Technology Enhanced Learning

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Editors

Technology Enhanced Learning

Research Themes

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Preface

This book provides an introduction to research in learning with technology in classrooms, online and outdoors. Written by leading international researchers, it covers foundational theories and methods as well as recent research into learning in virtual worlds and in social networks. It also discusses social issues and implications such as whether widening access to digital technologies will decrease or increase inequality in education.

Each chapter in the book covers one theme in technology-enhanced learning (TEL), discussing and expanding on four foundational research papers in that theme. The chapters, plus the introduction chapter, can be read as a primer for people new to the field of TEL (also called "e-learning", "educational technology" or "cyber-learning"). Or a chapter can be a route to exploring the theme in more depth, through reading and discussing the selected papers guided by the chapter commentary. Inevitably, we have had to be selective in coverage, and some areas of TEL are not discussed in the depth they deserve, including evaluation of TEL systems, learning through simulations, orchestration of learning with technology and technology-enhanced learning in subject areas including science, technology, arts and languages. In this book, you will find pointers to further reading in these and other related areas.

The idea for this book came from Erik Duval, and he guided its production. Erik was a leader in the STELLAR Network of Excellence in Technology Enhanced Learning, a stimulating nexus of people and ideas from education, computing, psychology and the social sciences. Other outcomes from STELLAR include a Vision and Strategy report and a set of Grand Challenges in Technology Enhanced Learning.[1]

Erik Duval died on 12 March 2016 after two years of illness with leukaemia. Erik's blog[2] starts in 2003 with entries that mix his research interests with commentaries on technology and culture. As his illness takes hold, the blog charts

[1] http://www.teleurope.eu/

[2] erikduval.wordpress.com

in poignant detail his fears and hopes. The last entry from the 4th of January ends with typical optimism: “For now, I’m mostly hopeful and confident: I wish you all a hopeful and confident 2016 too!”.

Erik’s work exemplified the interdisciplinarity and continuing innovation of TEL. He researched and developed the core enabling technologies of learning objects and educational metadata and helped to establish learning analytics as a field of international research. As a teacher, he embraced open and social technologies, using his blog and Twitter to share ideas and communicate with students, and also led practice-based courses where students worked together, guided and inspired by Erik. Erik initiated this compendium of research in technology-enhanced learning, as he did many projects, with passion and commitment. In his name, we dedicate this book to all scholars of technology-enhanced learning who share a devotion to helping others learn.

Leuven, Belgium — Erik Duval
Milton Keynes, UK — Mike Sharples
Bristol, UK — Rosamund Sutherland

Contents

About the Editors and Authors

Editors

Erik Duval was full professor at the Katholieke Universiteit Leuven where he chaired the Informatics Section of the Computer Science Department and also chaired the Research Unit on Human-Computer Interaction. His research was situated in the long-standing quest to augment the human intellect, with a scope that included technology-enhanced learning and learning analytics, science 2.0, digital humanities, personal health and data journalism. He died on 12 March 2016.

Mike Sharples is professor of educational technology in the Institute of Educational Technology at The Open University, UK. He also has a post as academic lead for the FutureLearn company. His research involves human-centred design of new technologies and environments for learning. He inaugurated the mLearn conference series and was founding president of the International Association for Mobile Learning. He is associate editor-in-chief of *IEEE Transactions on Learning Technologies*. He is author of over 300 papers in the areas of educational technology, science education, human-centred design of personal technologies, artificial intelligence and cognitive science.

Rosamund Sutherland is professor of education at the University of Bristol and was formerly head of the Graduate School of Education. Her research is concerned with teaching and learning with ICT, young people's use of digital technologies outside school and mathematics education. She recently published the book *Education and Social Justice in a Digital Age*, and nowadays she uses her research to inform her work as governor of Merchants' Academy in South Bristol.

Authors

Hans Christian Arnseth is an associate professor in the Department of Education at the University of Oslo. He holds a PhD in the educational sciences in the field of technology-enhanced learning and specialises in how and what students learn in subjects in school and in their leisure time. His main contributions are in the field of computer-supported collaborative learning. Based on a sociocultural stance, he contributes with studies within themes like games and simulations, learning and identity, science education, learning across sites and methodological issues related to discourse and interaction analysis. He is a member of the editorial board of the the International Journal of Computer-Supported Learning (IJCSCL).

