# **AUTHOR'S PROOF**

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# Investigating the complexity of computer-supported collaborative learning in action

U. Cress<sup>1</sup> • C. P. Rosé<sup>2</sup> • N. Law<sup>3</sup> • S. Ludvigsen<sup>4</sup>

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## Introduction

One of the most notable developments in computer-supported collaborative learning (CSCL) 12 over the years has dealt with the scale and scope of the research. Early CSCL research typically 13investigated scenarios that were quite restricted (e.g., by doing controlled laboratory experi-14ments on non-representative student samples, focusing on learning outcomes rather than 15learning processes, or by analyzing snippets of interaction). However, as our field matures, 16research increasingly addresses the complexity of real CSCL settings as they unfold. As a 17 consequence, much contemporary CSCL research not only focuses on the core of CSCL 18 (technologically mediated peer-learning interactions) but also on how CSCL interactions may 19develop within larger social systems and practices, taking account of the contextual constraints 20and affordances. The papers in the current issue of the International Journal of Computer-21Supported Collaborative Learning all provide excellent examples of how CSCL's core 22processes are affected by a combination of intentional design elements and properties of 23existing contexts. 24

When CSCL is an integral part of regular classroom practice, the context of the collabo-25rative interaction is largely defined by teachers who orchestrate, monitor, and guide CSCL26activities among peer learners (Matuk and Linn 2018). In other CSCL contexts, embedded27

S. Ludvigsen s.r.ludvigsen@iped.uio.no

> U. Cress u.cress@iwm-tuebingen.de

C. P. Rosé cprose@cs.cmu.edu

N. Law nlaw@hku.hk

- <sup>1</sup> Leibniz-Institut für Wissensmedien (Knowledge Media Research Center), Tübingen, Germany
- <sup>2</sup> Carnegie Mellon University Language Technologies Institute and HCI Institute, Pittsburgh, PA, USA
- <sup>3</sup> University of Hong Kong, Hong Kong, China
- <sup>4</sup> University of Oslo, Oslo, Norway

designs bring learners into contact with practitioners from other professional fields or simulate28authentic learning environments in the classroom.29

A taxonomy for conceptualizing authenticity is the focus of the first paper (Hod & Sagy). 30 The second paper in this issue (van Heijst, de Jong, van Aalst, de Hoog, & Kirschner) 31investigates how the dynamics of CSCL discourse may be affected by the socio-cognitive 32 openness of the context. In the third paper, Slakmon and Schwarz raise questions about how to 33 balance social, cognitive, and emotional aspects in hot-topic discussions. They show that 34emotions are often neglected both conceptually and empirically. They also demonstrate how 35emotions can be accounted for and how we can design CSCL environments that involve 36 emotions in hot-topic discussions. 37

The final two contributions are responses to the ongoing discussions based on the Wise and 38 Schwarz (2017) squib which raised eight provocations for the field. The squib contribution 39from Borge and Mercier reflects on the idea that a proper analysis of the contextual richness of 40CSCL activities requires a micro-ecological approach that might go beyond standard theoret-41 ical conceptualizations. In the other squib, Tchounikine argues that we need to take account of 42the learner's agency and understand how emancipatory agency can be realized in CSCL 43 settings. The authors question many established assumptions in the CSCL field. Both squibs 44 should provoke the CSCL community to continue the discussion. 45

#### Authentic learning contexts for CSCL: a taxonomy

Socio-cultural theories of learning have made important contributions to our understanding of 47contextual factors. A central tenet of these approaches is that learning is a process of 48 enculturation; through participation in the activities of a community of practice, learners 49acquire the norms, values, and skills that shape the core identity of the community (Brown 50et al. 1989; White 2018). Socio-cultural theories have therefore posited that enculturation 51requires students to get into contact with the practices of different professional cultures, a claim 52that is generally subsumed under the umbrella term "authentic learning environments" 53(Edelson and Reiser 2006). Many empirical studies have provided excellent examples of 54how the authenticity of learning environments can be established or increased. However, due 55to the vast scope of contexts found in studies of classroom practice, it is difficult to conduct 56systematic comparisons of authenticity in empirical studies. 57

In order to address this difficulty, the paper by Hod and Sagy offers a taxonomy and conceptualization to categorize and compare different authentic learning scenarios. This 59 conceptualization builds on a basic distinction between simulation environments and hybrid 60 environments. In a simulated environment within a classroom context, attempts are made to 61 match or approximate a learning environment to an authentic culture. In a hybrid environment, 62 students interact with practitioners of a professional culture, and these interactions at least 63 partially take place in the professional setting itself. 64

