to measure the different aspects of competence development. This presentation focuses on mapping the performance of virtual classroom teachers on SOL competences. We aim to achieve this by coding videos of online lessons, using a self-constructed and validated rubric. During our presentation, we also want to discuss other methodologies (e.g. eye tracking, mapping facial expressions or emotions, analysing log-files, automatic coding, …) and the advantages and disadvantages of using them for the purpose of measuring teachers' behaviour in a virtual classroom. Furthermore, we will question how to analyse the data and combine the different results.

*3 Exploring Regulatory Patterns in Collaborative Learning Using Electrodermal Activity Data*
**Andy Nguyen, Sanna Järvelä (University of Oulu, Finland)**

Successful students self-regulate their learning, whilst socially shared regulation is at the centre of successful collaborative learning (Järvelä, Hadwin, Malmberg, & Miller, 2018). Although recent research has established significant theoretical and conceptual foundations to understand and

support regulation in learning, previously published studies are limited to reveal the “invisible” metacognitive level regulatory processes. The advancement in technology has offered novel opportunities by enabling new instruments for collecting and analysing novel data sets to extend our understanding of self-regulated learning (Azevedo & Gašević, 2019; Järvelä, Järvenoja, & Malmberg, 2019). Among the innovative sources of data, electrodermal activity (EDA) has been recognised as a fairly accurate means to indicate sympathetic responses, discovering paths to affective attention and arousal, and signaling changes in psychophysiological states. Previous studies suggest that EDA may be a way to characterise groups’ physiological activation in challenging collaborative learning situations inviting for regulation (Dindar, Malmberg, Järvelä, Haataja, & Kirschner, 2020; Haataja, Malmberg, & Järvelä, 2018; Pijeira-Díaz, Drachsler, Järvelä, & Kirschner, 2019). In this study, we attempted to explore regulatory patterns in collaborative learning from a psychophysiological perspective using EDA data. In particular, we examined a large EDA data set collected from secondary school students collaborative learning (N=94) groups during 5 sessions in science learning tasks. These results play a role in confirming our theoretical predictions and determining informative measures for revealing regulatory processes in collaborative learning. Furthermore, our results concern how psychophysiological data can be transferred via learning analytics to a biofeedback dashboard to monitor and support for regulation.

## Parallel session 2A – Instructional design

### *1 Eye-tracking testing of learners work with graphs in Physics*

**Stanislav Popelka[1], Jana Skrabankova[2], Markéta Beitlová[1] ([1]Palacký University Olomouc, Czech Republic, [2]University of Ostrava, Czech Republic)**

Graphs are commonly used to represent mathematical functions, illustrate data from social and natural sciences, or specify scientific theories in textbooks. With the growing emphasis on the development of scientific inquiry skills, the work with graphs and interpretation of data is becoming increasingly important. The paper describes the eye-tracking experiment conducted to evaluate the student's work with graphs in physics. Eye-movement data were recorded with the use of the GazePoint eye-tracker. A total of 40 grammar school students in the third year participated in the study. These students were nominated into three groups by a physics teacher. These groups were called PLUS, AVERAGE and MINUS. The PLUS group showed excellent results in education and included gifted students in physics. The MINUS group comprised the opposite end of this cognitive spectrum, and its members made the most mistakes in graph reading. The aim of the experiment was to find the differences between students nominated these three groups and evaluate if the nomination based on the teacher's experience, long-term observations and student achievements is sufficient. The results showed that students from all three groups had problems with physics graph reading. Moreover, based on eye-movement data, we identified several students that had been incorrectly assigned to groups.