Brett Bligh is a lecturer in the Department of Educational Research at Lancaster University. He conducts research into the connections between our material surroundings, the technologies that permeate them and the ways we act, think and learn. Part of that research involves studying uses of technology in complex institutional settings and attendant approaches to organisational change. Brett uses activity theory to underpin his empirical work and also investigates that theory as a research object in its own right. His current work focusses on academic collaboration in the design of technology-rich university learning spaces.

Tom Boyle is emeritus professor at London Metropolitan University and former director of its Learning Technology Research Institute (LTRI) from 2000 to 2012. He championed the role of learning design in the learning objects movement as a complement to the predominantly technical emphasis on metadata and packaging. Professor Boyle led several projects that used ICT to significantly improve the quality of the learning experience for students, as measured both by student evaluation and improved pass rates. He has published widely on technology-enhanced learning both on theory and practical guides to development. The learning objects for Java that he designed won an EASA (European Academic Software Award) in 2004.

Michael Callaghan is a reader at Ulster University. His research interests include serious games, virtual worlds, remote experimentation/laboratories and e-learning. He is a fellow of the Higher Education Academy, is a distinguished fellow of the university, is an editor of the *International Journal of Online Engineering*, serves on the Scientific Advisory Board of the International Association of Online Engineering and is a reviewer for a number of IEEE journals and funding bodies including the AHRC, HEA and EU in his areas of expertise. He has been a grant holder on funded projects from the AHRC, DETI, INVESTNI, JISC and Higher Education Academy.

Ulrike Cress studied psychology and completed her PhD with a dissertation about self-regulated learning. She is the director of the Leibniz-Institut für Wissensmedien (IWM) and a full professor at the University of Tübingen in the Department of Psychology. In her lab Knowledge Construction, she researches social and cognitive

processes that are relevant for the joint construction and usage of knowledge. Her research foci include computer-supported collaborative learning (CSCL), mass collaboration, social software, knowledge management, embodied interaction as well as design and evaluation of media-supported learning and working environments.

Charles Crook is professor of education at the University of Nottingham and director of its Learning Sciences Research Institute. He has held posts at Brown, Strathclyde, Durham and Loughborough Universities. His main interest is in the psychology of human development, with special concern for young people's use of new social media. He has authored a number of papers developing a cultural psychological approach to educational practice and has published empirical papers in most of the major journals of developmental psychology. His current work is focussing on the integration of voice and image in young people's multimodal compositions.

Vania Dimitrova is an associate professor at the School of Computing, University of Leeds, UK. She is a member of the Knowledge Representation and Reasoning Group where she leads the research activity on user modelling and adaptive systems. Vania's research focuses on developing intelligent systems that adapt to individuals, groups and communities. Her research interests include learner/user modelling, dialogic interaction, knowledge capture, meta-cognitive skills, community adaptation, ontological modelling and reasoning.

Rebecca Eynon is an associate professor and senior research fellow at the University of Oxford. She holds a joint academic post between the Oxford Internet Institute (OII) and the Department of Education. Her research examines the relationships between technology, learning and inequalities, and she has carried out projects in a range of settings (higher education, schools and the home) and life stages (childhood, adolescence and late adulthood). She is co-author of *Teenagers and Technology* (Routledge, 2013) and *Education and Technology: Major Themes* (Routledge, 2015). Rebecca is co-editor of *Learning, Media and Technology*.

Liz Falconer is professor of technology-enhanced learning and director of the Education Innovation Centre at the University of the West of England, Bristol, UK. She is a chartered manager and member of the CMI and is a principal fellow of the Higher Education Academy. Her current area of research is in learning in immersive virtual environments and virtual worlds. She publishes in national and international journals and speaks at international conferences on subjects related to technology-enhanced learning, majoring upon situated and contextual learning in immersive virtual environments to support simulation and practice-based learning.

Gerhard Fischer is a professor adjunct and professor emeritus of computer science, a fellow of the Institute of Cognitive Science and the director of the Center for Lifelong Learning and Design (L3D) at the University of Colorado at Boulder. He is a member of the Computer-Human Interaction Academy, a fellow of the Association for Computing Machinery and a recipient of the RIGO Award of ACM-SIGDOC. In 2015, he was awarded an honorary doctorate from the University of Gothenburg,

Sweden. His research has focused on new conceptual frameworks and new media for learning, working and collaborating, human-centred computing and design.

Lyndsay Grant is a doctoral researcher at the University of Bristol. She has worked as a researcher in education, technology and society for over 10 years at the University of Bristol and previously at the independent educational technology research lab, Futurelab. Her research has explored social justice and digital inclusion, connections between learning in and outside schools with digital technologies and participatory approaches to the design of educational interventions using technologies. Her doctoral research focuses on the use of data technologies in schools.