Hod and Sagy reviewed a corpus of more than 40 scientific papers that describe authentic 65 learning environments, focusing on 23 articles that provide extensive information about 66 authentic design. The top level of their classification of the learning environments comprised 67 two categories: simulation or hybrid. For each of these two broad categories, Hod and Sagy 68 propose a list of five descriptors to characterize the different contexts and scenarios: type of 69 participants, the setting, the temporal dimension of collaboration (timeframe), the kind of 70 computer support used, and the if the collaboration was meaningful. The authors have also 71 Intern. J. Comput.-Support. Collab. Learn.

developed a specific type of visualization that displays the relations between participants,72settings, and cultures. This helps to identify commonalities and differences between authentic73learning environments.74

Based on their review the authors identified a baseline simulation approach, a baseline 75 hybrid approach, and characteristic variations of these baseline types. By matching the two 76 different basic approaches and their variants to the five dimensions, Hod and Sagy identify 77 meaningful patterns. For instance, simulation and hybrid approaches do not necessarily differ 78 with regard to participants or the extent they experience the collaboration as meaningful. 79

Many empirical papers have provided best-practice examples of how learning environments can be designed. However, as many of these papers present case studies, they are difficult to compare. The taxonomy by Hod and Sagy provides a framework for classifying authentic learning environments that can be used to assess the existing fieldwork and to guide future research. 84

#### Cognitive and social openness: a new construct for CSCL?

While the other contributions in this issue address CSCL contextual factors on a meso level86(e.g., in orchestrating classroom activities), the paper by van Heijst et al. examines the87contextual factors of the core CSCL processes themselves.88

Knowledge-building through the mutual refinement of ideas and explanations is generally 89 regarded as the key process in CSCL activities. Yet, while knowledge building is at the heart of 90 CSCL, many empirical studies have shown that the actual levels of knowledge-building 91reached are not very high. Van Heijst et al. discuss how students sometimes do not build 92upon the prior work of their peers and need scaffolding to do so (Wang et al. 2017). This led 93 the authors to develop a new explanatory construct for CSCL, which they call socio-cognitive 94openness. Based on the focal constructs developed by various CSCL scholars, van Heijst et al. 95distinguish between two dimensions of openness (cognitive and social) that can be further 96 divided into four knowledge-building discourse acts (knowledge-building, the expression of 97 uncertainty, community orientation, the expression of self) and into eight different compo-98nents. Van Heijst et al. have empirically tested the framework of socio-cognitive openness by 99 careful analysis and coding of Knowledge Forum contributions. The subjects were two mixed 100cohorts of students and teachers that participated in courses with the theme of learning and 101 innovation. After validating the two-factor structure of the socio-cognitive openness construct, 102van Heijen et al. investigated the frequency of the eight components in student's discourse and 103the likelihood that the expression of a particular component led to follow-up. 104

Results indicated that three of the eight components were present in the large majority of 105Knowledge Forum notes (connecting knowledge, transactivity, authority). Interestingly, two of 106these components of openness (transactivity, authority) were associated with decreased rather 107than increased likelihood of follow-up. However, when participants were connecting knowl-108edge, justifying knowledge (which they rarely did), and inviting responses (which they also 109rarely did), their notes were more likely to receive follow-up. In other words, whereas 110components of cognitive openness seemed to invite further knowledge-building, expressing 111 social openness actually had slightly detrimental effects on follow-up. 112

The notion of socio-cognitive openness offers some promising potential to advance our 113 understanding of the contextual factors that influence knowledge-building activities. The 114 expression of openness is a great candidate in describing the glue that creates knowledge-115

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building. Further conceptual and empirical research could try to combine socio-cognitive	116
openness with related factors in social sciences, such as trust (Balliet and Van Lange 2013)	117
or social capital (Coleman 1988).	118

#### Talk, cognition, and emotions in CSCL settings

Talk, artefacts, and social interaction constitute the foundation for supporting CSCL participants.120pants. Particular CSCL designs can support, facilitate, and structure how cognition and121emotions play out in collaborative efforts. In CSCL (as in many other fields of knowledge),122emotions have not been given adequate attention. One exception is the paper by Polo et al.123(2016) published in a previous edition of this journal; it analyzes emotion as part of social and124cognitive processes in argumentation.125

