Earli SIG 6&7

The Learning *Confoederatio* – Navigating (Digital) Change through Evidence

Book of Abstracts

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SYMPOSIA

AI-Based Feedback and Learning Processes: Engagement, Design, and Motivation

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Discussant(s)

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Theoretical and empirical research has shown that feedback can effectively support learning and writing processes by guiding learner's cognitive and metacognitive activities. With the growing availability of generative artificial intelligence (AI), AI-based feedback is increasingly used in educational contexts, promising individualized, scalable support and reduced workload for instructors. However, it is still unclear how learners engage with AI feedback and under which conditions it fosters meaningful learning rather than superficial uptake. This symposium addresses the learning process-oriented design of generative AI-based feedback by focusing on learners' engagement, cognitive activities, and regulatory processes as central mechanisms of learning. Across diverse learning and writing formats, including learning journals, argumentative and academic writing, as well as intelligent tutoring systems, the four contributions investigate how specific AI feedback design features influence learners' engagement with feedback. These features include differently pre-prompted AI chat environments, instructional and reflective feedback dialogues, worked examples as additional learning support, and erroneous AI-generated feedback. The studies examine how engagement patterns translate into cognitive, metacognitive, motivational, and affective processes, and under which conditions motivational benefits or costs emerge. Taken together, the contributions demonstrate that AI-based feedback entails both learning opportunities and risks, depending on feedback design, patterns of use, and learner characteristics. A leading expert on feedback processes will conclude the symposium by synthesizing the findings and discussing implications for designing AI feedback that supports deep learning while balancing engagement, metacognition, and motivation across educational contexts.

Included Papers

Instructive vs. Reflective AI Feedback Chatbots: Students' Interaction, Perception, and Reflection

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Generative AI (GenAI) is increasingly used by university students as a conversational feedback partner in academic writing and revision. This raises questions about how different AI feedback chatbot designs influence students' feedback interactions in authentic higher education contexts. This mixed-methods study compares the effect of two purpose-built AI feedback chatbots (instructive vs. reflective) on students' feedback interactions, feedback perceptions, and reflection during an abstract writing exercise. Conducted in a master-level course (N = 23), the between-subjects study combined pre- and post-surveys, draft and revised abstracts, AI chat logs, and observation notes from mixed-group discussions. Quantitative results showed that students in the instructive condition had significantly higher feedback perceptions and greater self-perceived improvement in abstract quality, while chat log analysis revealed significantly higher levels of feedback interaction in the reflective condition. Qualitative analyses indicated that participants in the instructive condition often uncritically adopted AI suggestions, whereas students in the reflective condition showed greater deliberation, monitoring of writing decisions, and project-level reflection, but also increased frustration when the chatbot did not meet expectations of direct solutions. Observational field notes from mixed-group discussions revealed students' critical reflection on their use of the two AI designs, where students articulated tensions between efficiency, autonomy, and responsibility for self-regulated writing. Overall, the findings show that chatbot design significantly shaped students' feedback interactions, feedback perceptions, and self-assessed improvement. We found that explicitly comparing instructive vs. reflective AI feedback chatbots in the classroom can stimulate productive peer discussions about critical and self-regulated uses of GenAI in academic writing.

Pre-Service Teachers' Engagement in AI-Based Argumentation Learning

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Argumentation skills are essential for professional teaching, yet many pre-service and in-service teachers struggle to construct coherent arguments. Although worked examples and AI-based

feedback offer promising support opportunities for argumentation learning in teacher education, little is known about how and why they are used in job-related argumentative writing tasks. In a seven-week online course, 255 German pre-service teachers were randomly assigned to a feedback-only or a feedback-example condition. Following a pretest on argument structure and fallacies, students completed four job-related argumentative writing tasks supported by an AI-based feedback tool. Engagement was assessed by the frequency of feedback requests and revision behavior. In the feedback-example condition, color-coded worked examples were presented additionally. Results showed no group-level differences in feedback engagement, and revisions following worked examples were rare. Across groups, 52.5% of the students did not revise their texts. Among students who revised their texts at least once, a model-based cluster analysis identified three distinct engagement patterns differing in feedback intensity and revision frequency. Engagement was associated with acceptance of AI, prior experience with AI, and pretest knowledge of argument structure, but not with general motivation toward argumentation or pretest knowledge of argumentation fallacies. Overall, the findings highlight substantial heterogeneity in feedback engagement and provide a basis for subsequent analyses of pre-service teachers' argumentation learning.

Improving learning success and strategy use in journal writing with ChatGPT as a feedback tool

Presenter(s)

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Journal writing is a beneficial medium for self-regulated learning by promoting cognitive and metacognitive learning strategies. While feedback on strategy use can enhance learning, evidence on the quality and effectiveness of AI-generated feedback remains mixed. Drawing on situated learning theory, we conceptualize ChatGPT – following Vygotsky – as a cognitive tool that may learners enable to learn and to solve problems on a higher level as they would be able to realize independently, that is, without the support by ChatGPT. However, the effectiveness of the cognitive tool use depends on the quality by which learners engage with the feedback provided by ChatGPT. Study 1 examined whether ChatGPT feedback improves learning success and strategy use in journal writing more than teacher feedback. In a field experiment (N = 169), feedback increased strategy use but did not enhance learning success compared to no feedback, and ChatGPT feedback was not superior to teacher feedback. A mediation analysis indicated that elaboration strategies partially explained feedback effects. Study 2 (ongoing, current N = 45, targeted N = 120) investigates whether structuring the feedback as interactive human-AI dialogue improves learning. Preliminary results suggest that the quality of the interaction with ChatGPT strongly predicts learning success. Together, the findings indicate that feedback effectiveness depends less on merely receiving feedback as a static product and more on learner engagement with ChatGPT as cognitive tool. Structuring feedback as an interactive process may better

support self-regulated learning, highlighting the importance of pedagogically structured human-AI interaction in educational contexts.

Learner Motivation Declines With Erroneous AI-Generated Feedback in Tutoring Systems

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Feedback can enhance motivation and learning, and large language models (LLMs) have the potential to provide elaborated feedback automatically. However, feedback generated by LLMs may be erroneous due to hallucinations. To fully understand the potential harmful consequences of LLM-generated feedback in education, learners' motivational responses to erroneous LLM-generated feedback must be explored. In a mathematics tutoring system, this randomized controlled study investigates the effects of LLM-generated feedback containing errors on engagement with feedback and self-reported task-related motivation and self-concept. In our preregistered study (N = 249), the learners were assigned to one of four conditions with different proportions of problems with feedback containing errors due to hallucinations: 0% hallucinations (all feedback was accurate), (2) 50% hallucinations (one half of the feedback instances contained errors), (3) 100% hallucinations (all feedback instances contained errors), or (4) no feedback (control condition). Learners receiving feedback with more hallucinations showed higher engagement (i.e., time spent on feedback), but also reported lower self-reported task-related intrinsic motivation compared to learners receiving less hallucinations or no feedback. No effects were found for self-concept or the moderating role of prior knowledge. Highlighting the importance of considering both time on feedback as indicator of feedback engagement and task motivation, the findings provide initial evidence for the potential motivational risks associated with LLM-generated feedback. Further research is needed to shed more light on the underlying mechanisms that caused the contrasting patterns of results observed.

Beyond "More Theory": What Models in Learning & Instruction Can and Can't Do

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Discussant(s)
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The claim that "there is nothing as practical as a good theory" remains timely in educational psychology. Theory guides empirical research, and it informs and provides orientation for

instructional practice. Educational researchers have renewed calls for “more theory,” yet the field rarely specifies what an instructional theory should accomplish. Some theories primarily describe and explain learning processes; others generate testable predictions and research questions; and still others guide instructional design and evaluation. Noting this fragmented state, Renkl(2023) recommends stronger theoretical integration. The present symposium follows that recommendation by convening proponents of current theoretical models on instructional design and multimedia learning.Four papers compare models that differ in scope, complexity, and intended use. The FoRe-Squares Model highlights actionable levers for technology-augmented instruction by specifying how focused support and reward relate to instructional effectiveness. CASTLEexplains learning in digital environments through coordinated cognitive, affective, and social mechanisms, thereby specifying boundary conditions and multidimensional outcomes. CAT4LearnIn offers a deliberately simple alignment heuristic that links learning goals, instruction, and assessment under classroom constraints and supports shared description across research and educational settings. A fourth paper rounds out the symposium by contributing an additional instructional theory, enabling a more comprehensive contrast in scope, precision, and instructional usefulness. The discussant will evaluate the contributions, not primarily by the classical criteria for evaluating theories (e.g., internal consistence, parsimony) but particularly by the typical deficits of theories in psychology and related fields, as specified in respective articles (e.g., Insufficiently specified phenomenon and explanatory questions meant to address).

Included Papers

FoRe-Squares Model

Presenter(s)
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Technology is omnipresent in education (e.g., through LLMs, explainer videos) and practitioners should know evidence-based answers to questions about when and why technology-augmented instruction helps or hinders learning. Finding evidence-based answers however requires them to integrate many theories and concepts from multiple research fields (e.g., multimedia learning, intelligent tutoring systems, gamification) and perspectives on learning (cognition, motivation), which makes those answers less likely to be found. We drafted a simple model (i.e., FoRe-Squares model) that integrates research from multiple research fields as well as cognitive and motivational theory to address this problem. The FoRe-Squares model postulates that effective instruction requires both Focus support (cognitive factor) and Reward (motivational factor) to enable and energize active goal-directed processing, leading to good learning outcomes. A low level of either focus support or reward is unable to do so. It follows that instruction is effective when it not only provides cognitive support (e.g., through signaling, contiguity, testing) to increase focus support, but also provides motivational support (e.g., through choice,

gamification) to increase reward. By predicting learning outcomes across a broad range of situations based on the combination of these two factors only (focus support, reward), the FoRe-Squares model is a simple but evidence-based guide to both inform instructional practice and stimulate further research that closely considers the interplay between cognitive and motivational processes.

SEPE: An Abductive Theory Model of Pedagogical Enactment of Technology-Augmented Instruction

Presenter(s)
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Research on Technology-Augmented Instruction (TAI) is limited by a static, linear approach that emphasises enabling conditions rather than dynamic mechanisms and treats pedagogy and technology as independent drivers rather than as embedded in their contexts. This approach fails to account for the situated negotiation among teacher intent, digital affordances, and the classroom's contextual realities. By treating TAI as a fixed state defined by conditions rather than a fluctuating enactment, existing theory fails to explain the striking inter- and intrapersonal variability in teachers' TAI practices, nor the lack of uniform predictors. These gaps suggest the reality of instruction is far more complex and situational than current static variable snapshots suggest.To address this contextual complexity, we introduce the Socio-Ecological Processual Enactment (SEPE) model. SEPE shifts the focus from static conditions to process: the reciprocal, situated interactions through which technology is actually enacted in an instructional setting. For example, SEPE captures how a teacher's instructional pivots, such as abandoning a digital drill for a collaborative digital mind-map when sensing student confusion, represent high-level orchestration of teacher agency, tool affordances, and learner cues. This movement constitutes the actual engine of TAI.Based on an abductive theory-building process analysing 169 observations and 79 interviews, SEPE explains why TAI remains heterogeneous even under homogenous conditions. It argues that while provision (e.g., infrastructure, skill, and will) is foundational, TAI must be understood as a situated negotiation rather than a catalogue of conditions, reframing the field's focus toward the processual reality of classroom practice.

CAT4LearnIn: A Constructive Alignment Taxonomy for Learning and Instruction

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We introduce the Constructive Alignment Taxonomy for Learning and Instruction (CAT4LearnIn), a theoretically grounded but deliberately simple taxonomy for aligning learning goals, instruction, and assessment. Existing taxonomies are often too demanding for everyday practice and too heterogeneous for clear comparison across studies; the CAT4LearnIn addresses this gap by offering a shared, basic heuristic for research and practice.Building on work in constructive alignment, major learning-goal taxonomies, and psychological science, we abstract the diversity

of existing models into two orthogonal dimensions: cognitive processes (acquire vs. practice) and information complexity (low vs. high). Crossing these dimensions yields four cells—associate, retrieve, restructure, and apply—which capture core combinations of process and complexity. Each cell can be linked to characteristic learning goals, typical instructional strategies, and aligned assessments. Based on an analytical review and synthesis of existing frameworks, we justify the abstraction to the two key dimensions, and construction and operationalization of the four-cell matrix. The CAT4LearnIn is intended as a bridge between highly differentiated taxonomies and models and everyday teaching. It supports coherent constructive alignment, fosters diagnostic and adaptive instruction, and offers a common language for describing interventions, thereby enabling translation between research and practice as well as contributing to cumulative educational research.

The cognitive-affective-social theory of learning in digital environments (CASTLE)

Presenter(s)

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Digital learning research has traditionally been guided by cognitive and multimedia learning theories that explain how learners choose, organize, and integrate information within capacity limits. However, increasing evidence indicates that learners often treat digital materials as social, responding to voices, gestures, feedback, or polite phrasing as if another person is present. These social responses can influence attention, motivation, emotion, and metacognition, yet they are not systematically incorporated into current models of learning in digital environments. The Cognitive-Affective-Social Theory of Learning in digital Environments (CASTLE) is an integrated learning theory that describes how social cues in digital content affect learning by activating social schemata in long-term memory. It provides a structured taxonomy of social cues across different modalities, including linguistic (e.g., personalization), visual (e.g., anthropomorphic features), dynamic (e.g., gaze and gesture), auditory (e.g., prosody), and interactive cues (e.g., adaptive feedback and comparative indicators), as well as structural cues indicating collaboration or conflict. CASTLE suggests mediating processes—such as parasocial engagement, social comparison, perceived social presence, and conflict elaboration—that interact with cognitive, motivational, emotional, and metacognitive mechanisms to influence how information is processed and evaluated. The theory offers testable hypotheses about when and for whom social cues impact learning, outlining boundary conditions based on cue strength, modality, timing, interactivity, and learners' prior schemata. By integrating findings from multimedia learning, social psychology, and human–computer interaction, CASTLE provides a research framework to explain inconsistent effects of design features and to guide the development and assessment of digital learning environments.

Cognitive Activation in Digitally Supported Learning Environments Spanning Multiple Learning Phases

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Discussant(s)
Sascha Schneider | University of Zurich, Switzerland

Teaching often unfolds in multiple phases, each with distinct goals and instructional methods. Multi-phase settings can leverage the strengths of each phase to enhance learning, for example, by building intermediate knowledge in one phase that serves as a foundation for deeper understanding in the next (Loibl et al., 2024). Learning in these phases can be supported by digital tools. Digital tools can, for instance, support discovery-based learning and can cognitively activate learners during direct instruction. While numerous digital tools exist for practice, there is a lack of well-founded didactic concepts and empirical evidence for how digital tools foster cognitive activation when introducing new content (Drijvers et al., 2021) and building on intermediate knowledge. Cognitive activation is a key quality criterion in both digital and conventional teaching (Klieme, 2020). In digitally supported learning environments, the central question is which digital features promote which cognitive activities, and how these lead to learning success (Reinhold et al., 2024; Sailer et al., 2024). The following research questions are examined: Which learning processes mediate the effect of specific digital features on learning success? How does intermediate knowledge moderate these effects? These questions are specified in different projects that investigate these questions with different digital features: 1) using digital simulations with mapping prompts to support the understanding of price formation; 2) supporting conceptual change in fractions with digital refutation or elaboration tools; 3) using virtual reality for fostering understanding of sea level rise; and 4) promoting systems thinking about climate change through digital graphs and simulations.

Included Papers

From Concrete Market Experience to an Abstract Model – Understanding Price Formation

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Instruction that combines concrete and abstract representations is widely used to support conceptual understanding, yet research has primarily focused on the sequencing of representations rather than on the cognitive processes that enable successful transitions

between them. Building on the composite instructional design (CID) framework, this study investigates mapping processes as a key learning mechanism underlying the transition from concrete to abstract representations in economics education. The study examines a three-phase instructional design for promoting conceptual knowledge of price formation, comprising a classroom market experiment, a digitally supported simulation as an intermediate representation, and the graphical model of supply and demand. During the simulation-based and diagram-based phases, instructional support features were systematically varied using explicit verbal linking and self-explanation support in a 2 × 2 factorial design with an additional control condition using a standard tabular representation. Learning processes were captured through learners' written self-explanations, which are coded for the quality of mapping processes, while learning outcomes focus on knowledge retention and transfer. The study further examines how learners' intermediate knowledge moderates the activation of mapping processes and whether mapping mediates instructional effects on learning outcomes. By shifting the focus from instructional sequencing to learning mechanisms, the study contributes to a process-oriented understanding of digitally supported multi-phase instruction.

Using Virtual Reality in a Multi-Phased Inquiry-Based Learning Environment on Climate Change

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Teaching complex socioscientific issues such as climate change often unfolds across multiple instructional phases, each serving distinct learning functions. The use of virtual reality in relevant phases is a promising approach to support cognitive activation by providing immersive, interactive, and embodied learning experiences. This study investigates how immersive virtual field trips, embedded within a multi-phase inquiry-based learning environment, support students' understanding of and emotional response to climate change. We organized an after-school science workshop focusing on sea level rise with middle school students. Two immersive virtual field trips were integrated into the explore phase of an inquiry model, guided by a learning progression on sea level rise. We scaffolded the VR field trips in the five-phased inquiry design with worksheets and group activities to enable embodied exploration of climate change phenomena and sense-making processes. Findings from quantitative and qualitative analyses indicate a significant improvement in students' conceptual understanding of sea level rise. In addition, students reported increased climate change hope following the intervention, while levels of climate change worry remained unchanged. Overall, the study provides empirical evidence for how immersive digital tools can be integrated in multi-phase learning environments to improve both cognitive and affective learning outcomes when introducing new content.

Supporting Conceptual Change in the Concept of Fractions – Building on Problem-Solving Results

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The Natural Number Bias (NNB) constitutes a significant obstacle in fraction learning. This study investigates how different instructional strategies in multi-phase digital learning environments can reduce the NNB when introducing fractions. Following the Problem Solving prior to Instruction (PS-I) approach (Loibl et al., 2017), a digital tool supports discovery-based learning in an initial problem-solving phase. In this phase, learners use a drag-and-drop interface to create partitioned bar models, activating prior knowledge and eliciting misconceptions. In the subsequent instruction phase, the study contrasts two digital instructional designs: refutative tasks, which target negative knowledge (i.e., knowledge on how not to solve the task) and conceptual magnitude tasks, which promote holistic perception of fractions. We investigate an Aptitude-Treatment Interaction (ATI) by analyzing how learners' initial NNB tendency moderates the effectiveness of a refutative instructional strategy versus a magnitude-based instructional strategy. We hypothesize that learners with a strong NNB tendency benefit more from refutative instruction—potentially due to increased activation driven by epistemic emotions. In contrast, for learners without an NNB tendency, refuting natural number concepts may be redundant; these students are expected to benefit more from the conceptual construction of magnitude representations. A pre-post-delayed-post-test design with fifth-graders is employed to compare the learning outcomes of the two instructional designs and an additional control group. By identifying which instructional features foster conceptual change in multi-phase settings, this project contributes to the symposium's goal of providing empirical evidence for cognitively activating digital designs that build effectively on learners' initial discovery processes in mathematics education.

Education for Sustainable Development: Effects of Guidance on Modelling Causal Loop Diagrams

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Understanding complex and dynamic systems is central to Education for Sustainable Development, particularly for addressing climate change. Prior research suggests that combining qualitative and quantitative system models such as causal loop diagrams (CLDs) and problem-oriented simulations supports systems thinking, yet substantial performance variance remains

after problem-oriented learning phases. This study examined how different forms of instructional guidance influence students' systems modelling within a two-phase instructional design using the En-ROADS climate simulation. In a 2 × 2 experimental design (N = 242), students created and subsequently refined CLDs with conceptual and/or procedural guidance. CLD quality was assessed using a structural complexity index. Results showed a significant overall increase in CLD quality and a differential effect of procedural guidance. Conceptual guidance moderated learning by particularly supporting students with lower initial CLD quality, whereas procedural guidance negatively predicted refinement outcomes. These findings highlight the importance of early modelling CLDs and suggest that conceptual scaffolding is more effective than directive procedural support for fostering systems thinking in climate change education.

Digital Technologies in Higher Education: Task Design, Learner Prerequisites, and Learning Processes

Organiser(s)

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Jörg Zumbach | University of Salzburg, Austria

Discussant(s)

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Digital learning environments are central to contemporary higher education, yet their impact depends critically on how well instructional design features align with learners' cognitive and motivational prerequisites. Although digital tools—from animations and AR to AI-supported study practices and simulations—are rapidly evolving, research on how learners engage with these environments and which learner characteristics shape their effectiveness remains limited. This symposium brings together four complementary studies that examine how different forms of digital learning environments support key learning processes in higher education. The contributions span conceptual change, media literacy, self-regulated learning, and collaborative diagnostic reasoning, offering a unified perspective on how design features and learner prerequisites interact. The first contribution investigates how refutation animations enriched with cognitive prompts foster conceptual change by reducing educational misconceptions and activating deeper engagement. The second contribution examines how an augmented reality escape game strengthens learners' critical attitudes toward online information and their confidence in identifying misinformation, highlighting the potential of immersive technologies for media literacy education. Shifting to everyday study practices, the third contribution uses experience sampling to reveal how pre-service teachers integrate AI tools into their self-regulated learning and how individual differences shape usage patterns and perceived utility. The fourth contribution applies nonlinear modeling to identify which learner prerequisites predict gains in collaborative diagnostic reasoning in simulation-based environments. Together, these studies provide an integrated understanding of how digital learning environments can be designed to accommodate diverse learner characteristics and support adaptive, learner-centered learning processes in higher education.

Included Papers

Effects of an AR Escape Game on Attitudes Toward Fake News in Pre-Service Teacher Education

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The increasing spread of fake news presents a major societal challenge, undermining democratic discourse, distorting scientific evidence, and contributing to social polarization. As key agents in addressing this issue, teachers must be adequately prepared to critically evaluate online information. However, research suggests that pre-service teachers are often insufficiently trained in this area. Serious games have shown promise in supporting learning about misinformation, yet few studies include reference data to contextualize observed effects.This study examines the effects of the augmented reality (AR) escape game Escape Fake on two attitude-related learning outcomes: attitudes toward online information verification and self-efficacy in recognizing misinformation. A pre-post design was applied with pre-service teachers from Switzerland and Austria playing the Escape Fake game during class (intervention group, n = 53), in comparison to a reference group of pre-service media and computer science teachers (reference group, n = 66) who had received extensive instruction in media education including fake news literacy training.First, in the intervention group, significant pre-post gains in both learning outcome measures (attitudes toward online information verification: d = 0.62; confidence in recognizing misinformation: d = 0.68) were found. Furthermore, posttest scores in the intervention group were significantly higher than those in the reference group (d = 0.86 and d = 1.16, respectively). These findings suggest that Escape Fake is an effective tool for fostering critical media engagement in teacher education. The study supports the integration of AR-based serious games as a complementary approach to media literacy education and highlights the value of addressing attitude-related learning objectives in combating misinformation.

Learner Prerequisites for Learning to Reason Collaboratively: A Nonlinear Modeling Perspective

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Accurate medical diagnosis often relies on collaborative diagnostic reasoning (CDR) skills. To inform adaptive scaffolding, we examined which learner prerequisites predict gains in CDR performance. Meta-analytic evidence suggests a predictive hierarchy: prior knowledge is strongest, followed by regulatory/social skills and motivational states, with personality traits weakest, and empirical work indicates these prerequisites may interact non-additively. Building on methodological calls for nonlinear modeling in aptitude–treatment interaction (ATI) research, we tested whether nonlinear models better capture gains in CDR performance and whether this hierarchy of learner prerequisites holds in cognitively demanding CDR tasks.We conducted a preregistered secondary analysis of data from 195 German medical students who completed five cases in an agent-based simulation. Gains in CDR performance were operationalized as pre–post residualized change in justification quality. Predictors included prior knowledge in learners' own and the collaborator's domain, collaboration knowledge, self-regulated skills, social skills, situated interest, expectancy, task value, self-concept, and mindset. A random forest model predicting CDR performance gains from learner prerequisites outperformed linear and null baselines. Conditional permutation importance showed that prior knowledge was most predictive, whereas regulatory/social skills, motivational states, and personality traits contributed substantially less. Our findings indicate that gains in CDR performance are most strongly associated with prior knowledge in learners' own and the collaborator's domain, and that nonlinear, prerequisite-sensitive models may better inform adaptive scaffolding and ATI research. Regulatory and social skills, context-specific motivational states, and personality traits may matter more in longer-term achievement contexts than in goal-directed tasks.

Pre-service teachers' AI Usage in Initial Teacher Education: an Experience Sampling Method Study

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With AI transforming higher education, it is paramount that we know who is doing what with AI tools, ideally down to the prompts. However, studies in higher education have not yielded robust insights into AI usage, as they assess usage indirectly, retrospectively, and for unspecific application and time-spans. This research gap is even wider for pre-service teachers in their initial teacher education (ITE). Therefore, we studied pre-service teachers' (n = 23) daily AI usage and their personnel characteristics by Experience Sampling Method with event-sampling over ten days. For each AI usage for ITE, pre-service teachers specified the AI tool and purpose, uploaded a picture of their prompt, and evaluated utility. We analysed the data with Bayesian group comparisons and Bayesian Hodges-Lehmann-Tests, cumulative link models and cumulative link mixed models; robustness was checked with single-/two-level Bayesian generalized linear models. Prompts were analysed qualitatively in a self-regulated learning (SRL) framework. Results showed that pre-service teachers mostly used ChatGPT to further their own understanding. Usage followed a tailed distribution (21.7% no AI usage). Users were more conscientious and less procrastinating than non-users. Likewise, conscientiousness and procrastination predicted overall usage. More performance-approach goal orientated pre-service teachers with less negative attitudes towards AI perceived more utility. Most prompts could be classified as SRL, the others aimed at fulfilling concrete assignments or generating text. We conclude that well-researched psychological constructs are better suited to predict AI usage in ITE than currently emerging proximal constructs and that researchers should refine modes of assessing AI usage.

Reducing Educational Myths in Higher Education Through Digital Refutation Animations

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Jörg Zumbach | University of Salzburg, Austria

Educational myths are prevalent in higher education, especially among pre-service teachers, and can negatively influence instructional decision-making. Technology-based instructional formats such as digital refutation animations offer a scalable approach to addressing these misconceptions, yet prior research has shown that their effects often remain limited to explicitly

refuted myths. Cognitive prompts may strengthen conceptual change processes in digital learning environments by fostering deeper cognitive engagement. This study investigates whether cognitive prompts embedded in a digital refutation animation, as well as teacher-training, influence belief change for both myths refuted and myths not refuted in the digital animation, and whether the effectiveness of cognitive prompts depends on learners' degree of engagement. A total of 107 participants, pre-service teachers and learners without teacher education, completed a study with pretest–posttest design in which cognitive prompts and teacher training were manipulated between subjects. Beliefs in refuted and non-refuted myths were assessed via self-report questionnaires before and after the animation. Learners' engagement with prompts was rated based on their written responses to the prompts. Results showed significant decreases in agreement with both refuted and non-refuted myths from pre- to posttest. Cognitive prompts significantly reduced beliefs in both refuted and non-refuted myths. Teacher training had no significant effect on beliefs in myths. Learners' engagement with prompts moderated the effectiveness of cognitive prompts. These findings suggest that cognitive prompts can broaden the impact of refutation animations and support deeper conceptual restructuring. Integrating such prompts into technology-enhanced learning materials may strengthen evidence-informed thinking in teacher education.

Effort by Choice: Navigating Desirable Difficulty in Digital Learning

Organiser(s)

Roman Abel | Ruhr University Bochum, Germany

Erdem Onan | Delft University of Technology, Netherlands

Discussant(s)

Andreas Lachner | University of Tübingen, Germany

Desirable difficulties, learning strategies that introduce productive challenges to enhance long-term learning, are not only relevant in traditional classrooms but are equally critical in contemporary digital contexts. Yet, the empirical basis regarding the benefits of desirable difficulties, as well as student engagement with desirable difficulties in digital learning, remains scarce. Addressing this gap requires closer attention to how learners regulate effort and make strategic learning decisions, which forms the central goal of this symposium. The first contribution demonstrates the benefits of desirable difficulties through pre-questioning supported by generative AI. The second and third contributions focus on two well-established desirable difficulty strategies, distributed and interleaved practice, showing that although these approaches reliably improve learning outcomes, they remain underutilized by both secondary school and university students. Extending these findings, the third contribution further investigates why learners tend to avoid such strategies by examining the role of effort sensitivity. Finally, the fourth contribution evaluates the effectiveness of a self-regulated learning intervention, aiming to increase students' engagement with desirable difficulties through the "smart" use of generative AI. Taken together, these four contributions provide a multifaceted perspective on effort regulation and strategy use in digital environments. The symposium highlights both the instructional opportunities afforded by emerging technologies and the psychological and motivational barriers that may hinder their effective use. By bridging research

on desirable difficulties, SRL, and AI-supported learning, this session offers instructional insights for fostering lasting learning.

Included Papers

Who Bears the Burden, Teacher or Student? Outsourcing Effort Costs Promotes Interleaved Practice

Presenter(s)
Roman Abel | Ruhr University Bochum, Germany

Co-author(s)
Julian Roelle | University of Münster, Germany

Previous research indicates that while desirable difficulties such as interleaved practice (mixed task sequences) enhance long-term learning, they are often avoided because they are perceived as more effortful than more familiar learning strategies such as blocked practice. Effort avoidance is particularly problematic in digital environments, where students have the autonomy to create their own learning sequences. This study investigated whether the goal to teach can bypass this effort avoidance by externalizing the subjective costs of learning. We hypothesized that when participants plan a task sequence for others rather than themselves, they become less sensitive to effort demands, leading to more use of interleaved practice. In a between-subjects design, university students created a sequence of mathematical volume tasks. Participants were assigned either a learning goal (planning for oneself) or a teaching goal (planning for peers). Consistent with our predictions, the teaching goal group used more interleaving than the learning goal group. Analysis of oral justifications revealed that participants in the teaching goal group referred more often to learning principles (e.g., easy-to-difficult) and goals that require effort investment (e.g., flexibilization). Accordingly, the goal to teach reduces the impact of effort demands in the decision-making process. These findings suggest that adopting a teaching goal can help learners overcome the "burden" of effort, promoting the use of more effective, albeit difficult, learning strategies in mathematics when using educational technologies.

The distributed practice effect and its boundary conditions: Insights from vocabulary app trace data

Presenter(s)
Lea Nobbe | Goethe University Frankfurt, Germany

Co-author(s)
Jasmin Breitwieser | DIPF | Leibniz Institute for Research and Information in Education, Germany
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Distributed practice is considered an effective learning strategy for various age groups and materials, yet its underlying mechanisms remain debated—especially in ecologically valid

contexts. In the present study, we leveraged trace-data from 345 fifth- and sixth-graders using an English vocabulary app to study in a self-directed manner. These fine-grained data allowed us to capture intraindividual variability in learning (i.e., at the level of individual vocabulary words for each child). We investigated multiple constructs derived from prominent accounts of distributed practice. To examine the role of breaks, we used the number of study days as a practically relevant indicator. To examine study context effects, we leveraged variation in study modes and the proportion of activity spent on practice testing. Each model included potential boundary conditions such as the total study activity and test delay. We found that distributing study time over more days and using varied study modes was beneficial for recalling a vocabulary word at longer test delays, but detrimental at shorter ones. Practice testing brought about positive effects at average and longer test delays, but detrimental effects at shorter than usual test delays. The results underline the moderating role of test delay for the distributed practice effect and illustrate the value of fine-grained trace data for approaching the mechanisms underlying distributed practice.

Enhancing Student-GAI Interaction: A Self-regulated Learning Perspective

Presenter(s)

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Co-author(s)

Betul Unal | Akdeniz University, Faculty of Engineering, Department of Electrical and Electronics Engineering, Türkiye

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The rise of Generative Artificial Intelligence (GAI) chatbots in higher education has created both opportunities and concerns regarding student learning. While these tools may enhance access to information and feedback, they may also encourage cognitive offloading and reduce engagement in deeper learning processes. This quasi-experimental mixed-methods field study examines student–GAI interaction from a self-regulated learning (SRL) perspective among 77 second-year electrical engineering students in an authentic learning environment. The study pursued three objectives: (1) exploring how students use GAI during authentic problem-solving tasks, with a focus on their engagement in critical SRL processes; (2) evaluating the effectiveness of a 60-minute SRL intervention designed to improve prompt and assignment quality and to promote engagement with desirably difficult learning strategies; and (3) investigating students' perceptions of the intervention. Preliminary findings indicate that before the intervention, many students relied on full-task delegation, while few employed (meta)cognitive strategies when interacting with GAI, highlighting the risks of uncritical use. Quantitative analyses showed no significant intervention effect on assignment quality across tasks. Together, the study contributes practical insights into how principles of SRL can support students in making more effective and reflective use of AI tools in education, and advances theoretical discussions on cognitive offloading and engagement with desirable difficulties in AI-supported learning.

Using AI-Generated Prequestions to Enhance Memory and Text Comprehension

Presenter(s)
Steven Pan | National University of Singapore, Singapore

Co-author(s)
Judith Schweppe | University of Passau, Germany
Andy Z. J. Teo | National University of Singapore, Singapore
Alyssa Indrajaya | National Unversity of Singapore, Singapore
Niklas Wenzel | School of Health Professions Education (SHE) - Maastricht University, Netherlands

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A growing body of research reveals that prequestioning—attempting to answer questions prior to studying—can enhance subsequent learning. Yet the use of prequestioning in self-regulated learning is often constrained by limited access to suitable practice questions. In this study, we investigated whether generative artificial intelligence can overcome this limitation by enabling learners to engage in effective prequestioning using AI-generated questions. Across four experiments, participants studied an educational text after answering prequestions generated by the large language model–based chatbot ChatGPT. In Experiment 1, AI-generated prequestioning improved learning relative to reading alone. In Experiment 2, prequestioning with AI-generated questions yielded learning outcomes comparable to those following human-generated questions. In Experiments 3 and 4, AI-generated prequestioning outperformed studying an AI-generated outline, demonstrating advantages over a commonly used advance organizer. Across experiments, prequestioning benefited performance on both identical and non-identical criterial test questions, indicating learning that extended beyond rote repetition. Overall, these findings establish generative AI as a viable and scalable means of implementing prequestioning and demonstrate that AI-enabled prequestioning can produce robust and transferable learning benefits.

Experimental evidence on AI-enhanced feedback in higher education

Organiser(s)
Elisabeth Bauer | University of Augsburg

Discussant(s)
Johanna Fleckenstein | University of Hildesheim, Germany

Generative AI is increasingly integrated into digital learning environments to provide and enhance feedback, raising questions about its effects on learning processes and outcomes. This symposium brings together experimental evidence on AI-enhanced feedback in comparison to non-AI and alternative AI conditions. Across diverse higher education contexts, including argumentative writing, conceptual analysis, statistics learning, and teacher education, the contributions examine when and how AI-enhanced feedback shapes cognitive and motivational-affective learning processes and outcomes. Conceptually, the symposium is unified by its focus on feedback as an instructional approach and by examining different design features of AI feedback, such as prompting strategies, avatar interaction, and adaptivity with or without learner

control. Methodologically, all studies employ experimental designs, including randomized comparisons of AI versus human feedback and controlled variations in AI feedback designs. Some contributions build on related paradigms and partially replicate design elements across contexts, enabling cumulative insights while testing boundary conditions such as different learning contexts. By synthesizing findings across different higher education settings, the symposium investigates under which conditions AI-enhanced feedback influences learning and when non-AI alternatives provide advantages. Together, the contributions advance theory-informed and methodologically rigorous research on AI-supported feedback in technology-enhanced learning.

Included Papers

Generative AI offers more but students revise less: Teacher vs AI feedback effects on essay revision

Presenter(s)
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Saeed Latifi | Kharazmi University, Iran
Pantelis M. Papadopoulos | University of Twente, Netherlands
Loes Hogenkamp | University of Twente, Netherlands
hannie gijlers | University of Twente, Netherlands
Hassan Khosravi | The University of Queensland, Australia
Omid Noroozi | Wageningen University and Research Centre, Netherlands

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High-quality feedback is a cornerstone of effective writing instruction in higher education, yet instructors face increasing constraints in providing individualized, timely responses. This empirical study investigated whether generative artificial intelligence (GenAI) can provide feedback comparable or superior to teacher feedback in argumentative essay revision, and whether prompt engineering enhances feedback effectiveness. Seventy Persian-speaking undergraduate students in educational sciences were randomly assigned to one of three conditions: teacher feedback, ChatGPT (GPT-4o) feedback generated via zero-shot prompting, or ChatGPT feedback generated via chain-of-thought (CoT) prompting. Students wrote an argumentative essay in Persian, received written feedback, and submitted a revised version one week later. Essay and feedback quality were evaluated using parallel Toulmin-based rubrics (0–14 scale). Results showed that CoT prompting significantly increased feedback quality compared to zero-shot prompting and teacher feedback. However, despite substantial improvements from initial to revised drafts across all groups, no significant differences in revision outcomes emerged between conditions after controlling for baseline essay quality. Furthermore, GenAI feedback quality was moderately associated with initial essay quality, whereas teacher feedback was not. The findings reveal a quality–uptake gap: structurally stronger AI feedback does not automatically translate into superior revision performance. The study underscores the importance of feedback literacy and suggests hybrid models combining AI-generated feedback with pedagogical scaffolding.

AI-generated adaptive feedback with and without learner control in the field of learning statistics

Presenter(s)
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Melissa Özsoy | LMU Munich, Germany
Laura Brandl | Ludwig-Maximilians-Universität München, Germany
Marcel Holzer | University of Augsburg, Germany
Tanja Fritz | University of Augsburg, Germany
Matthias Stadler | LMU University Hospital, Germany
Michael Sailer | University of Augsburg, Germany

Fostering statistical skills remains a central goal in higher education, yet many students struggle to accurately interpret and report statistical results. Adaptive feedback has been proposed to support skill acquisition, but its motivational effects remain unclear. Drawing on self-determination theory, this experimental study examined whether adding learner control to AI-generated adaptive feedback enhances statistical skill acquisition, psychological need satisfaction, and interest in statistics. In an ongoing data collection, so far, 36 undergraduate and graduate social science students were randomly assigned to receive adaptive feedback either with or without learner control while solving t-test interpretation tasks. In the condition with learner control, students were asked to request AI-generated feedback via chat while specifying focus and depth, whereas the condition without learner control received AI-generated adaptive feedback automatically after each task. Statistical skills were assessed through coded performance on pre- and posttest tasks. Preliminary mixed ANOVA results showed a significant main effect of time, indicating substantial improvements in statistical performance across conditions. However, no significant interaction effects emerged for performance or interest in statistics. Independent samples t-tests revealed no differences in autonomy and competence need satisfaction between conditions. Although both feedback formats appear to foster statistical skill acquisition, with the highly structured learning tasks, the addition of learner control did not yield differential effects on learning outcomes or psychological need satisfaction in this preliminary sample. Ongoing data collection will clarify whether these patterns remain stable with increased statistical power.

Exploring students' experiences of humanlike AI avatars feedback vs human feedback

Presenter(s)
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Co-author(s)
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Feedback is one of the most impactful instructional methods in higher education, but because of limited teacher resources, expert feedback is often rare. Generative AI (GenAI) offers new opportunities for scalable and personalised dialogical feedback. Recent developments now allow highly realistic humanlike AI avatars to act as interactive feedback providers. This study explored how GenAI avatar feedback shapes students' feedback experience compared to human feedback.In an experimental mixed-methods study, 39 Bachelor students completed an analysis task in a digital learning environment. After watching a lecture on Cognitive Load Theory and Multimedia Learning, they analysed a short lecture sample, received a 10-minute dialogical feedback interaction, and revised their work. Students were randomized into a human feedback group (n=19) interacting with a teacher via Zoom, or a GenAI avatar group (n=20) interacting with a highly realistic avatar resembling the same teacher. Questionnaires assessed feedback perception, cognitive load, and emotions, complemented by interviews (n=8).Results showed significantly higher feedback perception and germane cognitive load in the human feedback condition. Students in the GenAI avatar condition reported more confusion, frustration, and boredom, whereas human feedback evoked greater curiosity and excitement. Thematic analysis identified four themes: the uncanniness of the avatar, engaging in co-construction, the avatar as a safe space, and presuppositions about AI capabilities. Overall, GenAI avatar feedback shifts students into a more active role and offers psychological safety, but provides a less positive relational experience than human feedback. These findings highlight opportunities and challenges for designing multimodal GenAI-supported feedback processes.

Personalised AI-generated support to foster peer-feedback skills

Presenter(s)
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Elisabeth Bauer | University of Augsburg, Germany
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Meral Roeben | University of Augsburg, Germany
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Teachers' peer-feedback skills are relevant when observing teaching behaviour and providing helpful peer-feedback to colleagues. Adaptive support can facilitate teachers in acquiring complex skills, like providing peer feedback. Such adaptive support can be provided by systems

that adapt to learning prerequisites and processes, or it can additionally be adjusted by learners. It remains unclear to what extent adaptive support with or without learner control affects learners with different prerequisites, such as prior knowledge or self-regulated learning (SRL) skills. Giving learners control could increase their satisfaction with autonomy and competence. We investigated the effects of adaptive, AI-generated support with or without learner control on peer-feedback and on satisfaction with autonomy and competence. In an experiment, 177 pre-service teachers were randomly assigned to receive adaptive support with or without learner control while providing peer-feedback on technology-enhanced teaching. We analysed the effect of adaptive support with or without learner control on peer-feedback skills, as well as autonomy and competence satisfaction, considering prior knowledge and SRL skills. Compared to adaptive support with learner control, adaptive support without learner control significantly improved peer-feedback skills. However, adaptive support with learner control significantly enhanced autonomy and competence satisfaction. We found no moderating effects for prior knowledge or SRL skills. While learner control may primarily benefit autonomy and competence satisfaction, adaptive support without learner control may be more effective for cognitive outcomes, such as peer-feedback skills, by ensuring that support aligns with learners' performance.