### *2 The Effects of Task Complexity on Learner's Gaze Behaviour when Observing Live Modeling Examples*

**Tim van Marlen[1], Suzanne L. Gerritsen[1], Bob J. Timmer[1], Vincent Hoogerheide[1], Halszka Maria Jarodzka[2], Tamara Van Gog[1] ([1]Utrecht University, Netherlands, [2]Open University of the Netherlands, Netherlands)**

Observing how another person executes a task is an effective way of learning referred to as example-based learning (Van Gog & Rummel, 2010). Recent research on video modelling examples has shown that gaze cues (seeing where the model is looking at during explaining) can guide the learner's attention toward the relevant information (Ouwehand, Van Gog, & Paas, 2015) and thereby improve their learning (Pi, Xu, Liu, & Wang, in press). However, inconsistent findings from fundamental research suggest that whether a person looks at another person's face might differ between live and video contexts. Therefore, this study will address the open question whether gaze cues would also guide attention and enhance learning when students observe live modelling examples. Participants will be seated face-to-face with the instructor who will be giving a live modelling example demonstrating how to assemble an electrical circuit of which some parts will be easy (easy-events) and others more complex (difficult-events). Participants will have to build along with the instructor while wearing eye-tracking glasses to examine how the participant's attention is distributed. Based on the findings that people fixate another person's face more often when the person is uncertain about what the other person is referring to (Hanna & Brennan, 2007) it is expected that participants will fixate the instructor's face more during the difficult events and that the use of gaze cues is positively related to performance. Given the spatial nature of the task, it will be examined how spatial ability affects attention allocation.

### *3 Promises and pitfalls of using neurophysiology to study the effects of pictorial seductive details*

**Christian Scharinger (Leibniz-Institut fûr Wissensmedien, Germany)**

EEG measures like the alpha frequency band power as well as eye-tracking measures like pupil dilation seem to be promising online process measures to study subjects' effort during task performance. Hence, these measures may provide valuable insights in the cognitive consequences of instructional design decisions. However, the feasibility and validity of using these measures for studying complex task materials have to be addressed further. The current research project pursues this goal by focusing on the pictorial seductive details (PSD) effect. Features of the PSD are systematically varied in the context of natural text reading tasks and highly controlled working memory tasks. An initial study addressed the hypothesized effects of PSD on working memory load. Subjects (N=32) performed text reading tasks followed by n-back working memory tasks. The presence of PSD (present /absent) as well as the task-inherent working memory load (low/high) was manipulated. It was hypothesized that increased working memory load would result in the EEG in a decreased parietal alpha frequency band power and in the eye-tracking data in an increased pupil dilation. Furthermore, the PSD-effect might be modulated by the task-inherent working memory load. Both, the EEG alpha frequency band power and the pupil dilation were sensitive for the intrinsic load-manipulation of the text reading as well as the n-back tasks. Although weak, the physiological measures also showed a load-effect for the PSD-manipulation, whereas the behavioral performance measures and the learning outcomes did not. Thus, the physiological measures seem to provide more fine-grained insights in the effects of PSD.

## Parallel session 3A – Eye-tracking

*1 Mobile gaze-tracking study: How photography influences attention on mathematically relevant targets*

**Antje Meier[1], Markku Hannula[2] ([1]Volda University College, Norway, [2]University of Helsinki, Finland)**

The aim of this study is to present our findings from a mobile gaze-tracking study in a natural setting on campus, both outside and inside. The tool for analysing gaze-tracking data depends on the goal of the study (Evans et al., 2012). Our goal was to explore in-service teacher education student' visual behavior during a photography activity and, for comparison, during a free walk (without taking pictures) after a group discussion about their pictures. Our research questions are: 1. How would photo-taking influence the duration of gazes? 2. Would a discussion on the pictures influence the amount and duration of fixations in the free-walk afterwards? And 3. How would photo-taking and discussion influence the amount and duration of fixations towards mathematics relevant objects in the free-walk? Our main findings show that students had longer fixations when taking pictures. While the number of gazes on discussed objects decreased, the number of gazes on new mathematically relevant objects increased. These findings indicate a higher degree of visual attention while photographing and more focus at novel mathematical objects afterwards. In the presentation we will present and discuss these and additional qualitative analyses of the photos and videos.