In "Deliberate Emotional Talk," the paper by Slakmon and Schwartz, emotions are treated 126127 as central aspects when students engage in dialogue on hot and controversial topics. The perspectives that inform the foundation of the paper are very rich. The authors draw on ideas 128and research from political education, dialogical theory, cognitive development, and CSCL 129studies. The review shows that emotions are seldom explicitly analyzed in contexts such as 130conversations. The authors apply a critical review to the classical contributions of Piaget as 131well as more recent dialogical approaches (Mercer and Dawes 2014; Perret-Clermont 1980). 13202 The authors emphasize that in the conceptualization of conversations, social aspects and the 133balance between cognition and emotions need to be considered. 134

In this study, the digital environment in which the students engaged in conversation is 135called the "Hot Discussions Platform (HDP)." This platform affords both written and oral 136contributions. The oral contributions take place in small groups. The design also includes a 137reflection mode in which a moderator can freeze the discussion or make select aspects of the 138discourse available for participants. The selected aspects can be used as resources for a new 139layer of discourse. The subjects in the study were 25 teachers enrolled in a course on 140professional development. The participants were assigned to different group configurations 141 during the course. They were given open-ended tasks that were potentially hot and 142controversial. 143

The findings are interesting and point to new directions for CSCL research. Given that 144 digital environments such as hot-topic discussion platforms are viewed as lived spaces for 145 todays' generation of students, they will become increasingly important in educational practices. The implication for CSCL is that we need to design more refined and nuanced tools and 147 environments connected to large infrastructure that can provide data for improvement. Such 148 improvement also needs to be based on studies of social practices, such as that of Slakmon and Schwarz in this edition. 150

### New squibs: two new contribution to the provocations – 151 the conversation continues 152

The ijCSCL paper by Wise and Schwarz (2017) was poignant and provocative, and it is 153 encouraging that it continues to garner "squib" responses from the CSCL community. In this 154 issue, we publish two squibs, one by Marcela Borge and Emma Mercier and the other by 155 Pierre Tchounikine. 156

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Borge and Mercier provide a brief overview of the four overarching learning theories within 157CSCL (information-processing perspective, constructivism, socio-constructivist/socio-158cultural approaches, group cognition), arguing that each of these approaches has 159developed theoretical lenses that are too narrow to capture the true contextual richness 160of CSCL in action. As an alternative to the four perspectives, Borge and Mercier 161propose a micro-ecological approach that cuts across multiple levels of analysis 162(individual, group, community) and analyzes how each of these levels influences 163and is influenced by the other levels. 164

Borge and Mercier argue that, for instance, simply analyzing episodes on one level would 165leave many events unexplained (e.g., why the facilitators came up with different orchestration 166moves, why one student destroyed the Minecraft world). A full picture could only emerge if 167one also looks at activities at the community/group level (e.g., it was one particular group that 168noticed the server failure) and the individual level (e.g., it was one student who tried to 169individually solve the technical problem before facilitators turned that effort into a collabora-170tive endeavor). It remains to be seen if such a micro-ecological approach could offer a new 171analytical lens, since the socio-cultural perspective has combined various levels of analysis for 172many years (Steier et al. 2019; Solli et al. 2018; White 2018). The approach developed by 173Cress and colleagues has also worked to connect levels of analysis, such as cognition and 174social systems (Cress and Kimmerle 2008). 175

Whether a micro-ecological approach could bridge the gaps between different epistemol-<br/>ogies in CSCL and provide a viable solution for the commensurability in Wise and Schwarz's<br/>(2017) provocations is an interesting problem. In any case, the squib by Borge and Mercier is<br/>an important reminder that many of us tend to see the field of CSCL through a particular<br/>theoretical lens.176178179180

In the squib by Tchounikine, the author raises questions about how CSCL treats the 181 learner's agency. He argues that CSCL settings are often predefined for learners. Participants 182are expected to use specific features of a setting or environment but not to choose digital tools 183(types of software) of their own selection as part of their learning. Tchounikine emphasizes that 184we should start understanding participants' actions and activities from an emancipatory 185perspective. This implies that participants should be given the opportunity to select, change, 186and combine the technologies that they think would be most beneficial for their learning 187 trajectories. Such trajectories would not be possible without a deep appropriation of a set of 188different digital tools. 189