How Teacher Characteristics Shape Dashboard Use in Practice

Organiser(s)

Katharina M. Bach | Universität Potsdam, Germany

Stefanie Vanbecelaere | KU Leuven, Belgium

Discussant(s)

Nikol Rummel | Ruhr University Bochum, Germany

Increasing student heterogeneity challenges teachers to provide instruction that is responsive to learners' diverse needs. Teacher dashboards aim to support this process by offering accessible information on student performance and learning progress, thereby informing instructional decision-making and enhancing teaching practices [1][2]. Prior research has shown, for example, that dashboard use can foster more process-oriented feedback [3]. Nevertheless, teachers' dashboard use remains limited and highly variable across contexts [4][5], and there is a growing need to better understand which individual and contextual factors contribute to effective use [6][7]. In the symposium, we examine (1) the quantity and quality of dashboard use in authentic classroom settings and (2) the teacher characteristics associated with meaningful dashboard use. Study 1 presents a systematic mapping of the design features of teacher dashboards currently used in K-12 education in the Netherlands and Flanders, alongside observed usage patterns. Study 2 investigates how secondary physics teachers' pedagogical and technological knowledge relates to dashboard use frequency and how different competence and usage profiles are associated with student learning outcomes. Study 3 examines how teacher and contextual factors, such as motivation, ICT knowledge, and self-efficacy, influence dashboard use in primary education. Study 4 explores pre-service teachers' ability to identify relevant dashboard elements, interpret data accurately, and derive appropriate instructional decisions, and relates this ability to, among others, attitudes and data literacy knowledge.Together, these studies offer

a comprehensive perspective on current dashboard use and identify leverage points for teacher education and professional development to foster effective use of teacher dashboards.

Included Papers

Associations Between Teachers' Data Literacy Knowledge, Beliefs and Skills to Use Dashboards

Presenter(s)
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Co-author(s)
Stefanie Vanbecelaere | KU Leuven, Belgium
Bert Reynvoet | KU Leuven, Belgium
Fien Depaepe | KU Leuven, Belgium

Learning analytics dashboards (LADs) are increasingly embedded in digital practice platforms to support data-informed instructional decision-making. Yet we know little about how good primary school teachers are in interpreting and planning actions on dashboard data. This study investigates (1) pre-service primary school teachers' ability to perceive (P), interpret (I), and make pedagogically relevant decisions (D) based on LAD data (i.e., their PID-skills), and (2) examines how these PID-skills relate to data literacy knowledge, beliefs about data use, and other individual characteristics.In total, 412 pre-service teachers from two Flemish teacher education institutions completed an online instrument consisting of a validated data literacy knowledge test, self-report measures of data-related beliefs, background questions, and a performance-based, scenario-driven assessment using authentic LADs from a digital mathematics practice platform to assess participants' PID-skills. In the latter, students described how they perceive and interpret the simulated data and which instructional decisions they suggest. Their answers were coded using a comprehensive coding scheme. Results concerning RQ1 revealed substantial variation and generally low proficiency in pre-service teachers' PID-skills. Concerning RQ2, data literacy knowledge and attitudes toward data use were positively associated with teachers' PID-skills, whereas data use anxiety and self-efficacy towards data use were not. Second-year students and those with stronger mathematical backgrounds showed higher PID-skills, while experience with digital practice platforms showed a small negative association.The findings underscore the need for explicit preparation regarding data literacy and data-informed decision-making in teacher education programs to support meaningful and effective use of learning analytics in primary education.

The Design and Implementation of Teacher-Facing Learning Analytics Dashboards in Primary Schools

Presenter(s)
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Fien Depaepe | KU Leuven, Belgium
Carolien Knoop-van Campen | Radboud University Nijmegen, Netherlands
Inge Molenaar | Radboud University Nijmegen, Netherlands
Stefanie Vanbecelaere | KU Leuven, Belgium

Adaptive learning technologies (ALTs) increasingly shape personalized learning in primary education, yet their potential depends on how teachers interpret and act upon data presented in learning analytics dashboards (LADs). This study investigates the design and implementation of teacher-facing LADs to understand their role in fostering teacher-tool synergy for digital personalized learning. Regarding design, we conducted a systematic mapping of dashboard features in ALTs for primary education in the Netherlands and Flanders. Regarding implementation, we are currently exploring their pedagogical implications on evolving teacher roles. Data sources include documentation, demo accounts and semi-structured interviews (N=39) with company representatives and teachers, analyzed using a theory-based classification scheme and an abductive thematic approach. Findings reveal that dashboards predominantly visualize cognitive outcomes, while metacognitive and affective indicators remain scarce. Although advanced functionalities (e.g., real-time monitoring, advising features) are available in some dashboards, their uptake by teachers still appears limited due to time constraints, lack of awareness and concerns about trustworthiness. This suggests that design enhancements alone will not guarantee that dashboards will support teacher decision-making and action-taking. Instead, emerging themes from further interview analyses highlight the need for deliberate implementation strategies towards a thoughtfully balanced collaboration between teachers and ALTs, for instance by offering professional development programs that focus on integrating dashboard consultations into existing workflows. By systematically categorizing LAD features and their pedagogical implications, this study contributes to evidence-informed recommendations that empower teacher-tool partnerships in personalized learning environments.

Explaining Teachers' Use of Learning Analytics Dashboards with Multi-Model Machine Learning

Presenter(s)
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Mario de Jonge | ICLON, Leiden University Graduate School of Teaching, Netherlands
Inge Molenaar | Radboud University Nijmegen, Netherlands
Nadira Saab | Leiden University, Netherlands
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Learning analytics dashboards are increasingly implemented in primary education to support data-informed teaching, yet teachers vary substantially in how frequently they use these tools. This study investigates which teacher and context-level predictors explain variation in self-reported dashboard use among primary school teachers. A questionnaire was administered to 629 Dutch primary teachers who had access to dashboards embedded in adaptive learning systems. A three-step analytical strategy was applied to analyse the data. First, a Random Forest classifier was used to identify the most influential predictors of daily dashboard use. Second, an interpretable rule based in Trees analysis clarified how combinations of predictors related to frequent use. Third, a path model estimated the unique contribution and direction of the key predictors. Across analyses, four teacher-level variables emerged as most important: teachers' self-reported ICT knowledge and skills, ICT-related didactic self-efficacy, intrinsic motivation, and extrinsic motivation. Path modelling showed that ICT-related didactic self-efficacy and extrinsic motivation were positively associated with daily use. In contrast, ICT knowledge and skills showed a small negative association, and intrinsic motivation was not significant. The study illustrates how combining machine learning and explanatory modelling can deepen understanding of dashboard use in everyday practice.

Who Uses Dashboards? Teacher Profiles as Predictors of Dashboard Use and Student Performance

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Dashboards aggregate data on students' progress, performance, and behavior and present it to teachers in a comprehensive and accessible manner, facilitating individualized instruction. Despite their affordances, dashboards are still rarely used and little is known about how

pedagogical and technological competence affect teachers' use of dashboards and how these characteristics and different usage patterns relate to their students' learning. Using data from secondary school physics teachers (N = 17) and their respective students, we explore 1) how teachers can be clustered concerning their pedagogical and technological competences, 2) how these competences relate to their dashboard use frequency, and 3) whether students' learning is affected by dashboard use frequency or teachers' competences. First, teachers were qualitatively clustered into four competence profiles reflecting different combinations of technological and pedagogical expertise, ranging from beginners to experts in one or both domains. Second, using log data, we clustered participants into low-, medium-, and high-use groups based on the number of clicks (ranging from 10 to 80). Third, regarding student learning outcomes, the z-standardized frequency of teachers' dashboard use was not a significant predictor of students' post-test performance. However, students taught by teachers with high levels of technological and pedagogical competence achieved significantly higher post-test performance than those taught by teachers with lower levels of competence. This indicates that the frequency of dashboard use alone, largely driven by technological competence, is insufficient to positively affect student outcomes. Rather, pedagogical competence appears crucial in shaping how dashboard data are interpreted and used to individualize instruction.

Interleaved Practice in School Settings: Benefits for Lasting Learning

Organiser(s)

Veit Kubik | Freie Universität Berlin, Germany

Discussant(s)

Shana Carpenter | Oregon State University, United States

When learning new concepts, learners typically study multiple examples to identify the underlying regularities of each concept. The sequence in which these examples are presented, either grouped by concept (blocked) or mixed across concepts (interleaved), can significantly influence learning outcomes. Interleaved practice has been shown to support learning when concepts are easily confused; however, its effectiveness likely depends on characteristics of the learning content and its potential to support lasting learning has not yet been fully examined. This symposium examines the effectiveness of interleaving and its moderators in authentic educational settings across physics, mathematics, and biology. It comprises three preregistered classroom-based contributions that examine interleaved practice with delayed tests of at least eight weeks, as well as one meta-analysis. The first contribution reports an experiment with students in Grades 12/13 that examines whether collaborative learning enhances the benefits of interleaved practice when acquiring complex physics concepts. The second contribution presents an experiment with children from Grade 3 on adaptive subtraction strategies, investigating whether a preliminary blocked phase before interleaving and self-explanation prompts enhance adaptive strategy use. The third contribution reports two experiments, one with university students and one with children from Grade 8, that examine the effects of interleaved versus blocked practice on learning the four operant conditioning concepts from short textual vignettes. The fourth contribution presents a meta-analysis of interleaving with verbal materials and examines potential moderators. Overall, the contributions offer insight into

the conditions under which interleaved practice supports meaningful and lasting learning across diverse educational contexts.

Included Papers

Collaboration Facilitates the Benefits of Interleaved Practice in Complex Physics Learning

Presenter(s)
Maria Danzglock | Universität Kassel, Germany

Co-author(s)
Roland Berger | University of Osnabrück, Germany
Martin Hänze | University of Kassel, Germany

Interleaved practice is considered a desirable difficulty that promotes conceptual differentiation, yet its effectiveness appears to depend on task complexity and learners' cognitive resources. This field experiment investigated whether collaboration can enhance the benefits of interleaved practice when students learn highly complex physics concepts. A preregistered 2x2 design was implemented with 376 upper secondary students who practiced either in an interleaved or blocked sequence, individually or collaboratively. Learning outcomes were assessed immediately and after an eight week delay, and practice performance was captured through log data. A consistent interaction between interleaving and collaboration emerged across both the immediate and delayed tests: Interleaved practice improved learning outcomes only when combined with collaboration, with the interleaved collaborative group achieving the highest scores at both time points. No positive main effects of interleaving or collaboration appeared on their own, and interleaving even impaired delayed performance in the individual condition. Log data confirmed that individual learners in the interleaved condition made the most errors, whereas collaborative dyads showed higher accuracy. Exploratory analyses further revealed that prior knowledge moderated interleaving effects in the individual setting. These findings indicate that interleaving complex content can overload individual learners but becomes effective when cognitive demands are shared within dyads. Collaboration therefore offers a practical means to sustain the benefits of interleaving in challenging learning contexts.

Interleaved Practice as a Tool for Scientific Concept Formation

Presenter(s)
Marina Klimovich | University of Würzburg, Germany

Co-author(s)
Veit Kubik | Freie Universität Berlin, Germany
Tobias Richter | University of Würzburg, Germany

Interleaving exemplars from different categories tends to improve the acquisition of underlying concepts compared to blocking. The benefits of interleaving have been demonstrated in several domains, but research on its application to textual materials remains inconclusive. We report

two preregistered experiments examining the effects of interleaved practice in learning from short textual vignettes. Participants studied vignettes illustrating the four types of operant conditioning presented either in a blocked or an interleaved sequence. Both experiments employed the same design but differed in their samples. Experiment 1, conducted with university students, has been completed, whereas Experiment 2 is currently conducted with eighth-grade children. Furthermore, Experiment 2 implements an 8-week follow-up test to investigate the effects of interleaving on lasting learning. Results from Experiment 1 showed an interleaving advantage for both classification performance and conceptual knowledge on an immediate test. The results suggest that interleaving may be a promising approach for structuring text-based learning materials to support concept acquisition. Experiment 2 will provide further insights into the effectiveness of interleaved practice in classroom settings, particularly in subjects such as biology, in which learners frequently engage with text-based examples and cases to construct conceptual knowledge.

The Interleaving Effect in Verbal Materials: A Systematic Review and Meta-Analysis

Presenter(s)

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Co-author(s)

Marina Klimovich | University of Würzburg, Germany

Tobias Richter | University of Würzburg, Germany

Interleaved presentation of items, compared to blocked presentation, has been proposed to foster inductive learning by emphasizing discriminative contrasts between categories (e.g., sequential-attention framework). While metaanalyses report robust interleaving benefits for visual materials, the generality to verbal materials, which play an important role at all educational levels, remains unclear (Brunmair & Richter, 2019). We are conducting a systematic review and multilevel metaanalysis of to-date 36 empirical studies (167 effect sizes; N = 4,236) comparing interleaved and blocked practice with verbal stimuli (words, letters/characters, short and long expository texts, language-learning tasks). The literature search in the databases (PsycINFO, ProQuest, Web of Science, Scopus, and ERIC) has been completed through June 2025, and will be updated through February 2026. Any new studies identified in the update will be screened and, if eligible, incorporated into subsequent analyses and reported in the presentation. Preliminary results indicate that the pooled effect of interleaving was small but significant, with substantial between-study heterogeneity. Importantly, we will test predictions from the sequential-attention framework by means of meta-regression analyses: After rating similarity within and between categories of verbal learning material, as well as their complexity and familiarity, we will be able to test these theoretically important moderator variables and boundary conditions of the interleaving effect in verbal materials that were established for visual and other domains. Implications for theory and practice will be discussed and recommendations for future experimental studies will be provided.

Interleaved Practice of Subtraction Strategies: A Field Study in Third-Grade Classrooms

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Students often show deficits in flexible and adaptive use of subtraction strategies, underscoring the need for instruction that fosters adaptive expertise. Interleaved practice, which mixes strategies within a session, may promote such expertise by eliciting between-category comparison and retrieval. A blocked-to-interleaved sequence (B2I) could further enhance these benefits by establishing initial competence level during blocked practice before transitioning to interleaved practice. Moreover, self-explanation prompts may strengthen links between task features and strategies. In this study, we investigate the lasting effect of interleaving and whether additional support can optimize its effectiveness. We conducted a pre-registered 3 (blocking vs. interleaving vs. B2I) × 2 (self-explanation vs. additional practice) between-subjects experiment with 238 German third graders learning three number-based strategies for three-digit subtraction. Adaptivity, flexibility, and accuracy were assessed at pretest, immediate posttest, and 8- and 16-week follow-ups; CSK was assessed only after the intervention. Both interleaving and B2I improved adaptivity, flexibility, and CSK relative to blocking at posttest and follow-ups, with some effects lasting up to 16 weeks. No direct effects on accuracy emerged, and neither B2I nor self-explanation added benefits over pure interleaving. Taken together, the results tentatively indicate that interleaving has beneficial effects on its own in primary mathematics education.

Toward Lasting Learning? Generative Learning and Retrieval Practice in Authentic School Lessons

Organiser(s)
Heike Russ | University of Tübingen, Germany

Discussant(s)
Martina Rau | ETH Zurich, Switzerland

Lasting learning is a central educational goal. However, many students struggle to acquire lasting knowledge in classroom instruction. While generative learning fosters comprehension and retrieval practice supports consolidation, their distinct functions suggest that combining both approaches may be particularly effective. Yet, evidence on their combination remains scarce, especially in educational practice and at longer time scales. Against this background, the symposium examines how generative and consolidation activities can be effectively implemented and combined to foster lasting learning in authentic, curriculum-aligned school lessons.The first contribution reports a classroom experiment in authentic upper-secondary physics lessons

examining self-explanation prompts, retrieval demands, and constructive retrieval, with outcomes assessed after eight weeks.The second contribution reports two classroom experiments with secondary school students comparing closed- and open-book generative drawing with instructional support, with learning assessed after two and eight weeks.The third contribution reports a 2 × 2 classroom experiment in secondary school physics combining generative learning and retrieval practice, focusing on conceptual knowledge and monitoring accuracy assessed immediately and after eight weeks. The fourth contribution reports a 2 × 2 classroom experiment comparing testing and restudy with texts of low versus high complexity, with learning assessed after one and eight weeks. All four contributions feature delayed outcome measures and are conducted in authentic, curriculum-aligned school lessons, with statistical power about 90%. The symposium takes an interdisciplinary perspective, integrating educational psychology, instructional design, subject-matter education, and learning technologies. An instructional design expert will discuss the contributions.

Included Papers

How to Enhance Lasting Learning by Generative Drawing Through Integration of Retrieval Practice

Presenter(s)
Seokyoung Kim | University of Münster, Germany

Co-author(s)
Julian Roelle | University of Münster, Germany
Roman Abel | University of Bochum, Germany
Philipp Schmiemann | University of Duisburg-Essen, Germany
Detlev Leutner | University of Duisburg-Essen, Germany
Logan Fiorella | University of Georgia, United States

Engaging learners in generative drawing after reading an expository text is an effective means of fostering comprehension. Generative activities alone, however, are not sufficient for lasting learning. That is, empirical evidence suggests that the consolidation function of generative activities is relatively weak. Hence, a promising supplement for generative drawing could be retrieval practice, which triggers a more pronounced consolidation process than generative activities. On this basis, in two experiments we investigated whether the long-term benefits of generative drawing could be enhanced through the integration of retrieval practice. In Experiment 1 (N = 279), high school students read an expository text and were randomly assigned to one of two conditions. In the closed-then-open-book condition, learners first created drawings without access to the text, which required retrieval of the text's content from memory, and then revised their drawings with access to the text. In the open-book condition, learners had access to the text throughout creating and revising their drawings. The revision was supported by checklists for both groups. Learning outcomes were assessed after two and eight weeks. Results indicated that the closed-then-open-book group outperformed the open-book group on the 2-week-delayed posttest but not on the 8-week-delayed posttest. To further optimize generative drawing with integrated retrieval practice, in Experiment 2 we implemented prompts that were

designed to induce deep processing of core idea units during initial reading, which in turn may increase retrieval success. Data collection for Experiment 2 is ongoing, and results will be available at the conference.

Is text complexity a moderator of the testing effect?

Presenter(s)
Annika Lenk-Blochowitz | University of Erfurt, Germany

Co-author(s)
Judith Schweppe | University of Erfurt, Germany
Sarah Glim | University of Kassel, Germany
Ralf Rummer | University of Kassel, Germany

Practice testing is an effective learning technique, especially for lasting learning. Yet, it has been proposed that the testing effect may diminish when learning materials are of high element interactivity. Element interactivity, a concept from Cognitive Load Theory, arises from the number of interconnected idea units that must be held in working memory simultaneously to understand the content and was suggested as an operationalization of complexity. In a field study in a classroom setting with a 2x2 between subject design, we manipulated both learning technique (restudy vs. testing) and element interactivity of a text (high vs. low). Participants were secondary school students. Learning was assessed after one and eight weeks. Across both time points, significant medium-sized testing effects emerged. Additionally, higher element interactivity impaired performance. However, there was no interaction, indicating that testing was beneficial regardless of element interactivity of the text. Moreover, contrasts confirmed significant testing effects for both text versions. Overall, the findings demonstrate that practice tests are effective even for complex learning materials, while supporting Cognitive Load Theory's emphasis on reducing element interactivity to facilitate comprehension.

Training and Applying Constructive Retrieval to Foster Lasting Learning – A Classroom-Experiment

Presenter(s)
Dwayne Lieck | Albert-Ludwigs-Universität Freiburg, Germany

Co-author(s)
Tino Endres | UniDistance Suisse, Switzerland
Andreas Vorholzer | Technical University of Munich, Germany
Alexander Eitel | University of Giessen, Germany
Claudia von Aufschnaiter | University of Giessen, Germany
Alexander Renkl | University of Freiburg, Germany

We examined the effects of constructive demands and retrieval demands, as well as their combination constructive retrieval on lasting learning of Newtonian mechanics in school. Students either received description tasks (low constructive demands) or self-explanation tasks

(high constructive demands). They completed these tasks in either an open-book format (low retrieval demands) or closed-book format (high retrieval demands). Additionally, we examined, whether a short informed training intervention would improve students' application of the prompted strategies (e.g., self-explanation quality). We designed informed training videos addressing students' attitudes, subjective norms and perceived behavioral control concerning the prompted strategies. The experiment was conducted within 11th grade physics classrooms, with 197 students participating in the study. Unexpectedly, results show no effects of constructive demands or retrieval demands, as well as their combination (constructive retrieval) on lasting comprehension. While there was a positive effect of constructive retrieval on strategy-application quality, we did not find a mediational effect to the outcome of lasting comprehension. The informed training did not improve learners' strategy-application quality or mental effort. Mental effort and time on task significantly declined within the tasks in all conditions. Our results suggest, that constructive retrieval has important boundary conditions. Specifically, learners need the cognitive and motivational prerequisites to understand and apply both the learning content as well as the learning strategies. Both facets of motivation and ability seem especially important considerations for a successful implementation of constructive retrieval. Understanding and addressing these boundary conditions is crucial for both research and potential applications of constructive retrieval.

Happy or Redundant? Combining Generative Activities and Retrieval Practice for Lasting Learning

Presenter(s)

Heike Russ | University of Tübingen, Germany

Co-author(s)

Tino Endres | UniDistance Suisse, Switzerland
Leonie Sibley | Zurich University of Teacher Education, Switzerland
Salome Flegr | Dresden University of Technology, Germany
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Vincent Hoogerheide | Utrecht University, Netherlands
Katharina Scheiter | University of Potsdam, Germany
Andreas Lachner | University of Tübingen, Germany

Supporting lasting learning is a central goal in education, particularly in schools where long-term retention is crucial for students' academic success. Generative learning helps construct meaningful mental representations, while retrieval practice supports consolidation and long-term retention. Combining both strategies may foster learning; however, research remains scarce. We investigated how combining generative activities and retrieval practice affects students' conceptual knowledge and monitoring accuracy in authentic school settings for immediate and lasting learning. Additionally, we explored associations between generation, retrieval, and explanation quality (i.e., completeness, elaboration, correctness).The classroom experiment was conducted in authentic physics lessons with N = 344 secondary students, participating in a physics teaching unit about converging lenses. Students were randomly assigned within each class to one of four combinations of sequential learning activities crossing

two factors (non-generation vs. generation; non-retrieval vs. retrieval). Conceptual knowledge and monitoring accuracy were measured immediately and after eight weeks.Results showed that conceptual knowledge and monitoring accuracy did not significantly differ between generation, retrieval, or their sequential combination at either test. However, exploratory analyses revealed that retrieval practice supported lasting learning when prior generative processing was of low quality—that is, when students' explanations were incomplete, less elaborated, or inaccurate.The findings demonstrate that combining generation and retrieval does not universally enhance learning. Its effectiveness appears to depend on the quality of prior generative processing. In this sense, retrieval practice may serve a happy role—compensating for fragile knowledge—or a redundant one, offering no added benefit when prior understanding is already strong.

Virtual Reality in Healthcare: Applying the cognitive affective model of immersive learning (CAMIL)

Organiser(s)

Maria-Luisa Schmitz | Swiss Federal University of Vocational Education and Training, Switzerland

Juliette Désiron | University of Fribourg, Switzerland

Discussant(s)

Guido Makransky | University of Copenhagen, Denmark

Virtual reality (VR) can be considered a helpful tool to practice in authentic learning scenarios since regardless of time and space nursing and medical students can immerse themselves in a realistic hospital environment without endangering patients (Gasteiger et al., 2022).One well-established model to explain the potential effects of VR to promote nursing and medical students learning is the cognitive affective model of immersive learning (CAMIL; Makransky & Petersen, 2021). The effects of the different factors specified by the model on learning are depicted in Figure 1.The present symposium explores how the potential of VR can be exploited for healthcare education through the lens of the CAMIL model. The first contribution investigates the effects of the degree of immersion and generative prompts on situational awareness and cognitive load in an endoscopy training simulation. The second contribution examines the effects of immersion and sense of presence on motivation and noticing performance in nursing students' oral examinations using a 360° immersive video. The third presentation explores the effects of immersion, sense of presence, self-efficacy motivation and cognitive load while watching a 360° video on nursing students' knowledge about patient data protection and security. Finally, the last presentation investigates the effects of different visual feedback on procedural knowledge related to medical students' hand hygiene considering cognitive load and sense of presence as mediators. These studies will allow the discussant to comment on model testing and derive design guidelines for future healthcare training in VR.

Included Papers

Using Virtual Reality to Enhance the Assessment of Situational Awareness in Nursing Oral Exams

Presenter(s)

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Co-author(s)

Franziska Wettstein | Swiss Federal University for Vocational Eduation and Training (SFUVET), Switzerland

Alberto A.P. Cattaneo | Swiss Federal University for Vocational Education and Training, Switzerland

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In Swiss vocational nursing education, oral exams traditionally assess professional competences through text-based case analyses. These competences rely on situation awareness, the ability to notice relevant cues in complex clinical situations. Virtual Reality (VR) may offer new opportunities to support the assessment of such abilities.Grounded in the Cognitive Affective Model of Immersive Learning (CAMIL; Makransky & Petersen, 2021), this study examines whether immersion influences sense of presence, motivation and performance in noticing during oral exams. A quasi-experimental design compared a traditional text-based exam (n = 39) with a VR-based exam using a 360° immersive video (n = 40). Sense of presence (spatial and emotional), motivation, and noticing performance were assessed using validated instruments and a checklist of relevant elements for noticing.Results showed that VR significantly increased both sense of presence and motivation compared to the traditional condition. Differences in noticing performance were small and non-significant. PLS-SEM supported the investigated CAMIL pathway, indicating that immersion predicted sense of presence, which in turn predicted motivation and had a small effect on noticing. Qualitative feedback highlighted VR's contribution to visualizing the patient and clinical environment.Overall, findings suggest that VR can enrich experiential and motivational aspects of assessment, potentially enhancing the validity of oral examinations by providing candidates with richer perceptual cues to demonstrate situational awareness abilities.

Supporting Mental Visualisation in iVR Improves Contamination Prevention Despite Reduced Presence

Presenter(s)
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Co-author(s)
Agnese Nanni | University of Zurich, Switzerland
Sanha Lee | University of Zurich, Switzerland
Aline Wolfensberger | Institute for Implementation Science in Health Care, University of Zurich, Switzerland
Tino Endres | UniDistance Suisse, Switzerland

Immersive Virtual Reality (iVR) enables safe practice of medical procedures to improve critical protocols such as hand hygiene, which is detrimental in the prevention of healthcare-associated infections. In this context, iVR enables the visualization of otherwise invisible elements as temporary visual support. This study examined whether fading out support by signaling germs and patient zones, paralleling scaffolding, improves adherence to hand hygiene, and whether potential effects follow the performance–immersion–load pathway proposed by the Cognitive Affective Model of Immersive Learning (CAMIL). First-year medical students (N=185) trained with an iVR-simulator during two patient-care rounds. In round-1, participants were randomly assigned to one of four signaling conditions in a 2-Germs (visible vs. invisible) x 2-Patients-Zones (visible vs. invisible) design. Signaling used color-coded shapes to visualise germs and/or patient zones. Performance was assessed in round-2 via contamination prevention efficiency (CPE), computed from contamination frequency and completion time. Presence and mental effort were measured as potential mediators after round-1. Results showed a main effect of germs (p<.001) and patients' zones (p=.045) on CPE, with more efficiency in the visible conditions, but no significant interaction. Germ visibility reduced sense of presence (p=.021), which increased mental effort (p=.021), but neither a simple nor a sequential mediation on CPE was found. Signaling patients' zones showed no mediation effects. These findings suggest that signaling germs and patient zones can improve procedural efficiency, but the hypothesised mediation pathway of the CAMIL was not supported. Design choices should prioritise task-relevant support over immersive experience to optimise iVR-based medical training.

Immersion Interrupted: Optimizing Medical IVR Training Through Non-Immersive Prompting

Presenter(s)
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Julian Kreiser | Visual Computing Group, Institute of Media Informatics, Ulm University, Germany
Alexander Hann | Interventional and Experimental Endoscopy (InExEn), Department of Internal Medicine II, University Hospital Würzburg, Germany
Monika Engelke | Bildungswerk e.V. Campus der St. Elisabeth Gruppe Katholische Kliniken RheinRuhr, Herne, Germany
Dorothea Henniger | Interventional and Experimental Endoscopy (InExEn), Department of Internal Medicine II, University Hospital Würzburg, Germany

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Immersive Virtual Reality (IVR) is a powerful tool for healthcare training, particularly for developing situational awareness (SA), but its high sensory demands can increase cognitive load (CL) and hinder learning. This study investigated the impact of prompts—designed to guide attention and foster deep processing—by comparing immersive (integrated) and non-immersive ("immersive breaks") designs. Using an aptitude-treatment interaction (ATI) approach, the research examined how these designs interact with learner characteristics: prior knowledge, situational interest, and prior IVR experience. Eighty-eight undergraduate students participated in an IVR endoscopy simulation. Results showed no significant main effect of prompting on SA; however, a significant ATI effect emerged regarding prior IVR experience. Participants without prior IVR experience achieved significantly higher SA scores and reported lower interactional extraneous CL when using non-immersive prompts compared to immersive or no prompts. Additionally, non-immersive prompts significantly increased germane CL compared to the control group. Prior knowledge was a positive predictor of SA and a negative predictor of intrinsic CL, while situational interest predicted higher germane CL. These findings suggest that non-immersive prompts serve as vital scaffolds for users inexperienced with IVR by providing an "immersive break" that mitigates cognitive overwhelm. Strategic interruptions of immersion can free up memory resources, allowing inexperienced learners to better engage with instructional content and improve situational awareness in complex virtual environments.

Motivation is key for learning with 360° videos in nursing: A design experiment

Presenter(s)

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Vito Candido | SFUVET, Switzerland
Alberto A.P. Cattaneo | Swiss Federal University for Vocational Education and Training, Switzerland
Patrizia Salzmann | Swiss Federal University of Vocational Education and Training, Switzerland

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This study has the goal to investigate the effect of 360° videos on factual knowledge regarding patient data protection and security. The cognitive affective model of immersive learning (CAMIL) serves as a theoretical framework. Thus, the degree of immersion, sense of presence, self-efficacy, motivation and cognitive load were investigated as relevant predictors of knowledge acquisition. In a pre-posttest study including a delayed posttest 82 nursing students were randomly assigned to the group watching the 360° video on a desktop computer or via virtual reality (VR) googles to manipulate the degree of immersion. Repeated measurement analysis of variance (ANOVA) showed no significant difference between the two groups. Still, a significant and positive effect of time for knowledge acquisition could be detected in both conditions. This indicates that nursing students in both conditions performed significantly better in the knowledge test after watching the video and could retain the knowledge six weeks after the treatment. Partial least squares structural equation modeling (PLS-SEM) revealed that students in the VR googles condition benefited indirectly from the experience: A higher degree of immersion had a significant and positive effect on sense of presence which was a significant and positive predictor of motivation and in turn motivation significantly and positively affected knowledge acquisition. However, self-efficacy and cognitive load had no significant effects in the model. Thus, teachers should be encouraged to use 360° videos to promote knowledge about patient data protection and security and offer an authentic learning setting without endangering real patients.

Virtual Reality, Context, and Reflection in Learning and Comprehension

Organiser(s)

Ting-Yu Liu | Universität Tübingen, Germany

Discussant(s)

Yizhen Huang | Hector Research Institute of Education Sciences and Psychology, Germany

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Virtual Reality (VR) is increasingly employed in educational research, yet its effectiveness for comprehension and learning depends on how immersive experiences are theoretically framed, empirically investigated, and pedagogically embedded. This symposium is organized around a shared conceptual framework that conceptualizes VR as object of study, practical application, and research method, providing a coherent lens through which the four contributions are connected. The first contribution establishes this triadic framework, arguing that VR-based

learning research benefits from systematic interaction between these three roles. VR must be examined as an object of study to understand how users perceive, process, and interact with virtual environments; as an application to support learning, training, and therapy; and as a method that enables controlled yet ecologically valid investigations of language, communication, and cognition. The remaining contributions instantiate and empirically elaborate this framework in complementary ways. The second contribution primarily addresses VR as an application, demonstrating that context-rich and embodied VR environments significantly enhance second-language listening comprehension and metacognitive monitoring accuracy in secondary education. The third contribution foregrounds VR as a method, using immersive simulations to investigate how different forms of post-experience debriefing including human-moderated and AI-supported shape reflection, learning outcomes, and perceived authenticity in higher education. The fourth contribution bridges VR as object and application by comparing real-world museum experiences with immersive 360° exhibitions, examining how presence, motivation, and repeated exposure influence learning in informal contexts.Together, the symposium advances an integrated perspective on VR-supported comprehension that emphasizes contextualization, reflection, and learner engagement over immersion alone.

Included Papers

Real versus 360° Exhibitions: Similar Learning, but Motivation Beliefs Crucial for Repeated Exposure

Presenter(s)
Birgit Brucker | Leibniz-Institut für Wissensmedien (IWM), Germany

Co-author(s)
Robin Wagner | Leibniz-Institut für Wissensmedien (IWM), Germany
Luisa Scherer | Universität Tübingen, Germany
Peter Gerjets | Leibniz-Institut für Wissensmedien (IWM), Germany

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Immersive 360°-images of informal learning environments, such as museum exhibitions, are becoming increasingly realistic and allow people to experience the exhibition contents in locations going beyond the actual on-site museum setting. This study investigated whether 360°-photographs can serve as valuable supplements to in-person museum visits. Participants experienced a real museum exhibition room and an immersive 360°-photograph of this room (both accompanied by the same audio guide; within-subjects: real versus 360°). Presentation order was counterbalanced (between-subjects: real-360° versus 360°-real; 2x2-mixed design). Dependent variables included spatial presence, user engagement, cognitive load, perceived impressiveness, perceived realism, existential authenticity, and learning outcomes. Control variables were prior knowledge and value beliefs (intrinsic, attainment, utility, cost). Results yielded higher spatial presence for the real than the 360° exhibition, particularly if participants saw the real exhibition second. The real exhibition resulted in higher user engagement and germane cognitive load than the 360° exhibition. Moreover, perceived impressiveness, perceived realism, and existential authenticity were lower for the 360° than the real exhibition, particularly if participants saw the 360° after the real exhibition. Intrinsic cognitive load was higher in the first

compared to the second exposure of the real exhibition. Furthermore, the second exposure (independent from exhibition format) led to better learning. However, this was particularly true for participants with more favorable motivational beliefs (attainment and utility value, and cost). In sum, real exhibitions were perceived to be superior, however learning outcomes were comparable in 360° and real exhibitions, and only participants who value paleontology benefitted from the second exposure.

A Comparison of Human-Moderated, Generative Chatbot, and AI-Avatar Debriefing After VR Training

Presenter(s)

Dominik Evangelou | University of Duisburg-Essen, Germany

Virtual Reality (VR) is increasingly used in higher education to support learning in domains that require complex interpersonal skills, such as counseling. While immersive VR environments can be highly engaging, learning is assumed to emerge primarily through reflection after the experience rather than during immersion itself. Debriefing therefore plays a central role in translating experience into understanding and competence, yet human-moderated debriefings are resource-intensive and difficult to scale. This paper presents an ongoing research project comparing three debriefing formats following VR-based counseling training: human-moderated debriefing, generative chatbot-guided self-debriefing, and embodied, AI-driven avatar-based debriefing. The project builds on a mixed-methods pilot study that compared moderated and chatbot-guided debriefings and found comparable gains in counseling competence and self-efficacy, with learning gains occurring mainly after debriefing. However, moderated debriefings were perceived as higher in quality, and qualitative analyses revealed differences in reflective depth and perceived authenticity. The ongoing study extends this work by introducing AI-driven avatars as a third debriefing format. The symposium paper will report empirical data from this new study, examining how embodiment and social presence influence reflection, learner perceptions, and learning outcomes.

Listening Comprehension in Virtual Reality Language Learning: Effects of Varying Visual Context

Presenter(s)
Ting-Yu Liu | Universität Tübingen, Germany

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Andreas Lachner | University of Tübingen, Germany

Listening comprehension is a foundational yet persistently challenging skill in second language (L2) learning, largely due to the limited availability of authentic, context-rich instructional materials in formal educational settings. Virtual reality (VR) offers new possibilities for addressing this challenge by situating learners in immersive environments that approximate real-life communicative contexts. This study investigates the effectiveness of VR-enhanced listening interventions by examining how different degrees of contextual support influence L2 learners' listening comprehension and metacognitive monitoring accuracy. Using a within-subject design, 160 seventh/eighth grade students from German secondary schools completed listening tasks under three VR conditions: (1) a neutral classroom setting with audio (neutral condition), (2) a visually contextualized scene with audio (visual context condition), and (3) a visually contextualized scene with audio delivered by actors (visual context + actor condition). Learning outcomes and monitoring accuracy were analyzed using (generalized) linear mixed-effects models. Results showed that both context-rich conditions significantly outperformed the neutral condition in terms of listening comprehension and monitoring accuracy, with the visual context plus actor condition yielding the strongest effects on learning outcomes. These findings provide empirical support for context-based and embodied learning, highlighting the role of multimodal, authentic input in enhancing comprehension and self-evaluation. The study contributes to the growing body of VR-assisted language learning research and offers pedagogical implications for integrating immersive, context-rich listening activities into secondary school L2 instruction.

Virtual Reality as Object of Study, Practical Application, and Research Method

Presenter(s)
David Peeters | Tilburg University, Netherlands

Virtual Reality (VR) is an increasingly popular research technique in the study of human communication, learning, and cognition. In this talk, I will show how VR has been investigated as an object of scientific study itself, how it is used as an application for language-and-communication-related learning, training, and therapy, and how it is employed as a research method to investigate fundamental research questions related to the study of human language and communication. A theoretical analysis of the literature makes clear not only that VR offers

great potential for learning, but also that more systematic work is needed to establish how effective it is compared to alternative types of stimulus display. Concretely, I will argue for an integrated approach in which the uses of VR as object, application, and method dynamically interact to provide the experimental researcher with a validated and replicable tool that combines high experimental control with high ecological validity to benefit both science and society.

When and Why Does Exploring Before Instruction Improve Students' Conceptual Understanding?

Organiser(s)

Inga Glogger-Frey | University of Erfurt, Germany

Discussant(s)

Logan Fiorella | University of Georgia, United States

In education, there is a longstanding tension between instructor-centered direct instruction and student-centered discovery learning methods (Sweller et al., 2024). A growing number of studies have found that an explore-then-instruct sequence can provide benefits of both. For example, inventing to prepare for future learning (Schwartz & Martin, 2004), problem-solve-instruct methods (PS-I, Loibl et al., 2017), and productive failure experiences (Kapur, 2016) are all known to help students engage in learning at a deeper level–improving conceptual understanding and transfer to new learning. However, not all research finds these results. More work is needed to uncover when and why exploring before instruction fosters conceptual knowledge. The presentations in this symposium address this goal across a range of subject domains (biology, statistics, computer programming), yet common mechanisms emerge. For example, presentations discuss how students become aware of, and process, deep conceptual features, and methods to facilitate students in noticing these features. Presentations discuss the role of cognitive load in how exploration impacts learning—from the design of materials or learners' prior knowledge. The presentations include various outcome measures, including learning, transfer, metacognition (knowledge gap awareness), and motivation (interest, curiosity). Though all studies examine exploring before instruction, they vary in comparison conditions and use of novel versus traditionally-studied subject domains. Together, these presentations demonstrate learning benefits of exploration, mechanisms that support these benefits, as well as best practices for its use. Discussion will synthesize and build upon these studies to inform theory, best practices, and future research on when and why exploring before instruction works.

Included Papers

Knowing when and why a solution fails - Fostering Negative Knowledge in Exploring Before Instruction

Presenter(s)
Charleen Brand | ETH Zürich, D-GESS, Switzerland

Co-author(s)
Valentina Nachtigall | Ruhr University Bochum, Germany
Katharina Ockl | University of Erfurt, Germany
Inga Glogger-Frey | University of Erfurt, Germany
Timo Leuders | University of Education Freiburg, Germany
Katharina Loibl | University of Education Freiburg, Germany

In explore-then-instruct sequences such as problem-solving prior to instruction (PS-I), students are expected to become aware of their own knowledge gaps, preparing them for learning from subsequent instruction (Loibl et al., 2017, 2025). However, they often struggle to recognize and specify their knowledge gaps (Brand et al., 2025a; Lee et al., 2023). When students specify their knowledge gaps, this could help them build negative knowledge, that is, knowledge on how not to solve the problem (Oser et al., 2012). This specifies what knowledge they still need to acquire from instruction (Glogger-Frey et al. 2015, 2022).In our study, we manipulate the specificity of negative knowledge that students build when studying erroneous solution attempts in a vicarious PS-I setting ranging from unspecific to specific negative knowledge by providing them with information that specifies that, when, and why a solution is incorrect. We hypothesize that providing students with more specific information on how not to solve a solution attempt, will result in more specific negative knowledge after problem solving, which in turn will better prepare them for subsequent instruction, leading to higher conceptual knowledge after instruction. Moreover, we examine motivational effects of knowledge gap awareness on their learning outcomes. Results will be able to show first evidence of the effect of negative knowledge on a cognitive and motivational level, advancing the theoretical understanding of PS-I. It will also provide an instructional design for educational practice that may support students who struggle to become aware and specify their knowledge gaps.

Considering Cognitive Load: Exploring Simple versus Complex Activities Before Instruction

Presenter(s)
Marci DeCaro | University of Louisville, United States

Co-author(s)
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Angela Thompson | University of Louisville, United States
Ryan Patrick | University of Georgia, United States

Exploring a new concept before instruction can deepen students' conceptual understanding compared to typical instructional methods—but does not always. The current research examined whether the complexity of the exploration activity can limit its conceptual benefits. In Experiment 1, undergraduate first-year engineering students (N=400) learned about common programming errors. Students in the instruct-first order received a lecture, then completed a practice activity targeting three error types. Students in the explore-first order explored the activity before lecture. Afterwards, students completed a survey and a posttest assessing knowledge of basic facts and concepts. Compared to the instruct-first order, students in the explore-first order scored lower on the posttest, reported equal interest/curiosity, and higher cognitive load. Experiment 2 (N=817) examined whether exploration activities should focus on fewer learning objectives at once, by manipulating both order and activity complexity. The complex activity condition again targeted three error types, and results overall replicated Experiment 1. The simple activity condition split the error types into three activities, interleaved with mini-lectures. The results largely reversed. Exploring first boosted conceptual knowledge, and equalized fact knowledge between orders. Exploring first also led to higher interest, curiosity, and cognitive load than receiving instruction first. Overall, conceptual knowledge was highest when exploring simple activities, lower for both instruct-first orders (simple and complex activities), and lowest when exploring the complex activity. Exploring before instruction can backfire if targeting too many objectives at once. Exploration activities with smaller conceptual units may help learners discern important conceptual features and deepen understanding.