*2 Analysing problem-solving processes in a computer-based office simulation using eye tracking*

**Christian Mayer, Juergen Seifried, Andreas Rausch (University of Mannheim, Germany)**

To learn more about how knowledge workers solve domain-specific problems, we develop a computer-based office simulation, including typical workplace tools (e.g., e-mail, spreadsheets, ERP-software) and based on an authentic model company. In our study, we use eye tracking to analyse the problem-solving processes of test takers. First, by determining eye-tracking indices such as fixation or saccade duration, we expect to gain insights into behavioural differences among learners and in the effectiveness of interventions within the scenarios. Second, we include facial emotional recognition to supplement our eye-tracking data. Finally, we want to contribute to the emerging research of eye tracking in education and online measure of learning. While this research is on an early stage, we like to discuss research design, analysis issues or other issues related to this work.

*3 Students visual behavior during problem-solving of electrical circuits* **Michael Thees[1], Eva Rexigel[1], Sebastian Kapp[1], Kristin Altmeyer[2], Fabian Beil[1], Sarah Malone[2], Pascal Klein[1], Roland Bruenken[2], Jochen Kuhn[1] ([1]Technische Universität Kaiserslautern, Germany, [2]Saarland University, Germany)**

Eye tracking techniques enables researchers to analyze detailed problem-solving processes in science education (Tsai, 2012; Klein et al. 2019). In the context of graph understanding, Klein et al. (2019) demonstrate that information about students' selection and integration of representational forms are provided by measuring learners' visual attention allocation. Yet, little research was conducted on electric circuits using eye tracking as method to investigate learners' interaction with schematic representations. The goal of the study was to explore the impact of common pre-concepts on students' visual behavior during problem-solving tasks. We used a Tobii X3-120 remote eye-tracker to detect the visual behavior of first-semester engineering students (N=107) solving a selection of 10 items from an electrical concept test (Urban-Woldron & Hopf, 2018). We used a pattern analysis method to explore differences in students' spatial distribution of visual attention allocation.

Concerning items examining multiple parallel connections, crucial regions can be outlined based on the pre-concept of local reasoning. There, experts are intended to interpret the connecting nodes correctly and therefore to choose the correct answers. The pattern analyses reveal experts to have a higher relative proportion of their attention on connecting nodes than students using the pre-concept. However, the clear assignment of specific regions to experts and novices was not always possible, depending on the answer format, the specific circuit, and the allocated pre-concept.

## Parallel session 3C – Learning analytics and technology-enhanced learning

### *1 Are Online Behaviors Enough? Scientific Reasoning and Performance during Game-based Learning*

**Megan Wiedbusch, Elizabeth Cloude, Roger Azevedo (University of Central Florida, US)**

Active inquiry learning (e.g., scientific reasoning) is key for developing a deep repertoire of rich content knowledge[1,2,3]. The Scientific Discovery as Dual Search (SDDS) framework defines this learning as occurring in both hypothesis and experimental spaces[4]. Specifically, within the hypotheses space, attention and effort are directed to the research problem and specific aspects of the environment (e.g., the potential source of a virus) while within the experimental space, learners develop causal relationship models and test their hypotheses (e.g., testing milk for pathogens). In this study, undergraduates engaged in scientific reasoning while learning with Crystal Island, a serious game, to solve a mysterious disease outbreak on a fictitious island. We show that college students that had guidance during inquiry learning with the serious game outperformed those without any guidance, consistent with previous research[2,5]. Additionally, learners without any guidance traversed from the hypothesis space to the experimental space later in their gameplay, suggesting more time spent developing hypotheses. Surprisingly however, the point at which learners transition from the hypothesis space to the experimental space is not predictive of performance. This suggests that using just behavioral markers mapped to the SDDS framework is not enough to explain learning. Additional channels of data capturing cognitive, metacognitive, affective, and motivational processes may provide more information that explains performance.