Do Tchounikine's arguments exclude CSCL designs? He argues not, but design should be190envisioned from the perspective of participants' agency. The use of digital tools and environ-191ments can bring us down unexpected paths, which means that what can be learned cannot be192fully defined in advance. Learning can become an expansive activity beyond what is given in193predefined tasks.194

Empowering participants through emancipation might imply different forms of feedback. In 195CSCL, learning analytics are an emerging and important topic. Analytics for supporting 196collaborative learning have a long history in CSCL, and many core CSCL concepts should 197be seen as part of supporting participants in their engagement. Tchounikine views analytics 198from the perspective of how it can emancipate the learner's agency. He argues that feedback 199should be viewed as a means for raising awareness and recommendations that the learner must 200choose to act on. From an editorial perspective, one can ask is Tchounikine's line of argument 201realistic or romantic? We hope our readers can examine and engage with the problems that are 202emphasized in this squib. 203

# Conclusion

The mutual refinement of ideas through interaction, arguably constitutes the core process of<br/>CSCL. However, the contributions in this issue of the IJCSCL nicely illustrate how this core<br/>process is embedded within multiple contextual layers, which influence the conversations and<br/>interactions in multiple ways, each of which needs to be analyzed, understood, and ultimately<br/>integrated into the orchestration and facilitation of CSCL activities.205<br/>208

# References

- Balliet, D., & Van Lange, P. A. M. (2013). Trust, conflict, and cooperation: A meta-analysis. *Psychological* 212 *Bulletin, 139*, 1090–1112. 213
- Brown, J. S., Collins, A., Duguid, P., & Brown, S. (1989). Situated cognition and the culture of learning. 214 *Educational Researcher, 18*(1), 32–42. 215
- Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, 216 94, 95–120. 217 Cress. U., & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with 218
- Cress, U., & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with wikis. *International Journal of Computer-Supported Collaborative Learning*, 3(2), 105–122.
- Edelson, D., & Reiser, B. (2006). Making authentic practices accessible to learning: Design challenges and strategies. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 335–354). New York: Cambridge University Press.
- Matuk, C., & Linn, M. C. (2018). Why and how do middle school students exchange ideas during science inquiry? *International Journal of Computer-Supported Collaborative Learning*, 13(3), 263–299. https://doi.org/10.1007/s11412-018-9282-1.
- Mercer, N., & Dawes, L. (2014). The study of talk between teachers and students, from the 1970s until the 2010s. Oxford Review of Education, 40(4), 430–445.
- Perret-Clermont, A. N. (1980). Social interaction and cognitive development in children. London: Academic.
- Polo, C., Lund, K., Plantin, C., & Niccolai, G. P. (2016). Group emotions: The social and cognitive functions of emotions in argumentation. *International Journal of Computer-Supported Collaborative Learning*, 11(2), 123–156.
- Sinha, S., Rogat, T. K., Adams-Wiggins, K. R., & Hmelo-Silver, C. E. (2015). Collaborative group engagement in a computer-supported inquiry learning environment. *International Journal of Computer Supported Collaborative Learning*, 10(3), 273–307.
- Solli, A., Mäkitalo, Å., & Hillman, T. (2018). Rendering controversial socioscientific issues legible through digital mapping tools. *International Journal of Computer-Supported Collaborative Learning*, 13, 391–418.
- Steier, R., Kersting, M., & Silseth, K. (2019). Imagining with improvised representations in CSCL environments. International Journal of Computer-Supported Collaborative Learning, 14(1), 109–136.
- Van Es, E. A., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education*, 10(4), 571–596.
- Verbert, K., Duval, E., Klerkx, J., Govaerts, S., & Santos, J. L. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, 57(10), 1500–1509.
- Wang, X., Kollar, I., Stegmann, K., & Intern, J. (2017). Adaptable scripting to foster regulation processes and skills in computer-supported collaborative learning. *International Journal of Computer-Supported Collaborative Learning*, 12(2), 153–172. https://doi.org/10.1007/s11412-017-9254-x.
- White, T. (2018). Connecting levels of activity with classroom network technology. *International Journal of Computer-Supported Collaborative Learning*, 13(1), 93–122. https://doi.org/10.1007/s11412-018-9272-3.
  Wise, A. F., & Schwarz, B. B. (2017). Visions of CSCL: Eight provocations for the future of the field.
- Wise, A. F., & Schwarz, B. B. (2017). Visions of CSCL: Eight provocations for the future of the field. International Journal of Computer-Supported Collaborative Learning, 12(4), 423–467.

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