Understanding Mechanisms of Exploring before Instruction Using Think Aloud

Presenter(s)
Inga Glogger-Frey | University of Erfurt, Germany

Co-author(s)
Katharina Ockl | University of Erfurt, Germany

Exploration tasks before instruction are expected to foster learning-relevant cognitive processes to prepare learners for subsequent instruction. Such tasks can differ in the degrees of generation the learners have to engage in, preparing them differently. Open-problem-solving can make learners more aware of knowledge gaps, while self-explaining a solution of the same problem can help learners to process relevant learning content more deeply. This study compares the cognitive processes during preparation tasks differing in how much generation they require, and

their influence on learning outcomes.135 undergraduate psychology students were randomly assigned to either a condition inventing a solution (inventing, n = 66) or self-explaining a worked-out solution of the same problem (worked example, n = 69) while thinking aloud. The cognitive process variables 'expressed knowledge gaps' and 'deep feature processing' were coded. After the preparation phase, participants learned with an instructional video. Then, they completed a post-test targeting near and far transfer. Results show that a worked example can prepare learners for far transfer. Deep-feature processing can even mediate outcomes (near transfer). The different preparation activities foster different cognitive mechanisms: students who self-explained a worked example processed deep features more deeply whereas students who invented expressed more knowledge gaps.

Exploring Before Instruction Supports Transfer and Idea Generation Across Prior Knowledge Levels

Presenter(s)
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Undergraduate students often struggle to develop transferable understanding of complex biological concepts, particularly those that require integrating multiple representations and systems thinking, such as metabolic pathway dynamics and regulation (MPDR). Two instructional sequences have been proposed to support learning: instruction followed by problem solving (I-PS), grounded in cognitive load theory, and problem solving followed by instruction (PS-I), grounded in the broader design paradigm of preparation for future learning. However, it remains unclear whether the effectiveness of these sequences depends on learners' prior knowledge.We conducted two randomized-controlled studies involving 295 introductory biology students and 282 biochemistry students, representing relatively lower and higher prior knowledge levels, respectively. Participants received instruction using either the I-PS or PS-I approach. We assessed learning using students' written responses to near- and far-transfer problems and analyzed outcomes using a non-parametric Quade ANCOVA that controlled for prior knowledge.Among lower-prior-knowledge introductory biology students, the PS-I group generated more ideas during both near- and far-transfer tasks and outperformed the I-PS group on far-transfer performance, even though near-transfer performance did not differ across conditions. Among higher-prior-knowledge biochemistry students, the PS-I group outperformed the I-PS group and generated more ideas on near-transfer tasks, whereas performance and idea generation did not differ between conditions on far-transfer tasks. Together, these findings indicate that problem solving before instruction promotes idea generation and conceptual flexibility across prior knowledge levels, providing empirical support for exploration before instruction in learning complex biological systems.

EMPIRICAL PAPER

Designing for Motivation: Effects of Autonomy-Enhancing Language and Learning Partner on Learning

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Digital learning materials and environments are often designed with a primary focus on cognitive processing, while motivational processes that support learning remain underexplored. Drawing on Self-Determination Theory (SDT), this study investigated how autonomy-support (autonomy-enhancing language in the learning material) and relatedness-support (presence of a learning partner in the learning environment), implemented as instructional design features, influence learners' motivational, cognitive, and social perceptions, as well as learning outcomes. In a 2 × 2 between-subjects design, 135 Swiss secondary-school students studied an instructional text on Aurora and completed measures of motivation, cognitive load, social presence, mental load/effort, and learning outcomes, assessed either immediately or after a delay. Results showed that autonomy-support reduced extraneous cognitive load and invested mental effort and yielded delayed benefits for transfer performance, suggesting deeper knowledge integration over time. Relatedness-support increased perceived social presence and reduced invested mental effort in the immediate condition. No additive effects of autonomy- and relatedness-support were observed; however, a three-way interaction with test-timing emerged for retention, with descriptively highest delayed retention when both supports were present. Across conditions, perceived task demands remained unchanged, indicating that need support primarily affected subjective engagement rather than task difficulty. These findings demonstrate that autonomy- and relatedness-support foster nuanced and temporally sensitive effects in digital learning. The study highlights the importance of considering timing and interactive mechanisms when evaluating need-supportive instructional design and suggests that motivational benefits may emerge indirectly through changes in cognitive engagement and longer-term learning outcomes rather than immediate self-reported motivation.

From Clicks to Conclusions: The Role of Instructional Scaffolding on Diagnostic Reasoning

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Effective medical diagnosis and decision-making depend heavily on collaborative diagnostic reasoning (CDR), which encompasses activities such as evidence generation, evidence and hypothesis sharing, and conclusion drawing, collectively referred to as collaborative diagnostic activities (CDAs). Simulation-based learning environments provide valuable opportunities for medical students to practice these skills in a controlled setting. In this study, we examined how reflection phases and collaboration scripts as types of scaffolding shape CDR processes within an agent-based simulation. Using process mining based on log data, we qualitatively explored how 117 medical students worked on a fictitious patient case in interaction with an agent-based radiologist, aiming to illuminate support-dependent differences in their diagnostic pathways. The process models revealed that the type of scaffolding substantially influenced students' CDAs: reflection phases fostered repeated evidence generation with the patient's health record and a more comprehensive sharing of evidence and hypotheses, whereas collaboration scripts were associated with evidence generation only at the beginning and frequent omission of specific steps as part of the evidence sharing. Despite these procedural differences, neither form of scaffolding significantly improved diagnostic accuracy. Building on these insights, we argue that traditional performance outcome measures, such as diagnostic accuracy alone, are insufficient for capturing the effects and mechanisms of scaffolding. Instead, a more nuanced assessment of reflective practices and the impact of scaffolding on the development of complex skills is necessary.

The Instructor's Role in Fostering Student Teachers' Competencies with Double-Content Examples

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Effective classroom management relies on teachers' knowledge, self-efficacy, and professional vision (PV). In teacher education, these competencies are often fostered through video-based analyses, provided that instructional support is adequately designed. Although double-content examples are considered a promising instructional approach, their use in expert teachers' video-based analyses has been shown to negatively affect PV, likely due to student teachers' difficulties

in processing the complex materials, highlighting the need for instructional guidance. Nevertheless, research has paid little attention to whether instructor-guided discussions can support learning from double-content examples or to effects on domain-specific knowledge and self-efficacy. Thus, this study investigates how double-content examples of expert teachers' video-based analyses can be incorporated into teacher education to enhance student teachers' PV, knowledge, and self-efficacy of classroom management. Using a quasi-experimental pre-post-test design, 79 student teachers participated in three eight-week video-based courses, all taught by the same instructor. They read preparatory texts and conducted biweekly video-based classroom analyses, which were discussed with the instructor. Two intervention groups additionally self-studied double-content examples, with one group also discussing them with the instructor. We measured PV, knowledge, and self-efficacy of classroom management. Results of linear regression analyses with residualized change scores indicated that self-studying double-content examples negatively affected PV, while instructor-guided discussions mitigated these effects but did improve PV more than video-based analyses alone. There were no group differences for knowledge or self-efficacy. The findings indicate that complex double-content examples require instructor guidance, as student teachers struggle to apply them for video-based analyses. Limitations and implications are discussed.

How Course Design Shapes the Experience of Learner Control: A Qualitative Study

Presenter(s)

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Learner control (LC) and instructional choice are widely assumed to support autonomy and adaptive learning in online and blended environment. However, empirical findings remain inconsistent: while some studies report motivational and performance benefits, others document increased cognitive load and reduced efficiency, particularly for less experienced learners. Explanations typically focus on learner characteristics or perceived learner control, but less attention has been paid to how LC is instructionally presented, despite the fact that instructional design features can influence student perceptions. This qualitative study examines how students experience LC in a course where flexible options (pacing, optional self-diagnostics, participation format) are structurally available but not explicitly framed as learner decisions. Semi-structured interviews with master's students were analyzed using reflexive thematic analysis. The analysis explored whether students recognized available options as choice, how they interpreted responsibility boundaries, and how these interpretations related to perceived autonomy and cognitive load. Findings show that LC is often not explicitly noticed. When flexibility is not salient, students interpret the course primarily through fixed structural elements such as deadlines and assessment rules. When LC is recognized, autonomy is experienced as regulation within clearly defined boundaries rather than as unbounded freedom. Depending on how responsibility is interpreted, LC may function either as autonomy-supportive or as cognitively demanding. The

study introduces instructional explicitness of learner control as a design-level consideration shaping whether LC operates as choice or as burden.

Learning within Immersive Augmented Reality – A Test of the Modality and Signaling Principles

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Augmented Reality (AR) has shown overall positive effects for learning in various studies conducted in the last decade. However, there is a distinct lack of value-added studies implementing theory-driven designs of educational AR and an overrepresentation of media comparison studies in this space. This study aimed to address this gap by investigating if established instructional design principles could be transferred into an immersive AR learning environment by implementing the signaling and modality principles proposed through the Cognitive Theory of Multimedia Learning (CTML). Furthermore, cognitive-affective factors usability and motivation were included as moderators of their effects. Overall, N = 80 adult learners participated in the resulting 2x2 experimental investigation in which the presence of virtual signals (absent vs. present) and the content modality (text vs. audio) were manipulated between-subjects. The results revealed no significant main or interaction effects through either instructional design principle on declarative or procedural knowledge scores, and neither usability nor motivation moderated these effects. These findings underscore the difficulty in transferring established methods into immersive media and highlight the need for further investigations into matching instructional design to the technological affordances provided through immersive AR.

Supporting Technical Drawing and Mental Rotation in Immersive Technologies

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Short Abstract Augmented reality and virtual reality have the potential to improve mental rotation abilities, a key ability in vocational education. Despite the increasing number of studies on these technologies, there is still a lack of longitudinal studies, thus undermining the reliability of current evidence due to the novelty effect, the initial excitement that can hinder learning outcomes while increasing motivation levels. The present study compared the same application developed for AR and VR head-mounted display devices. The application supported the participants in studying technical drawing. The study was conducted using a longitudinal design

in an ecological course at a vocational school involving 28 apprentice plumbers for over a month. Mental rotation abilities and technical drawing skills were tested pre- and post-intervention, while motivation was tested after each session in which they use the application. The novelty effect was observed in terms of a reduction in motivation levels over time, but this did not hinder learning. Indeed, the results demonstrate that AR and VR are effective in supporting the improvement of technical drawing skills and mental rotation abilities. These results shed light on the role of the novelty effect when adopting immersive technologies within a longitudinal design, a still very under-researched area. From a practical perspective, the results support the adoption of these technologies as a valuable option in training programs.

How do pre-service teachers tackle GenAI overreliance?

Presenter(s)

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Generative Artificial Intelligence (GenAI) offers promising opportunities for enhancing learning and teaching by supporting adaptive feedback and assisting in knowledge creation. However, its rapid integration into educational settings has raised increasing concerns about students' overreliance on GenAI tools. When learners delegate thinking or problem-solving to GenAI, critical thinking, cognitive engagement, and human judgement may decline. Teachers play a central role in guiding students toward responsible and meaningful uses of GenAI, yet many pre-service teachers receive limited preparation for recognizing or preventing overreliance. Consequently, little is known about how teacher education programs can train future teachers to integrate GenAI in ways that preserve agency and cognitive effort. This study investigates how pre-service teachers address GenAI overreliance. The results show that pre-service teachers try to balance between underuse and overuse of GenAI. We also identify four key strategies adopted by pre-service teachers to avoid GenAI overreliance in the classroom: Eliminating, Limiting, Improving and Anchoring (ELIA). We also identify how identified ELIA strategies connect to teacher knowledge and skills using Intelligent TPACK and AI literacy scales.

Teacher educators' GenAI integration: Analysis of perceptions, needs and use with Intelligent-TPACK

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Generative artificial intelligence (GenAI) technologies are transforming teaching and learning by offering new pedagogical opportunities while posing challenges. Despite their critical role in preparing future teachers, many teacher educators lack the necessary AI-related knowledge and pedagogical strategies for responsible GenAI integration. The current study first aimed to reveal teacher educators' perceptions, actual use, and needs regarding GenAI integration. For this, we interviewed teacher educators, transformed their collected experiences into case studies, and asked them to reflect on them. Our second aim was to explore the role of teacher educators' AI-specific knowledge and skills in these case reflections. For understanding such knowledge and skills, we used the Intelligent-TPACK and AI literacy frameworks. Epistemic Network Analysis (ENA) revealed that higher AI literacy and Intelligent-TPACK were linked to critical, multi-layered reflections, while lower levels reflected practice-focused, classroom-level reasoning. Interviews further showed that teacher educators (a) perceived GenAI as useful for teaching tasks but emphasized critical evaluation, (b) mainly used it for academic writing correction and lesson planning, and (c) expressed a need for practical and ethical guidelines. This study contributes to teacher education by demonstrating the potential of structured, case-based reflection to build AI-related knowledge and skills for pedagogical and ethical GenAI integration.

Routing the Talk Move into Different ICAP Engagement Modes: A Grounded Theory Study

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This study used grounded theory to analyze classroom dialogue transcripts from 23 mathematics lessons taught in 2020 in U.S. The analysis suggests that improvements in students' cognitive engagement do not depend primarily on the inherent effectiveness or skillfulness of particular discourse moves. Rather, engagement outcomes depend on: (a) the epistemic demand of the current task and the availability of relevant information; and (b) how discourse moves are embedded within interactional sequences. The model helps address a gap between research on classroom discourse and student cognitive engagement. It identifies four classroom discourse

strategy patterns that can effectively promote higher levels of cognitive engagement. From the perspective of the ICAP framework, the findings further indicate that even the same type of teacher talk move may elicit different engagement modes. ICAP enables the analysis to differentiate episodes that appear similar at the level of talk-move labels but differ in epistemic demand and in how the interaction is enacted in practice.

Adaptive explanatory feedback in a digital fraction game

Presenter(s)

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Digital educational games offer rich opportunities to personalize learning, yet empirical evidence on which forms of adaptivity add educational value remains limited. Personalisation might be especially relevant when targeting challenging learning content, such as fraction understanding, given the conceptual errors students suffer from when learning fractions, such as treating the numerator and denominator as independent whole numbers (e.g., natural number bias) or difficulties in grasping the meaning of a unit (e.g., unit of reference error). In a randomized controlled experiment, 288 fourth-grade students were assigned to one of three conditions: (1) a digital fraction game with explanatory adaptive feedback, (2) the same game with corrective feedback only, or (3) an active control condition using non-adaptive digital mathematics activities. Cognitive learning outcomes (near and far transfer fraction knowledge) and non-cognitive outcomes (math anxiety, motivation, and self-concept) were assessed using pre-, post-, and retention tests. Furthermore, in-game performance (accuracy and misconception errors) was investigated through gameplay log data. Using multilevel linear regression and explanatory item response analyses, we examined overall effects of experimental condition on cognitive, non-cognitive, and in-game performance outcomes, as well as differential effects for students with varying prior knowledge and motivational-affective profiles. Results show that both game conditions improved fraction knowledge compared to the active control condition, while explanatory adaptive feedback led to stronger gains in in-game accuracy and reduced math anxiety. However, explanatory feedback did not consistently reduce misconception errors beyond corrective feedback. Implications for theory and instructional design of adaptive game-based learning environments are discussed.

Designing Emotionally Intelligent GenAI: Effects on Self-Regulated Learning and Achievement Emotions

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While generative AI (GenAI) tools hold considerable promise for education, mainstream applications such as ChatGPT are not explicitly designed to support the metacognitive and socio-emotional dimensions of learning, often failing to address students' emotional states or promote independent thinking. In response, this study investigates the impact of a learner-centred GenAI chatbot design that combines self-regulated learning (SRL) scaffolding and emotional support. In a pre-registered experiment conducted in an authentic classroom setting, 144 high school students were randomly assigned to one of the three conditions: (1) ChatGPT, (2) SRLbot (GenAI with SRL scaffolding), (3) Emotional SRLbot (GenAI with SRL and emotional support). Outcomes included learning achievement (conceptual knowledge and transfer), trace-based and self-reported engagement across SRL phases (forethought, performance, self-reflection), and measures of achievement emotions (enjoyment, boredom, hopelessness). Data were collected at pre-test, post-test, and four-week follow-up. All chatbot conditions improved conceptual knowledge and transfer from pre- to post-test and retained these gains four weeks later; however, the ChatGPT group showed an indication of decline in both outcomes at follow-up. Both the SRLbot and Emotional SRLbot outperformed ChatGPT in fostering trace-based SRL behaviours, enhancing enjoyment, and reducing boredom. In addition, the Emotional SRLbot prompted greater engagement in performance-phase and self-reflection processes than the other conditions. These findings offer preliminary evidence that GenAI agents integrating SRL and emotional scaffolding can support more productive emotional states and SRL behaviours than general-purpose GenAI. We invite research that tests longer interventions and extends this design logic to multi-agent architectures for sustained SRL development.

Disentangling learning mechanisms in a generative AI-enhanced EFL collaborative writing environment

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This study examined learning mechanisms in a generative artificial intelligence (GenAI)-enhanced collaborative writing intervention in Japanese university English-as-a-foreign-language (EFL) classes. Analyses focused on links among psychological need satisfaction and frustration, engagement, and learning outcomes. The study was situated within the fourth cycle of an ongoing design-based research project involving [Application name], a web application

designed to increase engagement with writing, improve writing skills, and support AI literacy. In a 7-week intervention (N = 310), data were collected from a custom grammar test and TOEIC (a standardized English proficiency test) administered pre- and post-intervention, psychological surveys completed after the first and final application-use sessions, and aggregated usage metrics from application logs. A two-wave longitudinal structural equation model, followed by a mediation analysis, supported a dual-pathway learning model. Gains in targeted grammar skills were directly predicted by engagement with pre-learning tasks. In contrast, TOEIC posttest performance was predicted indirectly via competence satisfaction, which was in turn predicted by text production (controlling for TOEIC pretest). These findings suggest a model of learning that distinguishes behaviors for skill acquisition versus proficiency development and highlights the central role of psychological need states.

Virtual Reality vs Real Objects: Encouraging positive mindsets towards insects

Presenter(s)

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Research on insect biodiversity happens away from the public eye, and only few species get positive attention, whereas others are met with disinterest or even negativity, if not forgotten entirely.By employing digital museum exhibits made in virtual reality, we aim to provide a new perspective on insects and give visitors a glance behind the scenes of museum research. As part of a collaboration with a natural history museum, these exhibits have been and will be again integrated into exhibitions on insect biodiversity and science communication.For this research project, we investigate how digital exhibits need to be constructed in order to have a positive effect on visitors' interest in and appreciation for insects. In the study presented here, we focus on how virtual exhibits compare with real objects. Furthermore, we also examine the effect of the way information is provided, comparing knowledge-based instruction with emotion-based instruction.In this study, which took place in 2025, we compared a virtual representation of part of the museum's insect collection with physical collection boxes. Results showed that in both conditions, this exhibit significantly increases empathy, positive behavioral intentions, and positive attitudes towards insects, as well as significantly decreasing disgust, in the short term, with no significant difference between conditions.Our results show that even comparably small interventions in an informal, free-choice learning setting can positively influence how people feel about insect biodiversity, introducing them to new perspectives and creating deeper connections that can foster future development.

Assessing the quality of technology integration by combining SAMR and ICAP: A video study

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Despite the positive effects of digital technologies on learning, little is known about how teachers effectively integrate technology into teaching. This study investigates technology integra-tion combining two models of learning and teaching: the SAMR model, which categorizes functions of technology (substitution, augmentation, modification, redefinition) and the ICAP model, which categorizes learning activities according to their potential to foster cognitive en-gagement (interactive, constructive, active, passive). Video-recorded lessons of 83 secondary pre-service teachers are analyzed to explore the models' contributions in describing how teachers integrate technology into teaching. It is expected that the models will either yield simi-lar descriptions or provide unique contributions to what constitutes high-quality teaching with technology.Preliminary findings are based on analysis of 33 videos. A mixed-method analysis of teaching situations is used, noting frequent technology use patterns and associated student activities. Qualitative analyses were conducted by coding technology integration according to SAMR and ICAP levels. Building on this qualitative coding, quantitative analyses were used to examine correlations between SAMR and ICAP to assess either alignment or unique contributions of each model to describe technology integration. Preliminary results show that technology inte-gration at substitution level is most frequently combined with passive student engagement and augmentation is predominantly connected to active engagement.Additional analyses will be presented considering the connections between SAMR, ICAP, pre-service teachers' individual prerequisites, pedagogical experience, and the completion of prac-tical studies. Aggregated teaching quality ratings from the videos will be correlated with aggre-gated values of the ICAP and the SAMR ratings to explore possible connections.

Fostering Knowledge Transfer in Augmented Reality: The Role of Learning-Related Factors

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Augmented reality (AR) enables situated learning environments that can promote knowledge transfer – the ability to apply previous learned knowledge to new contexts by reducing the

distance between learning and application. While recent research has shown the potential of AR for educational purposes, it remains unclear how AR specifically supports knowledge transfer. Using a correlational design, the present study aims to identify the key factors influencing knowledge transfer and perceived transferability. N = 55 participants used a tablet-based AR application in which they learned to connect and apply chemical concepts in cooking tasks. We measured the knowledge level in chemistry, prior experience in cooking, motivation, immersion, cognitive load, and metacognitive skills (i.e., planning, monitoring, and reflection and evaluation) as learning-related factors to evaluate their relationship with knowledge transfer and perceived transferability. Results showed that perceived transferability was primarily predicted by motivation and prior experience in cooking, whereas knowledge transfer was significantly predicted by monitoring and the knowledge level in chemistry. The impact of immersion on perceived transferability was mediated by motivation. These findings suggest that motivational-affective factors are mainly relevant for the subjective judgement about the ability to transfer while knowledge transfer relies more on (meta-)cognitive processes. This study provides first insights into the key factors that impact knowledge transfer in AR-based learning environments.

A Critical Epistemological Audit of Early Evidence Syntheses in Generative AI Educational Research

Presenter(s)

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The rapid diffusion of generative artificial intelligence (GenAI), following the release of ChatGPT in late 2022, has prompted a swift empirical response, including early meta-analyses assessing ChatGPT's effects on student learning outcomes. However, given the novelty and volatility of this research field, concerns have emerged regarding the maturity and quality of the underlying evidence base. This study presents a systematic epistemological audit of published meta-analyses on ChatGPT in education, aiming to exemplify whether these syntheses rest on a sufficiently robust empirical foundation. Following PRISMA guidelines and a preregistered protocol, we identified five eligible meta-analyses comprising 92 primary studies. Using a comprehensive coding scheme, we evaluated methodological rigor, transparency, and open science practices at both the meta-analytic and primary-study level. Results indicate substantial methodological limitations. Although all meta-analyses reported systematic searches and basic

statistical diagnostics, none employed independent double screening or coding, preregistration, or full data and code sharing. The primary studies showed moderate overall quality, with pronounced weaknesses in open science practices and key design and reporting standards. Most primary studies focused on short-term performance outcomes rather than learning outcomes, raising concerns about construct conflation and the interpretability of aggregated effects. Overall, our findings suggest that current meta-analytic conclusions on the educational effectiveness of ChatGPT may convey a misleading sense of certainty. At the conference, we will extend this audit by examining the learning activities and support strategies targeted in the primary studies and by comparing effect size distributions between studies focusing on learning versus performance outcomes.

Audience Matters: The Effect of Addressees on Pre-Service Teachers' Professional Vision

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Abstract Professional vision (PV), teachers' ability to notice and reason about instructionally relevant events, is a key competence linked to students' achievement. PV is often fostered through video analysis and written reflections, yet the quality of reflection may depend on how tasks are socially framed. Social cues can activate social schema and increase motivational and metacognitive engagements, thereby supporting deeper cognitive processing. Across two studies, we tested audience-based scaffolds by separating addressee prompts from recipient responsiveness, implemented via generative AI (GenAI). Study 1 (N = 128) varied addressees in the prompt during video reflection (non-social control, self-explaining, peer addressee, teacher-addressee) and assessed text-based indicators of PV in pre-service teachers' written reflections. Results show that introducing social addressees particularly supports coherence and the use of professional vocabulary. Study 2 (N = 100) introduced role-based GenAI recipients via an integrated chat to test whether responsive dialogue provides added value beyond addressee framing. Findings indicate that the recipient's role matters: teachers-like recipients more consistently support explanation- and prediction-oriented processing. Overall, the studies demonstrate that the audience is a core design variable for PV-focused video reflection. Prompt designs should specify both who learners write for and who responds. Scalable GenAI dialogue appears most promising when configured as an expert-oriented recipient aligned with PV indicators.

Designing video-based training to support teacher noticing of classroom disruptions

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Designing video-based training to support pre-service teachers' noticing of classroom disruptions is a central concern in teacher education. Based on the cognitive theory of visual expertise, noticing relevant classroom situations is conceptualized as a knowledge-based decision about which information is selected and which is ignored. Video-based case work can guide this decision-making process through different types of instructional support. The present paper reports two studies comparing the effects of (a) a specific task instruction before video viewing and (b) prompts during video viewing on noticing information relevant to classroom management. In Study 1 (N = 85 pre-service teachers), noticing was operationalized in three dimensions: number, speed, and relevance of identified classroom situations. Participants watched two classroom videos and indicated relevant situations via mouse clicks. Results showed similar effects between conditions. Study 2 (N = 135) replicated this design and extended it using eye-tracking methodology to examine attention-guiding mechanisms. While both conditions again resulted in a comparable number of identified situations, participants in the prompting condition demonstrated a significantly shorter time to first fixation on classroom disruptions. Overall, both types of instructional support appear to foster noticing to a similar extent at the outcome level. On a process level, however, prompts during video viewing may facilitate faster visual attention allocation to disruptive events. Implications for designing video-based teacher education are discussed.

Engagement Dynamics and Achievement Change in Online Learning

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Understanding how student engagement changes during learning is critical for explaining differences in academic development in online courses. While engagement has been examined longitudinally, prior research has largely focused on development across courses or programmes, leaving limited insight into how participation patterns evolve under a shared course design. This study explores longitudinal patterns of behavioural engagement within a single online course and examines how these patterns relate to achievement change. Grounded in a complex dynamic systems perspective, engagement is defined as a dynamic process that may

converge toward recurring patterns of participation. Longitudinal learning management system data were analysed from a 14-week online physics course (N = 108). Students' weekly engagement was represented as discrete states and analysed as time-ordered sequences to identify longitudinal engagement trajectories. The analysis distinguished three recurring trajectories reflecting progressive disengagement, sustained active involvement, and stable selective participation. Longitudinal achievement analyses indicated that trajectories characterised by sustained engagement - both active and selective - were associated with stronger performance growth than trajectories marked by increasing disengagement. These findings highlight that engagement within a course can converge into distinct steady trajectories and productive learning may be supported through more than one stable pattern of participation.

The Long-Term Impact of LLM Feedback on Writing Performance and Revision Engagement

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Writing and revising texts is a demanding task that strongly benefits from formative feedback, which teachers often cannot provide in sufficient depth. AI-based feedback systems, particularly large language models (LLMs), offer new opportunities to support students throughout the writing process. While prior research has shown short-term positive effects of automated feedback on revision performance and engagement, evidence on longer-term effects in lower secondary education remains limited. This randomized controlled study examined the impact of LLM feedback on writing performance and engagement among N = 608 lower secondary students over six weeks. All students participated in weekly online writing strategy training based on self-regulated strategy development before composing argumentative texts. During revision, only the experimental group received LLM-generated feedback. Analyses indicated that students in the experimental group showed significantly greater improvements from their initial drafts to the revised texts compared to those in the control group. However, no systematic changes were observed across the repeated measurement points for either the initial drafts or the revised texts. In terms of engagement, participants who received LLM-generated feedback performed more extensive revisions and invested more time in the revision process than students in the control condition. Moreover, there was a significant effect of time on task across measurement points. Overall, the findings indicate that LLM-based feedback enhances revision quality, and increases active engagement in the revision process in lower secondary classrooms. Long-term effects of the intervention appeared to be limited.

Cognitive engagement in learner-controlled video learning: A cognitive load perspective

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Research on engagement in video-based learning often relies on behavioral indicators from interaction logs, yet it remains unclear whether these behaviors reflect cognitive engagement or mere activity. Guided by cognitive load theory, this study examined when common video-watching behaviors can be meaningfully interpreted as indicators of cognitive engagement. We analyzed relationships between time-on-video, click frequency, playback speed manipulation, and learners' intrinsic, extraneous, and germane cognitive load in a learner-controlled video environment (N = 97). Time-on-video and click frequency showed no systematic associations with cognitive load. In contrast, playback speed manipulation exhibited selective and theoretically consistent relationships: slowing down videos was associated with lower intrinsic load, speeding up videos with higher germane load, and both forms of speed adjustment with lower extraneous load. Overall, the findings demonstrate how cognitive load theory can be used to interpret digital trace data and to distinguish between behavioral activity and cognitively meaningful engagement in video-based learning.

Teachers' Competencies Addressing the Digital Divide: Development & Validation of a Measurement Tool

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The digital transformation of education has significantly altered the competency requirements for primary school teachers, to adapt and meet the changing needs of students: Recent research highlights a digital divide among students, which may directly affect their use of digital media, learning process and outcomes, and consequently, their participation in today's world (Heinz, 2023; Kutscher, 2021). More specifically, research indicates that students from families with lower socioeconomic status (SES) often have reduced access to hardware and software and exhibit lower digital competencies compared to their peers from higher SES backgrounds (Educa, 2021; Erzinger et al., 2023). Addressing this disparity requires teachers to have the necessary competencies to counteract it actively (Heinz, 2023). At the same time, there is currently no research examining and assessing the competencies among teachers addressing the digital

divide of students. This study aims to fill the existing research gap by 1) developing a measurement instrument to assess Teachers' Competencies addressing the Digital Divide (TeCoDD) and 2) investigating the validity of TeCoDD within two online surveys with teachers (N = 479). Results of the newly developed measurement instrument TeCoDD revealed excellent reliability (ω = .95), a data structure consistent with theory, and an acceptable model fit. In addition, the results showed that although teachers provide access to digital devices, they are only able to foster students' learning-oriented motivation, use and digital competencies to a limited extent. Further research is needed to deeper understand and increase teachers' competencies in the context of digital divide.

It is Less Effective to Self-explain Audio than Video Examples—Unless They're Segmented

Presenter(s)

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Learning with audio examples has gained in popularity in recent years. However, is choosing audio-only over video as the presentation mode for examples the best choice in terms of learning processes and outcomes? In two experiments with high school students (N1 = 42, 18 female, mean age = 16.9; N2 = 69, 62 female, mean age = 22.8), we analyzed the effects of certain examples' presentation mode (video or audio) on their effectiveness. The students self-explained two examples to acquire conceptual knowledge about argumentation. In Experiment 1, we presented these two examples in four segments, each followed by a self-explanation prompt. In Experiment 2, we presented two unsegmented examples, each followed by a self-explanation prompt. Overall, we found that learning by self-explaining examples was highly effective in both experiments—regardless of the examples' presentation mode. However, it was only in Experiment 2 featuring the unsegmented examples that the video group demonstrated higher self-explanation quality than the audio group. The video group also outperformed the audio group in the posttest on conceptual knowledge about argumentation. This effect was mediated by self-explanation quality. Overall, deep processing the given examples by generating high quality self-explanations is crucial for learning outcomes. Unsegmented audio examples cannot ensure this deep processing as much as video examples. After all, they lack visible social cues and model-observer similarity, and tempt listeners to engage in simultaneous off-topic behavior. Segmenting the examples in smaller chunks can, however, remedy this.

Unpacking Challenges in Virtual Youth Mentoring: A Mixed-Method Approach

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Mentoring is an extracurricular learning opportunity that is widely applied to foster the professional development of youth. Career-oriented programs for school and university students now increasingly implement virtual mentoring, where mentors and mentees interact partially or entirely via interaction and communication technologies (ICTs). However, existing research has focused on the individual perspectives of mentors and mentees and has overlooked contextual influences (e.g., the mentoring organization), such that we currently lack a holistic understanding of virtual youth mentoring challenges. In this paper, we extended systemic mentoring models to the virtual context and explored challenges at the level of the individual, the mentoring relationship, the mentoring organization, and the broader societal context. We conducted three studies using a mixed method/multiple source approach that aimed at deriving an initial set of challenges in Study 1 and elaborating this set in Studies 2 and 3. At the individual level, challenges referred to technical equipment, spatial requirements, and digital competence. Challenges at the mentoring relationship level referred to relationship building, goal setting and commitment. At the mentoring organization level, challenges encompassed participant attraction, screening, training, matching, supervision, and mentoring closure. Challenges at the societal level referred to general risks of virtual environments. Our findings show that challenges are not limited to individual or relationship factors, but also present at the level of the mentoring organization and the broader societal context. These challenges critically constrain effective relationship building in youth mentoring contexts and require adaptation to virtual settings (e.g., targeted digital competence training, or intensive supervision).

Multimedia design in test items: An eye-tracking study

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Adding representational pictures to text-based test item stems has been shown to be beneficial for test performance (i.e., multimedia effect in testing) and student perception of test items.

However, research on visualizations in response options is sparse. This study examined effects of multimedia design for both test item stem and response options on performance, perceived difficulty, and confidence when solving multiple-choice test items. Participants (N = 80) solved 16 items on a physics topic, which were presented as items containing text-only or text-picture test item stems combined with four text-only or text-picture item response options. Eye-tracking data were collected while participants worked on the test items. Although no effects on test item performance were observed, adding pictures to test item response options reduced perceived difficulty and increased confidence in solving the items. Moreover, eye-tracking data showed that adding pictures attracted attention, as evidenced, for instance, by a shorter fixation time on textual parts of the test item stem or response options. The results suggest that the presentation format guides processing of test items and that presentation format in test item stem and response options serves different functions, making the distinction between the two theoretically and practically important.

Retrieval Practice in Higher Education: Effects of Feedback Type and Exam Relevance

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Retrieval practice with feedback is an effective learning technique, yet the type of feedback that optimizes learning in authentic educational settings remains unclear. While field experiments suggest advantages of elaborate feedback over simple corrective feedback, laboratory research indicates that the benefits of elaboration are primarily evident in transfer tasks. We predicted that exam relevance motivates deeper engagement with elaborate feedback in field experiments, thereby enhancing its effectiveness for both retention and transfer. In a field experiment, N = 94 second-semester psychology students completed a learning module on research ethics. Half of the content was marked as exam-relevant, the other half as supplementary. After studying, students completed 12 true-false questions (6 per content type) and were randomly assigned to receive either simple corrective feedback (correct answer only, n = 49) or elaborate feedback (correct answer plus explanation, n = 45). Learning was assessed one week and four weeks later using identical items, inverted items, and short-answer questions. Results showed that elaborate feedback improved performance on identical items after one week ($p = .003$, $\eta^2 = 0.05$) and on short-answer questions after four weeks ($p = .025$, $\eta^2 = 0.03$). Elaborate feedback already improved practice test performance, though this did not account for the later learning benefits. Exam relevance enhanced transfer performance ($\eta^2 = 0.17$-0.23) but did not interact with feedback type. These findings suggest that elaborate feedback supports learning through mechanisms beyond engagement - even when content is not framed as exam-relevant.

Learning with Virtual Reality: Validating and Extending the CAMIL Model with Motion Sickness

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This study empirically validates the CAMIL and extends it by incorporating motion sickness as an additional factor. Data were collected from 161 vocational students in retail education who participated in a four-unit instructional intervention combining traditional instruction with immersive IVR-based learning. CAMIL constructs, motion sickness, and learning outcomes were assessed using validated instruments and a pre–post design. Path analyses revealed an excellent overall model fit and largely confirmed the relationships postulated by the CAMIL. Presence emerged as a stronger predictor of affective and cognitive factors than agency, while self-efficacy and embodiment were identified as key predictors of learning outcomes. Motion sickness was negatively associated with presence, motivation, and embodiment but showed no direct effect on learning outcomes. The use of immersive virtual reality (IVR) in school-based learning environments has gained increasing attention due to its potential to enhance learning through high levels of immersion and interactivity. The Cognitive Affective Model of Immersive Learning (CAMIL) provides a theoretical framework describing how IVR characteristics influence affective and cognitive factors related to learning outcomes. However, comprehensive empirical validation of the model remains limited, and potentially learning-inhibiting factors such as motion sickness have rarely been integrated into existing models.The findings contribute to the theoretical advancement of immersive learning models and highlight the importance of systematically considering both facilitating and inhibiting factors when integrating IVR into educational practice.

Motivating Overestimating Learners in a Problem- Solving Before Instruction Setting

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This study's aim is to investigate whether overestimating learners can be motivated to put more effort into learning by giving feedback about their performance after a problem-solving task. To investigate this, we asked automotive apprentices to first solve a problem-solving task (car malfunction). The experimental group then received fictious feedback about their performance. All participants then received instruction in form of a modelled example in a simulation-based

learning environment before working on a posttest. First analyses showed high overestimation in the participants, but no significant differences between groups for knowledge gap awareness, amotivation, intended effort before the learning phase, or learning outcomes. However, overestimation was related to knowledge gap awareness and also slightly to learning outcome. The results help to better understand the relations between overestimation and knowledge gap awareness, amotivation and intended effort. They also show a significance to further investigate overestimation in learners and how to successfully reduce it in order to motivate the learners.

Direct instruction for performance versus guided independent learning: an 8-week field experiment.

Presenter(s)

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To our knowledge, hardly any randomized experiments on instruction for hard skill-acquisition have been conducted in the setting of an entire academic course. In a course on Psychometrics, 30 groups of approximately 19 students (N= 564) were randomly distributed over a direct instructions for performance condition (DIP, modelling with on-demand clarification) or an instructions for independent learning condition (IIL, to use relevant available support sources) for all seven weekly practicals on different analyses in R-studio, with a representative exam in week eight. Preliminary survey findings show that students receiving DIP handled more subtasks than students receiving IIL during the practicals, while receiving DIP instead of IIL lowered Extraneous and Intrinsic Cognitive Load and increased Germane Cognitive Load (Klepsch et al., 2017). Invested mental effort stayed the same in both instructional formats (Paas, 1992). Students also perceived more learning at the end of practicals with DIP than IIL (Leppink et al., 2014). Equal performance on the blindly graded exam may be caused by contradicting mechanisms in this natural environment: The direct instructional benefit of DIP may be countered by independent learning behaviors such as time investment and use of support sources during and outside practicals as a consequence of students' monitoring judgements. Such independent learning abilities are defendable as valid instructional outcomes in higher education (e.g. David et al., 2024; Weijers et al., 2023). For a full understanding of optimal instruction for hard skill-acquisition in higher education, such outcomes are to be studied.

When digital devices distract learning: An experience sampling study of student motivation

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AbstractEducational technology can enhance engagement but may also elicit distraction, amotivation and multitasking. We examined how in-class device use and non-study multitasking relate to students' situational motivation during lessons in authentic classrooms. Using experience sampling across two school weeks, 545 high school students (17–18 years) reported after each class on device use (yes/no), multitasking (yes/no), and motivational experiences (interest, perceived competence, participation, distraction, judgments of learning). After a ≥3 on-class response criterion, analyses included 5980 reports from 442 students. Technology use occurred in 76.8% of class reports, multitasking in 22.4%. Intraclass correlation coefficients indicated substantial within-student variability in class-specific motivation. Random-intercept mixed models were used to assess associations. The findings indicated that when students used technology in class, they reported finding the lesson less interesting, participating less actively, having more difficulty concentrating and feeling less competent with accounts of attentional costs and cognitive load. Furthermore, the added harms linked to multitasking: students feeling they learned less and perceiving technology as less helpful for learning, suggests that technology-related costs are even bigger when multitasking is salient. Together, these results show that both the presence and the purpose of device use matter, and that motivational states may mediate technology's classroom impact. Educationally, the study highlights the need for device practices that minimize off-task exploration while preserving the benefits of purposeful technology use.

Comparing Instructional Designs to Improve Pre-service Teachers' Writing Assessment Literacy

Presenter(s)
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Pre-service teachers face the challenge of learning both theory and practice through diverse instructional approaches, yet empirical research in this area remains scarce. Thus, this study compared three instructional designs for developing pre-service language teachers' writing assessment literacy: traditional lecture, explicit instruction (modeling plus stepwise, student-led practice), and structured peer interaction (facilitated calibration and negotiated scoring). A quasi-experimental pretest–posttest design was implemented with 263 upper-level pre-service teachers majoring in language education. Participants completed repeated scoring-and-feedback tasks at pre- and post-instruction using authentic Grade 9 student texts at three proficiency levels (high/mid/low). Scoring accuracy was operationalized as the absolute difference between expert

benchmark scores and participant scores across four analytic criteria (lower = better). Feedback quality was indexed by expert ratings on five dimensions (higher = better): evaluation quality, criterion relevance, accuracy, actionable suggestions, and comment level. Type-III mixed-design ANOVAs with repeated moderators (text level × criterion/dimension) and Holm-adjusted follow-up contrasts were conducted. Overall, both practice-based designs—explicit instruction and peer interaction—demonstrated advantages over traditional lecture, with a clearer and more consistent pattern for feedback quality across most level-by-dimension comparisons. For scoring accuracy, improvements were more conditional, emerging for specific criterion-by-level combinations, and meaningful differences between explicit instruction and peer interaction were also observed depending on detailed task conditions. These findings provide design-level evidence for constructing efficient, evidence-based teacher-education programs that strengthen pre-service teachers' scoring alignment and feedback quality.

A systematic review of learner characteristics in AR-supported STEM education

Presenter(s)

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Understanding how augmented reality (AR) influences STEM learning across different learners requires adopting an Aptitude-Treatment Interaction (ATI) perspective, which looks into how individual characteristics interact with AR affordances. This systematic review examined how individual differences have been examined in AR research over the past decade (2013-2022). Out of 498 studies screened at phase 1, only 38 studies examined individual variables as predictors, with prior knowledge being the most examined learner characteristic. Only five studies examined how learner characteristics interact with AR versus traditional learning environments. Among the characteristics studied, spatial ability was the most frequently investigated. However, due to the different facets of spatial ability studied, its relationship with learning outcomes remains unclear. We address possible reasons for this limited and inconsistent evidence and suggest ways to improve future research. In addition, we present a research design framework to support the development of AR studies that more effectively incorporate an ATI perspective.

Examining the effect of spatial abilities learning in AR

Presenter(s)

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Augmented reality (AR) can visualize spatial representations, which has a lot of potential for spatial topics in STEM education. While spatial abilities play an important role in STEM success, findings are inconclusive concerning the effects of spatial abilities when learning with 3D representations in learning technologies like AR. Furthermore, the interaction of learners' spatial

abilities and design considerations may lead to additional complications, including components like cognitive load. Using an aptitude-treatment interaction design, the current study aims at examining the moderating effect of spatial abilities when interacting with AR in different ways. A study with N = 128 participants was conducted in a 2x2 between-subjects design, manipulating physical interaction (high vs. low) and mental interaction (high vs. low). The AR application focused on the functionalities of a combined-cycle power plant and the task included hypothesis testing. Spatial abilities were measured through the mental rotation test and knowledge outcomes were tested in a self-developed test. The outcomes show that an interaction effect of the two manipulated factors mental and physical interaction only appears when spatial abilities are low, but not when they are average or high. This shows that design decisions concerning the interaction with an AR application may mainly influence lower spatial ability learners. This is important to consider in instructional design, but also in future research on AR-based learning.