Eelco Herder works as a senior researcher at the L3S Research Center in Hannover, Germany. His main research interests include Web personalisation, user modelling, usability and HCI in general. Other research topics include Web usage analysis and the development of tools for personal information management. He is board member of the SIG User Modeling Inc. and served as chair of ABIS, the German SIG on adaptive systems, between 2007 and 2015. Eelco served as programme, workshop, poster, publicity and local chair at various conferences, among which are Hypertext 2016, IUI 2015, Hypertext 2014, CHI 2012, UMAP 2010–2013 and Adaptive Hypermedia 2008.

Celia Hoyles is professor of mathematics education at the UCL Institute of Education. She holds a first class honours degree in mathematics and a master's and doctorate in mathematics education. Before moving into higher education, she taught in London secondary schools. An enduring research interest has been the design of computer environments to engage students in learning mathematics. She was the first recipient of the International Commission of Mathematics Instruction (ICMI) Hans Freudenthal Medal in 2004 and the Royal Society Kavli Education Medal in 2011. She was awarded foreign fellow of the Union of Bulgarian Mathematicians. She was the UK government's chief adviser for mathematics (2004–2007) and the director of the National Centre for Excellence in the Teaching of Mathematics (2007–2013). She was president of the Institute of Mathematics and Its Applications (IMA) (2014–2015). Celia was awarded an OBE in 2004 and made a dame commander of the Order of the British Empire in 2014 for services to mathematics and mathematics education.

Yael Kali is an associate professor of technology-enhanced learning in the Department of Learning, Instruction and Teacher Education at the University of Haifa. She is also the director of the Learning in a Networked Society (LINKS) of the Israeli Centers for Research Excellence (I-CORE). Using a design-based research approach, she explores technology-enhanced learning and teaching at various levels from junior high school to higher education and is especially interested in the role of design and design principles for supporting computer-supported collaborative learning (CSCL) and teacher professional development, in a teachers as designers (TaD) approach.

Sten Ludvigsen Professor Sten Ludvigsen holds a PhD in educational sciences (education psychology, from the University of Oslo, 1998). He led the Kaleidoscope European Network of Excellence (NoE) (Programme: Technology Enhanced Learning) from 2007 to 2008. He was director of InterMedia (2004–2009) and scientific leader of NATED: the National Research School in Educational Science (2008–2012) and now leads the research group Mediate at the Faculty of Education (2013–present). He leads the public committee that in 2015 delivered a report to the Norwegian government about the future of the Norwegian school system (K-12). He is the editor-in-chief for the *International Journal of Computer-Supported Collaborative Learning* (IJCSCL).

Susan McKenney is professor of teacher professionalisation, school development and educational technology at the University of Twente. Her research focuses on these three themes, especially in relation to curriculum design. She also studies synergetic research-practice interactions. In addition to authoring numerous articles, she co-edited the book, *Educational Design Research* and, together with Tom Reeves, wrote the book *Conducting Educational Design Research*. She currently serves as executive chair of the International Society for Design and Development in Education.

Richard Noss is professor of mathematics education at the University College London Institute of Education and, until the end of 2015, was director of the London Knowledge Lab for its first 11 years. Until it ended in 2012, he was director of the Technology Enhanced Learning Research Programme. He is a fellow of the Institute of Mathematics and Its Applications and a fellow of the Academy of the Social Sciences. Richard is a past editor-in-chief of the *International Journal of Computers for Mathematical Learning*. He was co-founder and deputy scientific manager of Kaleidoscope, the European network of excellence for technology-enhanced learning. Richard holds a master's degree in pure mathematics and a PhD in mathematical education, focusing on the educational potential of programming for learning mathematics.

Xavier Ochoa is a principal professor at the Faculty of Electrical and Computer Engineering at Escuela Superior Politécnica del Litoral (ESPOL) in Guayaquil, Ecuador. He is the coordinator of the Research Group on Teaching and Learning Technologies (TEA). He obtained his PhD at the University of Leuven in 2008 for his work on Learnometrics. Xavier has served in many coordination bodies in the field: the ARIADNE Foundation, the Latin American Community of Learning Objects and Technologies (LACLO), the Latin American Open Textbook Initiative (LATIn), the Global Learning Objects Brokered Exchange (GLOBE) and the Society for Learning Analytics Research. He coordinates several international and regional projects in the field of learning technologies. His main research interests revolve around multimodal learning analytics, curricular analytics and personalised learning. More information can be found at http://ariadne.cti.espol.edu.ec/xavier on standardisation in TEL, including ProLearn, MELT, MACE, ASPECT, iCoper, Share.TEC, OpenScout, weSPOT and ECO.

