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The richness of CSCL environments

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It has been a year of transition and challenge for the journal and we are excited to bring you the fourth edition of 2020. This fourth issue of the International Journal of Computer-supported Collaboration presents four full papers and a review of the upcoming International Handbook of Computer-supported Collaborative Learning.

The four papers illustrate the richness of CSCL environments: Learning can be supported by collaboration between individuals, by collaboration within groups, or by collaboration with artificial agents. Moderators of cooperation can be language, talk, gestures, or other forms of embodied actions, as well as material tools or artifacts. Prompts and scripts can provide scaffolds. Last, but not least, the surrounding environment, may it be furniture or digital tools, influence people's interactions and behavior through their affordances.

Each of the four papers featured in this issue deal with different slice through this rich tapestry.

The first paper, by Jianwei Zhang, Guangji Yuan and Maria Bogouslavsky, analyses knowledge building. And thus this paper draws from one of the most prominent theories in CSCL. The paper shows how knowledge building occurring within individual classes is extended through bridging into other classes through software that introduces cross-class interactions. Two grade-5/6 science classrooms, each taught by a different teacher, are interlinked in the Knowledge Forum via "super notes". These are notes that the classes can post in a cross-community meta-space. The super-notes serve as boundary objects that link the knowledge building processes taking place separately in each classroom. Whereas interaction within the two classes enable a kind of horizontal integration of ideas (where students within the same class incorporate additional topics, deal with the diversity of ideas among their peers, and integrate multiple information sources), the use of super notes allows for vertical moves in which the students dig deeper into the underlying issues and problems as progress is made and to "rise above" to higher planes of thinking and conceptualization.

The paper demonstrates how super-notes can prompt such rise-above syntheses, and how they can serve as and "epistemic ladder" that supports deeper understanding. While regular notes in the Knowledge Forum online discourse typically focus on direct responses to the ideas posted by classmates, super notes helped to consolidate knowledge advances. Students

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considered them mainly as a means to provide knowledge to others. Accordingly, both the teachers of both classrooms conceived the "super view" as a higher-level space of discourse where students formulated major questions and "big ideas" for cross-community sharing. Generalizing from these findings, the authors conclude that learning designs should support people in "climbing the social and epistemic ladders together". Super notes can serve as such an epistemic boundary object that boosts this form of epistemic and social emergence of ideas. In providing such affordances, knowledge building interaction can be sustained by idea interaction across levels and spaces. This provides a kind of maximal richness of knowledge building in CSCL environments.

The second paper, authored by Anu Kajamaa and Kristiina Kumpulainen, deals with a highly complex type of learning environment to study: makerspaces. These are materially rich collaborative learning and working environments where people have access to multiple digital and hands-on tools. Makerspaces are open in several senses: they are open for different people with different interests, heterogeneous levels of knowledge and engagement. They are also open with regard to the task people deal with, and the form of cooperation and participation realized within them. However, some effort is required to bridge between this very open format of makerspaces and what is already known about school learning in order to begin building an empirical foundation of knowledge regarding learning within makerspaces embedded in schools (Riikonen et al. 2020). The study of Anu Kajamaa and Kristiina Kumpulainen even deals with such a school-based makerspace, where students can engage in challenges ranging from designing jewelry to building a dream house with 3D modelling software, making windmills, solar-powered cars, laser mazes, and roller coasters.

The study analyses video records from two homogeneous-gender groups of students between the age of 9 and 12. Each group included four student members, with oversight from their teachers. The rich video data allowed the researchers to carry out a sociocultural discourse analysis where they annotated student talk and analyzed their knowledge creation. They considered verbal and non-verbal embodied actions, students' interactions with epistemic objects, material artifacts and spatial arrangement.

The authors identified four intertwined multimodal knowledge practices: Orientation to knowledge, interpreting knowledge, concretizing knowledge and expanding knowledge. The study shows that each of these practices includes special forms of embodied actions, typical positioning in the physical space, special forms of talk and ways of thinking, and interacting with tools, artifacts and people. The processes differed with regard to their dynamics: some processes were more straightforward, others changed their direction, iterated and repeated parts of the processes. In some situations discourse, gestures, postures and the joint use of digital and hands-on materials accompanied knowledge creation, which in others the verbal mode was absent.

Maker spaces may be the richest learning environments we can offer students for learning. So, the authors claim with some justification that their findings will further inform the design and implementation of novel pedagogical approaches, that consider multiple mediations at the intersection between tacit and explicit knowledge. There is still much to learn, and we hope to receive more such papers.

The final study, that of María Jesús Rodríguez-Triana, Luis P. Prieto, Tobias Ley, Ton de Jong and Denis Gillet, deals with another kind of richness, namely the richness that results from the linkage between theory and practice. The large-scale study is conducted using data from Go-Lab, a large teachers' online community where teachers exchange knowledge and materials about instructional design for inquiry learning. Several tools and platforms link community members and provide them with access to online labs, apps and other resources.

The platforms allow not just for sharing, but also for refining and reusing ideas and materials, which are called Inquiry Learning Spaces (ILS). Tracing their provision, revision, use and re-use allows the authors to observe individual and social processes of professional learning. The online community is a great example of mass collaboration (Cress, Jeong & Moskaliuk 2016; Roque et al. 2016), where users use the platform in order to reach individual goals, and simultaneously. However, there is an increasing synergy through the shared resources, the communities create (Jeong, Cress, Mosakliuk & Kimmerle 2017).