Where Should I Look in the Video? Signaling with Spotlight and Captions

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Educational animations can enhance learning by visualizing complex or abstract phenomena. However, learning from animations can be challenged by two features: the animation effect on nonessential elements and the transient nature of animation. The signaling principle addresses these challenges by using visual/textual cues to guide attention, reduce unnecessary cognitive load (CL), and improve learning. However, prior research rarely explains how different types of cues support specific stages of information processing in animation-based learning. Therefore, based on the Animation Processing Model (APM), which describes information processing from perceptual selection to cognitive mental model construction, we investigated how cues targeting different processing stages enhance learning.We also considered the redundancy principle, which states that presenting identical information repeatedly can increase CL and hinder learning. However, partial redundancy, repeating only essential information, has shown to facilitate learning. To examine this principle, this study differentiated full captions (transcribe the whole narration) and partial captions (transcribe key points).In a 2×3 factorial experiment, 122 university students completed measures of intrinsic (ICL), extraneous (ECL), and germane cognitive load (GCL), as well as retention and transfer tests. Results showed that spotlighting reduced ICL, increased GCL, and improved retention, while partial captions reduced ECL. Interaction effect indicates that spotlighting with partial caption yielded the highest retention. These findings suggest that cues aligned with information processing stages can optimize animation-based learning, providing practical guidance for designing instructional animations. The study contributes to signaling study by integrating APM and extends redundancy principle by demonstrating the partial redundancy effect.

Pausing to Imagine: How Image Generation Supports Video-Based Learning

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Learning from instructional videos is a popular way of conveying information, but it places specific demands on learners' cognitive processing due to the dynamic nature of the information. An important question is which instructional design features effectively foster students' generative processing during video-based learning (Mayer et al., 2020).This study examined whether inserting pauses into an instructional video – prompting students to generate mental images, to view images, or to both generate and view images – enhances understanding. The results show that inserting pauses for generating images and pauses for viewing images fostered recall performance, whereas only pauses for generating images fostered transfer performance. Combining both activities did not yield any additive benefit beyond that of generating or viewing alone.These findings extend the mental imagination effect to video-based learning. They point to the limits of simply providing images to stimulate revision processes and instead highlight the importance of instructional designs that deliberately foster generative processing.

How can teachers' (mis)conceptions about learning and teaching with videos be measured and refuted?

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Videos are widely used by teachers in educational contexts, however, not always in an effective way. That's why we aim to gain insight into their knowledge towards the use of videos as a learning medium and further into how to teach that knowledge effectively. Therefore, we first investigated which (mis-)conceptions pre-service teachers (N = 124) have on learning and teaching with (explainer) videos with a self-developed misconceptions scale based on the Misconceptions about Multimedia Learning Questionnaire (MMLQ) but specific to learning with (explainer) videos. Our results indicate that about two-thirds of our participants hold at least one of the following misconceptions about learning and teaching with videos: naïve summation, learner types, motivation primacy, and multimedia heuristic. Secondly, we aim to investigate the effectiveness of different intervention designs for refuting these misconceptions. Therefore, we are currently conducting a lab study with pre-service teachers (planned N = 128), using a 2x2 between-subjects design manipulating the use of refutation design (with vs. without) and learning medium (text vs. video). As data collection for the lab study is still ongoing, results will be presented at the conference.

Effectiveness of Large Language Model–Generated Feedback: A Systematic Review and Meta-Analysis

Presenter(s)

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Large language models (LLMs) are increasingly used to generate instructional feedback at scale, and a rapidly growing body of research examines the effect of LLM-generated feedback across a broad range of outcomes, including students' performance, motivation, engagement, affect, feedback perception, or feedback quality. However, existing evidence is methodologically heterogeneous and fragmented, leading to contradictory conclusions. Therefore, the present study addressed this gap by conducting a meta-analysis to quantify the potential of LLM-generated feedback to foster these outcomes as indicators of feedback effectiveness and to elucidate potential moderators explaining inconsistent findings. We synthesized 617 effect-sizes from 87 experimental and quasi-experimental studies published since 2022, involving 19,564 participants. Random-effects models with three levels were applied to estimate overall effects for each outcome and comparison condition (LLM-generated feedback vs. other feedback vs. no feedback), complemented by moderator analyses examining feedback, prompt design, or task characteristics. Results indicated that LLM-generated feedback has a positive overall effect on several outcomes (e.g., academic performance or engagement), although effect sizes vary substantially across outcomes and comparison conditions. For example, LLM-generated feedback outperformed computer-based feedback, but its effects were comparable to those of teacher feedback. Moderator analyses revealed that studies demonstrated larger effects, which established instructions for effective feedback, provided immediate and formative feedback. There was no substantial indication of publication bias and study-quality-related influences. There was partial evidence that LLM-generated feedback combined with human feedback outperformed LLM-generated feedback, indicating that LLMs can serve as a scalable complement to human feedback, rather than a replacement for human feedback.

Student Engagement and Learning in LLM-driven Conversation-Based Assessment

Presenter(s)

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Conversation-based assessment (CBA) presents test items in a structured dialogue in which students respond to open-ended questions, receive adaptive support, and obtain elaborated feedback during the interaction. In contrast to solely focusing on the outcome of whether students answer a question correctly or not, CBA aims to capture how students' reason while providing adaptive hints during the test. With the development of large language models (LLM), such dialogic assessments can now be implemented at scale. However, empirical evidence is limited on how LLM-driven CBA is experienced by students and whether the format can support learning compared to traditional multiple-choice assessment (MCA). Across two preregistered experiments, we examined whether CBA enhances student engagement, affective-motivational experiences, and learning outcomes compared to traditional MCA. In Study 1 (online, n = 220), participants completed both MCA and CBA on the carbon cycle in counter-balanced test blocks covering identical questions with elaborated feedback. In Study 2 (classroom, n = 248), students were assigned in a between-subject design to either a CBA or MCA condition, while retention and transfer learning was assessed in a post-test. Across these two studies, CBA substantially increased student engagement in terms of time on task. While MCA was perceived and found to be more efficient, participants overall preferred CBA and rated it as significantly more motivating, adaptive, interactive, and effective for learning. However, no significant differences emerged in post-test performance in the classroom experiment. These findings highlight the motivational potential but show an efficiency trade-off that needs to be considered.

Adopters, Agnostics, and Resisters: How Elementary Educators Respond to GenAI in Educational Apps

Presenter(s)

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As educational tools that incorporate generative artificial intelligence (GenAI) become more commonplace, educators must decide whether to select and use these tools for their classrooms. Using a repeated measures design, we investigated how apps' use of GenAI impacts educators' selection of educational apps. 101 K-6 educators in the US, UK, and Canada viewed and evaluated researcher-manipulated educational app pages, then completed measures of their knowledge, attitudes, and use of AI. A repeated measures MANOVA determined that educators rated

educational apps using GenAI lower than those without AI, but there were no significant differences in their willingness to download or pay for GenAI apps. Using hierarchical cluster analysis, educators were classified into GenAI resisters (14%), agnostics (58%), and adopters (28%). Most educators were agnostic to GenAI in apps, highlighting a need for more research to support educators' informed choices of whether and when to use GenAI tools. Preliminary evidence suggests that adopters reported higher knowledge, attitudes, and use of AI compared to adopters and resisters. Future research may build on our established classifications of educators to further explore how various factors predict educators' willingness to adopt GenAI tools.

Self-Monitoring Guides Learning Control: A Meta-Analysis on Developmental Patterns and Task Factors

Presenter(s)

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The ability to regulate learning by translating self-monitoring into effective control actions is a core component of successful self-regulated learning. Monitoring-based control enables learners to respond adaptively to uncertainty, for example, by restudying, seeking help, or adjusting study time. Although these skills develop across childhood and adolescence, empirical findings on their trajectory are mixed, likely reflecting differences in task domains, cognitive processing levels, and methods.This meta-analysis quantifies the relationship between monitoring and subsequent control in children and adolescents, examines how this relationship changes with age, and addresses task domains and cognitive processing levels as potential moderators. A search identified 44 manuscripts. Currently, 12 studies with complete data are included, comprising 1,629 participants aged 3 to 18 years and 56 effect sizes. Further studies require follow-up analyses but will be included soon. Monitoring-based control was analysed using three-level meta-analytic models (accounting for effect sizes nested within studies), with age as a continuous moderator.Results showed a strong association between monitoring and control that increased with age. This meta-analysis provides evidence that monitoring-based control strengthens developmentally. At the conference, we will report moderator analyses examining task domain and cognitive processing level to clarify how monitoring-based control may depend on these factors.

Effects of Accuracy Feedback, Restudy Feedback, or Both on Students' Task-Selection Accuracy

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Training students' task-selection skills has been shown to lead to more effective self-regulated learning with problem-solving tasks. However, variability in training outcomes was high and there was room for improvement in task-selection accuracy. We therefore investigated whether task-selection accuracy could be further improved through feedback interventions. After receiving training, secondary education students completed a practice phase in which we used a 2 × 2 design to manipulate the presence versus absence of accuracy feedback and restudy feedback following each initial task-selection decision. Students were then given the opportunity to revise their initial task-selection decision. Subsequently, they completed a test phase and transfer test phase, in which students had to adapt the trained task-selection skills to novel problem contexts; both without feedback. We also examined how accuracy and/or restudy feedback affected challenge/threat responses and self-efficacy. Preliminary checks showed that at the group-level, the revised task-selection decisions were significantly more accurate than the initial decisions. However, there were no differences in task-selection accuracy between conditions during the practice phase (i.e., revised task-selection), the test phase, or transfer test phase. Exploratory item-level analyses showed that the combination of accuracy and restudy feedback did lead to the most improvement during the practice phase on initially inaccurate items. Regarding affective responses, results showed that challenge and self-efficacy decreased over time, regardless of condition. Interestingly, threat decreased only for those who received the opportunity to restudy. Future research could examine whether adding a practice block with both accuracy and restudy feedback would foster self-regulated learning outcomes.

Group Awareness Tools for Supporting Transactive Discourse: Group-Level Effects

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Transactivity, the degree to which participants deepen and interact with one another's reasoning, has been viewed as a crucial component of knowledge co-construction in computer-supported collaborative learning. This study investigates the impacts Group Awareness Tools can have on the transactivity of collaborative processes and to what extent these are influenced by group-

level effects. A total of 122 participants were randomly paired into dyads and assigned to one of four experimental conditions in a 2 × 2 factorial design, with the factors epistemic (with versus without) and social (with versus without) Group Awareness Tools. Our findings indicate that the social Group Awareness Tool has a significant positive effect on the overall transactivity level of a discussion, while the interaction of epistemic and social Group Awareness Tools significantly lowered conflict-oriented consensus building contributions. Evaluating group-level effects, it was found that the social Group Awareness Tool lowered variance for the higher transactive modes, reducing the extent to which critical engagement was influenced by the specific interaction dynamics within a dyad.

Understanding Teachers' Acceptance of AI for Instructional Material Design

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Creating and adapting teaching materials is one of the most time-intensive tasks in teachers' daily work. AI-based tools, especially large language model (LLM) systems, offer promising support by enabling faster and more flexible instructional design. However, teachers' sustained adoption of such tools remains insufficiently understood. Addressing this gap, this study investigates how key constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) connect to teachers' intention to use such AI tools specifically designed for teaching material creation. 559 teachers from German-speaking countries completed a survey, including both users and non-users of AI tools for teaching material creation, which we developed based on LLMs that we specifically refined through prompt-engineering in an iterative expert-guided process. Introducing the predictors into the structural equation model explained 42.4% of the variance in intention to use these tools. Perceived usefulness emerged as the strongest predictor, followed by self-efficacy and subjective norms, while perceived risk negatively predicted intention. Context effects were limited, with lower intention among kindergarten teachers and higher intention among special education teachers. Moderation analyses revealed few effects, except that age strengthened and teaching experience weakened the influence of subjective norms on intention. Building on these findings, developers of such tools should enable users to see AI tools' pedagogical value while reducing risks such as bias and overreliance. Training and community building to foster positive social norms may also boost adoption. Future research should track longitudinal use and impact on quality and efficiency.

How interesting titles in educational videos affect learning outcomes and video evaluations

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When competing for learners' attention on the internet, educational videos need to trigger interest. In this pre-registered experiment, we investigated whether teasing an interesting fact in the title of a video without immediate resolution affects learning outcomes and learners' evaluations of the videos. Additionally, we investigated whether addressing this fact in the conclusion of the video affects evaluations. After indicating prior knowledge and interest, 143 participants were randomly assigned to one of four between participant conditions resulting from a variation of whether an interesting fact was teased in the title (yes vs. no) and whether this interesting fact was addressed in the conclusion of the video (yes vs. no). After watching the video about sustainable learning and before filling in a knowledge test, participants indicated their situational interest, cognitive load, and liking of the video. Regarding learning outcomes, there was a marginal negative effect of teasing the fact in the title. However, the teaser did not affect situational interest or liking of the video. In contrast, addressing the fact in the conclusion of the video did not affect learning outcomes but enhanced learners' liking of the video and germane cognitive load, independent of whether the fact had been teased in the title. Thus, whereas the teaser in the title may have served as a seductive detail that tended to hamper learning, addressing the fact in the conclusion positively affected learners' evaluations, without affecting the learning outcomes. Implications of these findings are discussed.

WR-AI-TING: AI Chatbots and the Originality of Creative Writing Tasks

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Using AI chatbots for creative writing can have both beneficial and detrimental effects on the quality and originality of prose texts. In this exploratory study, we observed how 96 students completed creative writing assignments with and without the possibility of receiving assistance from an AI chatbot. We found that 85% of the students used the AI chatbot at least once and that 55.7% of those users relied on copy-pasting strategies to complete the assignments. AI-assisted compositions were significantly longer than those written without assistance. To test whether AI assistance affects perceived originality, expert raters evaluated all texts using a custom-designed rubric assessing task compliance, content originality, narrative style originality, and narration

quality. The resulting data will offer novel insight into whether reliance on AI chatbots has a positive or negative impact on perceived originality. Depending on the evaluation outcomes, we discuss instructional strategies for fostering productive AI use and minimizing risks associated with copy-pasting.

The Power of Choice in Difficult Tasks: The Sweet Spot Between Motivation and Cognitive Demand

Presenter(s)

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Challenging learning tasks and sequences can strengthen learning outcomes, but also increase cognitive demand. When cognitive demand is perceived as high, learners' motivation to persist becomes especially important. From a self-determination theory perspective, providing learners with choice can support motivation under demanding conditions. However, choice can also reduce performance when learners select ineffective options or experience choice overload. In this study, we examined whether offering choice in test-question order can buffer the cognitive demands of challenging learning-testing sequences. In a 2×2 between-subjects yoked-control design, 136 university students were assessed in a choice or no-choice condition (i.e., choice of the test-question order) and in testing-order conditions (i.e., test order matched/mismatched the learning sequence). Results showed that choice positively affected learning. This effect was mediated by motivation. Moderated mediation analysis revealed that the influence of motivation was stronger under the mismatched testing-order, suggesting that choice enhances learning effectiveness, especially under demanding tasks.

Learning from Human vs. AI-Generated Instructors: No Differences in Learning Engagement and Outcomes

Presenter(s)

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Engagement is essential for successful learning and can be fostered in digital learning environments by increasing social presence. With generative AI (GenAI), social presence can be

enhanced by creating videos featuring highly realistic AI-generated instructors, yet prior research has reported mixed findings on their effectiveness compared with human instructors. In this study, we investigate whether potential differences in learners' cognitive engagement can be attributed to the instructor's visual appearance or voice. We deployed a 2x2 between-subjects design (N = 194), manipulating instructor appearance (human vs. AI-generated) and voice (human vs. AI-generated). German-speaking university students watched learning videos on color perception that differed only in the instructor's appearance or voice (human vs. AI-generated). Cognitive engagement was assessed via self-report, and learning outcomes via a post-test. Contrary to our hypothesis, we did not find any statistically significant differences for instructor appearance or voice in cognitive engagement or learning outcomes. Although AI-generated instructors were perceived as less human-like, this did not negatively affect other perception measures, engagement, or learning. These findings suggest that well-designed AI-generated instructors can be a valuable tool for supporting learners' engagement in digital education.

What do students know about self-regulated learning with GenAI? A situational judgment test

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The rapid diffusion of generative artificial intelligence (GenAI) tools such as ChatGPT is reshaping students' self-regulated learning (SRL) practices, yet little is known about learners' conditional knowledge for strategically employing these technologies. To address this gap, we developed and preliminarily validated a situational judgment test that measures students' strategic knowledge of interacting with GenAI across two typical higher-education learning scenarios. Following a multi-step design, we (1) conducted a literature review to identify the most frequent cognitive, metacognitive, and resource-oriented learning situations involving GenAI; (2) performed problem-centered interviews with 18 students from eight disciplines to elicit real-world strategies; and (3) refined these strategies into 36 items spanning the forethought, performance, and self-reflection phases of SRL for two generic scenarios—planning a study project and creating a summary. Experts (N = 48 SRL scholars and AI specialists) rated the usefulness of each strategy on a six-point Likert scale, yielding significant pairwise discriminations for the majority of items (28/36 for the summary scenario, 21/36 for the planning scenario). The situational judgment test thus captures conditional knowledge of SRL-GenAI interaction, offering a robust instrument for assessing metacognitive competence beyond self-report AI-literacy measures. Findings will inform educators on students' knowledge about SRL with GenAI and may guide interventions to foster effective, reflective AI-enhanced learning.

Sequential or Simultaneous Interleaved Task Presentation? The Role of Prior Knowledge

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Interleaved practice supports inductive learning by directing attention to discriminative features across tasks, yet little is known about how instructional design influences this process. The present pre-registered experiment examined whether presentation format in interleaved practice (sequential vs. simultaneous) affects the inductive learning of adaptive subtraction strategy use and whether effects depend on learners' prior knowledge. A total of 176 German third-grade students practiced three subtraction strategies across six lessons. In the simultaneous condition, tasks were presented side-by-side to support visual comparison; in the sequential condition, tasks were presented one at a time. Linear mixed-effects models showed no overall effect of presentation format on adaptive strategy use. However, prior knowledge positively predicted adaptivity, and this effect was moderated by presentation format. The association between prior knowledge and adaptivity was stronger in the sequential condition, whereas performance in the simultaneous condition was less dependent on prior knowledge, indicating that simultaneous presentation particularly supported learners with lower prior knowledge. No differential effects emerged for solution accuracy. These findings suggest that presentation format shapes how learners detect task–strategy relations in interleaved practice and that its effectiveness depends on learners' knowledge level. Aligning presentation format with learners' prior knowledge may therefore enhance instructional effectiveness.

Heterogeneous ECERS Intervention Gains: What Role Does Baseline Quality Take?

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Research on teacher professional development often reports average improvement in classroom quality, implicitly assuming homogenous intervention effects. Grounded in the Aptitude–Treatment Interaction theory, this study examined whether intervention effects in kindergartens varied according to baseline performance. A total of 116 Hong Kong kindergartens were recruited

and randomly assigned to the intervention group (n = 49) or the control group (n = 67). Three to five teaching staff or leaders per kindergarten participated in a 20-hour intervention across 5 sessions. Classroom quality was evaluated pre- and post-intervention using the Early Childhood Environment Rating Scale–Revised (ECERS-R) by certified coaches. To enhance classroom quality in a target-oriented way, the intervention, conducted by certified coaches, introduced, discussed, and reflected on classroom quality within the ECERS-R framework, which focused on the specific needs of the kindergartens. The current analysis focuses on the process quality subscales, as they are easier to improve without resource constraints. Three moderated structural equation models were specified to examine the Interaction, Language and Reasoning, and Program Structure subscales, where posttest performance regressed on intervention status, baseline performance, and their interaction. The results indicated a marginally significant positive "intervention × baseline" interaction only for the Interaction subscale ($\beta = .214$, $p = .077$), suggesting that intervention effects were stronger in kindergartens with better baseline classroom interaction and weaker in those with lower baseline scores. These results may suggest that ECERS-tailored interventions may benefit kindergartens with stronger baseline Interaction quality, whereas low-baseline kindergartens may require more intensive or individualized support.

Videos, Animations, or Static Images: How Authentic Do Representations of Practice Need to Be?

Presenter(s)

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Approximations of practice are increasingly used in teacher education to prepare pre-service teachers for core professional tasks such as diagnosing students' learning processes. While realistic classroom videos closely resemble practice, they raise concerns about the privacy of the depicted students, production costs, and limited adaptability. Alternative formats such as animations or image-based videos using static visual representations may be promising solutions, yet their impact on learning-relevant perceptions and diagnostic behavior remains insufficiently understood.This experimental study investigated how three video formats—realistic, animated, and image-based—affect pre-service mathematics teachers' perceptions of authenticity (physical resemblance and functional correspondence), salience of diagnostically relevant information, and diagnostic behavior within a validated video-based simulation. A total of 190 pre-service teachers were randomly assigned to one of the three conditions and diagnosed students' mathematical proof skills in identical student cases based on realistic, animated, or image-based formats.Results showed significant differences in perceived physical resemblance, with realistic videos rated highest and image-based videos lowest. In contrast, no significant differences were observed for functional correspondence, salience, and diagnostic behavior. Bayesian analyses provided moderate to strong evidence for equivalence across formats.The

findings suggest that alternative formats may not alter important learning-relevant perceptions and behaviors, apart from high physical resemblance. Therefore, animated and image-based formats may be comparably effective as realistic formats, but more privacy-conscious and resource-efficient. The study offers practical implications for designing scalable and adaptive simulation-based learning environments in teacher education.

Consolidating Comprehension Through Retrieval Practice

Presenter(s)

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After an initial study phase in which learners encounter new information, engaging learners in generative learning activities, which support the construction of coherent and well-integrated mental representations, can effectively foster comprehension. However, even quality mental representations become less accessible over time. Accordingly, instructional means to consolidate quality mental representations and hence learners' level of comprehension are needed. From a theoretical view, engaging learners in retrieval practice as a follow-up activity could be a promising way to attain this goal. However, so far, the consolidative benefits of retrieval practice after generative learning regarding comprehension appear to be minimal. One explanation for this lack of consolidative benefits could be that the retrieval practice merely required learners to recall the previously studied information from memory but did not require learners to activate the mental representations that they formed in generative learning. The present study was designed to test this explanation. In a lab experiment with N = 159 students, we manipulated the type of retrieval practice (explicit activation of generative-based representations: yes vs. no) and the posttest delay (immediate vs. one-week). We found significantly better consolidation of learners' level of comprehension when the retrieval practice required activation of the mental representations that were constructed in generative learning as well as no harming effect of such type of retrieval practice on the consolidation of factual knowledge. These findings imply that, to support durable comprehension, retrieval practice should require learners to draw on the mental representations formed in previous generative learning activities.

Why Did Teachers Not Use a GDPR-Compliant Chatbot in Schools? Findings from a Statewide Pilot

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The integration of generative AI (GenAI) chatbots into schools has attracted growing interest due to their potential to support teaching and learning, while raising concerns regarding data privacy and security. However, empirical evidence from large-scale and real-world deployments of GenAI systems in authentic school settings remains scarce. This study reports on a statewide, in-the-wild pilot of an education chatbot in southwestern Germany. This education chatbot is a GDPR-compliant, Moodle-integrated learning assistant designed for use by students and teachers. The pilot ran during the 2024–2025 school year across 199 schools, and 566 teachers completed surveys assessing their GenAI-related perceptions and practices prior to using the chatbot. Preliminary survey analyses indicated that teachers generally held positive views toward AI and that most reported using AI for planning and preparation. Additionally, a majority expressed intention to implement the chatbot in their classes. However, usage data from the field deployment revealed comparatively low engagement during the school year: the chatbot was used in 3,977 Moodle activities with an average of 4.30 users per activity and 45,171 total interactions for the whole pilot period. Chatlog analysis indicated that prompts were typically short (< 10 words) and that nearly 70% of users engaged with the chatbot for fewer than five days. Taken together, these findings provide rare empirical insights from a large-scale, naturalistic deployment of a GDPR-compliant GenAI system in schools and contribute to the evidence-based development of AI-supported digital education.

Prompted or Prepared? Determinants of Human-Level Argumentation Scoring in LLMs

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Inquiry learning can support students' scientific reasoning, but many struggle to formulate high-quality hypotheses and arguments, highlighting the need for adaptive feedback. Large language models (LLMs) offer new possibilities for providing such feedback, but their effectiveness depends on their ability to accurately evaluate students' hypotheses and arguments. This simulation study examined how much additional knowledge out-of-the-box LLMs require to approximate human judgments of hypothesis and argumentation quality. Using data from two

prior inquiry-learning studies, trained human raters had scored 298 student hypothesis and argumentation pairs. Twelve LLMs were tasked with scoring a subset of 43 pairs using the same coding scheme, and inter-rater reliability with the human ratings was assessed using Krippendorff's α. Few-shot prompting improved reliability compared to zero-shot prompting, but agreement remained below acceptable levels (α up to .30), with substantial variability across scoring categories. Larger models showed improved alignment (α = .34–.58), though difficulties remained for complex sub-categories such as reasoning and evidence. Supervised fine-tuning of a small model on 255 human-coded responses yielded the highest agreement (α = .72), substantially improving performance across all categories. These findings suggest that LLM assessment accuracy benefits the most from concrete examples of student input and their correct assessment values. Establishing a reliable assessment of students' hypothesis and argumentation quality is a necessary step toward using LLMs for valid, adaptive feedback in inquiry-based learning.

Beyond Performance: Social Presence and Parasocial Relationships in AI Learning

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Social presence (SP) and parasocial relationships (PSR) describe socio-emotional experiences in mediated communication that are crucial for motivation, engagement, and learning. SP refers to the subjective sense of being socially connected through reciprocal interaction, whereas PSR denotes an imagined, one-sided relationship between a media user and a mediated persona. In technology-based learning environments, both constructs have been shown to shape learners' experiences and learning-related behaviors.This study investigated whether AI-based tutoring can foster SP and PSR comparable to human tutoring and how this relates to satisfaction and performance. Using an experimental design, higher education students were randomly assigned to one of three conditions: learning with a text-based Socratic ChatGPT tutor, with a Socratic human tutor via text chat, or with a Socratic human tutor via voice chat. Learning content focused on applying APA standards in scientific writing. Data were collected before and after a one-hour learning session, including measures of performance, social presence, parasocial relationship, and satisfaction.Results showed no group differences in learning performance or in the cognitive dimensions of social presence, indicating comparable cognitive effectiveness across conditions. However, significant differences emerged in affective outcomes: emotional facets of SP, PSR, and satisfaction were higher in the human tutor conditions than in the AI tutor condition. These findings suggest that while AI tutors can effectively support cognitive aspects of learning, they currently fall short in fostering socio-emotional relationships. Integrating human tutors or enhancing socio-emotional design features in AI systems may be critical for sustaining motivation and learner satisfaction.

Designing for Alignment: How Prompted Embodied Experiences Affect Learning

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Embodied learning theory proposes that bodily actions and sensory experiences support conceptual understanding, especially when students` bodily actions align with the target concept. However, it is still unclear whether instruction should explicitly draw learners' attention to the link between bodily activity and conceptual content. Building on conceptual salience theory, we tested how instructional design that aligns embodied experiences with concepts affects learning. Further, we tested whether making this explicit through prompting affects physics learning. All participants conducted the same physics experiments about force and motion concepts under three conditions: A Control condition (C) conducted experiments with one hand, impeding their ability to feel balanced forces, implicitly aligned (IA) and explicitly aligned (EA) conditions conducted experiments with two hands, allowing for congruent bodily experiences by feeling balanced forces. The EA condition additionally received verbal prompts to attend to the connection between their embodied experiences and the concepts. We used two types of scales, assessing both reproduction and transfer of knowledge for two concepts, and we also analyzed student-drawn force diagrams. Our study involved 165 university students. Results from the generalized linear mixed model analysis showed an interaction between condition and scale: the EA condition scored significantly better on the transfer scale. In addition, the analysis of student drawings revealed that after the intervention, students demonstrated fewer misconceptions related to everyday bodily experiences that conflict with scientific concepts. Overall, the findings suggest that instruction that explicitly connects relevant bodily actions to concepts can enhance learning of transferable knowledge.

Balancing Story and Activity: Narrative Design and Interaction Modality in AR Anatomy Learning

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Interactive and immersive approaches such as game-based learning (GBL) and augmented reality (AR) aim to foster active, student-centred learning through design features such as narrative framing and embodied interaction. While both narrative design and physical interaction have

been shown to enhance engagement and learning, their effectiveness may depend on individual learner characteristics. In a laboratory experiment using a 2×2 between-subjects design (N = 113), participants learned human musculoskeletal anatomy using a HoloLens 2 game. The game incorporated either a Frankenstein-themed narrative or no narrative context at all, and participants interacted either through a mental-physical (reflecting and manually adjusting virtual muscles) or a mental-only interaction modality (reflecting, with muscles placed automatically). Physical interaction increased perceived AR interactivity but also raised demands. Narrative design, in contrast, reduced perceived coherence between physical and virtual elements. Considering individual learner characteristics, narrative design and physical interaction scaffolded learners with low mental rotation ability but distracted or frustrated those with high ability, showing an expertise reversal effect. High-ability learners experienced more flow through either narrative or physical interaction, but not both together. Immersion enhanced learning via motivational or generative processing pathways, depending on learners' individual mental rotation ability. Overall, the findings highlight the importance of considering learners' spatial abilities in AR design.

Becoming the Catalyst: Embodied Interaction, Gaze, and Learning in a VR Biochemistry Simulation

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Immersive virtual reality (VR) enables learners to participate in scientific processes through embodied interaction and real-time multimodal feedback. Yet, for theory-rich and abstract domains such as organic chemistry, it remains unclear how specific design immersion-embodiment configurations relate to conceptual understanding, affective outcomes, and interaction traces. This study presents and evaluates ANONYMIZED, a VR simulation environment in which learners embody an enzyme biomolecule and enact biochemical reaction mechanisms (bacterial cell-wall breakdown) through multiple guided and unguided task phases. In a co-curricular, two-site deployment with undergraduates (N = 41), we collected pre–post measures of reaction-mechanism knowledge, intrinsic motivation, and self-efficacy, alongside perceived embodiment, controller interaction logs, and VR eye-tracking. Participation in the simulation was associated with substantial gains in SN1/SN2 mechanism knowledge ($p < .001$, $d = 1.28$), IM ($p < .001$, $d = 0.91$), and SE ($p < .001$, $d = 1.09$). Learners with higher conceptual knowledge gain entered embodied interaction faster ($p = .002$, $d = -1.17$) and produced more controller interactions overall ($p = .004$, $d = 1.10$). People with different groups exhibited different interaction behaviour across simulation-phases. Higher-gains were associated with more time allocation to guided exploration phases ($p = .006$, $d = 1.23$), and with higher phase-specific interaction intensity (ps = .007–.002, ds = 0.92–1.28). Findings highlight the importance of mechanistically meaningful gesture mapping, early embodied entry into the environment, and

instructional-phase structure for technology-enhanced immersive and embodied learning environment designs, while also underscoring current constraints for gaze analytics.

Preliminary Validation of the miniPXI for Educational Game-Based Learning with Adolescents

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Learner engagement is widely recognized as a critical mechanism through which game-based and technology-enhanced learning environments support learning. However, assessing engagement in these contexts remains challenging due to the need to balance conceptual rigor, developmental appropriateness, and practical constraints on measurement. This paper presents initial validation work examining the use of the mini Player Experience Inventory (miniPXI) as a measure of engagement for adolescent learners engaged in a narrative-centered learning environment.The Player Experience Inventory (PXI) and its abbreviated version, the miniPXI, are theory-driven approaches developed to assess engagement in digital games, primarily with adult populations. In this study, we examine the suitability of the miniPXI for use with middle school learners. We administered a survey consisting of miniPXI items, selected items from the full PXI for specific sub-scales, and legacy items adapted from other existing engagement surveys to approximately 100 middle school students following participation in a narrative-centered, game-based learning experience focused on ecosystems. Analyses focused on item-level performance, reliability, and initial validity evidence, with particular attention to redundancy and alignment with learning-oriented conceptions of engagement.Results indicate that the miniPXI demonstrates strong psychometric promise and function compared to longer existing measures of engagement, supporting its potential use as a low-burden indicator of engagement in educational contexts. This work contributes to researchers and designers seeking scalable, defensible approaches to measuring engagement in game-based and AI-supported learning environments with adolescent learners.

Comparing the Effects of Learning-by-Teaching Approaches on the Transfer of Task-Selection Skills

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Abstract Research has shown that task-selection skills, which are necessary for effective self-regulated learning, can be trained. Ideally, these trained task-selections skills would transfer to new problem-solving contexts. However, the limited research available suggests that students struggle to transfer these skills. For other learning materials, non-interactive learning-by-teaching (LBT) has been proposed to foster learning, and, to some extend transfer. However, it is unclear whether this is effective for transferring task-selection skills and whether the teaching should be focused on the training (as is typical in LBT research) or transfer context. Therefore, the present study aimed to examine the effects of explicit instruction and different LBT approaches on the transfer of trained task-selection skills. Results of the main analysis indicated no significant benefits for transfer task-selection accuracy of explicit instruction and LBT approaches (teaching how to select isomorphic tasks, teaching how to select transfer tasks or a combination of explicit instruction on how to select transfer tasks and teaching that) relative to the control condition either on the immediate or the delayed test (7-8 days later). Likewise, there was no significant difference among LBT conditions. Further exploratory analyses will be conducted to investigate whether/how invested mental effort, self-efficacy, challenge, threat, and social interaction anxiety measures are associated with task-selection accuracy and differ per condition, which may contribute to our understanding of when and for whom LBT approaches might support transfer. Results will be presented at the conference.

Revisiting Self-Regulation and Cognitive Load in Immersive Virtual Reality

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Immersive virtual reality (iVR) is increasingly used in higher education to create self-regulated learning environments, yet associated learning outcomes remain inconsistent. To explain how

learners manage self-regulation in learning, Seufert's (2018) model postulates an inverted U-shaped relationship between perceived task difficulty and self-regulation, determined by cognitive load and learner resources. This preregistered study tests Seufert's (2018) model in an iVR learning context using data from 473 undergraduate medical students studying geometric optics. We examined how intrinsic cognitive load (ICL) as an indicator of perceived task difficulty, self-reported frequency of self-regulation strategies, extraneous cognitive load (ECL), and learner resources interact and relate to conceptual learning outcomes. The relations proposed by Seufert (2018) could not be replicated in iVR, as no association was found between ICL and self-regulation. ECL showed a consistent negative linear effect on both self-regulation and learning outcomes. Importantly, ICL did not predict whether learners engaged in self-regulation, but constrained whether self-regulation translated into learning, particularly for metacognitive regulation strategies. Learner resources supported self-regulation under cognitive load and shaped whether regulatory activity resulted in learning gains. The findings suggest that, while theoretical assumptions about self-regulation and cognitive load may still hold in principle, their empirical manifestation in iVR differs from traditional learning environments. In iVR, self-regulation captured by established measures may be directed toward managing environment-related demands rather than learning itself. Consequently, applying established models of self-regulated learning to iVR requires careful consideration of how self-regulation is conceptualized and operationalized.

Learning Through Retrieval Practice: Elaboration Mediates Effects of Prompts & Informed Instruction

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Retrieval practice is a learning strategy that enhances long-term retention. Its effectiveness is further increased when learners engage in generative processes such as elaboration and organization, a combination known as constructive retrieval. However, students often struggle to apply these strategies effectively, limiting potential learning gains. Instructional support, including cognitive prompts designed to initiate elaboration and organization strategies and video-based informed instruction aimed at enhancing learners' metastrategic knowledge, may help overcome these difficulties (Hübner et al., 2010). This study examined how cognitive prompts and informed instruction influence learners' strategy use and learning outcomes. After completing a pretest, 131 undergraduate psychology students either received video-based informed instruction or not. All participants then watched a video lecture on Cognitive Load Theory and wrote a learning journal without access to the learning materials (i.e., they engaged in retrieval practice), receiving either cognitive prompts or no prompts. One week later, learning outcomes were assessed with retention and comprehension questions. Cognitive prompts significantly increased both the quality and quantity of elaboration strategies in the journals,

which in turn mediated improvements in learning outcomes. Informed instruction enhanced elaboration only in the absence of prompts, with these increases contributing indirectly to learning outcomes. Organization strategies were unaffected, and combining both support formats did not yield additional benefits. These findings show that both cognitive prompts and informed instruction can enhance strategy use and support learning indirectly through elaboration, but targeting both simultaneously does not further improve outcomes.

Retrieval Practice in School Classrooms: A Meta-Analysis of Effects and Boundary Conditions

Presenter(s)

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While retrieval practice is considered a promising strategy for practice after initial instruction or self-study, little is known about the average effect of this strategy in authentic classrooms in primary and secondary education and its moderators. Therefore, in the present study, we investigated the effectiveness and boundary conditions of retrieval practice in such classrooms. We did this using a three-level meta-analysis comprising 120 effect sizes from 31 studies (published 2006-2024) including 3,391 participants. We found an average testing effect of $g = 0.37$, moderated by type of knowledge, posttest format, format matching between practice and test phase, and type of learning outcome. The found average effect implies that the effectiveness of retrieval practice convincingly extends to authentic school classrooms. Found moderator effects imply that the most important boundary condition of the testing effect is whether the cognitive processes elicited during (retrieval) practice match those required for performance on a later posttest. This, in turn, implies that attention should be paid to the underlying cognitive processes, especially when using retrieval practice to foster meaningful learning.

From Digital Tools to Digital Change: Developing Final Examinations as Learning Spaces

Presenter(s)

Michael Ruloff | University of Teacher Education Zug, Switzerland

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Many Swiss schools, including upper secondary schools (Gymnasien), are now conducting parts of their final examinations in digital formats. Over the past two years, a major Swiss city has fully transitioned its graduation exams (“Abitur” or “Matura”) to digital technology. This means that these final exams are conducted using digital devices, following a BYOD approach in which

students complete their exams on their own devices.Beyond ensuring secure and data-protection-compliant exam administration, a key objective was to develop new digitally enabled assessment formats that foster new forms of learning, including collaborative work and the integration of artificial intelligence (AI). A longitudinal study accompanied the implementation of these new examinations over a two-year period. School principals at six schools were interviewed, and approximately 170 teachers and 800 students participated in a standardized questionnaire survey. The interviews were analyzed using qualitative content analysis, while the questionnaire data were examined using both quantitative and qualitative methods. The findings indicate that most teachers experienced the development of the new examination formats to be very challenging. Students' grades remained largely comparable to those of previous traditional final examinations. Nevertheless, the majority of students found the exams rather difficult: they perceived the requirements to be higher compared to previous exams. This perception was particularly strong among students who completed assessments based on innovative learning formats, such as collaborative approaches or the integration of artificial intelligence. The paper introduces the study design and key findings and then focuses in detail on examinations using innovative learning formats.

From Branch to Main: How International Campus Innovation Drives Institutional Curriculum Reform

Presenter(s)

Reya Saliba | Carnegie Mellon University in Qatar, Qatar

This paper examines collaborative curriculum development for Core@CMU, a foundational course for first-year undergraduates at Carnegie Mellon University, demonstrating how international campus perspectives drive meaningful curriculum reform at the main institution.The paper documents an iterative design process (2023-2025) that transformed a technically-focused skills course into a comprehensive competency-based program addressing four core competencies: Collaboration & Teamwork, Communication & Presentation, Information & Data Literacy, and Intercultural & Global Literacy.The methodology involved extensive cross-campus collaboration between faculty, instructional designers, and administrators. While the course was delivered via an asynchronous online platform to Pittsburgh students throughout the fall semester, Qatar campus adopted a hybrid model featuring weekly face-to-face sessions with online modules, creating guided learning communities demonstrating higher student engagement compared to asynchronous formats.Findings illustrate how culturally responsive pedagogy and customized delivery enhance student engagement while maintaining academic rigor across diverse contexts. The project challenges traditional transnational education models by demonstrating bidirectional learning where branch campuses serve as innovation laboratories rather than passive curriculum recipients. Our experience offers insights for institutions leveraging international partnerships for systematic curriculum improvement amid rapid technological and pedagogical change.

Technology-based practices in multilingual classrooms: insights from a scoping review

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As global migration increases, classrooms are becoming increasingly culturally and linguistically diverse. This shift presents both opportunities and challenges, particularly in supporting multilingual students' learning, for instance in relation to a limited proficiency in the language of instruction. Emerging research highlights the potential of technology to address these challenges, yet a comprehensive understanding of its role in diverse educational contexts remains limited. This scoping review explores how technology has been used to support multilingual students in culturally and linguistically diverse primary and secondary classrooms. To do so, it analyses empirical studies published in peer-reviewed journals and retrieved from 5 databases (ERIC, LLBA, MLA, Scopus and Web of Science) to map existing literature on technology-based practices in primary and secondary multilingual classrooms. Preliminary findings show that most of the studies used a qualitative approach, with a higher number of studies conducted in North America. Technology was mostly used for productive/creative purposes, and technology-based practices were often informed by translanguaging theory, theories of multimodality and culturally responsive teaching, overall showing promise in supporting multilingual learners. By highlight gaps in current research and offering insights into how technology can be meaningfully integrated to support effective and equitable learning for multilingual students, this review will serve as a practical resource for educators and researchers.

Teacher Scaffolding and Interactional Processes in Guided Inquiry

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Inquiry-based science instruction frequently relies on short, situation-specific teacher scaffolding to support students' learning. While such instructional support is assumed to be effective, existing research has paid limited attention to how different forms of teacher support are related to students' moment-to-moment engagement in collaborative inquiry and how these processes connect to learning outcomes. The present study addresses this limitation by examining instructional support and student activity at the level of observable interaction during inquiry lessons. Participants were 164 third- and fourth-grade students working in small groups on guided inquiry tasks in primary science classrooms. Classroom interactions were video-recorded and analysed with a focus on distinct forms of teacher support as well as students' peer-related activity and content-related talk. Students' inquiry-related knowledge was assessed

before and after instruction. Relations between instructional support, interactional processes, and learning outcomes were examined using a process model estimated with structural equation modelling. Results indicate that learning outcomes were not associated with the overall amount of peer interaction, but with students' engagement in content-related scientific talk following instructional support. Moreover, cognitively demanding teacher scaffolding practices were linked to short-term changes in students' interactional behavior, suggesting that reduced interaction does not necessarily signal reduced learning opportunities. By foregrounding interactional processes surrounding instructional support, this study advances a more differentiated understanding of how inquiry instruction unfolds in classrooms and highlights the value of process-sensitive approaches to studying teaching and learning in inquiry-based science education.

