Orchestrating learning activities on the social and the cognitive level to foster CSCL

Armin Weinberger[1], Douglas Clark[2], Pierre Dillenbourg[3], Dejana Diziol[4], Victor Sampson[2], Karsten Stegmann[1], Nikol Rummel[4], Fabrice Hong[3], Hans Spada[4], Bruce McLaren[5], Taiga Brahm[6], and Frank Fischer[1]
[1]Department of Psychology, University of Munich, Germany
[2]College of Education, Payne 203F, Arizona State University, Tempe, AZ 85287-0911, USA
[3]CRAFT, Ecole Polytechnique Fédérale de Lausanne, Switzerland
[4] Institute of Psychology, University of Freiburg, Germany
[5]Human Computer Interaction Institute, Carnegie Mellon University, Pittsburgh, PA, USA
[6]SCIL, University of St Gallen, Switzerland
Email: [1]{armin.weinberger, karsten.stegmann, frank.fischer}@psy.lmu.de, [2]{douglas.b.clark, victor.sampson}@asu.edu, [3]{pierre.dillenbourg, fabrice.hong}@epfl.ch, [4]{diziol, rummel, spada}@psychologie.uni-freiburg.de, [3]{pierre.dillenbourg, fabrice.hong}@epfl.ch, [4]bmclaren@cs.cmu.edu, taiga.brahm@unisg.ch

Abstract: CSCL includes a wide range of scenarios that integrate individual and collaborative learning. Scripts have repeatedly proven useful for guiding learners to engage in specific roles and activities in CSCL environments. The effective mechanisms of scripts in stimulating cognitive and collaborative processes, however, are not yet well understood. Moreover, scripts have been shown to be somewhat inflexible to variations in needs across individual learners, specific groups, and classroom constellations. In this symposium, we present research on how scripts impact socio-cognitive processes. The symposium additionally focuses on how CSCL environments can be orchestrated through flexible scripts that adapt to meet the special requirements at the classroom, small group, and individual levels.

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CSCL covers a range of scenarios in which learners both interact with each other supported by technology and engage in phases of individual learning activities, e.g., computer-mediated learners individually access specific resources before communicating through an asynchronous discussion board with each other (Dillenbourg & Fischer, 2006). But learners seem to rarely draw on CSCL's potential to engage in specific learning activities both on the cognitive and the social level. Hence, CSCL often benefits from socio-cognitive structuring, for example, in the form of scripts that guide learners' interactions (Fischer, Kollar, Mandl, & Haake, 2007). While scripts generally aim to facilitate specific socio-cognitive learning activities, scripts may have different foci and granularities leading researchers to distinguish between macro- and micro-scripts (e.g., Dillenbourg & Jermann, 2007; Kobbe et al., in press). Micro-scripts focus on specific activities of learners and may, for instance, prompt learners to build their arguments in a specific way or instruct students how to collaborate effectively. Macro-scripts rather support the teacher to implement CSCL scenarios within the classroom orchestrating individual and collaborative learning phases (e.g., by suggesting individual preparation before entering discussion). There is some need to better understand how micro- and macro-scripts can be tuned to orchestrate learning activities on the social and the cognitive level to foster CSCL. First, to understand how and when CSCL should encompass collaborative and individual learning activities, the effects of scripts on processes and outcomes of collaborative and individual computer-supported learning need to be investigated. Second, to understand how scripts should orchestrate learning activities on the social and the cognitive level, macro-scripts should be investigated that guide learners through the different individual and collaborative learning activities.

Research Presented

To answer these questions, we present studies ranging from hypotheses testing to design study and investigating micro- and macro-scripts. This symposium first focuses on how scripts can affect cognitive and collaborative processes in integrated learning environments (the studies by Weinberger et al. and Diziol et al.). The Weinberger et al. study indicates that CSCL has additional benefits over individual learning scenarios only when the collaborative learners are supported with a script that facilitates the construction of single arguments. The Diziol et al. study examines the extent to which learners in an individual learning environment that incorporates an intelligent tutoring system benefit from working collaboratively with a script that guides learners through different individual and collaborative phases. These phases include adaptive and meta-cognitive components. The second focus of this symposium is on how scripts can guide learners through different social levels by assigning learners to discussion groups based on differences in perspectives (the studies by Clark & Sampson and Dillenbourg et al.). The Clark & Sampson study compares a script that assigns learners to discussion groups based on their individual positions in comparison to a script that assigns learners to defend a specific perspective. The Dillenbourg et al. study presents a computer tool that supports teachers as they design and adapt a script that assigns learners to discussion groups based on their individual positions (similar to the Clark & Sampson study) to orchestrate learning activities on different social levels.

