

The Orchestrated Collaborative Classroom: Designing and Making Sense of Heterogeneous Ecologies of Teaching and Learning Resources

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Abstract: The physical face-to-face classroom still represents the core educational setting in which everyday CSCL practice takes place. However, current classrooms are not limited anymore to books, blackboards and other physical artifacts: laptops, tablets, digital whiteboards, wikis, shared applications and simulations have also become part of this learning landscape. These last ones add new layers of complexity to the everyday educational practices and the dynamics of the classroom. CSCL researchers have traditionally proposed standalone systems or innovations, focusing their evaluation on the effects and management of a single system/intervention. However, everyday classroom activities involve multiple subject matters, different pedagogical approaches as well as a variety of technologies. The assumption that our innovation is alone no longer holds. The multiplicity and heterogeneity of resources (digital and legacy) pose a unique set of opportunities and challenges for the CSCL research community, which are bound to become stronger as time goes by. This collaborative workshop brought together technology designers, researchers and practitioners, in an attempt to match CSCL technologies to the pedagogical needs and contextual constraints of practitioners, identify a set of guidelines to design and connect existing CSCL systems with each other and with legacy classroom resources, and help teachers and students to make sense of these heterogeneous learning ecologies.

Keywords: classroom, orchestration, design guidelines, heterogeneity, ecology of resources

Organizers' names and backgrounds

Luis P. Prieto is a Marie Curie postdoctoral fellow at the Computer Human Interaction for Learning and Instruction (CHILI) Lab in EPFL (Switzerland). He has done research on open architectures to communicate heterogeneous learning technologies, and currently he is modelling teacher orchestration load during collaborative work in technology-enhanced classrooms. He has organized multiple collaborative workshops for professional development of teachers, as well as for scientists in the context of research projects.

Yannis Dimitriadis is a Full Professor at the University of Valladolid, Spain, where he leads the GSIC/EMIC research group. His research interests include the technological support for orchestration of learning, from learning design to enactment and evaluation. He is an experienced workshop organizer, including several workshops in past editions of the CSCL and ICLS conferences, professional development workshops for teachers, and workshops in the context of research projects.

Andreas Harrer is currently leading the Human-Centered Information Systems group at the Technical University Clausthal. His research areas include collaborative technologies, interaction analysis and formal models for learning processes. He has co-organized and attended multiple CSCL workshops and symposia.

Marcelo Milrad is a Full Professor of Media Technology at the Linnaeus University in Sweden. His current research interests include the design of environments to support learning about complex domains, collaborative discovery learning and the development of mobile and wireless collaborative learning application. Professor Milrad has a wide experience organizing workshops and symposia in several events in Europe, Asia and the Americas. These include activities in past editions of the CSCL, ICLS and ICCE conferences, as well as

professional development workshops for teachers and various activities in the context of international research projects.

Miguel Nussbaum is a professor at the Computer Science Department of the School of Engineering of Pontificia Universidad Católica de Chile, member of Chile's Agency for Quality in Education since 2012, and from January 2015 he is co-editor of the *Computers & Education* journal. His work in instructional design, which integrates the use of technology, is focused on how to change teaching practices in the classroom to make children the protagonists of their learning experience. His scientific developments have been implemented in schools in Argentina, Brazil, Chile, Colombia, Costa Rica, the United States, Great Britain, Guatemala, India, Sweden and UK, and have received the support of UNESCO. He also studies the use of educational games in the classroom, and school effectiveness.

James D. Slotta is an Associate Professor of education at The University of Toronto, where he holds the Canada Research Chair in Education and Technology. Since 2005, he has directed the ENCORE lab (<http://encorelab.org>). ENCORE's research studies are often situated in smart classrooms, featuring user-contributed content, aggregated and emergent forms of knowledge, and a variety of scaffolds for the orchestration of individual, small group, and whole class activities. His current research is concerned with collective epistemology, immersive simulations, collaborative knowledge building, learning across contexts, and tangible and embodied forms of learning. Prof. Slotta participates in ICLS and CSCL workshops annually, and has organized or co-organized several of them, as well as interactive demo sessions and panels.

Workshop theme and goals

One of the major concerns of the CSCL research community in latest years is the apparent gap between the advances made by researchers, and the practice of computer-supported collaborative learning in everyday educational settings (Chan, 2011). This gap can also be related to the divergence between the relatively simple material conditions of learning in which many CSCL evaluations occur (to more clearly see the effects of such innovations), and the increasing heterogeneity and diversity of resource ecosystems (Luckin, 2008) that teachers and students face in their everyday learning. This diversity is apparent, not only in their physical classrooms (which no longer are solely a realm of books and blackboards), but also in other learning contexts that also end up connecting back to the classroom (mobile learning in museum visits, field trips, etc.). Such gap between research and practice has led some researchers within CSCL to focus on “orchestration” research (Dillenbourg, Järvelä & Fischer, 2009) as a way to study collaborative learning innovations within the multiple constraints of everyday educational settings (Roschelle, Dimitriadis & Hoppe, 2013).