Signals to Remember: Investigating the Retrieval Cue Function of Color Highlighting

Presenter(s)

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Learners often rely on visual cues, such as color highlights, to recall important information in instructional texts and pictures. Color can serve as an attention-guidance cue or a memory cue to promote learning. However, research has not yet thoroughly explored how colors can serve both purposes: signaling relevant information within the learning material and serving as memory cues to foster retrieval during testing. Therefore, this study investigates whether different signaling colors in digital learning environments can serve as memory cues to enhance retrieval and improve learning outcomes for secondary students. In a 2 (signaling color: monochromatic vs. polychromatic) × 2 (memory cue presence: during learning vs. during learning and retrieval) between-subjects experiment, 168 participants learned about auroras in a digital learning environment, presented across five texts and seven instructional pictures. Apart from prior knowledge, learning outcomes, cognitive load during learning, and mental load and mental effort during testing were assessed. Results revealed no effects of memory cue presence or signaling color, nor any interactions. Additional Bayes factors largely supported the null hypothesis across all measures. Results are discussed in terms of both color encoding and superficial processing. Color-based signaling does not automatically function as a memory cue, highlighting the need for instructional approaches that promote meaningful cue encoding and consistent reuse across learning and assessment contexts.

Effects of spatial contiguity on learning with multiple representations in physics

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Understanding physics requires students to integrate theoretical concepts and real-world phenomena—a process often supported by multiple external representations (MER). How these MER should be arranged in a way that best supports learning is described, for example, by the spatial contiguity principle: Presenting information related in content in close spatial proximity can facilitate cognitive integration. However, spatial contiguity effects in hands-on experiments including data-based visualisations have remained underexplored, particularly in authentic learning situations with varying complexity across tasks. This study examines spatial contiguity in an optics experiment with increasing task complexity applying augmented reality (AR) to implement physical and visual representations.In a randomised between-subjects study (N = 111) comparing conditions of high spatial contiguity (HC) against low spatial contiguity (LC), students completed three sequential tasks of increasing complexity. The experimental components were manipulated manually while AR displayed data-based visualisations either adjacent to referenced components (HC) or on a side panel (LC). Learning achievement was analysed overall and at task-specific levels using ANCOVAs controlling for prior knowledge. Results show that HC significantly improved overall learning achievement, with benefits peaking at intermediate task complexity, suggesting both a lower and an upper complexity threshold. These findings extend spatial contiguity principles to visual and physical MER by identifying an optimal range of task complexity and provide practical guidance for designing adaptive multimedia learning environments in science education.

Adaptive Learning in Primary Mathematics: Insights from Log Data and Learner Profiles

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Intelligent tutoring systems (ITS) are assumed to enhance learning outcomes by tailoring instruction to individual needs. However, little is known about their effectiveness for younger learners and how students' interaction patterns shape learning outcomes. This study investigated whether an adaptive ITS in primary mathematics instruction leads to higher learning gains than a non-adaptive version of the same environment. A field experiment with N = 139 second-grade students compared learning outcomes between adaptive and non-adaptive conditions using a pretest–posttest design. Contrary to preregistered expectations, regression

analyses revealed no overall advantage of the adaptive system regarding students' learning. To examine differentiated effects, learners' log data were analyzed to identify learning profiles. Three profiles reflecting distinct patterns of task success and hint use were identified. Exploratory moderation analysis indicated that students with higher prior knowledge benefited from both systems, with slightly higher outcomes in the non-adaptive condition. In contrast, lower-performing learners with limited prior knowledge performed worse in the adaptive system. These findings challenge assumptions of universal adaptivity and highlight the importance of aligning adaptive mechanisms with learners' prerequisites and behavior during learning. They further demonstrate the value of log data for informing theory-driven refinements in adaptive instructional design.

Learning With AI Avatars vs. Human Presenters: The Moderating Role of Prior Knowledge

Presenter(s)

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AI-generated avatars are increasingly used as presenters in instructional videos, yet their effects on learning outcomes and cognitive processing remain insufficiently understood. Drawing on Cognitive Load Theory, this study compared learning with an instructional video presented by a human speaker to learning with an otherwise identical video presented by an AI-generated avatar, and examined prior knowledge as a moderator of learning outcomes and cognitive load.Fifty-six adult learners (71.4% female; M age = 33.3 years) were randomly assigned to one of two conditions in a between-subjects design. Participants watched a 15-minute explanatory video on adaptive learning systems, either presented by the original human speaker or by an AI-generated avatar using the same voice but a calmer and less dynamic prosody. Learning outcomes were assessed using a performance test measuring recall and comprehension. Extraneous and germane cognitive load were measured using a validated self-report instrument.Initial analyses revealed no significant main effects of presenter type on learning outcomes or cognitive load. However, a significant interaction between presenter type and prior knowledge emerged for learning outcomes. Learners with lower prior knowledge achieved higher learning outcomes when learning with the avatar presenter, whereas learners with higher prior knowledge benefited more from the human presenter. No interaction effects were found for extraneous or germane cognitive load, although higher prior knowledge was associated with lower extraneous load overall.Overall, the findings indicate that AI-generated avatars are not inferior to human presenters in video-based instruction and that their instructional effectiveness critically depends on learners' prior knowledge.

An Empirical Investigation of Mutual Visibility in Immersive VRCL and CSCL on educational outcomes

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Immersive virtual reality-supported collaborative learning (VRCL) offers several opportunities to support collaboration in ways that closely resemble real-life interaction, while simultaneously enabling novel opportunities for collaborative learning that are otherwise unattainable in the real world. Despite this potential, VRCL has received less scholarly attention compared to computer-supported collaborative learning (CSCL). Given the potential limitations of distributed collaboration through CSCL in facilitating effective collaboration, particularly in supporting socio-emotional processes through nonverbal cues, this pre-registered study examined the extent to which such limitations manifested in practice and whether VRCL might help mitigate them. This manuscript addresses this question by systematically examining how collaborators' presence, in terms of mutual visibility (Avatar/Face-to-face) versus non-mutual visibility (No avatar/No face-to-face), and the type of media applied, VRCL versus CSCL, influence educational outcomes. In a 2x2 between-subjects design, N=148 high-school students were randomly assigned to groups of triads and one of four experimental conditions: (1) VRCL + mutual visibility, (2) VRCL + non-mutual visibility, (3) CSCL + mutual visibility, or (4) CSCL + non-mutual visibility. The results showed that mutual visibility enhanced social presence, while VRCL increased physical presence compared to CSCL. Moreover, significant interactions on individual learning and collaborative learning outcomes indicated that the impact of visibility on learning depended on the media used. Interestingly, CSCL without mutual visibility was associated with higher cognitive load and less favorable educational outcomes. This indicates that the practical implementation of distributed CSCL entails limitations that VRCL may help address by facilitating more lifelike and contextually grounded collaborative interactions.

Designing Synchronous Digital Collaboration: The Effect of Sociability on Metacognition

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As synchronous digital collaboration becomes a routine feature of contemporary education, instructors increasingly rely on social design strategies, such as camera use, to support engagement. While these practices are often assumed to improve learning, research on their consequences for learners' metacognitive monitoring remains limited. This mixed-methods study aimed to examine how sociability shapes social processes and metacognitive accuracy during synchronous collaborative problem-solving. Four-hundred and seventeen participants

(139 triads) completed the Winter Survival Exercise under conditions of high- or low-sociability in synchronous video sessions. Sociability was manipulated via camera use, introductions, and instructor-learner interaction. Quantitative analyses examined social presence, group cohesion, confidence, and metacognitive calibration, while qualitative analyses of interactional discourse and post-task focus groups explored how participants experienced and enacted collaboration. Results show that sociability reliably increased social presence and cohesion, but did not improve task performance. Instead, sociability indirectly heightened confidence and metacognitive bias, indicating inflated certainty without corresponding accuracy gains. Qualitative analyses suggested that high-sociability conditions involved richer, smoother socio-emotional communication and faster convergence, but less interactional depth, reflected in briefer discussions with less explicit coordination and argumentative elaboration. Together, the findings point to a trade-off in digitally mediated learning: social design can enhance engagement and interpersonal connection while simultaneously harming the accuracy of metacognitive monitoring. Theoretically, the study shows that sociability shapes not only social processes but also learners' metacognitive judgments in synchronous collaboration. Practically, the results suggest that sociability-enhancing practices should be accompanied by metacognitive scaffolds.

A Generative Artificial Intelligence Agent as Learning Group Support

Presenter(s)

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Generative Artificial Intelligence (genAI) has demonstrated success in supporting individual learners; however, research on its application within collaborative groups remains scarce. In this randomized controlled experiment, we deployed a genAI-based system as a group support tool within a dedicated collaborative task compared to a control group collaborating on the same task with no genAI support. The sample consisted of 77 people (Mean age = 18.34 years, SD = 0.73). The system and activity design were informed by Collaborative Cognitive Load Theory (CCLT). We investigate whether the additional cognitive load induced by coordinating collaboration with an artificial entity is outweighed by the benefits of genAI integration. Using pre- and post-transfer tests alongside self-report measures of self-efficacy, cognitive load, and collaborative flow in a between-subject study, we evaluate the system's impact. Preliminary results indicate that while the AI reduced collaborative cognitive load, it did not significantly enhance learning outcomes compared to the control group.

The Socio-Cognitive Impact of Interactivity in Embodied Pedagogical Agents

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This between-subjects experiment (N = 300) examined how interactivity influences socio-cognitive processes during learning with pedagogical agents (PAs). In this online study, participants were randomly assigned to one of two experimental conditions that varied during the learning phase: participants interacted with a PA through Controlling (video-player controls) or Dialoguing (speech-based inputs). The learning phase was self-paced and completed in a single session. The audiovisual presentation of both PAs was standardized across conditions to ensure the same quality and quantity of social cues. Based on the Social Cue Strength Hypothesis, it was predicted that the interactivity of a digital learning environment increases the impact of presented social cues. A MANOVA revealed that interactivity significantly enhanced perceived social presence (d = 0.62), connection (d = 0.55), and engagement (d = 0.68), whereas no significant difference in learning outcomes was observed. These findings suggest that while Dialoguing-based interactivity effectively enhances the learner's social perception and engagement, it does not inherently facilitate deeper cognitive processing required to improve learning outcomes.

Does What Students Know About Instruction Matter for Learning? The Role of Instructional Knowledge

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Students actively interpret and respond to learning environments rather than passively following external expectations. These interpretations are guided by several variables, including students' knowledge of micro-level education – or their 'instructional knowledge'. Research suggests that students' instructional knowledge often diverges from the actual learning environment, which may negatively affect learning behaviors and outcomes. It thus appears that to understand the actual effectiveness of learning environments, consideration of students' instructional knowledge is highly relevant. Despite its presumed significance, empirical evidence on its impact remains limited. To address this gap, the current study systematically investigates the unique role of instructional knowledge in shaping learning outcomes through the mediation of learning behaviors. Data were collected from 112 students in a first-year course on instructional psychology and technology. Validated instruments were used to assess students' instructional knowledge and control variables, while a combination of methods – such as student log files –

were employed to capture learning behaviors and performance outcomes. The findings of this study aim to contribute to the design of more effective learning environments by providing a better understanding of instructional knowledge and its role within the learning process.

Exploring Learner Agency in an AI-supported Simulation Environment for Complex Systems Education

Presenter(s)

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Understanding complex systems requires learners to connect micro-level interactions to emergent macro-level patterns, yet students frequently struggle with such reasoning. Interactive simulations and agent-based models provide promising affordances, but they also raise a persistent design tension between learner control and instructional guidance. With the integration of Large Language Models (LLMs) into higher education, learners now face additional decisions regarding whether and how to engage AI support during exploration. This study examines how university students enact learner agency in an AI-supported simulation environment for learning about flocking dynamics. We conceptualize agency as observable, time-based interaction behaviors, including parameter manipulation and AI-mediated question asking. Using a 2 × 2 factorial design (parameter-control agency × questioning agency), 69 students were randomly assigned to four conditions. Learning outcomes were measured using a validated complex systems assessment with log data captured interaction patterns. All groups demonstrated significant learning gains. However, access to agency features alone did not significantly predict posttest performance. Instead, regression analyses showed that sustained and focused parameter manipulation in conceptually demanding tasks predicted higher gains, whereas extensive interaction in conceptually easier tasks did not. AI-questioning behaviors varied widely and were not directly associated with learning gains. Findings highlight the importance of enacted, rather than merely afforded, agency in AI-supported simulations.

Assessing Linguistic and Content Characteristics of First Graders Texts Using Generative AI

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The aim of the present study is to evaluate how accurately a common Large Language Model (LLM) can assess linguistic and content characteristics of elementary school students' narrative texts. We consider consistency of LLM assessments and alignment between human and LLM assessments to be indicators of assessment accuracy. The data base consists of N=539 texts written by first-grade students in German elementary classrooms. LLM assessments were conducted using ChatGPT Version 5.0. Human assessments were drawn from the German NaSch1 study in which the elementary school students' texts were rated according to linguistic and content-related criteria. The results show that LLM assessments of linguistic text characteristics (e.g. vocabulary: rank ICC(2,1) = .099, $p < .001$) are not generally more consistent than LLM assessments of content characteristics (e.g., perspective taking, that is, the degree to which another person's perspective is adopted in the text: rank ICC(2) = .438, $p < .001$). Similarly, alignment between LLM and human assessments is not generally higher for linguistic than content characteristics, reflected both in correlational data (e.g., vocabulary: Spearman's ρ = .133, $p < .001$; perspective taking: Spearman's ρ = .307, $p < .001$) and agreement scores of Linear Weighted Kappas (e.g., vocabulary: κw=.023; p=.051, 95% CIMin=.001, 95% CIMax=.044; perspective taking: κw=.165; p

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Instructor Body Postures as Social Cues: Trustworthiness and Credibility as Mediators of Interest

Presenter(s)
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Research on educational videos highlights the importance of social cues in shaping learners' social, motivational, and metacognitive processes. While various nonverbal instructor cues have been shown to affect learning processes, instructors' body postures remain comparatively underexplored. Drawing on Source Credibility Theory, the present study examined whether instructors' body postures influence learners' perceptions of instructor trustworthiness and content credibility and, in turn, shape their situational interest. In a between-subjects online experiment N = 434 university students watched an educational video in which an instructor's body posture was systematically varied along two dimensions: verticality (upright/slumped) and horizontality (open/closed). After watching the video, participants rated instructor trustworthiness, content credibility, and situational interest. Results showed that both posture dimensions significantly affected perceived instructor trustworthiness, with upright and open postures leading to higher trustworthiness ratings. In contrast, content credibility and situational

interest were not directly influenced by posture variations. Mediation analyses demonstrated that instructor trustworthiness predicted content credibility and situational interest, and content credibility predicted situational interest. Significant indirect effects via instructor trustworthiness alone as well as serial indirect effects via instructor trustworthiness and content credibility were found, whereas no direct effects on situational interest emerged. The findings extend research on educational videos by highlighting body postures as relevant social cues that operates through perception-based mechanisms, consistent with Source Credibility Theory. From an educational perspective, variations in instructors' body postures represent easily adjustable aspects of nonverbal behaviour that can shape learners' perceptions of trustworthiness and thereby influence interest in video-based instructional processes.

Mind the Set: Learner Characteristics as Sources of Cognitive Load in Digital Learning

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Primary school students enter instruction with malleable ability beliefs, called mindsets, shaped by adult messaging. Ideally, this process culminates in growth mindsets that frame ability as developable. Nonideally, it culminates in fixed mindsets, that frame ability as stable. Although mindsets are primarily shaped through social interaction, instructional materials may contain cues that reflect particular views of learning and ability. This redirects attention to learning materials as sources of instructional cues, such as mindset cues. Prior research on mindset reported inconsistent effects on learning outcomes. Against this background, it remains unclear how mindset-related instructional cues function as effective design features for learning or interact with more stable learner characteristics that shape domain-specific evaluations (academic self-concept). To address this, 136 primary school students were randomly assigned to either a growth- or a fixed-mindset condition, (growth-mindset: emphasizing improvement through effort and practice; fixed-mindset: framing ability as stable). The topic covered combinatorics and was delivered individually within a digital learning environment. Prior knowledge, mathematics self-concept, cognitive load, and learning outcomes were assessed. While no main effect of growth-mindset on learning outcomes was found, mathematics self-concept was negatively associated with both intrinsic and extraneous cognitive load, indicating that learners' self-evaluations toward mathematics systematically influenced the perceived cognitive demands of the learning environment. Even in the absence on learning outcomes, the results highlight the relevance of learner-related factors for understanding perceived cognitive load. Accordingly, cognitive load may need to be conceptualized not only as a design-related construct, but also as a learner-dependent outcome of self-evaluative processes.

Making GenAI Classroom-Viable: Teacher Design Moves, Professional Role, and Peer Critique in PD

Presenter(s)
Diane Vassallo | University of Malta, Malta

Teachers increasingly use generative AI (GenAI) to draft lesson plans and classroom resources, yet research still under-specifies what teachers actually do to transform AI outputs into classroom-viable instruction. This study examines teacher agency during GenAI-supported instructional design in professional development (PD). Two PD sessions (3 hours each) were delivered in two public primary schools with 60 participants (teachers and learning support educators). Data sources comprised: (a) teachers' written task artefacts documenting prompts, AI-generated drafts, and in-the-moment decisions about fit/misfit; (b) structured group critique artefacts capturing collective evaluation and suggested revisions for classroom feasibility; (c) brief warm-up and close-up prompts eliciting changing framings of creativity and GenAI in teaching; and (d) post-session reflections focused on professional role, responsibility, and agency when working with GenAI. Data were analysed thematically, supported by process coding to identify recurring "design moves" enacted to make AI outputs workable in real classrooms. Findings indicate that teachers rarely accept AI drafts "as is" but instead, they enact iterative constraint-setting, selective uptake, verification/correction, contextualisation to learners and curriculum, and differentiation. Teachers position themselves as accountable professionals (e.g., editor/curator, ethical gatekeeper, facilitator), with peer critique functioning as a mechanism for surfacing tacit quality standards and negotiating what counts as "classroom-viable." Implications are discussed for PD designs that strengthen teacher ownership through critique protocols and explicit verification routines.

Development of a Lesson Series for Promoting Elementary School Students' Computational Thinking

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In an increasingly digitized society, many countries have incorporated digital literacy in their curriculums. Preparing learners for the future not only entails equipping them with knowledge about digital tools and media, but also supplying them with the systematicity of thinking like a computer(-programmer). The latter, a set of problem solving skills referred to as computational thinking (CT), is posited be useful beyond the context of programming. However, there is little evidence that learners can transfer CT learned through programming to other contexts. Hence, the aim of the study was to design, develop, and evaluate a CT lesson series for upper-elementary students in which transfer is already supported during the learning process. In accordance with the imminent Dutch curriculum, the CT lesson series incorporates programming, but also unplugged activities to foster transfer. The lesson series is being realized through two successive cycles of educational design research, including regular instances of educator co-creation.

During the first cycle, the first two lessons were developed and tested in three classes. The ongoing second cycle entails revising and developing the full lesson series and testing it in practice. The project delivers educational science a validated set of empirically-grounded design principles and tested instructional design characteristics that foster CT and potentially CT-transfer, and simultaneously provides practitioners a theory-based, ready-to-use lesson series. Furthermore, the lesson series facilitates future research into the effectivity of additional instructional supports for CT-transfer, ultimately contributing to fulfilling the promise of CT being a future-proof skill that will help students navigate digital change.

Validating and Scaling Webcam-based Gaze Analytics in Technology-Enhanced Teacher Education

Presenter(s)

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Technology-enhanced teacher education increasingly relies on process-sensitive data to understand how professional competences develop in video-based learning environments. Eye tracking has become a key method for capturing visual attention processes underlying professional learning. However, conventional infrared (IR) systems require laboratory infrastructure, limiting scalability, ecological validity, and integration into distributed digital learning platforms. This study evaluates whether webcam-based eye tracking provides sufficiently robust gaze analytics for scalable technology-enhanced teacher learning. In a mixed experimental design (N = 84), participants completed two gaze-tracking sessions while viewing dynamic classroom video vignettes: one using a high-precision IR system and one using a webcam-based system, implemented either in the laboratory or remotely at home. We compared spatial accuracy and precision alongside derived behavioral metrics, including fixation count, fixation duration, AOI hits, and saccade amplitude. Subjective usability and perceived environmental stability were additionally assessed. As expected, IR tracking demonstrated superior spatial fidelity. Importantly, however, region-based behavioral indicators remained highly stable across systems, and AOI-level attention patterns showed strong cross-method convergence. Perceived stability significantly predicted objective precision. These findings demonstrate that webcam-based eye tracking, despite reduced spatial accuracy, yields functionally robust gaze metrics suitable for many research and instructional applications. The results provide an empirical foundation for integrating scalable gaze analytics into distributed, video-based teacher education environments.

Attention Please, (for) Everybody! Emotional Design to Compensate Learners' Attentional Difficulties

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Sustaining attention over longer learning phases is equally crucial for all learners, but its difficulty varies. Exerting self-control to sustain attention is especially challenging for learners with attentional difficulties. The consequence can be increased mind-wandering or extraneous cognitive load from exerted self-control over the learning phase. However, learners with attentional difficulties can sustain attention more easily when learning tasks offer frequent reward. Emotional design can provide such reward for learning tasks by supporting situational interest development. Emotional design therefore should decrease the likelihood of mind-wandering and reduce extraneous cognitive load, especially for learners with attentional difficulties. Learning over longer learning phases should improve. We varied the between-subjects factor video design (neutral vs. emotional) and the within-subjects factor learning phase (four video sections; 2×4 mixed-design). Attentional difficulties were measured as a continuous moderator using a clinical screening questionnaire. Our data collection finishes in March (ntime_of_submission= 193, students aged 14-18). Participants watched a 16-minute learning video either in a neutral, minimalist design or an emotional design incorporating stimulating design elements. After the video, situational interest, mind-wandering, and extraneous cognitive load were assessed. Learning outcomes were assessed for all four video sections with open-answer questions. Until the SIG 6&7, we plan to examine whether emotional design enhances learning especially at the end of the learning phase and whether these benefits increase with attentional difficulties. Moderation analyses are preregistered to investigate the underlying motivational and cognitive mechanisms. Understanding how instructional materials may compensate for attentional difficulties could help to improve educational equity.

Comparing Knowledge and False Certainty Gains in Immersive and Non-Immersive Learning Videos

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Effective learning environments should foster confidence in correct answers while discouraging confidence in errors. Immersive videos viewed via head-mounted displays (HMDs) could provide a unique learning paradox: while they provide access to high-fidelity environments, such as

research laboratories, their intense realism may inadvertently trigger inflated subjective confidence, regardless of the objective response accuracy. In the present laboratory study, participants (N = 167) viewed a presentation on the topic of nanomaterials given by a scientist in a research lab either as a 360° learning video via an HMD or as an information-equivalent two-dimensional video on a tablet device. Across both formats, results indicated not only a significant increase in retrospective confidence regarding correct answers, but also an unwanted increase regarding incorrect answers—a phenomenon known as the false certainty effect (FaCE). Notably, this effect emerged for both tasks explicitly addressed in the video and for related topics not directly covered. In contrast to expectations, the magnitude of the FaCE remained constant across both video formats. Additionally, although the HMD condition elicited higher perceived social and spatial presence, lower extraneous cognitive load, and increased user engagement, the actual learning gains did not differ between the two groups. These findings suggest the need to further investigate the decoupling between improved subjective learning-relevant factors in immersive learning and objective learning performance, and, given that this study provides the first evidence of the FaCE in video-based learning, to further investigate the FaCE in learning with both immersive and non-immersive videos.

Explaining to the Bored Audience Promotes Learning-by-Teaching

Presenter(s)

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Learning by teaching is a generative learning strategy that enhances knowledge understanding through explaining content to others. It is unclear whether audience feedback and the medium of explaining impact the learning-by-teaching process and outcomes. This study employed a 2 (feedback valence: positive vs. bored) × 2 (explaining medium: face-to-face vs. online) between-subjects design. A total of 138 college students were randomly assigned to either face-to-face or online conditions to explain the learning materials to a real audience who displayed either positive (e.g., smiling, nodding, taking notes) or bored (e.g., blank stare, eye contact avoidance, chin resting) nonverbal behaviors. The results showed that: (1) positive feedback from audience increased interest, social presence and cognitive load but reduced anxiety; (2) bored feedback increased metacognitive involvement, monitoring and metacognitive accuracy; (3) bored feedback led to better transfer performance than positive feedback, especially in face-to-face conditions; (4) Mediation analyses revealed that bored feedback improved learning outcomes in face-to-face explaining by reducing cognitive load, generating more idea units, and increasing metacognitive accuracy. These findings suggest that positive feedback in learning-by-teaching gives learners a sense of satisfaction and enjoyment, whereas bored feedback enhances metacognitive involvement and learning performance. This finding highlights a trade-off between affective comfort and deep learning in the learning-by-teaching process.

Enhancing Personalized Learning-by-Teaching: Effects of AI-Assisted Preparation and Reflection

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Learning by non-interactive teaching is a generative learning strategy in which students prepare explanations for an imagined audience (e.g., recording a video). This study examined whether AI support can further improve learning outcomes when provided during (a) lesson preparation or (b) post-teaching reflection. Experiment 1 tested whether the timing of AI support during preparation matters. 120 college students studied a lesson and prepared a video explanation with AI guidance either before drafting (Early-AI), after an initial independent draft (Late-AI), or not at all (No-AI). The Late-AI condition showed higher teaching efficacy and transfer performance than the Early-AI and No-AI conditions. The No-AI condition reported higher germane cognitive load during teaching than both AI-supported conditions. Experiment 2 examined reflection supports after teaching. 163 college students generated an explanation and then completed one of four reflection activities: AI-assisted reflection (AI-generated diagnostic feedback and personalized recommendations), material-based reflection (comparing the explanation transcript with learning materials), no-support reflection (independent reflection on the explanation transcript), or no reflection. AI-assisted reflection yielded the highest transfer performance and was associated with higher teaching efficacy and germane cognitive load, greater metacognitive processing and learning motivation, and lower extraneous cognitive load during reflection. Material-based reflection also improved motivation and transfer relative to the no-support and no-reflection conditions. Overall, strategically timed AI scaffolding, especially late-stage preparation support and immediate AI-guided reflection, enhances learning by non-interactive teaching.

Developing and Validating an AI Assessor for Teaching Material Quality at Scale

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The quality of teaching materials is a key driver of effective classroom learning, yet existing multidimensional frameworks typically rely on expert judgments, limiting their scalability. To address this gap, we developed and evaluated an AI-based assessor that rates instructional materials using a large language model (LLM) aligned with the seven-dimensional framework by

Garay Abad and Hattie (2025) including learning goals and structure, differentiation, cognitive demand and depth of learning, collaboration, cultural relevance, time efficiency, and teacher growth features. These criteria were operationalized through iteratively refined structured prompting against expert benchmarks.To evaluate and improve the AI assessor, we conducted four tests in which criteria were rated as low, medium or high quality. First, agreement with expert ratings reached 81%, exceeding the predefined 80% benchmark. Second, repeated assessments of identical materials showed excellent stability (99.06%; target ≥95%). Third, we examined the validity of the assessor across subject domains, grade levels, and material types based on 2000 materials. Our analyses identified meaningful differences (e.g., higher ratings for Grade 13 vs. Grade 1, Ethics vs. Latin, and lesson plans vs. craft-based materials). Finally, expert validation of top-, middle-, and bottom-rated materials showed near-complete alignment (only one minor deviation).Overall, results demonstrate that specialized AI assessors can achieve strong expert agreement and high reliability, enabling scalable, theory-based quality evaluation of materials. Future work should further examine potential category biases for subject domains, grade levels, and material types and validate ratings against external outcomes such as classroom effectiveness.

Practicing Retrieval is Effective With Both Coherent and Incoherent Text Material

Presenter(s)

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During the last decade it has been discussed whether the complexity of learning materials posits a boundary condition for the testing effect. One of few studies in favor of this assumption was published by de Jonge and colleagues (2015). They showed that the long-term benefit of testing compared to restudying occurred only for a version of an expository text of low complexity (incoherent, sentences in a scrambled order) but not for a version of high complexity (coherent, sentences in an inferential order). A fill-in-the-blank test served as practice test and dependent variable. However, de Jonge et al. (2015) manipulated text complexity across two different experiments, which makes the data hard to interpret. Additionally, for a number of theoretical reasons (i.e., the multiple sources of this effect), we assumed that the testing effect can be found with texts both high and low in complexity. Therefore, we replicated the critical conditions of the Experiments with more power (Experiment 1, N=111). In addition, we ran a conceptual replication that replaced the fill-in-the-blank-tests with short-answer questions (Experiment 2, N=117). In our experiments, we exclusively investigated the delayed final test conditions. Both studies were based on a 2x2 design between participants with the factors text complexity (high vs. low) and the learning condition (testing vs. restudy). As expected, we found a testing effect which was independent from text complexity for fill-in-the-blank tests as well as short-answer

questions. Based on these results, we conclude that the testing effect is not restricted to texts low in complexity.

How to Scale Verbal Analysis in Learning Sciences? The TPV Approach for LLM-Based Coding

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Large Language Models (LLMs) hold growing potential for scaling the analysis of qualitative data in the learning sciences. One essential step in qualitative analysis is coding verbal data. While several approaches have been proposed for LLM-based coding, few meet the specific needs of this field, where coding must capture not only descriptive content categories but also pedagogical functions of utterances, which are often implicit and difficult to detect. To address this challenge, we developed the Theory–Prompt–Validation (TPV) approach, a three-step process comprising theory modeling, prompt engineering, and validation. The TPV approach provides a blueprint for evidence-based application of LLMs for context-sensitive coding of verbal data. The TPV approach builds on existing methods while incorporating requirements specific to the learning sciences. We emphasize a theory-driven, evidence-based process, including validation analyses to verify that pragmatic functions are accurately captured in coding. To illustrate the TPV approach, we applied it to AI-student tutoring dialogues. We developed a theory-driven codebook and implemented it in a Python-based script leveraging GPT-4o to segment utterances and assign codes automatically. Intercoder agreement between the LLM and a human coder was substantial (Cohen's $\kappa = .73$) and descriptively higher than between two human coders (Cohen's $\kappa = .69$). Validity analyses revealed theoretically meaningful patterns, such as positive effects when the code feedback was assigned more frequently. Our work demonstrates that LLM-based coding can reliably and validly scale the analysis of verbal data, bridging the gap between time-intensive qualitative methods and large-scale, evidence-based educational research.

Quantity Matters: Investigating the Impact of the Seductive Detail Amount on Learning

Presenter(s)

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Seductive details, which are interesting but irrelevant digressions included in a learning environment (e.g., fun facts), have been shown to impair the learning performance of students. However, to date, it is unclear whether the amount of seductive detail content is crucial for the

extent of this detrimental effect as other studies have been inconclusive in this regard. Hence, in the present studies (N = 191 and N = 101), learners were presented with a varying amount of seductive detail content embedded within a learning text. Instead, the number of text interruptions by seductive content was kept constant between conditions. Both studies consistently showed a linear negative effect of the seductive detail amount on recall performance. Furthermore, Study 2 indicated a polynomial trend regarding transfer performance, suggesting that small seductive detail amounts could improve transfer, even though cross-validation showed that this model is rather unstable. Prior knowledge and working memory capacity did not significantly attenuate the seductive details effect. The results imply that the extent of the seductive detail effect is dependent on the amount of seductive detail content presented. Especially the inclusion of large amounts of digressions should be avoided by teachers and instructional designers, while the inclusion of small amounts might have rather negligible effects.

Fostering Learning from Instructional Videos through Self-monitoring and Constructive Engagement

Presenter(s)

Anke Wischgoll | TU Dortmund University, Germany

Research in self-regulated learning (Zimmerman, 2002) and the ICAP framework (Chi & Wylie, 2014) has demonstrated that constructive engagement enhances learning outcomes. However, it remains unclear how different instructional designs (Henderson, 2019), specifically the integration of practicing tasks and monitoring activities in video-based digital learning environment, promote constructive engagement in authentic educational contexts. We aimed to find out how practicing tasks and monitoring activities support learning outcome when learning with instructional videos. Specifically, we were interested in the sustainability of the learning effect. We hypothesize that experimental groups will outperform a control group, that monitoring activities will enhance outcomes, and that combining monitoring with practicing tasks will produce the most durable learning gains. Therefore, we designed a digital learning environment on part-whole relationship in probability theory with three experimental groups in a 2x2 design with conditions involving practicing tasks, monitoring activities, or a combination of both. 313 pre-service math teachers participated in the intervention study with pre-, post-, and delayed post-test. Results revealed no significant differences for the learning outcomes in the post-test. However, we found that the experimental groups with monitoring activities outperformed those groups without monitoring activities in the delayed post-test significantly. The study contributes theoretically by clarifying how self-regulatory and generative processes interact to support constructive engagement. Practically, it offers guidance for designing digital learning environments with instructional videos that foster sustainable learning.

Digital Distraction through Tablets in the Classroom – Empirical Results of a Multiple Case Study

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The integration of digital technologies into vocational education expands pedagogical opportunities while simultaneously intensifying challenges related to student attention and digital off-task behaviour. Although digitally enriched instruction can enhance motivation and engagement, empirical research indicates that media use during class time is widespread and associated with diminished learning outcomes. Prevailing countermeasures often rely on restrictive or disciplinary approaches, which risk undermining motivation and limiting the pedagogical potential of digital tools. This study therefore investigates how instructional design patterns can proactively prevent digital off-task behaviour while preserving the benefits of digital education.A multiple-case study was employed, comprising ten vocational schools in Germany. In each school, one class and its teacher were examined. Data were collected through student questionnaires, focus group interviews, expert interviews with teachers, and analysis of teaching materials. Cross-case synthesis was conducted using qualitative type formation to identify recurring patterns across cases.The analysis revealed four qualitative learning types that differ in terms of self-efficacy, learning engagement and perceived meaningfulness of the lesson. The results show that digital off-task behaviour arises from the interaction between learners' internal prerequisites and external teaching conditions. Depending on the teaching environment and the students' perceptions, different learning types emerge in each class. Based on the identified types, effective patterns in lesson design were identified that contribute to preventing off-task behaviour. By refining a theoretical model of digital off-task behaviour and deriving empirically grounded instructional design patterns, the study provides both theoretical advancement and practical guidance for designing attention-supportive digital learning environments.

Teachers' Adaptive Expertise Influence on Student Learning in Technology-Mediated STEM Integration

Presenter(s)
Susan Yoon | University of Pennsylvania, United States

Educational technology offers powerful opportunities for STEM-integrated learning, yet its effective classroom implementation depends heavily on teachers' instructional expertise. Drawing on the framework of adaptive expertise, this mixed-methods study examines how high school biology teachers' adaptive expertise shaped students' learning experiences during implementation of a technology-rich bioinformatics curriculum. Data were drawn from a United States National Science Foundation funded project involving five teachers and 122 students. Teachers' adaptive expertise, operationalized as flexibility, deep-level understanding, and deliberate practice, was assessed through classroom observations and lesson debriefs, while student experiences were measured using pre- and post-surveys. Results indicated significant

variation in teachers' adaptive expertise, particularly in flexibility and deep-level understanding. Students reported significant gains in learning bioinformatics content, using computational tools, and applying science to local community issues. Regression analyses revealed that teachers' adaptive expertise significantly predicted students' overall STEM-integrated classroom experiences, even after controlling for pre-intervention scores. Findings highlight adaptive expertise as a key mechanism linking instructional quality and technology-mediated STEM learning and underscore the importance of professional development that foregrounds data literacy and computational reasoning as integrated instructional practices.

Acceptance of Teacher-Authored AI Chatbots in Education: Comparing Student and Teacher Perspectives

Presenter(s)

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Co-author(s)

Sabine Seufert | University of St.Gallen, Switzerland

Generative AI has increased interest in the didactic potential of AI chatbots in education, yet sustainable classroom use depends on acceptance by both students and teachers. Empirical comparisons of these perspectives remain scarce, particularly with regard to teacher-authored AI chatbots designed by teachers for their own instructional contexts. This study examines the acceptance of teacher-authored AI chatbots from both student and teacher perspectives.We investigated the use of teacher-authored AI chatbots implemented in the learning app Brian at the upper secondary level using a pre-post design. The study is based on survey data from N = 1455 students across 20 schools in 10 cantons (general and vocational education) collected between February and June 2025, complemented by an online survey of N = 27 teachers. Participants used Brian for at least six weeks. We assessed attitudes toward usefulness, motivation, performance improvement, practicality, and classroom integration using UTAUT scales and open-ended questions. Quantitative data analysis included structural equation modeling, latent mean comparisons and non-parametric tests. From the students' perspective, acceptance of Brian was moderate and independent of gender or school type. However, initial enthusiasm declined over time, suggesting a possible novelty effect. Overall, effects on grades appeared small, with indications that lower-performing students benefited more. Teachers emphasized pedagogical opportunities such as differentiated feedback and scaffolding, alongside challenges related to task design, response quality, time demands, and trust. Overall, the findings suggest that sustained acceptance requires purposeful pedagogical integration and targeted support to highlight long-term benefits.

THEORETICAL PAPER

Do Learning Analytics Visualizations Promote Actual Learner Behavior Changes? A Systematic Review

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Learning Analytics Visualizations (LAVs), including dashboards, are widely adopted to support learners' understanding of their learning processes. However, it remains unclear to what extent LAVs lead to actual learning behavior change, i.e., the mechanism through which meaningful learning impact is realized. This systematic review examines LAV research from the past decade (n = 69) through a behavior-change lens. We proposed a stage-based model for learning behavior change and used it to code the papers in terms of intended design and empirical evidence for how LAVs correspond to different stages of behavior change. The findings show that most studies concentrate on early stage awareness, and predominantly rely on descriptive LAVs. Although learner perceptions and intentions are frequently reported as outcomes, empirical evidence of enacted or sustained behavior change is limited. This finding suggests that impact is often inferred rather than demonstrated, revealing a persistent gap between LAV design intentions and verified behavioral outcomes. These results underscore the need to reposition LAVs as behavior-change interventions and to develop approaches for the design and evaluation of LAVs that explicitly measure observable and sustained learning behavior change.

From Framework to Learning Environment: Designing an AI Literacy Driving Licence

Presenter(s)
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As AI literacy frameworks gain prominence in education, a key challenge remains unresolved: how to translate normative competency descriptions into coherent instructional systems that support learning progression and assessment in real educational contexts. This paper presents the design of an AI Literacy Driving Licence as a mastery-oriented learning and assessment system aligned with the EU AI Literacy Framework.The Driving Licence operationalises the framework's five knowledge areas and four competence dimensions through sequenced learning modules, pedagogically framed AI use scenarios, and assessment components embedded across the learning process. The design moves beyond tool-centred training by foregrounding judgement, responsibility, and agency in learners' engagement with AI. A shared instructional

architecture is implemented across lower and upper secondary education, with level-specific adaptations that address differences in abstraction, reflection, and contextual complexity. The contribution is design-oriented and conceptual. It explicates the design logic underlying the framework-to-learning environment translation, including alignment decisions, sequencing principles, mastery thresholds, and the use of pedagogical sandboxes to support bounded experimentation with AI. By positioning AI literacy as a learnable and assessable construct within a structured programme, the paper offers design principles for researchers and practitioners seeking to transform AI literacy frameworks into instructionally coherent learning systems.

The SCADI Model: A Framework for Implementing Adaptive Instruction

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Adaptive instruction holds strong promise for improving learning outcomes, yet a persistent gap exists between technological capabilities for personalization and theoretically grounded guidance for instructional action. The SCADI (Scaffolding for Adaptive Instruction) model addresses this gap by offering a structured framework for aligning learner characteristics, learning activities, and instructional support. Grounded in cognitive science and educational psychology, the model conceptualizes learning as the interaction of motivational-affective, metacognitive, and cognitive processes, each shaped by learners' internal resources. Learning difficulties are understood as mismatches between these resources and the demands of learning activities as implemented in specific tasks.The SCADI model proposes scaffolding as the primary mechanism for resolving such mismatches. It distinguishes between learning process scaffolding, which directly supports internal learner processes without altering the task, and representational scaffolding, which modifies task features to reduce intrinsic demands. Both forms can target motivational-affective, metacognitive, and cognitive dimensions, and can be combined through layered scaffolding. By explicitly linking learner resources, task demands, and scaffolding strategies, SCADI provides a pragmatic tool for designing adaptive instruction and generating testable research hypotheses. The model supports precise diagnosis of learning challenges and targeted adaptive interventions across instructional contexts.

Stuck in Ineffective Study Habits? A New Look at Learning Strategy Use

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Students often rely on learning strategies that are suboptimal for long-term retention, even when they are aware of more effective alternatives. Existing explanations typically emphasize students' deliberate decision-making, such as perceived effort or time constraints, or the alignment of strategies with students' academic goals. In this contribution, we aim to extend this perspective by examining the role of non-deliberate, habitual processes in learning strategy use. Drawing on modern habit theory, we first theoretically analyze how learning strategies align with habit characteristics and argue that ineffective strategies are especially likely to become habitual. Persistent strategy use may therefore reflect not only deliberate choices, but also automatic activation in response to environmental cues. To further illustrate this claim, we report findings from an exploratory study in which university students reported the habit strength of different learning strategies. Results indicate substantially stronger habitual tendencies for ineffective than for effective strategies. We synthesize theoretical and empirical findings to discuss how a habit perspective can enrich the understanding of learning strategy use and inform efforts aimed at promoting effective strategy use.

Learning with XR and GenAI: The Immersive Generative Learning Framework

Presenter(s)
Guido Makransky | University of Copenhagen, Denmark

Extended reality (XR) and generative artificial intelligence (GenAI) are rapidly converging into immersive generative technologies for interactive learning at scale. Their educational impact is urgent not simply because the tools are new, but because they may redistribute where and how people learn across schools and everyday digital platforms. Research shows that digital media are neither inherently beneficial nor harmful for learning; outcomes depend on instructional design and the learning processes they elicit. Immersive generative technologies raise the stakes for instructional design by combining XR features that heighten physical presence, agency and social presence with GenAI capabilities for scalability, individualisation and adaptivity. This makes it possible to deliver tailored guidance and social interaction within rich virtual experiences. Synthesising evidence, I show that effects on learning are typically contingent on instructional design, while both literatures remain methodologically fragile and often weakly theory anchored, limiting inferences about mechanisms and transfer. To guide research and practice, I propose a human centred, mechanism focused framework linking XR driven experiences to GenAI properties as potential magnifiers of cognitive, metacognitive, motivational, affective and social processes. The framework can be used to investigate when

these systems may support durable understanding and transfer, and when they may instead amplify distraction, cognitive offloading and erosion of epistemic agency, and outlines priorities for theory driven research, human centred design and evaluation standards as these systems begin to diffuse.