Carlo Perrotta is academic fellow in digital learning at the University of Leeds. He is interested in educational technology, and his background is in social psychology, sociology and cultural theory. He has carried out research about innovation in assessment, teacher beliefs, the datafication of education and the use of video games in schools.

Donatella Persico is senior researcher at the Institute for Educational Technology (ITD) of the Italian National Research Council (CNR). Her major research interests concern technology-enhanced learning and, specifically, learning design, e-learning, self-regulated learning, teacher training and digital scholarship. She has been lecturer of educational technology in several teacher training initiatives of the University of Genoa and presently sits on the board of the doctoral school of the Cà Foscari University of Venice. She is author of educational material and scientific publications of various kinds, including books, educational software, multimedia material and research papers concerning various aspects of educational technology. She is editor of the Italian journal *TD Tecnologie Didattiche*.

Maggi Savin-Baden is professor of education at the University of Worcester. Over the last 20 years, she has pioneered work on the use of problem-based learning nationally and internationally. To date she has published 13 books and over 50 research publications as well as gaining external funding to research and evaluate staff and student experience of learning. Her recent research is into cyber-influence. She has just completed her next book on *Research Methods for Education in the Digital Age* (with Gemma Tombs). In her spare time, she bakes, runs, rock-climbs, skis and attempts triathlons.

Sergey Sosnovsky is a group leader at the Center for e-Learning Technology (CeLTech), German Center for Artificial Intelligence (DFKI), and a principal researcher at the School of Education, Saarland University. He holds an MSc degree in information systems from Kazan State Technological University (Kazan, Russia) and a PhD degree in information sciences from the University of Pittsburgh (Pittsburgh, PA, USA). He is a receiver of the Marie Curie International Incoming Senior Fellowship and an author of about 100 peer-reviewed publications on various topics related to adaptive and intelligent educational systems. His research interests lie at the intersection of technology-enhanced learning, personalisation and semantic web technologies.

Daniel Spikol is assistant professor of media technology at the Faculty of Science and Technology, Malmö University, Sweden. His main research interests are in the design and development of mobile and ubiquitous environments that explore different modes of collaboration that foster formal and informal inquiry-based learning and play. Spikol is interested in expanding the role of design to support understanding how people can navigate across physical and virtual spaces in active and creative ways.

Karl Steffens is psychologist and senior researcher at the University of Cologne, Germany. He obtained his PhD from the University of Bonn and has been working at the Universities of Bonn, Cologne, Frankfurt, Erfurt and Barcelona (Spain). At the University of Barcelona, he conducted research in the field of ICT for a year with a grant from the European Commission. Since then, he participated in a number of European research projects and networks of excellence on technology-enhanced learning and on intercultural communication, with a focus on self-regulated learning in technology-enhanced learning environments. In his teaching, he focuses on learning and instruction, technology-enhanced learning, motivation, emotion and personality development, competences and assessment.

Stefaan Ternier is an assistant professor at the Welten Institute of The Open University of the Netherlands. From 2000 till 2008, Stefaan worked in the group of Erik Duval, as technical architect for the ARIADNE Foundation. His current areas of research include mobile learning, metadata management, architectures for learning object repositories and learning analytics. Stefaan was a member of the CEN/ISSS Workshop on Learning Technologies (WS/LT). At this workshop, he coordinated the developments of the Simple Publishing Interface (SPI) and contributed to several other standardisation initiatives (including SQI). Furthermore, he was involved in several European projects that had an impact.

Denise Whitelock is professor of technology-enhanced assessment and learning in the Institute of Educational Technology at The Open University. Her main research interests are concerned with automatic feedback systems that promote assessment for learning. She has been involved in a number of multidisciplinary collaborations. These are generating new thinking about modelling automatic socio-emotive feedback, which, combined with automated constructive cognitive comments, can enhance both student learning and motivation.

Katherine Wimpenny is co-lead for research in the Disruptive Media Learning Lab at Coventry University where she researches pedagogic development in new and disruptive spaces using methodologies including arts-related research, interactive documentary, qualitative research synthesis and evaluation research. Katherine works on a range of (inter)national projects enhancing the research capacity of the lab and its funding base, focusing on methodological and pedagogical creativity, open education practices and visual and experiential learning. She has over 40 publications including peer-reviewed research papers, scholarly reports, book chapters and a book on arts-related research. Katherine supervises three PhD students and has five completions.