The Assistance Dilemma in CSCL

Chairs
Manu Kapur, Learning Sciences Laboratory, National Institute of Education, Nanyang Technological University, Singapore, manu.kapur@nie.edu.sg
Nikol Rummel, University of Freiburg, Institute of Psychology, Engelbergerstr. 41, 79085 Freiburg, Germany, rummel@psychologie.uni-freiburg.de

Discussant
Pierre Dillenbourg, Professor of Computer Science at Swiss Federal Institute of Technology in Lausanne (EPFL), pierre.dillenbourg@epfl.ch

Abstract: How to design structure for supporting collaborative learning is a fundamental theoretical and design issue in CSCL research. At the center of this issue lies an assistance dilemma: when to provide support structures and when to withhold them (at least temporarily) to optimize student learning. On the one hand, providing support structures right from the start has the advantage of reducing cognitive load, avoiding floundering and potential frustration. It may well lead to productive success, but there is also the danger of unproductive success—an illusion of performance without learning. On the other hand, withholding support may well lead to productive failure as students persist in active sense-making and problem-solving activities, but there is the danger of unproductive failure in students being overwhelmed. This symposium aims to interrogate issues pertinent to the assistance dilemma continuum by bringing together an eclectic group of CSCL researchers with commitments on various points on the continuum.

Symposium Overview
Research on collaborative learning and problem solving suggests that productive collaboration does not automatically materialize when learners are left to their own devices (e.g., Salomon & Globerson, 1989). It is not surprising therefore that CSCL research focuses on structuring the process of collaboration so as to help learners achieve what they might not otherwise be able to in the absence of the structure. Structure, broadly conceived, has been operationalized in a variety of ways such as structuring the problem itself, process scaffolds and scripts, provision of tools, expert help, adaptive feedback, and so on (Puntambekar & Hübscher, 2005; Stahl, 2007). The question of what makes for optimal support for learning remains invariant across the diverse operationalizations of structure. In the context of individual learning, the problem of optimality is also known as the Assistance Dilemma (Koedinger & Aleven, 2007), that is, when and how to design structure for learning. In this symposium we attempt to broaden the discussion to the area of CSCL. On the one hand, there are CSCL researchers who propose structuring of collaborative processes, e.g., through interactional scripts (e.g., Fischer, Kollar, Haake, & Mandl, 2007). Research in this tradition generally supports the notion that structure should be provided right from the start, and potentially be reduced or faded later. A substantial amount of CSCL research speaks to this because understanding conditions under which structure can lead to productive success is an important line of research. On the other hand, there are CSCL researchers who examine conditions under which delaying structure may well be more beneficial than structuring from the outset especially in the longer term. For example, Kapur (2008) reported findings to suggest that there are conditions under which delaying structure in learning and problem solving activities can lead to productive failure. Along this continuum exist other positions that argue for adaptive ways of providing structure in CSCL (e.g., Rummel & Weinberger, 2008). The idea here is to scaffold collaboration in an adaptive fashion, based on the dynamically changing needs of the specific collaborators. The adaptive approach may serve as a bridge; adaptiveness would ideally take into account the benefit of providing or withholding support during collaboration. Implementing adaptiveness in such a manner seems particularly possible and potentially useful for CSCL settings.

The purpose of this symposium is to bring together an eclectic group of researchers with commitments to various points on the continuum in an effort to interrogate the assistance dilemma in CSCL. The symposium comprises three papers. Paper 1 presents findings from laboratory and field studies to suggest that providing collaboration scripts first and then fading them out engenders productive success, as evidenced by learning gains in domain-specific knowledge. In contrast to Paper 1 where structure was first provided and then faded, Paper 2 reports on a study where structure (in the form of problem-solving scaffolds) was first withheld and then provided, but only after students had persisted in agent-based modeling activities for learning concepts in Electricity. Compared with CSCL dyads whose problem-solving activities were heavily structured, dyads in the productive failure condition (who experienced a delay in structure) demonstrated significantly better learning gains. Paper 3 reports on a program of research that argues for adaptive structuring of CSCL groups.
Consolidating findings from a series of studies on computer-mediated individual and collaborative learning, the authors explore ways of designing for adaptive support in a computer-supported collaborative learning context.

Taken together, the three papers present different operationalization and designs for how and when one might structure CSCL groups. In so doing, these lines of inquiry speak to designing for productive success, productive failure, and adaptive support in important ways. More importantly, the symposium will provide an opportunity for these lines of inquiry to push back against and inform each other. Consequently, we might also achieve better understandings of conditions under which designs lead to unproductive success (an illusion of performance without learning) as well as unproductive failure (struggling without any learning).