LODAM: A New Model for Analysing Knowledge Construction in Digital Learning Environments

Presenter(s)

Dennis Rivera | Universität Zürich, Switzerland

When Henri (1992) developed her pioneering analytical model to examine learners' online discussions, little did she know that her work would inspire a myriad of future models. In general, current analytical models seek to capture the socio-cognitive processes learners mobilise when engaging in discussions (e.g., sharing information, asking questions, negotiating meaning, etc.). While these models offer valuable insights into how learners interact, they largely overlook the knowledge that results from discussions. This paper addresses this gap by introducing the Learners' Online Discussions Analysis Model (LODAM). LODAM offers a novel analytical perspective that shifts attention from learning processes to the outcomes emerging from learners' discussions. LODAM conceptualises discussions as a dialogic space defined by two continua: cognitive convergence–divergence and social collaboration–competition. Rather than classifying discussions into fixed categories, this model maps the spectrum of potential dialogues that may unfold as learners engage in knowledge construction. Using an empirical application in a large-scale online course, the paper illustrates how LODAM enables a more nuanced analysis of knowledge construction that integrates cognitive and social dimensions. By reframing the analysis of online discussions around dialogic outcomes, this paper advances theory in computer-supported collaborative learning and technology-enhanced learning. It further offers instructional design researchers and practitioners a tool to evaluate the quality and nature of the knowledge constructed through interaction.

Integrating Educational Apps in the Classroom: A Teacher Support Framework

Presenter(s)

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Despite growing access to smartphones and tablets in schools, many educational apps do not succeed in the classroom. Prior research shows that even well-designed and pedagogically grounded tools often fall short due to an insufficient integration into classroom practice. Building

on insights from educational psychology and digital health research, we argue that teacher support plays a critical role in determining whether educational apps become a meaningful part of students' learning activities. We propose a new framework that conceptualizes four key facets that determine integration success: fit, engagement, knowledge, and application. For each facet, we demonstrate how targeted teacher scaffolding can support effective app use and learning. To illustrate its diagnostic and practical value, we apply the framework to a case study of a mobile app designed to foster self-regulated learning in young students. We draw on mixed-methods data (app logs and questionnaire data from N = 263 students, Mage = 11.6 years; as well as open-ended student answers and two teacher-interviews) to identify points of failure and corresponding teacher support needs. The proposed framework offers a structured lens for researchers and practitioners seeking to understand and improve the integration of educational apps in classroom contexts.

Generative AI in the Design of Pedagogically Sound Assessments: A Scoping Review

Presenter(s)

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Although generative artificial intelligence (GenAI) is rapidly reshaping assessment design in education, its pedagogical value and integration with established instructional and assessment frameworks are not sufficiently explored. This scoping review maps the empirical literature on AI-assisted assessment design to inform evidence-based educational practice. The available literature was narrowed down to 83 relevant empirical studies from various disciplines and educational levels. The AI applications were interpreted and grouped using the SAMR (Substitution, Augmentation, Modification, Redefinition) framework. The preliminary findings reveal that GenAI is primarily employed on the substitution level, to generate assessment items, such as multiple-choice questions. On the augmentation level, AI can be used to enhance alignment of assessment items with learning objectives or pedagogical frameworks, whereas the modification level changes how assessments are administered, for example automated and adaptive assessments. Finally, we also see redefinition of assessment through interactive simulations and dialogic formats. While many studies report positive outcomes, the effectiveness of AI-generated assessments appears to depend largely on human expertise in areas such as prompt engineering, pedagogical judgement and systematic expert validation. Psychometric evaluations reveal mixed results, with AI-generated items often exhibiting lower cognitive demand despite promising discrimination indices. Overall, the review highlights the potential of GenAI to support efficiency, personalisation and innovation in assessment design. However, it also emphasises the need for stronger empirical evidence, theoretical grounding and systematic validation to ensure the implementation is both pedagogically sound and ethically responsible.

POSTER PRESENTATION

An Agency Lens for Teacher–AI Augmented Orchestration: A Middle School Case-Driven Framework

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Protecting and supporting the agency of educators has become a priority in the fields of Technology Enhanced Learning (TEL) and Artificial Intelligence in Education (AIEd) to ensure effective and trustworthy deployment of AI systems. However, teacher agency, understood as the capacity of educators to act purposefully and take ownership of changes, is a multifaceted concept that still needs more conceptual operationalization in these fields. The efforts to conceptualize teacher agency with Orchestration (that describes how teachers design and later coordinate multi-level learning activities in real-time) in TEL are challenged by the introduction of AI tools in the classrooms. Within that context, we are extending a conceptual framework that originally mapped facets of agency with orchestration activities by integrating a Human-AI interaction layer. The conceptual development of the TAMOA-AI (Teacher Agency Manifestations with Orchestration supported by AI technologies) framework has been motivated by the design and analytical demands of a case study in which middle-school teachers used a mixed-augmented reality device for enhanced detection of students' needs in maths classrooms. Orchestration activities function as observable proxies of agency; the human-AI layer accounts for the explicit affordances of the tool. Working towards an operationalization of how teacher agency manifests in the context of teacher-AI support could provide a theoretically sound basis for (i) enriching conceptual clarity on how teacher agency unfolds in these environments, and (ii) enabling the identification of problematic areas for improving AI features so they can genuinely support the theoretically established dimensions or mechanisms by which agency unfolds.

Can AI help teachers? Evidence on the effects of GenAI use and AI training on lesson preparation

Presenter(s)
Philipp Appel | German Institute for Adult Education - Leibniz Centre for Lifelong Learning (DIE), Germany

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Teachers face considerable workload outside the classroom. Generative Artificial Intelligence (GenAI)could support teachers by enhancing lesson preparation while also decreasing workload. Moreover,training on GenAI could further enhance its effectiveness and is increasingly demanded bypractitioners and researchers. The present study examines whether GenAI (ChatGPT) can effectivelysupport teachers during lesson preparation, and whether participation in AI training is beneficial. Forthis purpose, we conducted a preregistered, randomized controlled trial with N = 204 teachers whowere randomly assigned to one of three groups: (1) No access to ChatGPT, (2) access to ChatGPT, and(3) access to ChatGPT with prior AI training. Teachers completed four incentivized tasks related tolesson preparation - crafting an introductory quiz, writing a course mail, extending a textbookexercise and creating text and transfer questions. Dependent variables were (a) quality of thecompleted tasks, assessed through blinded expert ratings based on weighted criteria and (b) timespent on preparation, measured in minutes. Results indicated that GenAI (ChatGPT) effectivelyhelped teachers during lesson preparation tasks, demonstrated by improved task quality and a 34 %reduction in preparation time. AI training did not further improve task quality but led to an additional21 % reduction in preparation time compared to untrained teachers. As revealed by prompt data,trained teachers utilized longer, contextually richer and fewer prompts.

Social Interaction with a Pedagogical Agent: An Eye-Tracking Study

Presenter(s)
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Pedagogical agents are widely used in higher distance education and have been shown to support learning (Castro-Alonso et al., 2021; Dai et al., 2022; Schroeder et al., 2013). These effects are often attributed to the social cues conveyed by agents, which may foster social presence and learner engagement (Lane & Schroeder, 2022; Schneider et al., 2022). Despite twenty years of research, the mechanisms by which learners interact with pedagogical agents during learning remain insufficiently understood (Schroeder et al., 2025). In particular, it remains unclear whether the social cues conveyed by pedagogical agents relate to learners' perceived social presence, engagement, and emotional experience as reflected in their overall interaction experience. To address this gap, the present study adopts a quantitative, process-oriented eye-tracking approach to examine how learners visually interact with an interactive pedagogical agent (Holmqvist & Andersson, 2017; Jarodzka et al., 2017). Learners interact with an agent that

enables them to experience different leadership styles within a higher professional military education module. Eye-tracking captures visual attention to the agent, speech bubble, and answer options (Coskun & Cagiltay, 2022; Wang et al., 2018). To contextualize gaze patterns, subjective measures of social presence, engagement, and emotional experience are collected using selected constructs from the Artificial Social Agent Questionnaire (ASAQ; Fitrianie et al., 2025). By focusing on interaction processes rather than learning outcomes alone, the study aims to provide a more nuanced understanding of how pedagogical agents function as social and instructional supports in distance higher education.

Prompts for Focused Processing when Learning from Video Tutorials: Mental Answers are Sufficient

Presenter(s)

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Prompts for focused processing have been shown to be an effective type of instructional support for learning with video tutorials. However, answering such prompts requires a keyboard, which is impractical when wearing VR glasses, for example. Given the growing importance of immersive technologies (e.g., AR or VR glasses), we searched for instructional support for focused processing that also works without text input, for example through mental answers. In a lab experiment, we let 117 students (74 female, mean age = 24.7) watch three video tutorials on how to operate an industrial drill. According to the randomized assignment to one of the four experimental conditions, each video was followed by either prompts for written focus (n = 30), prompts for mental focus (n = 29), prompts for mental rehearsal (n = 31), or no prompts (control condition, n = 27). We found no statistically significant differences between the experimental conditions in terms of learning outcomes, learning engagement, or cognitive load. The learning time for learners in the written focus condition was longer than for those in the other conditions, however. Overall, we can conclude that answering prompts via a keyboard is unnecessary and mental answers suffice when learning with video tutorials (at least in an undisturbed environment with videos designed according to multimedia guidelines). This could benefit future studies on focused processing featuring AR/VR technology, where using a keyboard would be highly impractical.

Supporting Design Cognition in Education: A Review of (Digital) Tools and Instructional Support

Presenter(s)

Jelle Boers | Erasmus University Rotterdam, Netherlands

To address complex societal challenges such as the energy transition, K-12 STEM education must prioritize design cognition. Design cognition refers to the complex cognitive processes students

employ during open-ended engineering design tasks. While engineering design is increasingly integrated into classrooms, students often experience cognitive overload without proper support (Sung et al., 2019). To avoid cognitive overload, there remains a need to synthesize how instructional support effectively facilitates students' navigation of the design process. This systematic literature review employs the PRISMA framework to analyze instructional materials, digital tools, and pedagogical strategies supporting K-12 design cognition. The review addresses two primary research questions: (1) How have instructional materials, including digital tools, been designed and implemented to support K–12 students' design cognition during design tasks? (2) What instructional strategies have been used to support K–12 students' design cognition during design tasks? To address these questions, a comprehensive search across five academic databases (EBSCO, PsycInfo, Web of Science, Scopus, and ERIC) was conducted, which yielded 939 unique records. The study is currently in the screening phase, with a 15% calibration screening already completed to ensure inter-rater reliability and criteria refinement. The findings will identify the design phases and cognitive strategies where students struggle most. Ultimately, this review will allow researchers to better develop and test tools focusing on the design process and provide educators with a practical template for scaffolding the design process in different phases.

Tracing Intra-individual Trajectories of Critical AI Literacy in an Authentic Teaching Setting

Presenter(s)

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Artificial intelligence (AI) poses new didactic possibilities for education while simultaneously raising complex ethical and societal questions. Effective AI integration in education requires both integrated professional knowledge and motivational beliefs (Sadaf et al., 2025); however, research on teacher professional development is largely based on cross-sectional data and therefore provides little insight into how these components develop and interrelate over time, particularly during participation in professional development (Fütterer et al., 2024). Against this background, the present study examines whether pre-service teachers' professional knowledge and motivation remain stable or show intra-individual variability during a problem-based seminar on AI literacy in teacher education.Using a longitudinal design, pre-service teachers (N = 54) were assessed weekly across the seminar with respect to their integrated professional knowledge and motivational beliefs, including perceived utility and AI-related self-concept. Professional knowledge was measured using a combination of text-based knowledge tests and open-ended, problem-based vignettes requiring the integration of multiple knowledge components. Motivation was assessed repeatedly via self-report measures.The study aims to capture intra-individual trajectories of learning and motivation and to explore how changes in professional knowledge relate to motivational development across the seminar. By focusing on dynamic change processes in an authentic instructional context, this research contributes to a

deeper understanding of how critical-reflexive AI literacy can be fostered in pre-service teacher education.

Online Asynchronous Graduate Classes: Instructional Design Framework & Quality Assurance Protocol

Presenter(s)

Lisa Bosman | Purdue University, United States

This study addresses the pedagogical preparation gap among faculty transitioning to online asynchronous graduate courses, where limited training had the potential to result in inconsistent instructional design and suboptimal student outcomes. Drawing on the 5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate) and constructivist theory, this study proposes a preliminary Instructional Design Framework and Quality Assurance Protocol tailored for asynchronous delivery via learning management systems (LMS). The framework structures modules around core activities, including readings (Engage), learning activities with online discussions (Explore/Explain), group case study projects (Elaborate), and quizzes (Evaluate), leveraging publisher resources and AI-generated prompts to foster active knowledge construction and collaboration despite temporal flexibility. Guided by the research question, "How do graduate students perceive the online asynchronous instructional design as effective in supporting learning outcomes?", qualitative data were collected where students responded to 5 reflective prompts, analyzed thematically in NVivo. Preliminary findings reveal high engagement with learning activities (i.e., self-assessments) and group case studies, though challenges emerged in certain course topics such as destructive leadership. These insights affirm the framework's efficacy for outcome-aligned learning while highlighting refinement needs, such as enhanced scaffolding, orientations, and hybrid elements, under faculty autonomy. This contributes scalable, evidence-based protocols to elevate asynchronous learning, boosting retention and career readiness in graduate education.

Peer Matching as Adaptive Instructional Support in the Peer Feedback Process

Presenter(s)

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Peer feedback can activate (meta-)cognitive, motivational-affective, and social learning processes, yet learners vary in their learning prerequisites and engagement patterns. Despite this variability, peers are typically matched randomly or for convenience, and existing matching systems in computer science primarily optimise grading accuracy or efficiency rather than learning. Consequently, learner differences and provider–receiver compatibility remain mostly disregarded as ways to improve peer feedback processes and quality. This conceptual paper proposes a pedagogically-driven algorithm combining learning-science and computer-science perspectives to inform the design of peer matching that supports learning within peer feedback phases. We outline how design decisions are guided by five matching dimensions: target, aim, sources, method, and time. The matching target specifies what is adapted, such as symmetric, asymmetric, or reciprocal matching patterns. The matching aim clarifies which (meta-)cognitive, motivational-affective, or social processes or outcomes are promoted. Matching sources describe which learner information informs the matching decision, including learning prerequisites or process data. The matching method addresses how the decision is generated, according to what principles and using which computational procedure. The matching time distinguishes between macro-level, meso-level, and micro-level adaptations. The paper provides a foundation for designing matching systems that form dynamic learning groups based on their learning prerequisites and processes. This conceptual foundation will be complemented with empirical examples of matching mechanisms and how LLMs can contribute to this endeavour. Advances in these areas will allow matching to be used as an instructional lever for shaping peer feedback and improving its learning value.

Teaching in a virtual classroom with AI-powered virtual students: What do preservice teachers think?

Presenter(s)
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Technological advances in artificial intelligence (AI) hold great potential for enhancing the interactivity of virtual spaces. Social interactions are foundational aspects of teaching and learning and thus essential to include in designing virtual spaces for teacher training. The present pilot study investigated how preservice teachers experienced practicing teaching in an immersive virtual classroom, including virtual students powered by AI. Participants in this study were 14 preservice teachers who attended a seminar focused on developing core practices. Over the course of the semester, preservice teachers practiced and reflected on their experiences rehearsing in a virtual classroom. Their reflections were qualitatively analyzed using thematic analysis and revealed five positive (ease of use, space for practice, deeper awareness of teaching, interactive space, immersive context) and four negative themes (limited teacher agency, limited student interactions, frustration, technical issues). In addition, preservice teachers differed in their experiences and preferences for using the virtual classroom for practice based on their prior teaching experiences. The findings of this pilot study offer important insights for supporting teacher educators in understanding how, why, and for whom virtual classrooms can be beneficial, as well as for directing future research on and the design of virtual and AI-supported environments for teacher training.

Volumetric Videos in XR Learning: A Systematic Review of Potentials, Obstacles and Effects

Presenter(s)
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As a novel medium for fostering learning, volumetric technology is gaining increasing relevance in research and practice. While animations are well-suited for simulation-based learning, volumetric videos offer new potential for social, contextual and authentic learning processes through the three-dimensional representation of real people. The technology can foster the development of professional skills across domains and has substantial potential for implementation in educational and vocational training contexts. Despite this growing interest, a systematic overview of the potentials, obstacles and effects of volumetric videos in XR learning remains missing. This systematic literature review addresses this gap by analyzing n = 26 studies identified following the PRISMA framework. Didactic objectives include realistic representations in terms of temporal or spatial boundaries, the preservation of cultural heritage, the promotion

of physical activities and the development of professional skills. The findings provide a basis for future research and for the practical development of effective didactic concepts for the use of volumetric technology in educational contexts.

The Role of Technology in fostering Self-regulated learning: A Systematic Literature Review

Presenter(s)

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Short abstract (242 words) As higher education increasingly seeks scalable ways to personalise learning and support students' self-regulated learning (SRL), technology is often positioned as a key solution. However, prior research has largely focused on specific tools (e.g., MOOCs, e-learning platforms) rather than examining the technological features that support SRL. Moreover, there is limited clarity regarding which features are effective, how they operate across different interaction types, and how they relate to distinct SRL processes. This systematic literature review addresses these gaps by investigating (1) which technological features have been studied to foster SRL in higher education and (2) how these features relate to SRL outcomes. Following PRISMA guidelines, six databases were searched, resulting in 49 empirical studies published between 2014 and 2024. Features were analysed using Moore's (1989) interaction framework, distinguishing student-content, student-teacher, and student-student interactions, and were examined in relation to SRL processes. The results reveal a strong dominance of student-content interactions, with feedback, self-assessment, resource access, and prompting emerging as the most frequently studied features. Feedback, particularly visual or written feedback delivered through technology, was most consistently associated with positive SRL outcomes. In contrast, student-teacher and peer interactions were comparatively underrepresented, despite their pedagogical relevance. These findings highlight implicit assumptions within technology-SRL research regarding learner autonomy and the uniform effectiveness of feedback. By mapping specific technology features to interaction types and SRL processes, this review offers a feature-level framework to inform more strategic, evidence-based design, implementation, and evaluation of technology in higher education.

When and How Does Retrieval Practice Facilitate the Transfer of Learning?

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Retrieval practice readily enhances memory for fairly simple materials, but its effects on transfer are less clear. The current experiments explored the effects of retrieval on transfer under conditions where learners could readily recognize the relevance of prior learning in a new situation. In Experiment 1, participants learned principles of research design through studying a tutorial and then practicing to retrieve those principles three times (Quiz Group), studying the quiz questions and answers three times (Quiz Study Group), or restudying the tutorial (Restudy). On a final test one week later, the Quiz Group outperformed the other groups on both repeated questions as well as those that involved evaluating the validity of experimental scenarios based on the learned principles. In Experiment 2, participants learned statistical concepts through viewing an educational video about those concepts, followed by one round of retrieval practice vs. a chance to study a transcript of the video (Restudy). On a final test one week later, retrieval practice was more effective than restudy, but only for final test questions that matched those that were completed previously (i.e., factual questions facilitated performance on the same factual questions, and application questions facilitated performance on the same application questions), and not for new, never-before-seen application questions. In Experiment 3 using the same materials, however, three rounds of retrieval practice did benefit transfer performance on new application questions one week later, but only when initial retrieval practice involved application questions and not factual questions.

Digital Retrieval Practice Intervention for Learning Medications Across the Lifespan

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Associative learning is fundamental across the lifespan in many real-world contexts, including learning of health-related information such as medication names, side-effects, and potentially dangerous drug interactions. However, substantial evidence has revealed age-related declines in paired-associate learning. In an era of increasing digitalization of health information, older adults (60+ years old) are frequently required to learn and manage complex medication knowledge through technology-mediated resources. These demands are especially concerning given the high prevalence of polypharmacy in older adults, where failures to remember drug interactions

can lead to serious health risks. Identifying evidence-based instructional strategies that support associative learning in later life is therefore critical for both cognitive science and digital health education. We examined young and older adults' associative memory for drug interactions using a technology-based learning intervention grounded in learning science. Specifically, the digital intervention implemented retrieval practice, which has been found to significantly enhance long-term memory performance in younger and older adults. Participants studied 8 fictitious medications (e.g., Clavosec) and associated drug interactions (with magnesium can cause fainting) through repeated retrieval practice with corrective feedback or rereading. All participants completed a final delayed test assessing recall of interacting substances and side effects. We aim to determine the degree to which a digital retrieval practice intervention yields comparable learning of health information for young and older adults. This work lays the groundwork for developing low-cost, easy-to-implement interventions that use evidence-based learning principles to support effective learning across the lifespan.

Teachers' Artificial Intelligence–Related TPACK Levels Across Subject Areas

Presenter(s)

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The rapid development of artificial intelligence (AI) technologies has begun to reshape educational practices, raising important questions about teachers' professional knowledge and competencies. Extending the Technological Pedagogical Content Knowledge (TPACK) framework, this study examines teachers' Artificial Intelligence–related Technological Pedagogical Content Knowledge (AI-TPACK) and explores whether AI-TPACK levels differ across subject areas. Employing a quantitative descriptive research design with comparative analyses, data were collected from 61 in-service teachers using the AI-TPACK scale. Descriptive statistics were used to identify teachers' overall AI-TPACK levels, and a one-way analysis of variance (ANOVA) was conducted to examine differences across subject area groups, including STEM/Applied Sciences, Social Sciences and Humanities, and Other disciplines. The results indicated that teachers demonstrated a generally high level of AI-TPACK, suggesting that they perceive themselves as relatively competent in integrating AI technologies into their pedagogical and content-related practices. Although teachers in STEM/Applied Sciences reported slightly higher AI-TPACK scores, the ANOVA results revealed no statistically significant differences across subject areas, and the effect size was negligible. These findings suggest that AI-TPACK may function as a cross-disciplinary professional competence rather than one shaped primarily by disciplinary background. The study highlights the importance of inclusive, cross-disciplinary professional development initiatives that address pedagogical and ethical dimensions of AI integration in education.

Embedding an AI-based Tutor Into a Mathematics Learning Platform to Support Self-Regulated Learning

Presenter(s)

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Online learning platforms play an increasingly important role in mathematics education, for example, by allowing students to practice at home in a self-paced manner. However, self-paced online learning is often associated with challenges, such as high dropout rates and metacognitive laziness (i.e., overreliance on external support that reduces active monitoring and deep processing). Accordingly, self-regulated learning skills (SRL), defined as the ability to plan, monitor, and adapt one's learning, have been identified as a key prerequisite for successful learning in online environments. Against this background, the current project aims to foster students' SRL by integrating an AI-based SRL tutor into an existing mathematics learning platform. The tutor design is informed by research in mathematics education and SRL and is co-developed with practicing teachers to ensure alignment with school curricula and classroom realities. Following a design-based research approach, the project proceeds in two phases. First, existing log data from students using the platform in its current version (without any tutor) will be analyzed using learning analytics to identify usage patterns and their associations with dropout. Second, the effectiveness of the SRL tutor will be evaluated in a cluster-randomized controlled field trial comparing school classes that use the platform with and without the SRL tutor. Outcomes include dropout behavior, SRL measures, and mathematics performance. At the conference, we will present preliminary findings from Phase 1 and discuss implications for the iterative refinement of SRL support in scalable online mathematics learning.

Individual Differences in Learning with an immersive Virtual Reality Physics Experiment

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This study investigates how motivation and academic performance influence efficiency during an immersive Virtual Reality (iVR)-based physics experiment on converging lenses. N = 96 eighth-grade students (M = 13.65 years, SD = 0.57; 50.7 % female) participated in an inquiry-based learning task within a fully immersive virtual environment, while eye-tracking technology measured their visual attention. Additionally, students' gains of conceptual understanding were measured. Efficiency was operationalized as the number of correctly solved tasks divided by gaze transitions per minute between predefined Areas of Interest (AOIs). This measure was analyzed through multiple linear regression. The results revealed a significant correlation between academic achievement and efficiency: individuals with lower grades demonstrated markedly higher efficiency than expected. In contrast, motivation showed only a non-significant trend. Several (12.5% of total) motivated low-performing students displayed high efficiency and task success, suggesting that motivation may compensate for limited domain-specific knowledge. Consistent with this, students' conceptual understanding improved significantly from pre- to posttest. Gaze data indicated high cognitive engagement, with most visual attention directed at task-relevant areas. These findings support the Cognitive Affective Model of Immersive Learning. The study demonstrates that iVR environments can benefit low-performing but motivated learners and underlines the value of eye-tracking in identifying learner profiles.

Developing a Voice-Operated Adaptive Tutoring System for Gifted Primary School Students

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Providing early individualized and adaptive support is essential for enabling gifted students to translate high potential into academic achievement. However, such early individualized support is difficult to implement at scale in everyday educational contexts. AI-based tutoring systems offer promising solutions, but many existing approaches rely on text-based interaction, which

can be cognitively demanding, especially for younger learners at primary school age. In addition, current approaches often fail to adequately integrate established findings from educational psychology and instructional design. Against this backdrop, this project aims to develop an evidence-based, voice-operated adaptive tutoring system tailored to the needs of gifted primary school students. The agent will enable natural, real-time spoken interaction through an integrated voice-to-voice architecture. Its pedagogical design is informed by research on giftedness, subject-matter didactics, and effective tutoring practices, emphasizing adaptive scaffolding, formative feedback, and self-regulated learning. The development follows a user-centered, co-design approach involving students and teachers. The contribution will report interim findings from prototype testing and qualitative needs assessments, and lessons learned from early user tests of the prototype. It invites discussion on how voice-based adaptive tutoring systems can be systematically developed based on evidence from educational research.

Teachers' acceptance of genAI use for non-instructional duties

Presenter(s)

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Teachers' workload is increasing, particularly in non-instructional duties such as documentation, coordination, communication, and organizational tasks. While generative AI (GenAI) is widely discussed for classroom use, less is known about factors shaping teachers' acceptance of genAI for non-instructional work. This study investigates vocational teachers' intention to use ChatGPT for non-instructional duties, drawing on UTAUT constructs and extending them with trust and perceived risk. Drawing on a pre-survey (N = 80) to identify the most time-consuming non-instructional duties, we developed six screencast-based scenario vignettes illustrating how ChatGPT can support selected tasks (e.g., meeting preparation, onboarding, internship counseling, writing invitations, research, documentation). We conducted semi-structured interviews with vocational teachers (N = 17), combining vignette-based quantitative ratings with in-depth explanations. The data were analyzed using qualitative content analysis. Results indicate generally high use intentions across scenarios, especially when teachers expect time savings and improved output quality. However, perceived risks (e.g., data protection, quality issues, legal concerns, fairness) and insufficient facilitating conditions (e.g., limited infrastructure, missing licenses, restrictive school policies) hinders acceptance, with task–technology fit emerging as critical. The findings inform professional development and policy efforts aimed at creating conditions for responsible genAI use beyond instruction.

Instructive vs. Reflective GenAI for Brainstorming: Students' Interaction, Motivation, and Learning

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Generative AI (GenAI) tools are increasingly used by university students to support writing processes, raising questions about how different GenAI chatbot designs shape students' interactions, motivation, and learning. Drawing on theories of self-regulated learning, this study examines how instructive versus reflective GenAI support during brainstorming influences students' self-regulated AI interactions, motivation, and learning outcomes. The poster presents findings from a mixed-methods experimental study with undergraduate students (N = 54). Participants watched an introductory theory lecture and completed a sequence of analytic writing tasks. They were assigned to one of three conditions: an instructive GenAI chatbot, a reflective GenAI chatbot, or a non-AI control group. In the two AI conditions, students engaged in AI-supported brainstorming and outlining before writing independently. Data sources include pre- and post-tests of theory knowledge, survey measures of intrinsic motivation and AI feedback perceptions, 72 AI chatlogs, and 30 stimulated recall interviews. Analyses examine differences in motivation and learning outcomes across all three conditions, as well as differences in AI perceptions and interaction patterns between the two AI designs. Quantitative and qualitative findings indicate that instructive and reflective GenAI supports foster distinct forms of self-regulated AI interaction during brainstorming. Instructive AI was often used as a directive resource supporting efficient explanation, outlining, and drafting, whereas reflective AI prompted greater deliberation, self-explanation, and evaluation of ideas for some students, while eliciting frustration and disengagement for others. Overall, the findings underscore the importance of GenAI design for shaping students' AI interactions, motivation, and learning during AI-supported writing.

Enhancing Teaching Quality with Artificial Intelligence: The Teaching Copilot App

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Teaching quality is a multidimensional construct central to student learning. Established assessment methods such as student ratings, self-assessments, and classroom observations are often biased, resource-intensive, and limited to delayed, summative feedback. In this project, we address these shortcomings by developing and evaluating an AI-based teaching copilot that provides real-time, formative, theory-driven feedback from classroom audio data. Within a three-year research and development approach, we design a privacy-compliant mobile application that forms the entry point to a multi-stage pipeline, collecting classroom recordings, transcribing and preprocessing audio data, and analyzing transcripts to generate theory-aligned feedback. Human ratings serve as ground truth for fine-tuning machine learning (ML) and large language models (LLM). Model performance is iteratively optimized and evaluated. Accompanying studies examine the feasibility of automated teaching quality assessment from classroom audio, demonstrating that transcription quality, speaker diarization, and preprocessing substantially affect downstream prediction accuracy. Further work investigates how automated scores can be translated into faithful explanations, showing that model-based attribution methods provide more reliable and transparent justifications for teaching-quality predictions than the rationales from prompted language models. Furthermore, we examine data parsimony and modality sufficiency using large-scale datasets, comparing unimodal and multimodal models and teacher- and student-level inputs. The project advances theoretically grounded operationalizations of teaching quality and establishes methodological standards for privacy-preserving, responsible AI in educational research, while providing a scalable tool to support teachers' continuous professional development.

Teachers' emphasis on competence-oriented digital media use and students' digital competence

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Under what conditions does the use of digital media in the classroom promote students' digital competence? Studies considering only the frequency of digital media use show ambivalent results. Hence current research shifts the perspective from the quantity of use to its quality. Building on these findings and theories on teaching quality and digital media integration in teaching, this paper examines the effects of teachers' emphasis on digital competence promotion on sixth-grade students' digital competence. Teachers' emphasis on digital competence promotion as a predictive variable that has hardly been researched yet qualifies the use of digital media use and establishes its connection to students' digital competence (Siddiq et al., 2016), which is measured via the newly developed Digital Competence Test (Tural & Schwaß, 2023). The performance test is administered in German National Education Panel's starting cohort 8 (NEPS Network, 2025). It covers the critical-reflective and social-communicative skills necessary for dealing with challenges in a digital world, like information and source evaluation and dealing with influential intent, rather than primarily technical skills covered by conventional ICT literacy tests. Both, a direct effect of teachers' emphasis on digital competence promotion and its moderating role on the effect of quantitatively measured digital media use on students' digital competence are of interest. Therefore, cross-classified mixed effects models will be calculated to not only examine the assumed cross-level effects but also to deal with the non-hierarchical nesting of students in both teachers and classes. Findings are discussed and scientific and educational implications are derived.

Reducing Test Anxiety Through Prequestioning: Evidence from Two Experiments

Presenter(s)
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Test anxiety is often associated with poorer academic performance. As educational institutions increasingly utilize high-stakes testing, identifying evidence-based strategies that simultaneously support effective learning and reduce test anxiety is essential. In this study, we conducted two experiments to investigate whether having learners engage in an active learning strategy called

prequestioning (i.e., attempting questions before learning) could reduce test anxiety levels. The control conditions were objectives (i.e., viewing learning objectives) for Experiment 1 and typing (i.e., neutral typing task) for Experiment 2. Participants first completed a stress-induction phase and reported test anxiety, were then randomized to a learning condition, reported test anxiety again, and finally completed a test. In Experiment 1, test anxiety levels decreased for the prequestioning condition, but were maintained for the objectives condition. In Experiment 2, a decrease in test anxiety levels was observed in both the prequestioning and typing conditions, with a larger decrease in the prequestioning condition. Final test performance was superior in the prequestioning condition over all other conditions. Overall, these findings highlight the potential of prequestioning not only to boost academic performance but also to reduce test anxiety, ultimately strengthening the bridge between cognitive (i.e., study strategies) and affective (i.e., emotional) dimensions of the learning process.

Assisting Mathematics Video-Learning with AI-Generated Interpolated Tests

Presenter(s)

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In recent years, research has been investigating ways to develop tools using large language models (LLMs) for instructional support. The field of automatic question generation has also benefited from these developments, although most studies to date have focused on evaluating the quality of LLM-generated items, and few have investigated the educational benefits they might bring. One promising approach is using LLMs to generate test items for interpolated testing. Interpolated testing is an intervention that consists of interrupting learning sessions with practice test items and was shown to benefit learning across different tasks. In the context of video watching, the interpolated tests were shown to reduce periods of inattention, also known as mind wandering. The current study investigated whether these benefits of interpolated testing for video learning also occur when the test items were generated by an LLM. This would make interpolated testing a more scalable intervention, as item generation would no longer depend on teachers. We compared the learning outcomes of an LLM-generated interpolated test group with a teacher-generated interpolated test group, as well as a control condition without interpolated tests. Results show that no significant differences emerged between the three groups on post-test scores, judgement of learning calibration, monitoring accuracy, or mind wandering. Teacher- and LLM-generated interpolated tests performed similarly in this study. Further research is needed to clarify the role of LLMs in developing interpolated tests.

Technology enhanced personalized learning in higher education: A Scoping review

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Technology-enhanced personalized learning (TEPL) is increasingly promoted in higher education as a response to learner diversity, motivation, and the need for flexible learning pathways. Yet, research remains fragmented due to varying definitions of "personalized learning," diverse technologies, and inconsistent reporting of implementation processes and outcomes. This ongoing scoping review synthesizes empirical evidence on how TEPL is conceptualized and implemented in higher education for both students and teachers. We ask: (1) What key characteristics define TEPL approaches in higher education? (2) Which technologies are used to support personalization for students and teachers? (3) What cognitive and non-cognitive outcomes are reported? (4) What drivers and challenges shape implementation? and (5) How do TEPL approaches differ for students versus teachers? We search major databases (Scopus, Web of Science, ERIC, PsycINFO, ScienceDirect) using structured queries covering personalization constructs (e.g. personalized, adaptive, individualized), educational processes (learning/teaching), technology (e.g. learning analytics, adaptive systems, chatbots), and higher education contexts (2010–2025; English; peer-reviewed). Screening and extraction are underway. Preliminary scoping indicates very large retrieval volumes, highlighting the need for careful operationalization of TEPL during screening. Expected outputs include a typology of TEPL approaches (targets, mechanisms, data inputs, decision logic), a map of technologies used, and a synthesis of outcomes and implementation conditions to inform evidence-based design for personalization in higher education.

How Challenge/Threat States Affect Learning from Debiasing Instructions in Probabilistic Reasoning

Presenter(s)
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Biased reasoning is a pervasive problem in education and society. It is important that students learn to avoid biases in probabilistic reasoning, for their functioning in many professional contexts (e.g., medicine, law, teaching, economics), as well as in their daily lives (e.g., vaccination decisions). Feedback and instructions have proven effective for debiasing, resulting in considerable improvements in reasoning accuracy at group level; however, it is unclear why some individuals improve (much) more than others. We test whether this might be explained by

learners' affective-motivational responses, which is rarely investigated in reasoning research. Study 1 (Prolific, N = 431) showed that averaged over the entire sample, instruction led to a large improvement in reasoning. Yet, of the participants who were biased at pretest (N = 354), just over half improved; the other half remained biased after instruction. Those who improved were characterized by higher actively open-minded thinking, lower general overconfidence, and higher cognitive ability. In contrast to our hypothesis, it was not (under)graduate students' challenge/threat response to the negative feedback (telling them that they were biased), but their threat response to the subsequent instruction that was associated with remaining biased or improving at posttest (i.e., with learning from the instruction). Because findings from Study 1 are correlational, Study 2 (ongoing) will test the effects of experimentally inducing a challenge or threat state on learning from the debiasing training. Results from both studies will be presented at the conference.

Towards Conversation-Based Learning Analytics

Presenter(s)

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Advances in large language models (LLMs) have made conversation-based assessment (CBA) an increasingly scalable approach to formative educational assessment. In CBA settings, students interact with AI tutors through natural-language dialogue, enabling the simultaneous assessment and support of cognitive, behavioral, and affective learning processes. The present study examines how interaction data generated in CBA can be systematically analyzed and structured into meaningful metrics. A CBA on the topic of the carbon cycle was analyzed with N = 248 secondary school students in a controlled experimental school setting. Our work aims to systematize CBA-derived metrics across multiple dimensions and to explore their explanatory and diagnostic potential. We focus on: (1) performance measures within CBA, (2) content-related indicators reflecting domain-specific understanding and misconceptions, (3) lexical measures capturing response elaboration and structural characteristics, and (4) sentiment-based indicators. LLM-supported methods are used to extract, classify, and interpret these metrics. A key objective of our approach is to evaluate the validity and robustness of the proposed metrics, particularly with regard to their descriptive, diagnostic, and predictive value. Therefore, beyond CBA-derived measures, external measures such as student characteristics as well as human expert ratings are incorporated. Analyses are ongoing and will be presented at the conference.

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404 - Concept map not found: Who uses an optional concept map tool in an online course and how?

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Concept mapping is a learning technique designed to foster meaningful learning. However, not all learners engage in learning activities that seem effortful. In this study, we examined who uses an optional concept map tool in an asynchronous online course, how the tool is used, and whether distinct usage patterns can be predicted by learner characteristics and prior learning behavior. Participants were 632 teacher students enrolled in a five-unit online course. The concept map tool was optionally available in learning unit 3. Tool uptake was analyzed using binomial logistic regression. Usage patterns among students who created a concept map (N = 228) were examined using latent profile analysis based on log data (i.e., number of nodes and edges, proportion of labeled and directed edges). Multinomial logistic regression was used to predict profile membership. Only 36% of students used the concept map tool. Tool uptake was more likely among students with higher conscientiousness, greater use of elaborative strategies, higher activity levels in prior learning units, and those who watched the instructional video. Among users, a three-class solution distinguished between small maps, concept maps, and big maps. Completing the instructional video significantly increased the likelihood of producing concept maps in a strict sense. The findings suggest that optional concept map tools may primarily benefit highly self-regulated learners unless explicit instructional guidance is provided. Tool awareness appears to be a key prerequisite for both uptake and meaningful use, highlighting the importance of integrating guidance when implementing effortful learning techniques in online courses.

How Does Emotional Video Design Affect Learners with ADHD? Insights From a Mixed-Methods Study

Presenter(s)
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Learning with explainer videos is not only popular, but can also be effective. However, it is still unclear whether this also applies to learners with attentional difficulties, such as those with ADHD. In the present study, we were interested in the effect of emotional video design on learners with ADHD. Therefore, we conducted an exploratory mixed-methods study with 34 participants with ADHD to gain deeper insight in potential influences of video design on learning processes and outcomes. The first part of the study consisted of a learning experiment in which participants watched a 16 min explainer video. Half of the video was presented in a neutral design and the other half in an emotional design. The sequence of the video design was randomized between participants. After each part, we assessed learning process variables (e.g., mind-wandering, cognitive load). At the end, participants completed a knowledge test and afterwards an interview. Most participants (74%) stated in the interviews that it was easier to maintain attention with the emotional design compared to the neutral design. Moreover, participants reported significantly less mind-wandering and passive mental effort after watching the emotional design version. There were no significant differences in the overall posttest performance for the two design versions. Overall, results suggested a subjective beneficial effect of emotional design for learners with ADHD.

Educators' agency during interaction with a 4C/ID-inspired AI bot while designing for complex skills

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Agency is considered a core societal value, yet it remains unknown how human agency is affected in human-AI interactions. This study examines teacher educators' agency when interacting with generative AI (GenAI) during instructional design (ID) for complex cognitive skills. Although the 4C/ID model (van Merriënboer, 1997), which supports the design of training for complex skills, has gained significant popularity in academic environments, designing courses with this ID model remains challenging for practitioners. GenAI can automate parts of the 4C/ID design process and may facilitate managing the complexity. By using a GenAI bot, users can get personalized suggestions for learning tasks, supportive information, procedural information, and part-task practice. However, it is unknown how interactions with such an AI bot influence

educators' agency. We conducted a within-subject repeated measures experiment in which 27 teacher educators attended two sessions. In Session 1, participants received training on 4C/ID and designed a course using the model without digital support. In Session 2, they designed another course using a 4C/ID-inspired AI bot. After each session, participants completed a post-experimental survey measuring perceived agency. Results showed significantly higher perceived competence and perceived support in the AI condition (Session 2), while no significant differences were found for other dimensions of agency. Instructional design familiarity moderated this effect: less experienced participants showed larger gains in perceived competence with the AI bot. This provides tentative evidence for the value of using customized GenAI bots to help novices design learning environments in a theory-aligned way.

Towards a Shared Frame for AR Learning and Instruction: Practical and Theoretical Considerations

Presenter(s)

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Augmented Reality (AR) can provide interactive, immersive and situated learning experiences. However, we are still missing a shared theoretical understanding of AR in education from researcher and practitioner perspectives. Furthermore, the landscape of theoretical and pedagogical frameworks is broad and fragmented. As part of an ongoing project by a group of international researchers, this poster presentation has the goal to continue the conversation about AR learning within the educational technology community. As a basis, the outcomes of an interdisciplinary workshop with 24 practitioners and researchers as well as preliminary results of an ongoing scoping review of theoretical frameworks in AR learning will be presented. As currently no systematic approach from the AR learning and instruction community towards frameworks is apparent, in future steps we plan to cultivate a shared understanding and foundation for researchers and practitioners in AR learning and instruction in the form of a conceptual compass to navigate the educational AR landscape and scaffold the selection of theoretical and pedagogical foundations. Conversations during the poster presentation are expected to include discussions about the workshop results, frameworks from the scoping review, and future steps.