The design, application and evaluation of CSCL innovations in everyday settings has been widely recognized as one of the grand challenges of technology-enhanced learning (Sutherland & Joubert, 2009), and it is a complex problem that involves multiple stakeholders from different perspectives:

- For educational technology developers, who need to find ways of integrating CSCL technologies with each other and with novel and legacy tools present in this “extended classroom”. This includes both standards-based solutions such as LTI (IMS Global Learning Consortium, 2012) as well as ad-hoc integrations of technological tools with a pedagogical purpose.
- For user experience designers and other HCI practitioners, to design novel interfaces that allow both students and teachers to make sense of the learning processes across the multiplicity of learning resources that are now available at their fingertips (e.g., Rick, Horn & Martínez-Maldonado, 2013).
- For learning scientists, to find technologies most adequate to support certain kinds of collaborative learning processes, or better yet, that support the multiple pedagogical approaches that often have to coexist in an authentic classroom.
- For all kinds of CSCL researchers, to find feasible yet rigorous techniques and methodologies to study learning and teaching processes within these resource ecologies, and to evaluate CSCL innovations applied to them (e.g., Prieto, Dimitriadis & Asensio-Pérez, 2014).
- For teachers, school leaders and also researchers, to understand and share their deep knowledge of the constraints and everyday practice of concrete classroom contexts, which very often will decide the success or failure of any attempt to scale up CSCL innovations (Roschelle et al., 2011).

This workshop brought together these five sub-communities within CSCL, with the goal of contributing, refining and critiquing expert guidelines for orchestrated collaborative classroom research that can help guide future CSCL research in everyday (formal) educational settings with an important face-to-face

component. The value of these principles was illustrated during the workshop through their application to address the challenges of concrete authentic classrooms contributed by practitioners and other participants. This application also helped participants to uncover still unsolved challenges and future research lines in orchestrated classroom research, and served to spark discussion among the aforementioned collectives, and prompted new joint research efforts. All these outcomes are being made available through the workshop's own website (1), where the CSCL community can benefit and still contribute to refine them.

Theoretical background and relevance to CSCL

Traditional CSCL research that laid the foundations of current CSCL approaches has often focused on the study of applying a single technology or tool to foster collaborative learning. Examples of such efforts can be found on Belvedere (e.g., Suthers, 2003), CSILE and Knowledge Forum (e.g., Scardamalia & Bereiter, 1994) and many others. While this kind of single tool/intervention study is essential to understand the effects of each novel element introduced in educational settings, as researchers we should not restrict ourselves to those approaches. The study of CSCL innovations within the authentic conditions of learning for many students (face-to-face classroom and its extension to field trips and other organized activities), and the unexpected interactions between the different technologies and pedagogical approaches bound to appear there, also remains essential if we are to scale-up our innovations beyond small-scale studies (Looi, So, Toh & Chen, 2011).

This tension between more controlled, deeper studies and a more ecological, systemic perspective, has a long history in the different research perspectives that made up CSCL: Nardi & O'Day (1999) advanced the notion of "information ecologies", and in the realm of HCI, Hollan, Hutchins & Kirsh (2000) proposed distributed cognition as a novel way to conceptualize how we interact and learn with computers. Within recent CSCL research, this pull towards research within the constraints of authentic (formal) educational settings and the need to scale up the results and innovations of our community has been exemplified by systemic approaches to CSCL innovation (Chan, 2011; Looi, So, Toh & Chen, 2011), and by the increased attention of researchers on the notion of "orchestration" as the study of the specific usability challenges within the authentic conditions and constraints of formal learning (Dillenbourg et al., 2011).

A new wave of CSCL studies and proposals, featuring the integration and combination of multiple tools to enable novel pedagogical situations, has been reported recently: the SAIL Smart Space (Tissenbaum, Lui & Slotta, 2012), CollBoard (Alvarez, Salavati, Nussbaum & Milrad, 2013) and GLUEPS-AR (Muñoz-Cristóbal et al., accepted) are only a few examples. However, so far many of these efforts have developed independently and in an isolated manner, without a shared corpus of principles, and often are implemented as one-off prototypes and ad-hoc integrations, studied in a limited number of case studies.

This workshop aimed at sharing and further developing our community's knowledge about how to design, implement, evaluate and apply CSCL innovations within the constraints of everyday "extended classrooms", which often feature heterogeneous resource ecologies. While this workshop can be considered a follow-up to a consolidated line of CSCL and ICLS events on the topic of orchestration, in this case the focus was more on the collaborative knowledge building process of eliciting principles and applying them to concrete classroom cases, by using well-known collaborative techniques such as jigsaw scripts, problem-based learning and the figure of critical friends (Stenhouse, 1975).

Expected outcomes and contributions

Participants contributed, before the workshop, an initial set of expert principles that could be reusable by the rest of the CSCL community, clustered around four main aspects of the orchestrated classroom: a) Integration and communication of heterogeneous learning technologies; b) Designing interfaces and spaces for heterogeneity; c) Methods and techniques to research heterogeneous ecologies; d) Linking pedagogy and heterogeneous technological resource ecologies. A fifth kind of contribution described concrete cases of such classroom ecologies and their challenges.

During the workshop event itself, participants clustered into expert groups to refine the initial contributions made under each of the aforementioned aspects, and later formed multidisciplinary groups to apply those principles to the concrete classroom resource ecologies proposed. From these collaborative knowledge-building activities, several outcomes emerged (1):

- A set of *expert guidelines* for research in orchestrated collaborative classrooms, distilled during the workshop
- A set of *concrete cases* of application of the expert principles, to illustrate their usefulness and prompt for further discussions within the CSCL community

- A set of *unsolved challenges* in addressing the heterogeneous ecologies of current and future classrooms, which indicate *future research directions* within this area of CSCL
- The seed for further joint efforts was sowed, to actually implement the solutions proposed to the concrete illustrative cases, and to pursue the research directions and unsolved challenges elicited

Endnotes

(1) See <https://sites.google.com/site/occw15/>.

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