The authors observe this process through the lens of the *Knowledge Appropriation Model* (Ley et al. 2020). It integrates three processes: *Knowledge maturing* transforms individual knowledge to a collective level. People share their own ILSs with others, co-create them collaboratively and publishing them in order to make them accessible to others. Other people, who did not contribute to this creation process, can use the provided materials. This makes the ILSs become more and more standardized, and it can become part of a social practice. *Scaffolding practices* support individuals, who need help for a concrete problem in applying ILSs in their concrete working situations. Through *knowledge appropriation* individuals become aware of already existing knowledge about typical problems and about possible solutions. They can interact with others, share and refine their ideas, and adapt existing solutions to new situations.

The authors conducted an empirical study by tracing the development and use of about 40,000 ILSs and showing how teachers use them in their classroom practice. For each ILS they defined indicators for the processes that are regarded in the knowledge appropriation model. For example: indicators for knowledge maturing are the numbers of created, shared, co-edited, published and used ILSs. Knowledge scaffolding is measured by the frequency with which the teachers requested help from others, and knowledge appropriation by people's participation in activity events, or the frequency of reusing and refining existing ILSs. As a dependent variable the authors noted whether an ILS was implemented in a classroom. The study was able to show that almost all indicators had an effect. For example: the higher the maturation level (from create, share, co-create to publish), the higher the probability that an ILS has been implemented. Re-used ILSs were about four times more likely to have been implemented than those created from scratch. Scaffolding increased the implementation rate.

In sum, the impressive study was able to show the potential of online communities for increasing professional teaching knowledge. The exchange of knowledge through shared platforms had not just an influence on teachers' internal knowledge, but also on their classroom practice.

In addition to the substantial practical significance, the study is a great example of how data from communities forming around shared platforms allow observing complex interactions between individual and social processes. The study proposes a rich theoretical model that describes circles of maturation and appropriation. It includes processes at the individual level, the social level, and the interaction between the two. It is remarkable that the statistics, which are used in order to test the hypotheses, are quite simple at the end. This is possible because the complexity and richness is in the conceptual model, not in the statistics. It allows working with relatively easily measurable indicators. Nevertheless, this simple methodology is able to enlighten the complex processes of intraindividual knowledge transfer and collective knowledge practices.

Whereas the above described three papers deal with teaching and learning in schools, the paper of Yugo Hayashi is more universal, and shows in a more abstract way how learners can be supported through emerging technologies. In an experimental setting the author observes learning dyads that are involved in a kind of jigsaw-task. For the task, the learning partners are

required to communicate their knowledge, coordinate their activities and make use of each other's knowledge. This is a complex mechanism itself, but it may be even more complicated in a setting where people are not able to interact face-to-face. In a computer-mediated situation, digital tools may compensate for missing social cues. These may even be able to enrich the situation by providing stimuli that would not be present in direct interaction.

The study measures two such tools: One is more implicit: It is an awareness tool (Janssen and Bodemer 2013), making both learners aware of their partner's gaze. This is possible through eye-trackers that measure learners' gazes and present them on the partner's screen where the texts is provided. This makes each person aware of what part of the learning material the learning partner is focusing on, how fast he or she is moving through the material, and where he or she pauses.

The other tool that the study investigates is a more explicit tool. It is a pedagogical conversational agent that automatically analyzes a learners' text and automatically provides explicit – almost script-like - prompts such as: "Please remember that the task is to explain the topic using the two concepts" or "when you have finished explaining one concept, switch turns."

The study tested both tools in a 2×2 experimental design. As dependend variables the author identified stances of mutual understanding, dialogue management, or reciprocal interaction. An important dependent measure was the learning gains of each student within pairs. The analysis included an assessment of how well a learner explained the concept of their own assigned area of expertise, the concept assigned to their partner, and of the entire phenomena, which required the integration of both concepts.

The results show a positive effect of gaze awareness on the collaborative process. The gaze-awareness tool affected dialog management, information pooling and consensus reaching. The effect of the agent, providing metacognitive support, was much smaller. It seems that an agent was able to compensate if there was no gaze awareness. So, this study shows once more that an implicit awareness tool may often be even more effective than an explicit tool. Other studies have shown the potency of implicit tools (Rummel et al. 2009; Miller and Hadwin 2015), though explicit scaffolding can serve a norm-setting function that appears to be absent in implicit forms of support (Wang et al. 2017).

In sum, the four studies paint a broad canvas illustrating the large range of possible configurations of support for collaboration: from hands-on materials, to technologically rich tools; from individual, volatile gestures and gazes to permanent existing, material artifacts, and from individual internal knowledge to collaborative, shared practices. It is always the richness that makes learning in CSCL so attractive and effective.

The issue ends with a review of the International Handbook of Computer-Supported Collaborative Learning, written by Jeremy Roschelle. The handbook will appear 2021 in the CSCL-book series published by Springer. It is the first international handbook of CSCL, and it will be "a landmark for this thirty-year-old field within the learning sciences", as Roschelle writes. The book, edited by Ulrike Cress et al. (2020) provides 35 chapters, grouped into four sections about theories, processes, methods and tools for CSCL. Roschelle suggest that readers can see this Handbook either "as a consensus about the state of the art, upon which they can build the next layer of scholarship" or as "this book as describing the disequilibria in CSCL—the unresolved tensions, unmet challenges, unrealized opportunities—that present scholars within opportunities to make their mark in more creative, transformative or potentially paradigm-shifting ways". The handbook thereby offers two complementary resources to scholars who wish to advance "the next 30 years of CSCL: a consensus they can build upon and disequilibria they can tackle with creativity and verve to make their mark."

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It will be the task of the readers to verify both interpretations when they go through the handbook with its chapters. Whether they primarily perceive consensus or disequilibria - they will encounter the richness of CSCL.

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