Strengthening Early-Stage EdTech Evidence Reasoning in Innovation Supporting Programmes

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Contemporary EdTech ecosystems increasingly require founders to demonstrate “evidence of effectiveness”, yet there remains limited consensus about what constitutes meaningful evidence in educational contexts, how effectiveness should be defined, or at what stage such claims become epistemically defensible. These challenges are amplified by structural tensions between globally oriented EdTech markets and nationally governed education systems, which operate with divergent assumptions about value, accountability, and evidence use.To address a persistent support gap for early-stage EdTech innovators, we designed a module Designing for Impact: Evidence-Informed Pathways in EdTech Innovation. The module was implemented for the first time in autumn 2025 as a part of a startup incubator program which took place at an EdTech innovation hub operating in a major university in Northern Europe. Rather than prioritising outcome measures, the module foregrounds logic models and theories of change as design tools for articulating pedagogical mechanisms, assumptions, and contextual dependencies under conditions where formal evidence is premature or infeasible.This paper reports on a developmental evaluation of the module drawing on qualitative analysis of participant-generated artefacts (successive logic model iterations), post-module interviews, and focus group data. Findings indicate shifts in how founders articulate educational value: from aspirational, signalling-oriented claims towards more structured, mechanism-focused, and context-sensitive reasoning. The study contributes methodologically by illustrating how theory-informed evaluation tools can function as upstream pedagogical interventions, supporting evidence reasoning before outcome claims are possible. Ongoing research will examine the durability of these shifts in subsequent cohorts.

Technology-enhanced STEAM project to support regulation of learning during collaborative work

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Regulation of learning, the processes of how students manage and control their learning, is crucial for academic success, and students need repeated guided practice until they learn to

regulate their learning independently. Although the potential of technology to support self-regulated learning (SRL) and socially shared regulation of learning (SSRL) has been acknowledged, most research to date has focused on secondary or higher education, leaving its potential in primary school contexts understudied. In this study, primary school students' (N = 21) were supported in their use of SRL and SSRL strategies through group-level digital learning diaries during a fifteen-week-long STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning project. The aim was to explore the SRL and SSRL strategies that students employed with the support of the digital diary, and how these strategies related to students' motivation, particularly their interest in STEAM. Preliminary findings indicate that students used a variety of SRL and SSRL regulation strategies, such as planning, help-seeking, and reflection, throughout the digitally supported STEAM project. The groups varied in their use of SRL and SSRL strategies, and students' interest in STEAM, considered as an individual motivational component within collaborative learning, varied significantly over time. This study provides an in-depth insight into the primary school students' regulation processes in digitally supported collaborative STEAM learning contexts.

The Dynamic Interplay of Topic Alignment and Situational Interest in Personalized L2 Learning

Presenter(s)

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Interest is a critical variable in educational contexts as it significantly predicts academic performance. Traditionally, interest is categorized into Individual Interest (II), a relatively stable predisposition, and Situational Interest (SI), a transient emotional state triggered in the moment by environmental stimuli. While context personalization has been proposed to enhance SI, few studies have captured the development of SI over extended periods in second language learning (L2). We conducted a three-week pilot test to explore how learners' pre-existing II and interest-based tasks predict SI within a personalized L2 learning context. 45 participants from seven countries completed up to 22 English grammar conversation tasks, yielding over 500 ratings for multilevel modeling. Results indicated that learners' pre-existing II was not a significant predictor of their SI during specific tasks. Conversely, the alignment between tasks and topics emerged as a dominant predictor of SI. Specifically, the within-person effect indicated that SI responds dynamically and immediately to task topics. Furthermore, the temporal trajectory of SI followed a marginal inverted U-shaped pattern, peaking around the midpoint of the sequence before a slight decline. These findings suggest that while SI variance was stable across individuals (ICC = 0.65), SI remained malleable and was significantly driven by tasks ($\beta = 0.34^{***}$)

rather than fixed personal traits. The educational significance lies in the fact that educational platforms should leverage adaptive algorithms for real-time, interest-based matching to maintain learners' engagement. Additionally, pedagogical designs must introduce varied stimuli to counteract the inevitable fatigue effects in prolonged learning sequences.

Two Weeks to Improved Phonological Awareness: Digital vs Conventional Instruction in Chinese EFL

Presenter(s)

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Phonological awareness is a foundational skill for efficient decoding and reading development, yet providing standardised, high-quality phonological instruction remains challenging in naturalistic EFL classroom contexts. This study examined the effects of brief digital-based and conventional phonological instruction on learning outcomes and interest. Participants were 179 fourth-grade Chinese students assigned as intact classes to digital-based, conventional instruction, and control conditions. Both instructional approaches were implemented over a two-week period to account for realistic classroom constraints. Results showed that both instructional approaches improved phonological knowledge, with the digital-based group performed significantly better than the conventional group on rhyme generation, rhyme generation and phoneme blending. No group differences were found for task interest whereas the digital-based group reported significantly higher course interest. These findings suggest that even a brief digital phonological instruction can yield statistically significant learning outcomes, especially for cognitively demanding subskills, and can support the development of course interest. The study highlights the pedagogical value of time-efficient digital PA instruction grounded in cognitive and interest theory.

The FIDEMM Framework for Microlearning Design: Evidence-Based Development and Preliminary Validation

Presenter(s)

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In a rapidly digitizing world, microlearning has emerged as a pragmatic solution for training and upskilling, yet its impact hinges on rigorous instructional design. This study introduces FIDEMM, a theory-driven framework that adapts Gagné's nine events of instruction to the constraints of microlearning. A semi-structured literature review identified recurring design strategies, which

were integrated into FIDEMM and operationalized in a microlearning unit on the "Use and Function of Passkeys." The unit was evaluated using a pre-test/post-test design involving 21 business students, which included the User Engagement Scale (O'Brien et al., 2018), individual-level learning analytics, and FIDEMM elements. Results showed gains in knowledge and intention to adopt passkeys, high engagement, perceived value, and low reports of frustration and confusion. Analytics showed that learners spent their time primarily on content presentation and practice, highlighting their central role in instruction. These findings provide initial evidence for FIDEMM as an instructional design model for microlearning and show that its evidence-based implementation can effectively accompany digital learning change, establishing a foundation for further empirical validation in online learning.

Data and algorithmic literacy in teacher education: emerging professional needs in the age of AI

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The digital transformation of schools increasingly relies on data-driven systems and artificial intelligence (AI), raising new and still insufficiently specified challenges for teacher professional competencies. This paper focuses on teacher education and examines how data literacy and algorithmic literacy are currently defined, conceptualized, and integrated into teachers' digital competencies frameworks. Using an ongoing scoping review, we analyze peer-reviewed literature in education and teacher education, highlighting how these literacies are defined and related to pedagogical practice. Preliminary findings suggest that data literacy is predominantly framed in terms of general skills and data-informed instructional decision-making, whereas algorithmic literacy rarely appears as a distinct educational construct and is more often embedded in broader discussions of AI literacy. Critical perspectives such as awareness of bias, fairness, and social discrimination are emerging but remain largely implicit in teacher digital competencies frameworks. This research seeks to inform an explicit integration of data and algorithmic literacy as professional competencies of teacher educators for developing critical reflective practice in the age of AI.

GenAI and Human Emotions: A Scoping Review and Integrative Framework

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Generative AI (GenAI) is evolving from a functional tool into a social-affective agent capable of eliciting and modulating human emotions. This scoping review synthesizes 36 empirical studies (2021–2025) to map the emotional interplay between humans and GenAI. Findings reveal a dual-edged impact: GenAI can enhance positive emotions and well-being—such as reducing anxiety in learning and mitigating loneliness—through personalized feedback and empathetic companionship. However, it can also trigger negative emotions like distrust and threat when perceived as challenging human identity or authenticity. The field is dominated by text-based large language models (e.g., ChatGPT) and relies heavily on self-report methods, with limited use of multimodal systems or objective measures. Over 70% of studies lack an explicit theoretical foundation. We propose the GenAI Interaction-Adaptation Loop, a conceptual framework linking technical capabilities to psychological mechanisms. The review emphasizes that emotional outcomes are shaped by technical design, user psychology, and context, urging a transdisciplinary, theory-driven approach to foster positive emotional outcomes and mitigate harm.

Learning at 2×: On the effects of playback speed in educational podcasts

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As accelerated listening becomes widespread across digital media platforms, understanding how playback speed influences learning is an important theoretical and practical topic. Prior findings suggest that moderate increases in speech speed rate (up to ~1.5×) typically do not impair comprehension, yet extremely high speeds elevate cognitive load and perceived difficulty as well as reduce performance and learning satisfaction. Questions remain about optimal speeds, individual differences, and whether subjective reports accurately reflect underlying cognitive effort. This interdisciplinary study investigates how three podcast playback speeds (1×, 1.5×, and 2×) affect learning processes, combining self-report measures with neurophysiological

indicators, and learning performance. In a within-subjects design, 30 adults will listen to educational podcast episodes while their EEG, electrodermal activity, and heart rate are continuously recorded with Bitbrain wearable sensors. Participants will complete cognitive load, engagement, and comprehension assessments after each condition. Findings aim to inform the Cognitive Load Theory under temporal constraints and support the design of adaptive audio-based learning technologies.

The Error-Correction Effect in Educational Contexts: Learning Through Identifying Others' Errors

Presenter(s)

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A growing body of research reveals that learning is enhanced when learners actively engage with and correct their own mistakes. The effects of learning from others' errors, however, remain largely unexplored. In the present study, we investigated whether error-correction—defined as identifying and correcting errors in others' responses—constitutes an effective learning strategy when compared with practice testing (i.e., fill-in-the-blank) and read-review strategies, and whether the provision of correct answer feedback is influential. Across two experiments, participants learned biology concepts through error correction, practice testing, and read-review strategies, then completed a final memory and transfer test. For half of the concepts, correct answer feedback (or additional reading time) was provided. In Experiment 1, learners were first exposed to the material prior to engaging in the different learning strategies, such that learning operated on previously encoded information. Experiment 2 extended this design by examining learning when initial exposure to the material occurred within the learning strategies themselves. Across both experiments, when feedback was provided, error-correction reliably outperformed read-review on memory test performance. For transfer test performance, error-correction showed descriptively higher accuracy than both fill-in-the-blank and read-review under feedback conditions in Experiment 1. Under feedback conditions in Experiment 2, error-correction showed a statistically significant advantage over fill-in-the-blank on transfer-item short-answer questions. Together, these findings reveal that error-correction may support learning that generalizes beyond item-specific recall, particularly when corrective feedback is available.

Measuring Computational Thinking in Preservice Primary Teachers Using Code-Based Reasoning Tasks

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Digital technologies increasingly shape everyday life and future work, positioning computational thinking (CT) as a key competence in 21st century education. Although CT is increasingly discussed as a necessary component of primary teacher education, validated assessments to measure preservice teachers' CT competences remain scarce. Existing CT measures are heterogeneous, often rely on general cognitive indicators, and may not capture the level of code-based reasoning required at the teacher level.Against this background, this study reports on the first iteration of a Scratch-based CT test through code-based reasoning tasks. Data were collected in a mandatory online seminar with N=120 preservice primary teachers using a pre–post design. The instrument comprised 16 polytomously scored items.Results showed a small, non-significant increase in overall CT performance and moderate reliability. Substantial variability in item difficulty and weak inter-item correlations limited support for a coherent factor structure.At the conference, findings from both the first and a second iteration will be presented and discussed with regard to their implications for developing a valid and reliable assessment of CT competences in preservice primary teachers.

Enhancing pre-service teacher noticing through peer, expert, and GenAI-mediated student feedback

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The number of students struggling mentally at school is rising. This trend highlights the need for teachers to address relational aspects in teaching. Research links teachers' relational noticing skills to students' learning and well-being. Although relational skills can be developed in teacher education through activities like video clubs, such approaches often lack students' perspectives. To strengthen relational noticing skills, this study explores how including student perspectives through GenAI-mediated feedback affects pre-service teachers' developing noticing skills. In a quasi-experimental pre–post design, first-year pre-service teachers participate in one of three intervention groups: (1) collaborative reflection, (2) collaborative reflection enhanced by GenAI-mediated student feedback based on students' Lived Experience Descriptions, (3) collaborative reflection + GenAI feedback + individual reflection with teacher educators. Skill development is assessed through video analysis tasks and surveys on self-efficacy and perspective-taking.

Drawing on sociocultural and social constructivist theories of feedback and van Es and Sherin's (2021) framework of teacher noticing, the study examines how feedback and reflection models shape learning processes. Results will advance understanding of how video-based reflection and GenAI can enhance relational noticing skills in teacher education.

Gamification and Spacing in Foreign Language Vocabulary Learning

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Spaced practice is more effective than massed practice. Nevertheless, learners tend to cram before tests, possibly due to the perceived effort and motivational demands associated with spacing. This study investigates how learners implement massed and spaced practice in self-regulated learning and whether they can be supported in using spaced practice via gamification.In a preregistered experiment with self-regulated learning phases at home, students learned Swedish-German vocabulary pairs. The study followed a 2 × 2 between-participants design with practice schedule (massed vs. spaced) and gamification (no vs. yes) as factors and study behavior and final test performance as dependent variables. First, all participants (planned N = 204) worked through the vocabulary pairs at home. Participants in the massing conditions completed three practice tests directly afterwards; for the spacing conditions, practice was spread out across seven days. Practice took place online in an unsupervised manner. Gamification consisted of badges awarded for initial learning, practice tests, and the final test, which took place in the laboratory one week after the last practice session.Data collection is ongoing. We predict that the massed groups will practice more vocabulary pairs than the spaced groups and that the gamified groups practice more vocabulary pairs than the non-gamified groups. In addition, gamification is expected to reduce differences in the amount of practiced pairs between massed and spaced practice. Regarding final test performance, we predict better performance with gamification than without as well as a larger spacing effect with gamification than without.

AI-Based Pedagogical Agents for Computational Thinking: Learners' Perceptions and Preferences

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Pedagogical agents are virtual characters in digital learning environments that support student learning. Recent advances in artificial intelligence (AI) have expanded the capabilities of pedagogical agents, e.g., allowing them to flexibly and adaptively support learners as learning partners. However, little is known about learners' perceptions of different agent designs, which can influence various learning outcomes. The present study therefore investigates higher education students' evaluations of and preferences for different designs of AI-based pedagogical agents, presented as peer-like learning partners for computational thinking. In a within-subjects vignette experiment, participants watch a series of short video vignettes in which different AI agents introduce themselves as potential learning partners for computational thinking. The agents vary systematically along four design factors: interaction modality (written vs. spoken), gender (female vs. male), visual embodiment (avatar vs. no avatar), and level of anthropomorphism (realistic vs. cartoon vs. abstract avatar). After each vignette, participants rate the agent on learning-relevant perceptions, including trust, social presence, expected learning success, and willingness to use the agent. Additionally, learner characteristics such as gender, study discipline, computational thinking skills, self-concept, learning strategies, stereotype beliefs, and technological affinity are measured as potential moderators. Data collection is currently ongoing. Planned analyses will examine how different agent designs affect learners' perceptions of AI agents and how individual learner characteristics moderate these effects. The findings will expand research on AI-based pedagogical agents and provide empirically grounded guidance for their design.

Exploring Secondary School English Teachers' Integration of GenAI in Writing Assessment

Presenter(s)
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The rapid emergence of Generative Artificial Intelligence (GenAI) presents a "critical juncture" for language education, particularly in the labor-intensive domain of writing assessment. While technical affordances like personalized feedback are well-documented, a significant gap remains in understanding how secondary school teachers navigate these tools within rigid curricular constraints and high-stakes examination frameworks. This study examines a five-hour professional development (PD) program grounded in Design Thinking, involving ten secondary

English teachers in Hong Kong. Adopting a qualitative approach through unobtrusive observations, reflections, and artifact analysis, the research explores teachers' pedagogical and ethical concerns. Findings indicate that while teachers are motivated by efficiency gains to mitigate heavy grading workloads, their integration practices are heavily dictated by the local Diploma of Secondary Education (DSE) standards. Key challenges identified include concerns regarding student feedback literacy, the necessity for precise prompting skills, and the "human-in-the-loop" requirement to mitigate AI "hallucinations". The results suggest that teachers exercise pedagogical creativity to work around AI limitations, such as using AI for common error analysis rather than just individual grading. This research provides a framework for future PD programs, advocating for a shift from technical training toward fostering teacher agency and ethical decision-making in constrained educational environments.

Prequestions Boost Learning: Effects of Question Format, Test Format, and Epistemic Curiosity

Presenter(s)

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The prequestion effect refers to the phenomenon that learners perform better on a subsequent test when they try to answer questions about a text or lecture prior to studying. However, the mechanisms driving this effect remain largely unclear. Three main accounts are commonly discussed: (1) memory precursor in that answering prequestions directs learners' attention to the tested material during the study phase; (2) curiosity precursor in that prequestions make learners curious to learn the answers, which directs attention to relevant parts of the learning material; (3) transfer-appropriate processing in that test performance benefits from the overlap between the processes involved in answering prequestions and final test questions.To contrast these accounts, we designed a preregistered experiment with prequestion format (multiple-choice vs. short-answer) and final test format (multiple-choice vs. short-answer) manipulated between participants plus study only control groups. Data collection will take place in May 2026. Based on an a-priori power analysis, planned sample size is N = 250. Prequestion participants will be presented with questions before reading a text, study only participants will study the text for an equivalent total duration. Dependent measures are a state-level measure of epistemic curiosity (pre-post) and a briefly delayed final test consisting of repeated and new questions.We will compare predictions of the three accounts: (1) better performance with short-answer than with multiple-choice prequestions, (2) an increase in curiosity due to the prequestions and a mediation of the prequestion effect and (3) best performance when prequestion and final test format match.

Not a random study-buddy: Designing Collaboration in a large course via Random Partner Assignment

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In large STEM courses, students often form stable “default” partnerships early, which can reduce coordination costs but may limit opportunities to extend the social circle and learn adaptable teamwork skills. To address these issues, we studied a large foundation undergraduate engineering course that randomly reassigned partners for each assignment. We surveyed two past cohorts (Fall 2023 and Fall 2024; N>200, 50% response rate) asking students about (a) how many randomly assigned partners they are still in touch with, (b) the nature of ongoing ties (social /academic /professional), and (c) their reflections on how the experience (re)shaped their partner-selection strategies. 44.7% reported maintaining contact with at least one randomly-assigned partner, with most reported a single tie characterized by low-intensity familiarity (e.g., saying hi on campus), continued academic collaboration with the randomly-assigned partner (13-25%), and professional-oriented connections (12%). Thematic analysis indicated changes in partner-selection strategies towards developing clearer expectations (18%), prioritizing reliability and/or competence (15%), and selective openness to new partners (17%). With that, 21% of students reported a reinforced preferences for familiar partners for others and 46% reported no change. Findings suggest repeated random partnering can function as a scalable mechanism for developing partner-selection skills and collaboration adaptability beyond immediate course outcomes.

Self-Regulated Learning in Dialogue with Conversational AI during a Writing Task

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This study examines the interplay between students’ self-reported Self-Regulated Learning (SRL) traits and their verbal interactions with a Generative AI (GenAI) agent. While GenAI is often framed as a support tool for SRL, this research investigates the converse: how inherent self-reported self-regulated learning shapes the use of a privacy-first, database-supported Conversational AI ("Talkbot") during an argumentative writing task. To analyze data from 78 German secondary students and understand the relationship between students' SRL traits and their queries (questions asked when using the Talkbot), we first labeled queries using an adapted labelling framework. We then applied a Generalized Linear Mixed Model (GLMM) to examine the above-mentioned relationships. The final model included gender, grade, AI-chatbot experience,

motivational, and corresponding SRL subscales and yielded only partially significant results. Contrary to the hypothesis that high-SRL self-monitoring would be associated with more frequent engagement with self-monitoring-oriented queries, the results indicated a significant negative correlation ($\beta = -0.48$, $p = .012$). This suggests that high perceived self-monitoring proficiency may reduce the functional need for AI-mediated help-seeking by fostering greater task clarity. These findings challenge assumptions about "proactive" AI use, highlighting the need for more granular, task-specific metrics to trace SRL sequences in conversational interfaces and a deeper look into how students use GenAI. Keywords: Self-regulated learning and behavior, Artificial intelligence, Educational Technologies, Secondary education,

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Can teachers learn from their instruction? An international study of learning-by-teaching perception

Presenter(s)

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Learning by teaching finds considerable research with students, but it remains largely unexplored with professional teachers. This exploratory study aims to (1) report teachers' perception of their own learning-by-teaching opportunities in six domains of teacher knowledge across the three phases of teaching, (2) identify variables that may affect such perception, and (3) validate teachers' utterances of their specific learning in the six domains of teacher knowledge across the three phases of teaching. A survey was administered to 127 teachers from China, Norway, Mexico, and the Catalan Countries. Results show that teachers' learning-by-teaching perception is moderately frequent overall, while different phases may differently contribute to distinct domains. Before teaching, teachers especially report learning about content knowledge and organization of resources and materials over other domains. During teaching, knowledge of students is salient, while knowledge of assessment and curriculum and of instructional strategies are the least frequently reported domains. After teaching, knowledge of students is salient, while knowledge of assessment and curriculum is the least frequently reported domain. However, teachers' learning-by-teaching perception is complex, as suggested by the relatively low rate of comment validation and the variables that may affect teachers' perception (country, approach to teaching, self-efficacy, gender, educational stage, and subject). It is worth noting that the degree of different approaches to teaching (i.e., focused on conceptual change or information transmission) might differently impact the distinct domains of teacher knowledge. Future research will have to further explore such complexity and implications for instructional design.

Fostering Technology-Enhanced Instruction: An Observation Instrument for English Teachers

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One approach to acquire complex teaching skills—such as those needed for effective technology-enhanced instruction in English language teaching—is professional vision. To scaffold professional vision in the context of technology-enhanced instruction, an observation instrument was developed supporting the analysis of the effectiveness of technology-enhanced instruction in (scripted) classroom videos. As the observation instrument focuses on cross-domain aspects, but technology use is context-sensitive, we specified it for the domain of Teaching English as a Foreign Language (TEFL). This TEFL specification includes evidence-based indicators operationalizing four dimensions that reflect effective technology-enhanced TEFL.In a digital learning environment, three scripted TEFL videos and the TEFL specification were integrated with the task to use the dimensions and indicators of the TEFL specification to analyze the effectiveness of technology use. In a study with 187 pre-service English teachers, we examined the structure of the TEFL specification by conducting a second-order confirmatory factor analysis. The final model showed moderate to good fit indices (CFI = .905; TLI = 0.882; RMSEA = .027), supporting a hierarchical structure, with the dimensions loading significantly onto a general factor. Results indicate that, overall, the TEFL specification might serve as a suitable scaffold for developing reasoning skills in the context of technology-enhanced TEFL. However, two factor loadings exceed 1.0, and the model includes indicators with very low factor loadings. While this indicates that revision of the indicators is necessary, this study provides an important step toward making technology-enhanced TEFL measurable and, hence, towards fostering the respective skills.

Peer Assessment of Presentations: Effects of Frame-of-Reference Training on Assessment Accuracy

Presenter(s)
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Peer assessment is a powerful pedagogical tool, yet its implementation is often constrained by concerns about assessment accuracy. This study examined whether a peer assessment training based on the frame-of-reference (FOR) approach and/or topic-specific knowledge foster upper-secondary students' assessment accuracy. In a randomized 2x2 between-subjects experiment, 135 upper-secondary students received either a 45-minute FOR-based training (vs. an unrelated lesson) or topic-specific information provided as a fact sheet (vs. an unrelated fact sheet).Students were asked to assess two videotaped presentations using a nine-criterion assessment tool covering three domains (content/structure, nonverbal and paraverbal communication, and media usage). Students also provided written justifications for selected assessments. Multivariate analyses showed that FOR training improved assessment accuracy across domains in both presentations ($Fs(3, 128) \geq 4.05$, $ps \leq .009$, $\eta p^2 = .09$ -.16). It further increased assessment homogeneity and enhanced the quality of students' written justifications. Topic-specific knowledge had no significant effect on accuracy or justification quality. The findings suggest that assessment accuracy constitutes a learnable competence distinct from subject-matter knowledge and can be enhanced through short, classroom-feasible FOR training.
Keywords: Assessment methods, Peer interaction, Secondary education, Feedback

Looking Beyond the Glosses: Effects of Glosses on Vocabulary Learning and Text Comprehension

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Digital transformation in learning and instruction has profoundly changed the conditions under which (foreign) language and reading competences can be developed and improved.In this study, the effects of lexical and pictorial digital glosses implemented in a web-based instructional reading environment on incidental vocabulary learning and text comprehension were investigated.Drawing on Mayer's (2021) multimedia theory and the multimedia effect, lexical and pictorial combined glosses are assumed to promote incidental vocabulary learning the most, whereas all gloss types are expected to support text comprehension (cf. Al Bukhari & Dewey, 2023).To examine this research question, a 2x2 factorial between-subjects design was used, including lexical glosses presented as verbal explanations in the foreign language and pictorial glosses presented as sketches for the target words. After the reading phase, incidental vocabulary acquisition and text comprehension were assessed in an immediate and a delayed

post-test.Preliminary findings suggest that the alignment between glossing modalities employed during the learning phase and the testing format is of considerable relevance.

The more, the merrier: How Self-Regulated "Teaching" can support inclusion in TEL classrooms

Presenter(s)

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Abstract: The use of digital technologies in classrooms holds the potential either to reduce or to exacerbate educational inequalities. However, research consistently shows that the mere introduction of technology does not lead to meaningful improvement unless it is accompanied by sustained and high-quality teacher professional development that supports pedagogically sound integration. Despite extensive efforts to strengthen teachers' technological and pedagogical skills, comparatively little progress has been made to understand how teachers use their skills to support inclusive practices in technology-mediated classrooms. This exploratory study investigates which factors are associated with teachers' inclusive practices in technology-enhanced learning environments and proposes a preliminary model based on data from multiple teacher training programs across Europe within the frame of the EffecTive project. Preliminary findings reveal moderate to strong positive correlations between teachers' metacognitive regulation, their use of technology to empower students, and their inclusive instructional practices. These results suggest that beyond technological proficiency, teachers' self-regulation capacities, particularly metacognitive skills, play a crucial role in translating digital competence into inclusion awareness. The paper argues for an integrative approach to teacher professional development that combines technological, pedagogical, and self-regulatory dimensions, emphasizing self-regulation as a key mechanism underpinning inclusive technology use in education.

Teachers' Instructional Design with AI Chatbots to Support Inclusive Learning

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This ongoing study examines how teachers design and use AI chatbots to support inclusive learning in K–12 schools. Situated at the intersection of AI, instructional design, and inclusive education, the study foregrounds teachers' agency as a key condition for pedagogically meaningful AI integration.Teachers translate their didactic intentions into custom instructions for AI chatbots. These instructions function as instructional design artefacts, as they operationalise pedagogical decisions related to learning goals, learner diversity, and instructional support within specific educational contexts. Rather than treating AI chatbots as ready-made solutions, the study adopts a process-oriented understanding of instructional design in which teachers develop context-sensitive solutions through situated analysis and pedagogical decision-making. Teachers' agency is conceptualised as experienced autonomy in pedagogical decision-making, drawing on Self-Determination Theory. The updated TPACK framework further informs the analysis by framing AI chatbots as components of complex instructional systems whose educational value depends on the integrated alignment of technological, pedagogical, and content-related knowledge, particularly in relation to learner diversity.Preliminary findings indicate that actively designing AI chatbots as instructional artefacts is associated with higher levels of perceived epistemic agency among teachers compared to the use of general-purpose AI systems. While teachers perceive AI chatbots as supportive for differentiation and inclusive learning, they also express concerns regarding content reliability, potential bias, and pedagogical responsibility.The presentation invites discussion on emerging empirical insights and on how teachers can shape AI use in inclusive and pedaogically sound ways.

Effects of a learning cycle-based unit on pre-service teachers' and their pupils' learning outcomes

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Digital technologies such as instructional videos can foster pupils' learning. During teacher training, pre-service teachers should be prepared to plan and implement digital technologies to successfully foster pupil's knowledge. These core practices required for this implementation could be fostered within the learning cycle of practice-based teacher education. This study examined the effect of the format of a curricular unit on learning outcomes of pre-service teachers and their pupils. A pre-post control group design was implemented, with the format of curricular unit as the independent variable. There was no statistically significant effect of the

format of the curricular unit on the learning outcomes of the pre-service teachers except for perceived usefulness of integrating digital technologies. The participation in the practice-based curricular unit did not have a statistically significant effect on pupils' knowledge. Future research should explore potential factors which might inhibit an effect of a learning cycle-based unit on learning outcomes with larger samples.

Perceptions of LA Systems: A Comparative Study on Descriptive, Predictive & Prescriptive Approaches

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Learning analytics systems are increasingly integrated into educational contexts to enhance personalized learning and improve student outcomes. These systems can be distinguished into prescriptive, predictive and prescriptive types. Despite associated benefits of LA systems, learner acceptance and perceptions regarding learning support, ease of use, validity, stress induction and intention to use require further research. This study (N = 369) employs an online within-subject design to examine these aspects using video vignettes of three learning analytics systems (i.e., descriptive, predictive, prescriptive). Findings suggest that predictive learning analytics systems are perceived as less supportive, less valid, and more stressful than descriptive or prescriptive systems. Although the prescriptive learning analytics system is considered easier to use, it is regarded as less valid compared to the descriptive learning analytics system. Future research should investigate how student characteristics influence perceptions of learning analytics systems in more detail and incorporate eye-tracking and think-aloud methods for more qualitative insights.

Motivation under Digital Transformation: Learner Profiles in AI-Supported Self-Learning Environments

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Background: Generative artificial intelligence (GenAI) tools such as ChatGPT are increasingly integrated into classroom practice, yet their motivational–emotional implications remain insufficiently understood. Situated Expectancy–Value Theory (SEVT) conceptualizes motivation and emotion as embedded in contextual affordances, raising the question of how AI-supported learning environments reorganize motivation.Aims: This study examined motivational–emotional learner profiles in rubric-guided self-learning (SL) classrooms with and without ChatGPT access and tested whether perceived teacher motivational support and perceived ChatGPT assistance

were associated with profile membership.Sample(s): Participants were 1,674 German secondary students (Mage = 13.31, SD = 1.01) from non–AI-assisted SL classrooms (n = 709) and AI-assisted SL classrooms (n = 965).Methods: Using a cross-sectional, person-oriented design, students reported interest, self-efficacy, effort, and negative emotions. Latent profile analyses were conducted separately by learning condition, followed by multinomial logistic regression.Results: Four motivational profiles—Low Motivation, Medium Motivation, High Motivation, and one mixed profile—emerged in both contexts. Compared to non–AI-assisted classrooms, AI-assisted classrooms showed fewer students in Low Motivation (4% vs. 9%) and High Motivation (16% vs. 28%) profiles and a larger share clustered in intermediate configurations. Across contexts, higher perceived teacher support was associated with adaptive profile membership; perceived ChatGPT assistance provided additional differentiation in AI-assisted classrooms.

Motivational Profiles in AI-Driven Classrooms: A Self-Determination Theory Perspective

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This study examines how ChatGPT-supported instruction relates to student motivation and basic psychological need satisfaction in lower-secondary education. A cross-sectional sample of 2,469 students (grades 7–8) was drawn from two instructional contexts: (a) rubric-based, self-regulated competency-based learning (CBL) implemented either with ChatGPT integration or without AI tools, and (b) teacher-directed learning (TDL) organized in a traditional 45-minute lesson format with limited self-regulated phases. Using person-centered latent profile analysis combined with variable-centered mean comparisons, ChatGPT use was linked to higher autonomous motivation and competence support, but also to a greater share of low-quality profiles compared to non-AI CBL. Notably, these low-quality profiles in the AI-assisted CBL group showed higher intrinsic and identified motivation than low-quality profiles in both non-AI CBL and TDL. Relatedness played a weaker role in the AI-supported group, which may help explain why the overall motivational distribution did not surpass that of the already strong non-AI CBL baseline. Findings highlight GenAI's potential to enhance motivational quality within specific learner profiles when embedded in autonomy-supportive instructional designs.

Designing and Instructing an AI-Based Peer Agent for Learning Computational Thinking

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This PhD project aims to investigate how an AI-based peer agent can support the development of computational thinking (CT) as a key transversal competence in higher education. While CT is increasingly relevant for problem solving across disciplines, many students without a computer science background struggle to acquire CT skills through conventional instruction. Building on Biggs' 3P model, learning-by-teaching principles, and role-switching theory, the project addresses the following research questions: How does alternating between tutor and tutee roles with a conversational agent influence learners' CT performance and learning experiences? How do interaction patterns during tutor and tutee collaboration relate to learning outcomes? To what extent do learner characteristics (prior knowledge, preferences, attitudes, academic background) moderate these effects? The study uses an experimental role-switching design with two groups to control sequence effects. Group 1 starts as tutees receiving AI guidance and then switches to teaching the AI agent; Group 2 follows the reversed order. Tasks are varied across settings to further control sequence effects. Quantitative survey/ questionnaire data include initial learner knowledge, preferences and attitudes as well as post-tutorial learning experiences and performance measures (outcome variables). In addition, learner-agent interactions are recorded for analysis of interaction patterns. The project is ongoing: theoretical framing, conceptual design, and task development have been completed, but no full-scale experimental data have yet been collected. Two pilot studies resulted in six calibrated CT tasks. Findings will inform AI-based tutoring designs for CT learning.

Student Acceptance and Adoption of Extended Reality in Anatomy Education: A Mixed-Methods Study

Presenter(s)
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Traditional anatomy education has long been the cornerstone of medical education. However, there is an ongoing debate about whether it is the most suitable way for meeting contemporary learning needs. As eXtended Reality (XR; AR/VR/MR) matures, immersive learning environments are becoming increasingly accessible and pedagogically promising, offering complementary approaches for anatomy learning and teaching. Despite the rapid development of XR technologies, evidence on the forefront acceptance and adoption in anatomy education remains limited. Understanding user acceptance and adoption of XR technology is essential, as it serves as the fundamental prerequisite for future and sustainable integration of XR into anatomical education. Therefore, this study aims to identify factors influencing first-year medical and

biomedical students' acceptance and adoption of XR for anatomy learning, examine how acceptance relates to adoption and how adoption changes over time, and explore contextual and personal predictors of sustained XR use. Guided by the unified theory of acceptance and use of technology 2 (UTAUT2), this mixed-methods study will combine a validated acceptance questionnaire with focus group interviews to identify determinants of students' acceptance and adoption and to explore the underlying mechanisms. Quantitative relationships will be tested using partial least squares structural equation modelling in RStudio, and qualitative data will be analysed using thematic analysis in MAXQDA. The study will provide insights beyond one-off satisfaction measures for educational research and XR developers by incorporating antecedent factors, acceptance, adoption, and longitudinal use. Findings will also inform curriculum design for educators by identifying the conditions that support sustained XR uptake.

The Role of Parents and Teachers in Students' Sense of Belonging at School in Germany and Austria

Presenter(s)

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AbstractA strong sense of belonging at school plays a central role in students' motivation, engagement, and overall well-being, and is closely linked to academic achievement and reduced dropout risk. Feeling included, respected, and supported by others helps students engage more fully in learning and develop positive attitudes toward school. At the same time, the extent to which students experience belonging is shaped by multiple social and structural factors, including parental engagement, teacher support, socioeconomic background, and school track. This study investigates how parental engagement and teacher support relate to students' sense of belonging, while controlling for socioeconomic background and school track as covariates. Using PISA 2022 data from Germany and Austria, the analysis first validates measures and tests for measurement invariance. Structural equation modeling, including multi-group analyses, is then used to examine (1) the direct associations between parental and teacher support and school belonging, (2) the moderating effects of socioeconomic background and school track, and (3) differences in these relationships between Germany and Austria. By comparing the two countries, the study provides insights into how social and structural factors jointly shape students' experiences of belonging at school.

A Curious Ocean: Are Curiosity-Grounded Simulated VR and PC Learning Environments Effective?

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Curiosity relates to multiple important factors, such as more autotelic exploration and higher educational achievement. However, current evidence suggests that students' curiosity decreases during formal schooling, and research exploring theory-informed interventions focused on curiosity remains limited. This paper explores whether theory-informed simulated learning environments can increase children's curiosity and learning. The results of a preregistered randomized field trial with 217 elementary school children (Mage = 13.22, SD = 0.94) are presented, evaluating the educational simulation "A Curious Ocean". Participants were randomized to either access the simulation in immersive Virtual Reality (VR) or on laptops (PC). The study included measures of trait (pre-questionnaire) and state (pre- and post-questionnaire) curiosity, in-simulation and out-of-simulation behaviors, perceived presence and agency (post-questionnaire), and retention (pre-questionnaire and follow-up). The intervention significantly increased specific state curiosity and retention. State curiosity was associated with asking more in-simulation questions, and asking more questions was associated with higher retention. Trait and post-test state curiosity, as well as prior knowledge, were linked to information-seeking behaviors after the intervention. Agency and presence were positively associated with changes in state curiosity. However, no significant differences were found between conditions beyond higher perceived presence in VR compared to PC. The results show that theory-informed simulations can foster curiosity, but that differences between media may disappear when content is closely matched. How research on simulation-based learning and curiosity can be theoretically integrated to inform future intervention research is discussed.

Which Sequences Do Foster Conceptual Understanding When Incorporating Both Design Features?

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Cultivating conceptual understanding is widely recognized as a central goal of learning. Recent findings in instructional science have concluded that Problem Solving prior to Instruction (PS-I) improves conceptual understanding compared to the opposite sequence of Instruction prior to

Problem Solving (I-PS), particularly when a PS-I design feature is incorporated. However, while prior research has thoroughly examined the PS-I design feature, an I-PS design feature has been largely overlooked. To address this gap, this experiment examines the effect of the I-PS design feature and the relative effectiveness of both sequences while incorporating both design features. Specifically, the I-PS design feature refers to the provision of tasks that deepen learners' understanding during the problem-solving phase. The PS-I design feature refers to the instruction building on students' common errors. We conducted an experiment in learning physics with 59 eighth-grade students randomly assigned to three conditions: (1) I-PS with both design features, (2) I-PS with only the PS-I design feature, and (3) PS-I with both design features. Results revealed that I-PS with both design features fostered greater conceptual understanding than I-PS with only the PS-I design feature, suggesting the addition of the I-PS design feature might be critical. Moreover, results revealed that I-PS with both design features fostered greater conceptual understanding than PS-I with both design features, suggesting the I-PS design feature might affect the relative effectiveness of both sequences. We discussed these findings by focusing on the cognitive mechanisms underlying I-PS, specifically regarding the level of processing during the problem-solving phase.

Individual characteristics in immersive virtual reality: sequencing a real and virtual dissection

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Various findings are available on the learning effects of immersive virtual reality (IVR) and the influence of this technology on learning gains. The Cognitive Affective Model of Immersive Learning also describes the specific influences of technology on the learning process. However, many studies to date have been laboratory experiments or media comparison studies. Individual prerequisites and the pedagogical integration of IVR in specific teaching scenarios have been little investigated. This article presents the initial results of a field study in biology teaching, which is currently still being conducted. So far, four eighth-grade classes have participated in the study, either first completing an IVR learning unit and then dissecting a pig's heart, or vice versa. The results provide initial indications that the learners in the group that worked with IVR first had greater learning gains. In addition, general interest in biology proved to be a positive predictor of cognitive load while working with VR headsets. The results may provide initial indications for the integration of VR headsets into biology lessons and further insights into the learning processes involved in immersive learning.

Leveraging Learners' Embodied Knowledge Through Occluded VR Ball-Catching to Learn Free Fall

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People's understandings of falling objects (and the laws of mechanics) exist in multiple forms, involving conceptual, perceptual, and motor levels. While the conceptual and perceptual knowledge are susceptible to inaccurate heuristics, such as "heavier objects always fall faster", the embodied knowledge at the motor level is usually more robust. Recognizing the potential inefficiency of the prevailing pedagogy in suppressing misconceptions, we investigate whether learning can instead be supported by leveraging learners' accurate embodied knowledge. We designed an experiment in Virtual Reality comparing two conditions as preparatory learning activities: a visible condition, in which learners catch visibly falling balls and mainly rely on perceptual knowledge, and an occluded condition, in which learners catch falling balls whose trajectories are partially occluded and have to rely on motor knowledge. We hypothesize that the occluded condition, by reducing reliance on continuous perceptual information about the ball's fall, encourages learners to focus more on their embodied knowledge. As a result, this condition may develop a stronger intuitive understanding of motion and force, better preparing learners for subsequent formal lecture instruction and thus promoting deeper learning. Our work proposes a theory-driven, embodied alternative to traditional conceptual change approaches in physics education and opens discussions on embodied assessments.

Effect of Feedback Strategies for Learning in Virtual Reality: An Experimental Study

Presenter(s)

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Virtual Reality learning environments (VR-LEs) are increasingly used to support learning. However, experimental research on feedback strategies in VR-LEs remains scarce. Drawing on productive failure research, generative learning approaches, and the Interactive-Two-Feedback-Loops (ITFL) model, this experimental study addresses this gap by comparing two feedback conditions in a VR-LE on lunar phases: (a) knowledge of correct-response feedback (KCR), presenting the correct solution after task completion, and (b) informative tutoring feedback (ITF), providing stepwise hints and explanations to scaffold learners toward correct solutions. Participants (N = 182; currently n = 135) complete pre-post-surveys and engage in comprehension tasks of increasing complexity across three phases in VR. The first phase, the productive failure phase, requires solving the tasks without support. In the second phase, the feedback phase, participants receive either KCR or ITF while working on the same tasks again. The third phase uses parallel near-transfer tasks to assess learning gains. Outcome measures include task performance across the VR-phases, perceived competence, intrinsic and extrinsic task value, and metacognitive judgements assessed before and after the VR feedback phase. In addition, prior and post-VR knowledge are assessed. Following data collection, a repeated measures MANOVA will test effects of feedback strategy on repeated measures, and a one-way ANCOVA will examine effects on post-VR knowledge controlling for prior knowledge. We hypothesize more positive changes in task performance, motivational outcomes and metacognitive judgements and higher post-VR knowledge for ITF compared to KCR. Overall, the study provides insights into feedback strategies in VR-LEs to derive evidence-based instructional design principles.

The digital divide, parental support and declining performance: Evidence from PISA 2018 and 2022

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The 2022 PISA results revealed a substantial decline in student performance in Germany across all subjects, with drops in mathematics and reading comparable to the learning gains of one school year (OECD, 2023). One central explanation is the COVID-19 pandemic, during which German secondary schools were closed for an average of 183 days (Lewalter et al., 2023). However, the decline cannot be attributed solely to school closures. The pandemic also exacerbated already existing structural inequalities like differences in performance by socio-economic status, as the pandemic and distance learning disproportionately affected students with low SES (Betthäuser et al., 2023). As learning shifted online, access to digital devices and digital skills likely became more important for academic performance. Drawing on Digital Divide Theory and Self-Determination Theory, this study examines how SES, parental support, ICT availability, ICT use, and perceived ICT competence relate to academic performance. Using German data from PISA 2018 and 2022, it investigates whether pre-existing differences in digital skills were exacerbated during the pandemic and whether these differences help explain the performance decline. Structural equation modelling will be applied, accounting for measurement invariance, sampling weights, clustering, and the tracking structure of the German school system. The findings aim to contribute to research on digital inequality in education and inform strategies to support low-SES students through improved ICT access, strengthened digital skills or parental support.

