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EDITORIAL

Designing Effective Digital Learning Environments: Toward Learning Analytics Design

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The major lesson to be learned from over fifty years of research in the area of digital learning is that what happens in learning environments is quite complex and multi-faceted (Clark 1994; Ifenthaler 2010; Kozma 1994). Digital learning environments include any set of technology-based methods that can be applied to support learning and instruction (Wheeler 2012). There are many emerging opportunities for research in digital learning environments aiming to improve the student's experience and promoting deeper engagement to achieve higher order competences and learning outcomes as well as guarantee high-quality learning design and instruction. Accordingly, research in digital learning concentrates not so much on technology as on learning and instruction as well its design by avoiding techno-deterministic solutions in favour of the developments of tools that support the students' characteristics, learning processes, and instructional practice (Ifenthaler 2012). Accordingly, the design of learning environments offers optimal description for supporting learning processes and high engagement as well as reaching desired learning outcomes (Dalziel et al. 2016; Ge and Ifenthaler 2017).

Within these digital learning environments, vast amounts of information are collected that either come directly from the learner or secondarily from aggregations of those inputs which are further prescribed by algorithms (Ifenthaler 2015). Hence, the next frontier in educational research is a synergistic relationship between instructional design and learning analytics (Ifenthaler 2017). *Learning analytics design* involves the idea of using available information from various educational sources including learner characteristics, learner behavior, learner performance, as well as detailed information of the learning design (e.g., sequencing of events, task difficulty) for supporting pedagogical interventions and re-designs of learning environments (Berland et al. 2014; Ifenthaler and Widanapathirana

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2014). Learning analytics design will generate valuable insights for planning and optimizing learning environments. Educators may specify benchmarks which help to identify alignment or misalignment towards learning outcomes (Ifenthaler and Gosper 2014). In addition, detailed insights into learning processes may facilitate micro interventions whenever the learner needs it (Ifenthaler 2017).

The articles in this special issue stem from an interdisciplinary group of researchers, envisioning to facilitate scholarly research and theory focused on contemporary issues related to technology, instruction, cognition, and learning. Both, technological as well as pedagogical issues and manyfold implications for learning and instruction in digital learning environments will be presented.

1 Paper Selection Process

This special issue is assembled from the extended versions of best papers from the Special Interest Group *Technology, Instruction Cognition and Learning* (TICL; http://bit.ly/AERA-TICL) presented at the *American Educational Research Association* (AERA; www.aera.net) *2016 Annual Meeting* that was held in Washington, DC, USA in April 2016. Each contribution represents a unique research or technological approach that highlights the intersection of technology, instruction, cognition and learning.

During the *AERA 2016 Annual Meeting*, the editorial committee evaluated the paper presentations. Based on this evaluation and the previous results of the AERA double-blind review process, the highest ranked papers were selected for inclusion in this special issue. Authors of the selected papers were invited to extend their manuscripts for a full journal article by providing them detailed information about the journal's requirements. Authors submitted their full manuscripts by the end of October 2016. Each manuscript was assigned to at least three expert reviewers. Based on the comments of the reviewers and on the individual feedback of the editor, authors were asked to submit their final revised manuscript by the end of January 2017. The final acceptance of the six remaining manuscripts was completed by the end of May 2017.

2 Contributors to this Special Issue

This special issue begins with *Modeling Student Learning Behavior Patterns in an Online Science Inquiry Environment*. The authors, Daniel G. Brenner (WestEd STEM), Bryan J. Matlen (WestEd STEM), Michael J. Timms (Australian Council for Educational Research), Perman Gochyyev (UC Berkeley), Andrew Grillo-Hill (WestEd STEM), Kim Luttgen (WestEd STEM), and Marina Varfolomeeva (WestEd STEM), investigate how the frequency and level of assistance provided to students interact with prior knowledge to facilitate learning in a science inquiry-learning environment.

Brian C. Nelson (Arizona State University), Cassie Bowman (Arizona State University), and Judd Bowman (Arizona State University) address in *Designing for Data with Ask Dr. Discovery*: *Design Approaches for Facilitating Museum Evaluation with Real-Time Data Mining*, the need for ongoing, large-scale museum evaluation while investigating new ways to encourage museum visitors to engage deeply with museum content.

Introducing Computational Thinking to Young Learners: *Practicing Computational Perspectives Through Embodiment in Mathematics Education* by Woonhee Sung (Teachers College, Columbia University), Junghyun Ahn (Teachers College, Columbia

University), and John B. Black (Teachers College, Columbia University) aimed to bring computational thinking, an applicable skill set in computer science, into existing mathematics and programming education in elementary classrooms including recommendations for how to make the computational thinking process more concrete and relevant within the context of a standard curriculum, particularly mathematics.

Eunji Cho (University of Georgia), Kyunghwa Lee (University of Georgia), Shara Cherniak (University of Georgia), and Sung Eun Jung (University of Georgia) present in *Heterogeneous Associations of Second-Graders' Learning in Robotics Class,* a study of a robotics class in a public elementary school. The findings of the study encourage educators to pay careful attention to multiple elements, including the design of instructional materials and children's bodily exploration, associated with teaching and learning.

Affordance Access Matters: *Preschool Children's Learning Progressions While Interacting with Touch-Screen Mathematics Apps* by Emma P. Bullock (Utah State University), Jessica F. Shumway (Utah State University), Christina M. Watts (Utah State University), and Patricia S. Moyer-Packenham (Utah State University) contribute to the research on mathematics app use by very young children, and specifically mathematics apps for touch-screen mobile devices that contain virtual manipulatives. Their findings suggest that different affordances of apps were perceived in different ways, depending on the age of the child, and that these perceptions were observable in young children's patterns of behaviour.

The special issue concludes with *Teaching with Videogames*: *How Experience Impacts Classroom Integration*, by Amanda Bell (Vanderbilt University) and Melissa Gresalfi (Vanderbilt University). The authors explore the successful integration of games into instruction and argue that it requires teachers to shift instructional practices. Their findings point to the importance of considering the teacher's role when designing digital games for learning.

The six papers of this special issue demonstrate the many complex interactions between technology, instruction, cognition, and learning and the importance toward meaningful design for learning. The distinguished group of researchers of the AERA Special Interest Group *Technology, Instruction Cognition and Learning* propose implications for the transformative potential of digital technologies and shall be able to move forward toward utilising the potential of learning analytics design.

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