**Paper 1: Fostering domain-specific knowledge through the fading of scripts**

*Authors: Christof Wecker, Ingo Kollar & Frank Fischer, Department of Psychology, Ludwig-Maximilians-Universität (LMU), München, Germany*

The instructional approach of collaboration scripts (see Kollar, Fischer, & Hesse, 2006) has been suggested in CSCL as a form of socio-cognitive scaffolding to overcome problems of coordination, argumentation, and individual knowledge acquisition. The findings are promising (e.g., Stegmann, Weinberger & Fischer, 2007), but so far mostly limited to studies of short duration where learners were not expected to gradually take over control of their processes of collaboration and learning, and positive effects on domain-specific knowledge (in contrast to domain-general knowledge, e.g., on argumentation) are rare. It has been hypothesized that the necessity to process the procedural prompts and hints of the script might prevent clear effects of collaboration scripts on domain-specific knowledge. Thus, an important question is how to fade out instructional hints and prompts of the script with increased self-direction skills of the learners. Fading is the increase or decrease of instruction according to changes in learning prerequisites. However, there are hardly any studies on fading in the context of collaborative learning. In a lab study (Wecker & Fischer, 2007) and a consequential field experiment (Kollar, Wecker & Fischer, submitted) we investigated the effects of fading on domain-specific knowledge. In the lab experiment (N = 138), we compared unfaded and faded collaboration scripts and found that fading had a positive effect on domain-specific knowledge. In a field study, we implemented collaboration scripts with and without fading (including distributed monitoring) in a school classroom where pairs (N = 111 students) worked on a web-based inquiry environment in biology (genetics). The positive effect of scripting plus fading on content knowledge was replicated. These findings are discussed and related to research on the assistance dilemma, adaptive scaffolding and scripting.

**Paper 2: Delaying Structure: Productive Failure in Learning the Physics of Electricity using Agent-based models**

*Authors: Michael J. Jacobson(a), Suneeeta A. Pathak(b), Beaumie Kim(b), and BaoHui Zhang(b)*

(a)Centre for Research on Computer Supported Collaborative Learning and Cognition, The University of Sydney, Australia
(b) Learning Sciences Laboratory, National Institute of Education, Singapore

This research explored the efficacy of a productive failure design (Kapur, 2008) for learning the physics of electricity using NetLogo agent-based models (ABMs). The experimental condition involved Productive Failure (PF), where student dyads initially used a set of ABMs to solve problem-based tasks in a minimally-structured manner whereas the Non-Productive Failure (NPF) comparison condition was provided with a highly-scaffolded activity structure for the same. Dyads in both conditions groups then used ABMs for the same tasks that were structured, followed by minimally-structured problem-based tasks. This sequence was used for four different NetLogo models of electricity over four different days of the study. The participants were grade 10 male students in Singapore. Participants in the PF group performed significantly lower on the pretest than the NPF group. However, the PF group showed significant learning gains by the posttest that included open-ended and transfer items. The PF group also had a significantly higher score on the posttest than the NPF group. This paper will build upon the quantitative findings (see Jacobson, Pathak, Kim, & Zhang, 2009, for more details) with qualitative analyses of how two dyads used the ABMs—one from the PF and the other from the NPF groups—over the four sessions of the study and describe differences in their respective dyadic interactions related to their manipulations of the different NetLogo models of electricity. This analysis will potentially reveal the interactional dynamics and learning mechanisms underpinning the productive failure effect. Implications for theory and structuring CSCL dyads engaged in agent-based modeling activities will be discussed.
Paper 3: Adapting Assistance to the Student(s): Preliminary Ideas from Individual and Collaborative Computer-Supported Learning Contexts

Authors:
Bruce M. McLaren, Carnegie Mellon University, Pittsburgh, USA and Deutsches Forschungszentrum für Künstliche Intelligenz, Saarbrücken, Germany
Nikol Rummel, University of Freiburg, Institute of Psychology, Germany

We are interested in the assistance dilemma in both an individual and collaborative computer-supported learning context. For instance, in an individual learning setting we have investigated, in three separate studies involving chemistry, whether worked examples, a high-assistance approach, studied in conjunction with computer-tutored problems to be solved, a mid-level assistance approach, can lead to better learning. We found that worked examples alternating with isomorphic tutored problems did not produce more learning gains than tutored problems alone, but the examples group learned more efficiently. In summary, our results, as well as indications from other studies with worked examples and tutored problems, hint toward the potential advantages of adapting assistance to improve learning, for instance by exposing the student to less examples over time (i.e., switching from high to low assistance). Our studies in a collaborative context, involving both chemistry and algebra also hint toward advantages of adaptive assistance, that is, providing a level of assistance commensurate with the learners’ needs. In our chemistry studies, which were small-scale, we found that an approach balancing high-assistance (fixed collaboration script) and mid- to low-level assistance (tutoring by an “adaptive” human wizard) had a positive impact on student learning and collaboration. In our algebra studies, we also experimented with an adaptive assistance approach with indications that adaptive prompts yielded deeper learning processes following errors and hint requests. In general, our hypothesis is that an adaptive approach to assistance is likely to be the most successful, in both an individual and collaborative learning context, but this raises several key questions: How does one adapt a system to provide the right level of assistance per student or collaborating group of students? What should be adapted? When should the adaptation occur? In this talk, we explore some preliminary ideas about how one might adapt a computer system to support learning in a computer-based collaborative context, based on what we've observed from our individual and collaborative studies.

References

Acknowledgements
The Pittsburgh Science of Learning Center, NSF Grant # 0354420, has provided support for McLaren's and Rummel's research. The Learning Sciences Lab of the National Institute of Education, Singapore has provided support for Jacobson et al.’s research.