Debriefing the VR Anatomy Lectures: Effects on Learning and the Role of Individual Differences

Presenter(s)
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Immersive technologies have considerable potential to support anatomy learning by providing interactive and risk-free environments that facilitate spatial understanding. However, little is known about how to integrate immersive technologies in authentic teaching scenarios. We focus on a core element of simulation-based learning, debriefing, and investigate how it impacts students' learning in an anatomy lecture supported by virtual reality (VR), and from an aptitude-treatment interaction (ATI) perspective, how students' individual differences moderate the added

value of debriefing. A mixed-methods design is employed, with (1) approximately 80 students attending a small-scale (approximately 10 students/lecture) VR anatomy lecture with or without a debriefing session, (2) five interviews with the tutors, and (3) three focus groups with the students. We examine how the additional debriefing session influences students' (1) anatomy knowledge acquisition and (2) anxiety level towards prosection, and the moderating effect of students' individual differences (i.e., prior anatomy knowledge, prior experience in VR, visuospatial ability, and cognitive load). Our study will provide potential evidence on how debriefing functions for teaching scenarios with immersive technology integration, and on how ATI can be further extended to immersive learning environments.

Effects of Scaffolding Conditions on Cognitive Engagement in AI-Supported Learning

Presenter(s)

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Generative AI is increasingly being applied in education. However, the impact of AI-supported learning under natural conditions on students' cognitive engagement remains limited understanding. This study was conducted at a high school in China, with 20 students participating in a one-month intragroup intervention design. The students' learning focused on deep learning and natural language processing. One lesson each was given under high and low scaffolding. A 30-minute exam was conducted in the final week. The study encoded students' AI chat logs and learning notes using the ICAP framework (Interactive, Constructive, Active, Passive). Lag sequence analysis (Lag=1) and cognitive network analysis (Stanza window = 3) were used to examine the differences in engagement sequences and structures between high and low scaffolding students at different achievement levels. Results showed that high-achieving students exhibited a process of learning and understanding through AI under both scaffolding conditions, followed by constructive note-taking. Low-achieving students, while occasionally taking constructive notes, generally relied on AI. High scaffolding increased the likelihood of low-achieving students engaging in constructive learning, but did not eliminate reliance.

Desirable Difficulties and Task Complexity in Digital Foreign Language Learning

Presenter(s)

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This study investigated the individual and combined effects of task complexity (consistently high vs. gradually increasing) and desirable difficulties (interleaved vs. blocked practice) on performance, cognitive load, and metacomprehension judgments in an online foreign language problem-solving task. Additionally, the relationship between desirable difficulties and metacomprehension accuracy was examined. Data were collected from 130 undergraduate and

graduate students (46 male, 83 female, 1 non-binary; Mage = 21.36, SD = 2.83). Participants completed the task in either an interleaved or blocked practice format, with task complexity manipulated to be consistently high or gradually increasing. Performance was measured during the final task phase. Cognitive load and metacomprehension judgments were assessed via self-report questionnaires immediately after the problem-solving task. Metacomprehension accuracy was assessed by calculating the correlation between participants' actual performance and their metacomprehension judgments for the interleaved and blocked practice groups. Results revealed that consistently high complexity improved performance but, along with interleaved practice, increased cognitive load and lowered metacomprehension judgments compared to gradually increasing complexity and blocked practice. Notably, interleaved practice negatively correlated with metacomprehension accuracy, whereas no significant association emerged for blocked practice. These findings highlight the nuanced effects of digital instructional design on learners' cognitive and metacognitive processes during problem-solving.

What Makes Technical Instructional Videos Popular on YouTube? Design Cues and Human Interaction

Presenter(s)

Yaoyao Zhang | Technical University of Munich, Germany

User-generated instructional videos on YouTube have become a widely used form of open educational resources (OER) for self-directed learning in engineering and technology domains. Understanding which design cues influence learners' engagement is essential for sustaining high-quality digital learning ecosystems. Using learning analytics, this study examined heuristic and systematic design cues associated with the popularity of 638 user-generated technical instructional videos across carpentry, civil, hydropower, and electrical engineering. Results show that heuristic cues, including large channel followings, exclamatory title patterns, and video durations of 5-15 minutes, significantly predict popularity. Systematic cues related to instructional design and interaction, such as subtitles, self-designed covers, and producer-learner engagement via comments and contact information, also positively influence engagement. These findings indicate that learners' attention and pedagogical quality jointly shape engagement with instructional videos. Beyond design implications, the study highlights the limitations of AI-generated instructional videos. The analysis also leverages popularity-related design cues to reveal learners' preference for videos featuring human interaction. Such interactive, human-mediated features underscore the importance of social presence and pedagogical interaction, dimensions that remain structurally limited in current AI-generated instructional videos. Overall, the study provides empirical insights for educators, platform designers, and policymakers seeking to develop human-centered, AI-supported digital learning environments.

Mental Models in the Making: Imagination and Instructional Images for Learning Abstract Concepts

Presenter(s)
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Learning materials can be enhanced through instructional designs that prompt learners to imagine described concepts or processes. From an Integrated Text–Picture Comprehension perspective (Schnotz, 2014), imagination may support the integration of propositional and perceptual representations, thereby enhancing learning from text. Meta-analytic evidence demonstrates that imagination prompts foster learning from text (Mguidich et al., 2024), yet important research gaps remain regarding their underlying mechanisms and applicability to learning abstract concepts and within dynamic media. In particular, multimedia support (e.g. instructional images) may scaffold perceptual representations, and motivation and metacognition have been proposed as mediating processes, but not yet tested. Moreover, with videos becoming increasingly prevalent in educational contexts, it remains unclear whether the imagination effect generalizes beyond static media.To address these gaps, we employ a mini meta-analytic approach across two experimental studies examining imagination-based learning from text and video. The present contribution reports the first study, focusing on text-based learning. Using a 2 × 2 × 2 mixed design, we investigate how imagination activities and instructional images influence learning outcomes in German-speaking upper secondary students (16–18 years) learning abstract concepts in physics and history, and whether effects are mediated by motivation and metacognition. We expect imagination activities to enhance learning, particularly when combined with multimedia support, and to operate through motivational and metacognitive processes. By examining how imagination enhances learning of abstract concepts, this study will clarify how imagination activities can be implemented to foster learning outcomes, yielding practical recommendations for educators.

NO-OR-NOT-PERFECT DATA PRESENTATION

Test Efficiency as a Process-Oriented Measure of Engagement in Programming

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Programming with block-based environments such as Scratch is increasingly used in primary teacher education, yet many pre-service teachers struggle to engage productively with such learning activities. In digital and asynchronous settings, learners' engagement is difficult to capture, as commonly used indicators such as time-on-task or final performance provide limited insight into how learners interact with tasks and feedback. This study examines test efficiency as a process-oriented indicator of engagement in Scratch-based programming tasks and investigates its associations with behavioral, cognitive, and motivational factors. Participants (N = 87) completed questionnaires assessing programming prior knowledge and motivational beliefs before working on five programming tasks. Backend log data recorded all program executions and code characteristics. Preliminary analyses focused on the first task. Results showed that students with correct and incorrect submissions did not differ in overall testing frequency but differed in the variability of test efficiency. Incorrect submissions were associated with more heterogeneous efficiency patterns, ranging from premature submission to extensive but unsystematic testing. Correct submissions showed more homogeneous and functionally aligned test efficiency and were structurally closer to the model solution. CT prior knowledge emerged as a robust predictor of functional test efficiency, whereas motivational factors showed no consistent associations. These findings suggest that test efficiency is a promising indicator for capturing qualitative differences in engagement in programming-based learning environments. Ongoing analyses will extend this approach across tasks with varying demands and integrate additional process indicators.

Using Multimodal Data to Capture the Temporal Dynamics of Curiosity in Mathematical Problem-Solving

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While curiosity is recognized as a fundamental catalyst for learning, its real-time dynamics within authentic educational settings remain poorly understood due to a reliance on retrospective self-

reports and laboratory trivia paradigms. This study addresses these limitations by investigating curiosity as a dynamic, moment-to-moment driver of exploration within the context of mathematical failure-driven problem-solving. By framing curiosity as an epistemic response to information gaps, the research seeks to move beyond viewing it as a static outcome, instead positioning it as the primary engine that sustains engagement during cognitive struggle.The project uses a novel multimodal methodology to reconstruct the temporal trajectory of curiosity without disrupting the student's natural reasoning. Think-aloud protocols are synchronized with continuous physiological markers of arousal and grounded in subjective experience by prompting the student to provide rapid self-reports during periods of peak arousal. Currently in the developmental phase, the research focuses on refining data-fusion techniques to isolate the signatures of curiosity from related states like frustration. The ultimate goal is to establish a temporal model of curiosity that identifies the specific learning processes that trigger or inhibit exploratory behavior. These insights hold significant potential for the design of adaptive learning technologies and teacher training, enabling the intentional management of curiosity to facilitate deep conceptual understanding in mathematics.

Self-disclosure as a social cue in video-based learning

Presenter(s)

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Digital transformation opens new potential for location- and time-independent adult learning, but at the same time poses challenges in terms of social presence (Alamprese, 2024; Plass & Kaplan, 2016). In video-based formats, the lack of interactivity can lead to increased social distance and thus impair key learning-related processes. Against this backdrop, the targeted integration of social communication elements is becoming one focus of instructional design research. One promising approach is the inclusion of self-disclosure by teachers, which is understood as thematically relevant personal messages (e.g. a teacher sharing a personal experience related to the topic) (Cayanus & Martin, 2008). Initial studies from face-to-face contexts show positive effects on affective, motivational, and cognitive learning parameters (Froment et al., 2021). Social agency theory emphasizes the learning-promoting potential of social cues in the context of digital learning environments. However, empirical evidence on the effectiveness of self-disclosure in digital settings remains limited. Our experiment aims to close this research gap. The study focuses on the question of whether self-disclosure in video-based teaching settings influences learning-relevant processes such as learning success, parasocial interaction, and cognitive load. To test the research questions, we aim to conduct an online experiment using a between-subjects design, in which 168 learners are randomly assigned to one of three conditions. Either the teacher shares personal information (self-disclosure) at the beginning of the video, the same information is shared by another person (third-party disclosure), or the video starts without any personal information (control condition). The data will be collected in spring 2026.

Evaluation of a Learning-Analytics–Based Feedback Intervention to Foster SRL in Higher Education

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Short abstract (231 words) Supporting students' self-regulated learning (SRL) remains a major challenge in large-scale higher education, particularly in cognitively demanding first-year courses where learners must independently plan, monitor, and reflect on their learning. Although technology and learning analytics (LA) offer promising opportunities to support SRL at scale, existing research has primarily used LA as a measurement tool rather than as a basis for actively fostering learner self-regulation. Building on Zimmerman's cyclical SRL model and feedback theory, this study investigates how repeated, data-driven feedback based on learning analytics can support SRL as a dynamic learning process. Using a quasi-experimental design, the study was conducted in a compulsory first-year quantitative methods course (N = 1352) over eight weeks. Trace data from a digital learning environment were collected at three time points and used to identify SRL-related behavioural profiles through cluster analysis. Based on these profiles, students received personalised feedback aligned with SRL phases (forethought, performance, and self-reflection). Self-reported MSLQ and academic performance (midterm and final exams) were collected to examine changes over time. Preliminary findings indicate distinct learning-behaviour clusters and notable transitions across measurement phases, suggesting that students' engagement patterns evolve throughout the course. Ongoing analyses explore how LA-based feedback relates to behavioural change, SRL development, and performance. The study provides process-oriented evidence on how LA can be used not only to observe learning but also to actively support SRL development in mass higher education contexts.

Understanding Parents of Children with Problematic Media Use: A Needs Assessment Study

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The spread in digital technologies has spurred the ownership of many digital media devices in households and an increase in the time spent with those devices not only in adults but also in children. Hence, problematic media use (PMU) became a concern starting from very early ages. As a first step of a larger study that aims to prepare a parent education program for parents of preschool children who experience PMU, the purpose of the current study is to conduct a needs assessment prior to the preparation of the program. Using the Turkish version of the Problematic

Media Use Scale (Furuncu & Öztürk, 2020), for which validity and reliability have been established, the researcher will identify parents of preschool children with PMU. The parents also will be answering the Needs Assessment Questionnaire. Then, the volunteer parents will be interviewed with the purpose of understanding challenges they experience with their children with PMU and their educational needs in this manner. Within qualitative research methods, a phenomenological design will be employed in this study. The results of the study is expected to be worthy not only to inform the program that is planned to be prepared, but also for the literature in terms of revealing the essence of the PMU in children via lived experiences of parents which is a relatively new phenomenon in the area of early childhood. The study findings will be presented at the conference. Keywords: Qualitative methods, Parental involvement in learning, Digital literacy and learning, Early childhood education

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Widening the Digital Divide? A Systematic Review on Socioeconomic Disparities in Students' LLM Use

Presenter(s)

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Abstract The rapid diffusion of chatbots based on Large Language Models (LLMs) presents new opportunities for learning. However, although learners increasingly use chatbots for academic purposes, research indicated that digital innovations rarely benefit all students equally and may potentially exacerbate the digital divide. In particular, emerging evidence indicated that socioeconomic status (SES) differences determine how learners interact with LLMs, since learners with higher SES use LLMs more effectively. Although SES is an established predictor of educational success and technology adoption, its role in learners' interaction with LLMs remains underexplored, as only a few studies address how SES shapes AI use. Addressing this gap, this contribution presents a systematic review; synthesizing empirical evidence on the role of SES in students' learning-related use of LLM-based chatbots in secondary and higher education. Grounded in digital divide theory, the review follows PRISMA standards (2017–2026) and includes qualitative, quantitative, or mixed-methods studies that operationalize SES or related proxies. Data extraction will begin in spring, allowing first results to be presented at the conference. By consolidating emerging findings, the review extends digital divide research to AI-mediated learning and informs instructional design and policy debates on equitable classroom uses of LLMs.

Managing Cognitive Load in an Immersive Virtual Field Trip: Annotations and Oral Summaries

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Immersive virtual reality (IVR) enables learners to explore complex scientific processes but also increases perceptual and navigational demands, which may elevate cognitive load and constrain conventional study strategies such as note-taking or external elaboration. Identifying instructional supports that are feasible in head-mounted display settings and that target specific components of cognitive load is therefore essential. Two such supports are annotations, which function as signalling cues to guide visual attention, and oral summaries, which require learners to reorganise and articulate content and may thereby induce generative processing.The present study examines how these supports influence intrinsic, extraneous, and germane cognitive load during an immersive virtual field trip on wastewater treatment. By implementing both supports within a 2×2 factorial design, the study enables analysis of their independent and combined effects on distinct cognitive load components. An initial sample N=67 university students completed a 35-minute IVR learning phase with annotations, oral summaries, both, or neither. Pre- and post-tests assessed recall and comprehension; cognitive load, presence, and cybersickness were measured using validated scales. Spoken responses were recorded for subsequent coding to distinguish summaries, think-aloud utterances, and self-explanations. Preliminary analyses based on a subsample (n=37) indicate no significant main or interaction effects of annotations or oral summaries on cognitive load. Cybersickness was positively associated with extraneous load. Ongoing data collection and qualitative coding of spoken summaries will enable examination of whether different forms of learner-generated responses correspond to distinct cognitive load profiles and learning outcomes, thereby refining theoretical assumptions about generative processing in immersive environments.

How does your mind process AI feedback? Exploring metacognitive support and trust framing

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As systems like Chatbots are increasingly used to provide feedback in higher education, a central open question is not simply whether AI-feedback improves performance, but how learners cognitively and metacognitively engage with such feedback, and under which conditions it is actually used as a meaningful learning resource. This study addresses these issues in a realistic higher education setting and examines how the design of AI-feedback and learners individual characteristics jointly shape feedback processing and learning.In a 2 × 2 experimental design, we

manipulate (1) metacognitive support (included vs. not included) embedded in AI-generated feedback and (2) the trust framing (high vs. low) of the AI system. The learning activity focuses on learning myths embedded in a university curriculum subject. Measures include metacognitive experiences, situational trust, feedback uptake, learning, and process data captured via chat logs. In addition, need for cognition, feedback- literacy, and AI-literacy are assessed as moderators. The study is expected to reveal how metacognitive support and trust framing interact with learner traits to produce qualitatively different patterns of AI feedback use, thereby informing both theory and the design of pedagogically grounded AI feedback systems.

Gesture Imitation and Invention in Vocabulary Learning: A Multimodal Analytics Study

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Embodied approaches have demonstrated robust benefits for vocabulary acquisition; however, existing studies differ widely in how bodily engagement is implemented, particularly with respect to learners' roles and cognitive processes in performing actions. In particular, it remains unclear whether learning benefits arise primarily from observing and imitating provided gestures or from actively generating one's own movements, and which mechanisms underlie these effects. To address these issues, the present study investigates how English-speaking adults learn novel Mandarin words through either imitated or self-generated gestures representing the meanings of target words. Beyond learning outcomes, the study examines why gestures facilitate vocabulary learning by contrasting two mechanisms. For each target word, objective gesture–meaning congruence captures the extent to which the accompanying gesture structurally and semantically aligns with the word's meaning, as rated by independent coders, whereas subjective personal relevance reflects learners' perceived usefulness and meaningfulness of their gestures for supporting memory and integrating the word into their own meaning-making processes. As a follow-up, the study further employs a multimodal learning analytics approach, integrating movement-based gesture metrics and interaction log data to characterize learning dynamics across conditions. Overall, this study advances a process-oriented account of embodied vocabulary learning that clarifies when, why, and how bodily action supports word learning. This study is currently at the conceptual design stage.Keywords: Cognitive skills and processes, Learning analytics, Foreign and second language acquisition, Quantitative methods

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Can the Spacing Effect in Mathematics be Fostered by Worked Examples During the Instruction Phase?

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Acquiring lasting knowledge that remains accessible over time is an important educational goal. Spacing the practice phase across multiple sessions fosters lasting learning, but the effect is less robust for complex learning content, such as mathematics. The present study investigates whether deeper cognitive processing of the learning content during the instruction phase, evoked by worked examples, boosts the spacing effect on lasting learning of mathematics in secondary school. The experiment follows a 2 (practice schedule: spaced vs. massed) × 2 (instruction condition: worked examples vs. no worked examples during instruction) between-subjects design. A new arithmetical procedure (i.e., probability calculation) will be imparted to the students in the instruction phase, which is enriched by worked examples (versus pure problem solving as control condition). Thereafter, students will practice the procedure either in a massed manner on one day or spaced with an inter-study interval of two weeks. In a delayed test eight weeks after the last practice phase, their procedural and conceptual knowledge will be assessed. The required sample size is N = 217. Besides of potential main effects of spacing and worked examples, an interaction between spacing and worked examples is expected in that test performance should be best when students engaged with worked examples during the instruction and practiced the arithmetical procedure in a spaced manner. Students' general math ability, their specific prior knowledge, working memory, and long-term memory capacity will be assessed to test whether these individual variables moderate the expected effects.

Morphological Changes in Virtual Reality for Learning Mathematics

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Embodied cognition theories posit that physical experiences can shape abstract cognition; for example, finger counting can shape numerical understanding (Krenger & Thevenot, 2025). However, many concepts lack direct bodily mappings. Virtual Reality (VR) enables learners to embody novel morphologies, creating new action possibilities beyond those of the human body (Chatain et al., 2023). We investigate semantic avatars: VR avatars whose morphologies are deliberately designed to map onto mathematical concepts through embodied action (Chatain et al., 2023). Focusing on secondary-level mathematics, and specifically on alternative base

numerical systems, we examine whether semantic avatars can support understanding of concepts that are difficult to conceptually understand. We follow a two-phase design, combining a qualitative expert-informed design phase with an experimental study involving approximately 160 students aged 13-15, comparing learning outcomes with and without morphological change. This work expands embodied learning research by systematically exploring morphological changes as a new design space for concepts and their role in mathematical conceptual understanding.

Does Instructional Sequencing Matter in IVR? Balancing Immersion and Guidance to Optimize Learning

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Immersive virtual reality (IVR) is increasingly used to support STEM instruction, particularly for procedural skills requiring spatial interaction (Coban et al., 2022; Villena-Taranilla et al., 2022). However, findings regarding its effectiveness are mixed: IVR can enhance presence and engagement, yet it may also reduce learning due to increased cognitive load and affective demands (Makransky et al., 2019; Parong & Mayer, 2021). Guided by cognitive load theory (Sweller, 2024), the Cognitive Affective Model of Immersive Learning (CAMIL; Makransky & Petersen, 2021), and explicit instruction (Archer & Hughes, 2011), this pre-registered experimental study examines how instructional sequencing within IVR influences learning and motivation during STEM procedural learning. One hundred sixty participants will be randomly assigned to one of three instructional sequences based on the explicit instruction “I do, we do, you do” framework (Archer & Hughes, 2011): I do, I do, You do; I do, We do, You do; or We do, We do, You do. All participants will complete a micropipetting lesson in IVR, followed by a virtual serial dilution task and a real-world transfer task. Conceptual knowledge and procedural accuracy serve as primary learning outcomes. Participants complete pre-lesson measures of self-efficacy and intrinsic motivation. Post-lesson measures include self-efficacy, intrinsic motivation, situational interest, and cognitive load. Data collection is ongoing. This study contributes to research on learner-centered design in IVR by providing empirical evidence on how instructional sequencing can be designed to optimize both learning and motivational outcomes in immersive environments.

From Material Generation to Pedagogical Reasoning: Epistemic States in AI-Supported Lesson Planning

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Lesson planning is a core professional activity that requires teachers to make and justify instructional decisions by integrating evidence, theory, and experiential knowledge. Generative artificial intelligence (GenAI) holds considerable potential to support such evidence-oriented lesson planning; however, pre-service teachers use GenAI primarily in an implemental manner focused on rapid material generation rather than to support their pedagogical reasoning. As deliberative processes such as weighing instructional alternatives and justifying instructional decisions during planning are crucial for instructional quality, this study examines framing as a means to support pre-service teachers' deliberative use of GenAI during lesson planning. In a scenario-based task, 70 pre-service elementary teachers plan a lesson using a GenAI tool that is recommended in one of three framings, randomly varied between participants: (1) technical information only (control condition), (2) recommendation as a tool for quick material generation (implemental framing) or (3) as a "critical friend" for discussing instructional decisions (deliberative framing). We expect deliberative framing to increase deliberative task processing during AI-supported planning, and that such processing mediates effects on the justification quality assessed in a subsequent task without access to AI. The study aims to identify low-threshold approaches to supporting evidence-oriented practice in AI-supported lesson planning.

Timing matters: Investigating the Instructional Sequencing of Immersive VR in Educational Settings

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Immersive virtual reality (IVR) is increasingly integrated into educational contexts, yet empirical guidance on how to embed IVR effectively within instructional sequences remains scarce. In particular, little is known about how the temporal sequencing of immersive and non-immersive instructional components informs learning processes and outcomes. Building on the Cognitive Analysis of Composite Instructional Designs (CID) (Loibl et al., 2024), this preregistered, multi-site laboratory study investigates how different instructional sequences influence affective, cognitive, and behavioral learning outcomes in higher education. University students are randomly assigned to one of two instructional conditions: (a) immersive VR followed by video-based instruction (VR-first), or (b) video-based instruction followed by immersive VR (VR-

second). The instructional content focuses on biodiversity and pollination and is implemented using the immersive learning environment Pollinator Park combined with a structured explanatory video. Repeated measures assess affective outcomes (e.g., compassion, nature connectedness), cognitive outcomes (e.g., knowledge acquisition), engagement, cognitive load, and sense of presence. Pro-environmental behavior is captured using a validated donation task as a behavioral proxy. Data collection is currently ongoing across three university sites following ethical approval. This contribution presents the study's rationale, design, and statistical analytic strategy, and discusses emerging tendencies and open questions regarding instructional sequencing in immersive learning environments.

Money Matters – Storytelling to Promote Financial Literacy for Children

Presenter(s)

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Children begin to develop concepts and attitudes about financial topics very early on in life, even without any formal financial education. Much of this early learning is shaped by the parental home, where everyday experiences and family practices influence how children think about money. These early-formed ideas and attitudes can have lasting effects, shaping financial habits and overall financial wellbeing later in life. Given this long-term impact, it is important to start financial education at an early age. Although a range of financial education interventions targeting children in early secondary school exist, most of them are weakly theory-driven and fail to identify conditions for success and mechanisms of actions on why and how these interventions work in promoting financial literacy. Therefore, we designed a story-based learning environment on the topic of budgeting for children in grades five and six, drawing from the approach of anchored instruction. To test the effectiveness of the story-based learning environment compared to a traditional instructional approach, we will conduct a cluster randomized controlled field trial among students in grades five and six from secondary schools in Germany. We aim to promote evidence-based financial education and to investigate which financial education interventions are effective for whom, under what conditions, and why.

Primary students' use of metacognitive prompts in a DLE: the role of learner characteristics

Presenter(s)

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Metacognitive prompts can foster monitoring and regulation activities in digital learning environments (DLEs) and improve learning outcomes. However, research shows that prompts might not always be effectively used by students and therefore lack positive learning effects. Studies suggest that the perception and utilization of metacognitive prompts may depend on students' learner characteristics, yet this relationship remains underexplored. This intervention study therefore investigates (1) how primary school students perceive and utilize metacognitive prompts during a DLE unit and (2) how specific learner characteristics relate to prompt perception and utilization.Across 36 fifth-grade classrooms (N=625), students participated in a digital learning unit on glaciers that required selecting, reading, and integrating information to write a magazine article. In a within-class randomized design, the experimental group (n = 350) received metacognitive prompts from a digital agent at predefined points of the learning process; the control group worked with the same unit and agent without metacognitive prompting. Multiple data sources (student and teacher questionnaires, student interviews, system log data) were used to measure students' perception and utilization of prompts as well as their learner characteristics (e.g. achievement level, learning motivation, self-efficacy and attitudes toward metacognitive strategy use). Preliminary findings indicate heterogeneous (and sometimes ambivalent) evaluations of prompts and substantial interindividual differences in prompt use. Ongoing analyses identify post-prompt use-patterns through the analysis of behavioral sequences and relate them to learner characteristics. Triangulating self-report data with behavioral log data addresses important methodological limitation in the field and inform the design of adaptive metacognitive prompting.

Mathematics Teachers' Professional Competencies and the Use of a Digital Practice Platform

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Practice is a core component of mathematics instruction and is increasingly supported by digital practice programs. At the same time, the mere use of such technologies does not automatically lead to improved students' learning outcomes. Rather, technology-related research suggests that teachers' professional competencies (including knowledge, beliefs and motivation) play a central role in adapting technology into instructional contexts. Related evidence, however, is often based on decontextualized studies (e.g., laboratory-like or subject- or tool-unspecific settings) using self-reported measures to assess implementation frequency. Much less is known about teachers' use of mathematical practice programs and their actual frequency of use in an authentic, real-life context.Against this background, the present study investigates how teachers' technology-related competencies are associated with the actual use of a specific mathematical practice program.The study combines survey and platform log data from 435 mathematics teachers using MatheBattle, a large online practice platform. Applying linear models, we (1) examine how teachers' professional competencies relate to self-reported platform use and (2) test whether these associations replicate when platform use is captured via log data reflecting actual use in authentic classroom settings.

GenAI-Supported Learning: Exploring GenAI-Assistant Interaction for Problem Decomposition

Presenter(s)
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Generative AI (genAI) assistants offer new opportunities to support learning through personalized and interactive scaffolding in a human-like manner. However, they usually lack a pedagogical approach aiming at supporting student learning. We still know little about their impact on skill development. Given their adaptability, AI could support students in verifying their solution, scaffolding for desirable difficulties rather than for ease and efficiency. Such scaffolding could allow AI assistants to guide students in reasoning processes to generate transferable knowledge. At the same time, manipulating the presence or absence of user prompting guidance tests whether human scaffolding and behavior can compensate for the AI's lack of instructional

logic, obtaining a pedagogical partner.In this context, research suggests that successful transfer depends on a student's ability to recognize structural similarities across different tasks. In computer science, problem decomposition plays a key role in such transfer. This skill enables students to break up a complex task into manageable parts to solve problems. Developing decomposition skills could lead students into achieving successful knowledge transfer.This project explores whether and how dialogue-based interaction with genAI assistants supports students in developing and transferring problem decomposition skills in computer science education. Using a mixed-methods 2x2 design, an experiment will manipulate both human and AI behavior by (1) providing students with prompting cues for productive engagement and (2) configuring chatbots with pedagogical scaffolding.The project will examine student-AI interactions during the learning process, allowing exploration of how AI chatbots affect learning and transfer in the context of computational problem-solving.

Beyond virtual presence: exploring real-world disruptive presence in learning with immersive VR.

Presenter(s)

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Virtual Reality (VR) is increasingly used in health professions education to support experiential learning in immersive environments. While prior research has emphasized the role of presence—the psychological experience of "being there"—in explaining learning outcomes in VR, less attention has been paid to learners' awareness of the surrounding physical environment during VR use, particularly in shared educational spaces. To address this gap, this study examines real-world disruptive presence, defined as learners' awareness, expectancy, and experience of real-world stimuli while engaging in VR. Data are currently being collected from two educational institutions, using a fully immersive VR application designed to train operating room preparation procedures for students in higher and vocational education. Situated within the Cognitive Affective Model of Immersive Learning, this research aims to contribute theoretically by examining how real-world presence, as a separate construct, relates to cognitive and affective learning outcomes in VR, and practically by informing the design and implementation of VR training in shared educational spaces.

TOOL OR EDUCATIONAL TECHNOLOGY DEMONSTRATION

XR-GenAI-Biofeedback Toolkit for Stress-Resilient Communication Training

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Healthcare professionals routinely navigate emotionally charged conversations that can trigger acute stress and, over time, contribute to burnout. This demonstration presents a virtual reality training tool that links realistic communication practice with in-the-moment physiological self-regulation and structured reflection within a single, reusable learning journey.The tool follows a four-phase workflow: (1) a first stress scenario in a virtual hospital ward room with challenging patient-relative avatars and additional stressors, (2) a short relaxation phase using paced breathing supported by real-time heart-rate feedback rendered as simple visual and auditory cues, (3) a second stress scenario to rehearse coping strategies while maintaining communication quality, and (4) a coach-avatar debrief that connects concrete interaction moments to self-regulation strategies and transfer decisions. The demo is implemented as an open, self-paced station. Attendees can develop an independent understanding of the tool through a poster and a continuously running screencast video, then try the full workflow using five VR headsets. Two research authors support the station on demand, one for hands-on guidance and one for discussion of design criteria and implementation considerations. Participants can also leave structured, self-guided feedback via a QR-based micro-survey to inform the next design-based research iteration.

Supporting Classroom Orchestration and Collaborative Programming on Jupyter Notebooks

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Jupyter notebooks have been widely adopted in STEM courses that have programming or data science integrated. Jupyter Analytics, a learning analytics system, has been built to provide teachers with visibility into student activity. In combination with its existing functions as an awareness and reflection tool, this demo illustrates how the new code-sharing feature can address the real needs of both instructors and learners within Jupyter notebooks. Specifically, we discuss its potential value in two use cases: (1) supporting teachers in orchestrating live-coding lectures, and (2) helping students merge and synchronize work in collaborative

programming. This covers two common pedagogical contexts in higher education: teacher-led lectures and student-centered active learning environments with group projects or collaborative sessions. In this demo, we will showcase all current features of Jupyter Analytics, and the distinct interaction flows for teachers and students. Participants will engage with the system in real time by assuming the role of either a teacher or a student, working through example notebooks and interacting with one another using the tool. Throughout the session, we will actively solicit feedback on the tool's design and collaborate with participants to explore new directions for its use in both research and practice.

AI-Based Systems in Education: Bridging Pedagogy, Technology, and Evidence

Presenter(s)

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Artificial intelligence is increasingly shaping educational practice, yet its pedagogical integration requires careful theoretical grounding and empirical validation. This demo session presents a set of AI-based prototypes developed within a transdisciplinary research ecosystem integrating educational science, psychology, subject matter-didactics, and computer science. Central to our approach is the design of a modular Intelligent Tutoring Systems (ITS) that enable micro-adaptive tutoring dialogues and macro-adaptive, evidence-informed learning paths. Following the detect–diagnose–act framework, the systems combine performance data with brief motivational and interest-related assessments to provide cognitively and affectively responsive support. Current implementations focus on Mathematics and German and explicitly scaffold self-regulated learning. In addition, we present a voice-based tutoring interface to enhance accessibility for younger learners, as well as an AI-supported teacher self-assessment tool that provides formative feedback on instructional quality based on classroom audio analysis. The session invites critical discussion on pedagogical design, technical architecture, and responsible AI implementation in education.

Separated-display in-class vocabulary testing for BYOD classrooms

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Bring-your-own-device (BYOD) testing is now common in university classrooms, but it offers limited control over off-task tool use (including external generative AI assistance), especially when devices are predominantly smartphones, raising validity and fairness concerns for routine assessments that inform grading decisions. This demonstration introduces [Application name], a browser-based educational technology for in-class vocabulary testing and review in compulsory Japanese university English-as-a-foreign-language (EFL) courses. The application separates item presentation from response entry: test prompts are displayed on a classroom projector, with audio played via classroom speakers, while students submit answers on personal devices. Light-touch integrity features (e.g., temporary screen blur and logged warnings when leaving the test page) are combined with learning-first supports, including optional hints (reduced credit) and partial credit for near-miss spellings (e.g., one-letter errors or transpositions). The application is paired with an integrated Practice component, providing adaptive vocabulary activities and an instructor-timed, start-of-class review mode to align class pacing before testing.The session is hands-on. Attendees will experience the student interface and a simulated projected test view, and will explore the instructor dashboard and progress tracking using mock data. This educational technology is being iteratively developed through a design-based research approach. The research program is informed by self-determination theory, emphasizing autonomy-supportive design features and scaffolding competence within mandatory assessment routines. A preregistered longitudinal evaluation is set for Spring 2026, examining links between perceived competence states and objective vocabulary performance, illustrating a design–evidence loop where theory guides development and the tool enables theory-relevant measurement.

Digital Read-Pair-Share: A Web-based System for the Instruction and Support of Collaborative Reading

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Reading and understanding academic texts remains a key skill in tertiary-level education across disciplines, but novel patterns in media consumption promote less focused reading that can hinder comprehension. Research suggests that deliberately designed interactive interfaces and

explicit instruction can support critical reading. In particular, the Think–Pair–Share (TPS) method provides a structured approach to collaborative learning that allows the combination of reading strategies and cooperative sense-making.We present digital Read-Pair-Share (dRPS), a web-based system that adapts TPS instructional strategy to support collaborative academic reading in tertiary education. dRPS structures reading as an educational scripted activity within a course, comprising all materials and visual-supporting tools in a single digital environment. The system guides learners through five activities within the three respective TPS phases, including skimming, focused reading with annotations and questions, pair discussion, and collective sharing. To promote reflection, dRPS integrates a Visual Reading Analytics Interface (VRAI) that visualizes learners' interaction with the text, enabling both students and instructors to examine coverage of the text, reading and answering strategies, and engagement patterns.The demo introduces participants to the pedagogical rationale, system design, and visual analytics features of dRPS using authentic classroom data. Attendees will be guided through the activities and explore different work patterns from students. We invite discussion on the system's applicability across disciplines, its role in supporting novice academic readers, and future developments including AI-supported collaborative roles.

An AI-Driven Teacher Authoring Environment for Narrative-Centered Learning

Presenter(s)

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This demonstration presents an online authoring application that enables educators to design immersive, narrative-centered learning experiences. The tool leverages large language model technology to support teacher-directed pedagogical decision making and interactive scenario creation aligned with principles of narrative-centered learning. Through adaptive authoring features, educators can generate and refine three-dimensional scenes that integrate narrative structure, character interaction, and authentic problem contexts relevant to classroom instruction. The session will focus on the practical functionality of the authoring environment. Participants will experience how simple teacher prompts can be expanded into coherent storylines with customizable dialogue, contextualized settings, and opportunities for student inquiry. Demonstration activities will highlight scene-level customization, alignment with instructional goals, and supports for scaffolding disciplinary understanding across a narrative scene. Attendees will also have opportunities to explore example scenes and consider potential classroom applications. By foregrounding usability, instructional alignment, and teacher agency, this demonstration illustrates how AI-supported authoring tools can extend evidence-informed approaches to technology-enhanced learning while remaining responsive to the needs of practicing educators.

Supporting support: The SeLFI Teacher Training as a digital tool supporting teachers' SRL promotion

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Self-regulated learning (SRL) is widely recognized as a key competence for academic success and lifelong learning. However, its systematic promotion in classroom practice remains limited, partly due to teachers' insufficient professional knowledge, constrained beliefs about feasibility, and low self-efficacy. To address these challenges, we developed SeLFI Teacher Training, a modular digital professional development tool designed to support teachers understanding and implementation of SRL-supportive practices, but also to investigate teachers' learning behavior within online professional development contexts. Grounded in research on SRL interventions and teacher professional development, and informed by conceptual change theory, the tool targets teachers' preconceptions, knowledge, and pedagogical beliefs. Each module elicits existing conceptions, confronts misconceptions through refutational materials, and promotes reflective restructuring. Implemented in Moodle, the modular units combine theoretical input, practical examples, classroom-ready materials, and reflection tasks to facilitate transfer into everyday teaching. Initial pilot evaluations (N=44) indicate substantial gains in teachers' SRL knowledge and self-efficacy, while professional beliefs appear more resistant. Log file data further enable learning analytics to examine engagement and learning processes. By integrating research-based design principles with practical applicability, the tool aims to bridge the gap between educational research and classroom practice and to provide scalable, sustainable support for teachers' SRL promotion.

[name]CHAT: Demonstrating an LLM-Supported Platform for Adaptive Learning in Teacher Education

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Teacher education is increasingly under pressure due to high stress levels, early attrition, and declining well-being among teachers (Farley & Chamberlain, 2021; Federičová, 2021). In response, the [name] project ([abbreviation explanation]) was initiated to support the

psychological resilience and well-being of pre-service teachers. The [name] platform was shown to have positive effects on students' resilience and emotional exhaustion (anonymized).Building on the established [name] platform and prior work on institutionally hosted chatbots, [name]CHAT integrates large language models (LLMs) into the platform to enhance interactivity, personalization, and learner feedback without relying on commercial AI providers. [name]CHAT is a locally hosted, privacy-preserving educational technology designed to foster psychological resilience through interactive, dialogue-based learning.This tool demonstration focuses on the newly developed platform features, abbreviated as FRUIT:(1) F – Feedback and reflective tools, (2) R – Responsive persona-driven interaction, (3) U – Usability and navigation support, (4) I – Interactive dialogue-based task design, and (5) T – Task-based personalization. These new features implemented into [name]CHAT, transform the platform from a primarily self-directed learning tool (Figure 1) into a conversational and adaptive learning environment (Figure 2).During the session, participants will actively test selected newly added [name]CHAT features, including persona-based interactions, real-time reflective feedback, and adaptive task pathways. The demonstration is designed as a hands-on exploration, and participant feedback and improvement ideas will be collected to inform further development. [name]CHAT illustrates how LLMs can be meaningfully embedded into teacher education to support reflective learning, resilience development, and ethical, privacy-conscious educational technology design.

The Digital Training Companion: a Web Application to Transform Teaching and Training Evaluation

Presenter(s)

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Ensuring the effective transfer of acquired competence during professional training and facilitating sustainable changes in teaching practice remains challenging in higher education. While educational psychologists agree on the effectiveness of continuous evaluation in supporting this process, there is still a reliance on short-term, satisfaction-based evaluation methods, which offer limited insight into learning processes, behavioural change, and long-term impact. This demonstration presents a digital solution designed to address these challenges. The session will introduce the Digital Competence Training Assessment Model (DCTAM) and demonstrate how it can be implemented using the Digital Training Companion (DTC). The DTC is a web-based educational technology designed to support teachers and trainers in evaluation implementation to regulate and enahnce their teaching. Although the tool is primarily focused on digital competence development, it is applicable to a broad range of educational contexts. Based on Guskey's model, the DCTAM provides a structured, multi-dimensional framework that conceptualises evaluation as a continuous process before, during and after training through research-based evaluation indicators. The DTC operationalises this model by facilitating visible, contextualised and competence-oriented evaluation processes. Key features include designing assessment cycles, collecting structured feedback, visualising data and documenting professional training in relation to teaching practice. The demo session combines a brief

conceptual introduction, a live demonstration of the tool's core functionalities, and hands-on interaction. Participants will explore selected features on their own devices and reflect on potential applications of the DTC in their professional contexts. The demonstration will highlight how educational technology can support more meaningful, coherent, and sustainable evaluation practices.

An AI-Augmented Orchestration Assistant for Supporting Collaborative Inquiry in the Classroom

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Teachers orchestrating collaborative inquiry must interpret student progress, participation, and scientific reasoning as learning unfolds. In game-based collaborative inquiry environments, these processes generate complex data that are difficult for teachers to synthesize during instruction in real time. This demonstration introduces the AI-Augmented Orchestration Assistant, a real-time teacher facilitation tool designed to support classroom orchestration in a collaborative, inquiry game-based learning environment.The Orchestration Assistant (OA) presents live visualizations of student progress, participation patterns, and scientific discussion at multiple social levels. It integrates mirroring, alerting, and advising features to support teacher awareness and facilitation decisions. The current version of the tool also includes an AI-supported summary of student participation that synthesizes interaction data into concise natural-language summaries. This supports rapid interpretation of group dynamics and is used in the end of day summary, which provides suggestions for next-day instruction based on an aggregated picture of overall class activity and progress.The session will present the design rationale, features, and data representations of the Orchestration Assistant using examples from our classroom implementations. Discussion will center on these design choices, interpretability, and implications for future research on teacher-facing analytics tools in collaborative inquiry learning environments.

The PROMPT App: Supporting Self-Regulated Learning Skills in Early Secondary Education

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Self-regulated learning (SRL) is a key prerequisite for successful learning, yet many students struggle to apply SRL strategies consistently in everyday learning situations, particularly in less structured learning settings. Mobile educational technologies offer a promising opportunity to support SRL in authentic learning environments, but evidence-based tools remain scarce. This technology demonstration introduces the PROMPT App, a mobile application designed for early secondary school students (aged 10 to 13) that supports the development of four core SRL strategies: distributed practice, goal setting, planning, and self-monitoring. The app teaches these strategies using vocabulary learning as an exemplary context, with the aim of fostering transferable self-regulatory skills. During the session, participants will engage with the app through guided hands-on activities that illustrate how its training missions, planning tools, self-monitoring features, and motivational elements scaffold SRL processes. The session concludes with a discussion of the app's educational applications, research potential, and opportunities for further development.