### *2 Choosing in comparative judgement: how to model eye-gazing data?*

**Sven De Maeyer, Marije Lesterhuis, Marijn Gijsen (University of Antwerp, Belgium)**

Recently the method of comparative judgement, in which judges are asked to compare two pieces of student work, has gained attention in the literature on assessment. This research mainly focusses on the merits of this method. What is lacking however, is a deeper understanding of the processes underlying the choices made by judges when comparing two pieces of student work. The current study contributes to this field by introducing eye-tracking research and the use of finite mixture models to statistically model fixation duration data. In an eye-tracking lab we tracked eye movements of 23 judges while each making 10 comparisons of argumentative texts. Making use of Bayesian analyses we compare statistical models that reflect different types of processes that generate the fixation duration data. The results show that a model with two underlying processes fits the data best. From this we can conclude that two reading processes are reflected in the eye-gaze data: reading a text thoroughly vs scanning texts while actively comparing both texts.

### *3 Identifying learning analytics dashboards preferences through focus groups in higher education*

**Ellen De Bruyne, Wannes Heirman, Amber Hoefkens, Gert Vanthournout (AP University of Applied Sciences and Arts Antwerp, Belgium)**

This study presents preliminary results of the ongoing multidisciplinary applied research project “LAP!” (Learning Analytics at AP). The project aims at improving online learning environments and the development of a LA dashboard at AP University of Applied Sciences and Arts Antwerp. With learning analytics (LA), learning data are analyzed and reported with the aim of better understanding the learning process of students and optimizing their learning environment. Insights from LA can help

higher education institutions to respond to challenges, such as identifying and supervising risk students or organizing more effectively blended or online learning. This study aims to identify relevant learning analytics and graphical elements for the development of LA applications or 'dashboards'. Focus group methodology is used to examine user preferences of LA dashboards. Users' needs and preferences are mapped among three target groups: students, lecturers and deans. Preliminary results demonstrate the different preferences of these groups regarding learning performance indicators and lay-out characteristics of learning analytics' dashboards.

## Posters

### *1 Process-based measurement of professional vision of (prospective) teachers: a systematic review*

**Ann-Sophie Grub, Antje Biermann, Roland Bruenken (Saarland University, Germany)**

Effective classroom management is seen as a fundamental component of teachers' professional competence. The early detection of potential disturbances is of great importance for a proactive control of the teaching process. Professional vision serves as a link between teacher's knowledge and his or her actions in the event of deviations. Professional vision can be split into the two aspects noticing and reasoning. Previous research, based on subjective test procedures (i.e. video analysis or interviews) has mainly focused on the process of reasoning, whereas only a few studies focused on the basal process of noticing, i.e. the recognition of possible disturbing situations. It is known from expertise research in different domains (e.g. medicine, chess, aviation and traffic psychology) using process-based methods like eye-tracking that experts and novices show differences in noticing processes. To summarize eye-tracking research for the teaching profession – especially noticing in classroom management – a systematic literature search was carried out for the period from 1999 to 2019. A total of 12 studies were found which recorded professional vision using eye-tracking. Overall, there were stable differences in the eye movement patterns of experts and novices for different parameters. However, some questions about possible influencing factors on expertise dependent perception remain unsettled.

### *2 Combining a pen tablet and eye-tracking to analyse calculations procedure in Physics*

**Stanislav Popelka[1], Patrik Koci[2], Jana Skrabankova[3] ([1]Palacký University, Olomouc, Czech Republic, [2]Gymnasium Novy Jicin, Czech Republic, [3]University of Ostrava, Czech Republic)**

The contribution describes a new approach to analyse learners' strategies of calculations in physics. Three students were working with the newly created worksheets focused on the problematic of direct current. These worksheets were presented on the computer screen. Under the screen, the GazePoint eye-tracker has been placed for the recording of student's eye-movements. Students were able to write calculations and remarks directly into the worksheet using a pen tablet. The study aimed to prove if the combination of the pen tablet and eye-tracker will work. It showed that the system works very well. After a few minutes, the students get acquainted with the pen tablet control, and eye-movement recording also worked well. With the use of this combination of technologies, it was possible to recognize what students were doing during 45 minutes of working on the worksheet tasks. The qualitative analyses show that students return very often to the assignment, still verify their decisions, and return to them several times. The results proved the designed system functionality, and it might be used for the analysis of students' work not only in the field of physics but in any subject where it is beneficial to record eye-movements during the writing task.