Scripting argumentative knowledge construction: Effects on individual and collaborative learning

Armin Weinberger, Karsten Stegmann, & Frank Fischer
Department of Psychology, University of Munich, Germany

In argumentative knowledge construction (AKC), learners construct knowledge through the construction of arguments and counterarguments about a complex problem (Andriessen et al., 2003; Weinberger et al., 2006; Weinberger & Fischer, 2006). AKC research thus far has focused on both (1) the individual processes of learners self-explaining the learning material when constructing arguments (Baker, 2003; Stegmann et al., 2006) as well as (2) the inter-individual aspects of AKC involving the added value of confronting learners with peers' diverging conceptualizations of a problem (Leitão, 2000). Research in this area is challenging because social and cognitive processes are highly intertwined. To date, few empirical studies have examined the nature, existence, and added value of the inter-individual aspects of AKC. Exploring differences between individual and collaborative learning is often considered outdated against the assumption that learning in groups exceeds individual domain-specific learning depending on specific conditions that have to be met to foster collaborative learning (Slavin, 1993). Investigating the social form of learning, however, might involve more specific questions on how collaborative learning can be supported to foster domain-specific as well as domain-general knowledge such as argumentative knowledge.

One approach to facilitate AKC in online learning environments involves providing learners with computer-supported scripts that specify, sequence, and assign roles and activities to learners. Scripts may effectively structure different aspects of learners' interactions (e.g., formal or epistemic aspects of argumentation). Some scripts, for example, facilitate argumentative knowledge without reducing domain-specific knowledge acquisition (Stegmann et al., 2006). It remains unclear, however, whether this beneficial script effect is due to a reduction of process losses typically experienced by computer-supported collaborative learners, such as coordination problems (e.g., Strijbos et al., 2004), or the support of meaningful learning activities by the individual learner, such as sound argument construction (e.g., Stegmann et al., 2006).

Research Question 1: To what extent does an argumentative script (with vs. without) and the social form of learning (individual vs. collaborative) affect the formal and the epistemic quality of arguments that learners construct within an online learning environment? Regarding RQ1, we hypothesize that the script would foster the formal and the epistemic quality of arguments of individual and collaborative learners.

Research Question 2: To what extent does an argumentative script (with vs. without) and the social form of learning (individual vs. collaborative) affect individual learning outcomes? Regarding RQ2 we hypothesize that the script would foster learning outcomes of collaborative learners beyond the level that unscripted collaborative and individual learners would attain.

Methods

In this 2×2-factorial design ($n = 72$), we investigate the effects of an argumentative script (with vs. without) and the social form of learning (individual vs. collaborative) on learning processes and outcomes in the context of a computer-supported learning environment in higher education. Learners analyzed problem cases focusing on attribution theory (Weiner, 1985) individually or in groups of three. The script was designed to support specific formal aspects of argumentation, namely the construction of single arguments according to a simplified model of argument construction by Toulmin (1958). The script guides learners to specify their claims, provide at least one datum with a warrant that supports the claim, and identify at least one qualifier of the claim. The script was implemented into an asynchronous CSCL environment involving discussion boards with text windows for each of the three single argument components: (1) claim, (2) datum, and (3) qualifier (see Figure 1).

Based on the written analyses of the learners during the online learning session, we analyzed the *formal quality of arguments* (i.e. the frequency of warranted and qualified claims), the *epistemic quality of arguments* within the learning environment (i.e. the frequency of arguments that contributed to solving the learning task by applying specific theoretical concepts adequately to a problem case), individual learning outcomes with a pen and paper test regarding *domain-specific knowledge* (i.e. the extent to which learners were individually able to apply specific theoretical concepts to a transfer problem case after participating in the online learning session), and *argumentative knowledge* (i.e. the extent to which learners were individually able to recall argument components such as claim, warrant, and qualifier and to construct warranted and qualified claims on another topic).

Results

With regard to RQ1, the findings show clearly that the script increases formal quality and reduces epistemic quality of arguments. Although this holds true for both individual and collaborative learners, a positive interaction effect shows that the script particularly facilitates the formal quality of collaborative learners' arguments. Regarding learning outcomes (RQ2), formerly scripted collaborative learners acquired more domain-specific and argumentative knowledge than any other experimental group (see Figure 2). We found a disordinal interaction of the two factors (i.e. script and social form of learning), leading us to compare the effects of each factor controlled by the other factor.