### *3 I see what you did there: adaptive support with eye movement displays*

**Carolien A. N. Knoop-van Campen[1], Ellen Kok[2] ([1]Radboud University Nijmegen, Netherlands, [2]Utrecht University, Netherlands)**

Adaptivity in education is difficult for teachers to implement in their teaching. During assignments including reading comprehension teachers cannot see which reading strategy students are using, because those processes are covert. This makes it difficult for teachers to identify exactly where students are going wrong, and consequently to determine what kind of support students need. Due to emerging technological developments, teachers dashboards which provide visualizations of students' performances, are increasingly used to effectively support teachers in adapting their teaching to the individual needs or their students. As such, visualizing students reading

comprehension strategies to teachers, could support their adaptivity towards their students. A way to do so, is by means of displaying students eye movements when reading a text. Eye tracking shows where are students looking, for how long and in what order and may thus provide teachers important information about reading strategies. Therefore, in this study, we examined whether teachers can interpret the eye movements of students and relate them to reading comprehension strategies. We plan to provide teachers with various eye tracking displays (obtained from a previous study) showing the eye movements of students. These students completed reading comprehension questions in which the questions elicited different reading strategies and indicated their confidence with the given answer. Teachers were asked to indicate students' reading comprehension strategy and to estimate students' obtained score and indicated confidence. By connecting student and teacher data, a link can be made between what a student has actually done and the teacher's interpretation.

### *4 Expert and novice teachers managing classroom disturbances: First findings from a pilot study in the lab*

**Mandy Klatt (University of Leipzig, Germany)**

Teachers' attention in the classroom is key for effective classroom management, in particular, teachers' "withitness" (Dessus, Cosnefroy, & Luengo, 2016; Marcum, 2017; van den Bogert, 2016).For an upcoming study, we will use eye tracking methodology to investigate the professional vision of pre-service teachers in a classroom setting. The aim is to explore connections between teachers' visual attention and students' in-class experience of the teachers' withitness. Data will be collected from pre-service teachers in a between-subject design with a control and an experimental group. In each session, one student will take the role of the teacher simulating a brief lesson, while other students act as the class. During teaching, the teacher student's focus of attention is assessed by using a head mounted eye-tracking device, the speech is audiotaped by a wearable microphone, and movement, mimics, and gestures are recorded from different angles by several cameras. Teachers in the experimental group receive a briefing on how to react to disruptions in class in a low-profile manner, which is in line with recommendation for effective classroom management (e.g. Evertson & Harris, 1992). Teachers in the control group receive no such briefing. In order to match conditions, all teachers receive the same teacher-centered 20-min-lesson plan. The students representing the class receive behavioral instructions to simulate typical classroom events and disruptions. Finally, the students acting as the class answer items about their experience of the teacher's withitness, or presence, drawing on validated classroom management questionnaires (e.g. Helmke et al., 2016).

### *5 Evidence informed development of an online Learning Analytics (LA) dashboard for successful learning*

**Ellen De Bruyne, Amber Hoefkens, Wannes Heirman, David D'Haese, Gert Vanthournout (AP University of Applied Sciences and Arts Antwerp, Belgium)**

Learning analytics are typically represented by means of dashboards that display the most important information of learning traces. The LAP! project aims to develop a qualitative dashboard for different user groups at the university: students, lecturers and deans. The poster presents the project plan, development architecture, iterative design and the related research process that meets the needs of specific user groups. Preliminary results present technical and content related findings. The results will also cover learning insights of LA, prioritized learning activities, design principles and LA representation preferences of different user groups. This poster presents the ongoing multidisciplinary applied research project "LAP!" (Learning Analytics at AP). The project aims at improving online learning environments and the development of an LA dashboard at AP University of Applied Sciences and Arts Antwerp.