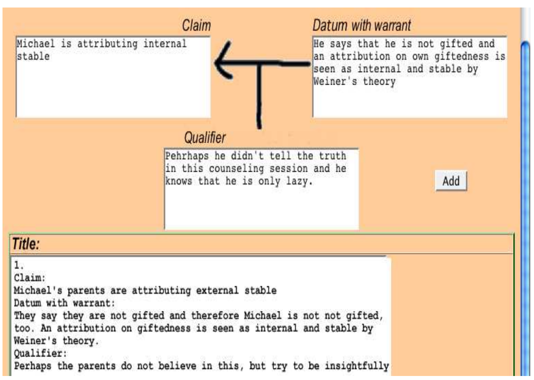


Figure 1. Interface of the scripted discussion board

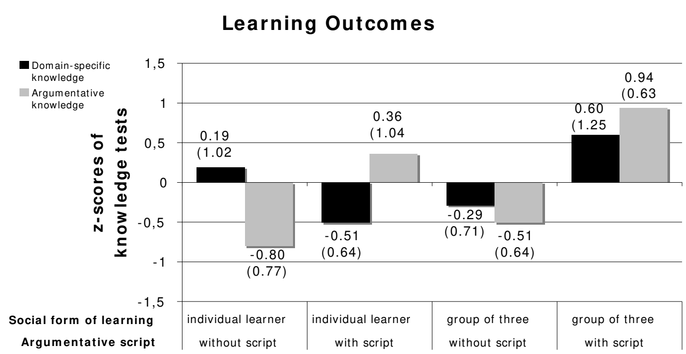


Figure 2. Z-scores of domain-specific and argumentative knowledge tests: means and standard deviations for each experimental group.

The multivariate ANOVA demonstrates no effects of the social form of learning for learners without support of the script. The multivariate comparisons between learners in groups with script and learners in groups without script ($F(2,15) = 16.26$, $p < .01$; $\eta^2 = 0.68$) as well as with individual learners without script ($F(2,15) = 4.99$, $p < .05$; $\eta^2 = 0.40$) show strong significant effects.

Discussion

(RQ1) The argumentative script facilitates the formal construction of arguments, but has detrimental effects on the epistemic quality of arguments. By focusing learners' efforts to construct formally adequate arguments, the script may have lead learners' attention away from building arguments of high epistemic quality (Dillenbourg, 2002). Learners seemed to somewhat lose sight of the theoretical concepts they were supposed to apply. This may be particularly problematic for scripted individual learners who cannot compensate by drawing on sound arguments from their learning partners (Leitão, 2000). For collaborative learners, on the contrary, the script seemed to reduce process losses normally resulting from learning together online (see Strijbos et al., 2004). (RQ2) Collaborative learning may outperform individual learning regarding learning outcomes when it is structured by a script. Put another way, individuals in unstructured groups did not learn better than individual learners, and CSCL unfolds its potential only, when the degree of freedom is not too large (Kirschner et al., 2006). Scripted collaborative learners acquired more domain-specific and more argumentative knowledge than any other experimental group.

Some limitations of the study should be considered, however. First, earlier studies comparing different supports of AKC for CSCL groups found that argumentative scripts have positive effects on domain-general knowledge but no effects on domain-specific knowledge. Studies with larger samples need to clarify the circumstances and the extent to which argumentative scripts also facilitate domain-specific knowledge. Second, because the participants of the study were first semester students with little prior domain-specific knowledge and little CSCL experience, the findings may not generalize to other, more experienced populations of learners. Future research needs to consider how scripts interact with varying levels of prior knowledge (Kollar et al., 2006). Third, although the problem cases could be regarded as complex (with the possibility of multiple solutions), the problem cases cannot be regarded as genuine group tasks (where co-learners are required to solve the task). Investigating scripts for genuine group tasks may clarify further how scripts need to be adapted to the needs of individual learners and how groups of learners benefit from determining their own procedures (see Clark & Sampson, this symposium).