*6 Using Smartpen Features to Predict Elementary School Children's Performance in Sketching Tasks*

**Kristin Altmeyer[1], Michael Barz[2], Sarah Malone[1], Luisa Lauer[1], Roland Bruenken[1] ([1]Saarland University, Germany, [2]German Research Center for Artificial Intelligence Saarbrücken, Germany)**

Smartpen features offer the possibility to record handwriting and sketching features during tasks of varying difficulty. Since children show problems in providing valid self-report of perceived task difficulty and can easily be distracted by external stimuli, the objective and non-intrusive real-time measurement of handwriting features seems to be of particular advantage for this target group. Previous research on adults could already show that several writing features proved to be related to mental workload, which was induced by task difficulty and in turn affected task completion time. The current study aimed at examining this predictive function of smartpen data for a sample of N = 33 primary school children. For this purpose, a within subject-design was applied: The children completed two parts of the Trail Making Test differing in their complexity as well as six drawing patterns of increasing difficulty extracted from a nonverbal intelligence test. Results revealed that using machine learning algorithms, two levels of difficulty can successfully be classified across all tasks by handwriting features. An accuracy of 94.73% was achieved. Moreover, smartpen data could predict task completion time ($R^2$ = .77). Consequently, handwriting features proved to be an adequate and valid measure to assess task difficulty and indicate performance in a sample of children. From a practical point of view, this easily applicable measure could be used to detect particular obstacles occurring during the task-solving process and support children more specifically.

*7 Mobile eye tracking for the diagnosis of learning difficulties in student experiments*

**Sebastian Becker, Stefan Küchemann, Pascal Klein, Jochen Kuhn (University of Kaiserslautern, Germany)**

Research questions that can be answered with stationary eye-tracking systems are limited to the presentation of learning content via computer screen. Especially for learning scientific content, typical learning scenarios require a more flexible use of eye-tracking systems. For example, learning by means of real lab experiments cannot be captured with stationary eye-tracking systems. Although lab experiments play a key role in science teaching, studies have shown that the potential for learning is only insufficiently exploited. Since student experiments are usually conducted in small groups of two to four students, a possible reason for a missing learning success could be that students are unskilled in collaboration so they are unable to contribute fully to the assigned experimental task. Mobile eye tracking should make it possible to investigate the interaction of the students in order to gain valuable new insights into cooperative learning difficulties and their relation to learning success when conducting student experiments, which to our knowledge is still largely unexplored. A similarly high value in school as well as in higher education environments is the construction of representations, typically called generation. Mobile eye tracking offers the great opportunity to understand learning and problem-solving strategies during generation and quantify underlying information selection and integration mechanisms on a process level. Furthermore, it would be also possible to study the generation of representation during labwork settings and so the combination of these two aspects.

*8 The Complexity of Comparative Judgement: Looking Decision Accuracy and Task Familiarity in The Eyes*

**Marijn Gijsen, Marije Lesterhuis, Sven De Maeyer, David Gijbels, Tine van Daal (University of Antwerp, Belgium)**

Comparative judgement (CJ) was recently introduced in the educational field to assess competences. Assessors are presented with two pieces of student work and are asked to choose which of both is better regarding the competences assessed. This results in a quality estimation of each product in the form of a scale. Student work is however heterogenous and highly information loaded, this raises the question whether this type of assessment is not too complex. Previous research operationalised experienced complexity by using self-report measures. Therefore, this study makes use of eye-tracking to operationalize experienced complexity while building on previous research which integrated the theoretical framework on task complexity by Campbell into CJ and formulated hypotheses regarding the role of decision accuracy. Based on this framework and previous research three hypotheses are formulated and empirically tested. Hypothesis 1 assumes that rank-order distance is negatively related to experienced complexity; irrespective of decision accuracy. Hypothesis 2 assumes that decision accuracy moderates the relationship between rank-order distance and experienced complexity. Hypothesis 3 expects a negative relationship between experience and experienced complexity. In all three hypotheses the average experienced complexity is assumed to vary between assessors as well as the strength of the expected relationships. All hypotheses were translated into a statistical model and their relative and absolute fit are assessed. The results provided evidence for hypothesis three. Both the moderating role of decision accuracy on the relationship between rank-order distance and experienced complexity and the relationship between experience and experienced complexity are confirmed.

*9 What if 'eye' find it too difficult? English non-native speakers' response to text simplification*

**Irina Rets (Open University, UK)**

Open Educational Resources (OER) aim to provide equal access to education. Yet, the language level used in OER in English was found to require native or advanced proficiency in English. There is a call to make these resources more comprehensible. This study combined eye-tracking methodology and comprehension assessment to explore the effect of text simplification on English second language (L2) users, while also accounting for text organisational structure, and individual predispositions. A total of 37 adult English L2 users took part in the study. They had to read either an authentic narrative, authentic expository OER, or their linguistically simplified versions. The analysis showed that simplification led to better text comprehension, and text narrativity facilitated text recall, particularly at lower English proficiency levels. Eye-tracking measures revealed that text simplification led to an increase in processing time during initial reading of the text, and a decrease in processing time during text reinspection. These findings have strong practical applications for online teaching with OER.

*10 Exploring teacher educators' and student teachers' "professional vision" with eye-tracking*

**Corinne Wyss[1], Katharina Rosenberger[2], Wolfgang Bührer[3] ([1]FHNW School of Education, Switzerland, [2]University College for Teacher Education, Austria, [3]PH Zürich, Switzerland)**

Current research approaches about teacher professionalism focus, among other issues, on the concept of "professional vision" (Goodwin, 1994). To investigate this concept, the eye-tracking method could provide important new insights. However, there are not yet many studies on this issue. In the exploratory study presented here, 56 study participants (28 student teachers and, as a reference group, 28 teacher educators at a university of teacher education) were each shown a one-minute video clip of a real teaching situation in which a critical incident (cf. Tripp, 1993) can be observed. The viewing behavior of the participants while watching the video on a computer screen was recorded and

the post-hoc think aloud verbalizations were audio-taped. Both eye-tracking data and verbalizations were analyzed. The study examines the following overarching question: To what extent can differences, which point to "professional vision", between student teachers and teacher educators be identified when viewing a videotaped teaching scene containing a "critical incident"? The results reveal differences between the two groups studied – both in eye tracking and in interview data. The statements of the teacher educators in the oral survey are generally more substantial and the critical incident was only explicitly mentioned by persons from this group. The eye-tracking analyses show that the viewing behavior of this group of teacher educators differs significantly from the other study participants with regard to the defined AOIs. The results substantiate those differences in "professional vision" between novices and experienced teaching relate to those in similar studies (e.g.Wolff et al., 2016).

*11 Eye-Tracking for investigating teachers' diagnostic judgments from a process-view*

**Saskia Schreiter, Markus Vogel, Markus Rehm & Tobias Dörfler (University of Education Heidelberg, Germany)**

Non-reviewed poster

*12 Comparing Augmented-Reality-Technologies in Learning Scenario on Electrics for Primary Education*

**Luisa Lauer, Markus Perschel, Kristin Altmeyer, Sarah Malone, Roland Brünken, Hamraz Javaheri, Agnes Grünerbl & Paul Lukowicz (Universität des Saarlandes, Germany)**

Non-reviewed poster

*13 Educational videos - Thesis circles for replications*

**Christian M. Stracke & Halszka Jarodzka (Open University, the Netherlands)**

Non-reviewed poster

*14 Students' joint visual attention to teacher gestures in collaborative mathematical problem solving*

**Eeva Haataja[1], Anniina Koskinen-Salmia[1], Visajaani Salonen[1], Miika Toivanen[2], & Marku Hannula[1] (University of Helsinki, Finland, SeeTrue Technologies, Finland)**

Non-reviewed poster