Promoting Learning in Mathematics: Script Support for Collaborative Problem Solving with the Cognitive Tutor Algebra

Dejana Diziol, Nikol Rummel, Hans Spada, Bruce McLaren
Institute of Psychology, University of Freiburg, Germany
Human Computer Interaction Institute, Carnegie Mellon University, Pittsburgh, PA, USA

We combined two different instructional methods both of which have been shown to improve students' learning in mathematics: Learning with intelligent tutoring systems (Koedinger et al., 1997) and collaborative problem solving (Berg, 1993). The problem-solving guidance provided by an intelligent tutoring system is effective, but because it places emphasis on learning problem solving skills, a deep understanding of underlying mathematical concepts is not necessarily achieved (Anderson et al., 1995). Collaborative activities can yield elaboration of learning content (Teasley, 1995) and thus increase the potential for the acquisition of deep knowledge, but students are not always able to effectively meet the challenges of a collaborative setting and tap this potential (Rummel & Spada, 2005). Collaboration scripts that prompt fruitful interaction have proven effectively in supporting collaborative learning (Kollar, et al., 2006). We believe that by combining intelligent tutoring and collaborative learning we could foster the advantages of both instructional methods and overcome their disadvantages. Collaborative interaction could augment the effects of an intelligent tutoring system by promoting deeper elaboration, and script support integrated in the tutoring environment could provide guidance to students as they collaborate and thus improve the quality of their collaboration.

Script Design

Our *collaboration script* was designed to guide students in collaborating while solving problems with the Cognitive Tutor Algebra (Koedinger et al., 1997), a tutor for mathematics instruction at the high school level. Its main features are immediate error feedback, the possibility to ask for a hint when encountering impasses, and knowledge tracing, i.e. the Tutor creates and updates a model of the student's knowledge and selects new problems tailored to the student's knowledge level. For the present study we focused on "systems of equations", content novel to the participating students. The script consisted of three components. First, it had a *fixed script component* that structured the problem solving process in two phases. During the *individual problem solving phase*, each student solved a problem in the Cognitive Tutor that consisted of one equation. In the *collaborative phase*, the two students joined on a single computer to solve a more complex system of equations problem that combined the two individual equations. They received instructions from the enhanced Tutor, e.g. prompting them to use collaborative skills. Second, the script had an *adaptive script component* that reacted when students met impasses that resulted in Tutor actions (e.g. hints). To encourage students to take advantage of these learning opportunities, the script asked the dyad to elaborate on the help received. Third, the script had a *metacognitive component.* Following each collaborative phase, students evaluated their collaboration and set goals for how to improve it during the next joint problem solving session. This component aimed at increasing students' ability to collaborate effectively even when no longer receiving script support. This is particularly important due to the risk of overscripting collaboration, i.e. motivation losses yielding reduced performance and learning, a phenomenon that has been discussed in conjunction with scripting for longer periods of time (Rummel & Spada, 2005).

Script Evaluation

We conducted a classroom study with a one-factorial design, comparing scripted collaboration with an unscripted collaboration condition in which students collaborated without support. This study was an initial, small scale study to establish basic effects and to test the procedure in a classroom setting. The study took place during three periods over the course of a week at a vocational high school outside of Pittsburgh in the U.S. Due to the disruptiveness of students in the same class using different interventions, we used a between-class design. The unscripted condition consisted of two classes (12 and 4 students), and the scripted condition consisted of one class (13 students). All classes were taught by the same teacher.

During day 1 and day 2 (*learning phase*), students learned how to solve system of equations problems. Depending on their condition, they collaboratively solved problems either with or without script support. On day 3 (*test phase*) we assessed students' individual and collaborative learning gains with three tests administered within the Cognitive Tutor and a paper and pencil test. The Tutor post-tests assessed the script's effect on students' *problem solving skills*. One post-test asked students to individually solve system of equations isomorphic to those during instruction, thus testing the individual's *retention* of the learned skills. A second post-test asked students to collaboratively solve system of equations without script support to assess the script's effect on improving *collaborative* problem solving skills. Learning from the script should also enable students to capitalize on future collaborations at the Tutor, i.e. it should *accelerate their future collaborative learning*. Hence, the third Cognitive Tutor post-test confronted students with a novel problem type: inequality problems. The paper and pencil post-test concentrated on assessing students' *conceptual knowledge* with two different problem sets. Problem set 1 tested for students' understanding of the *basic concepts y*-intercept and slope: Multiple choice questions asked students to make transformations between verbal, algebraic and graphical representations of those concepts, and open format questions asked them to explain their answers. Problem set 2 assessed students' understanding of the main new *system of equations concept* learned: the intersection point. Again, students had to answer two types of questions: questions with discrete answer possibilities (correct or incorrect), and open format questions that asked for explanations. Scores were summed for each problem set. For answers to the multiple choice questions of problem set 1 (basic concepts), a maximum of 11 points could be reached; the possible maximum for explanations on basic concepts was 22 points. For problem set 2 (intersection point), the maxima were six points for discrete answer format and 12 for open format questions.

Results

The analysis was restricted to students who always worked collaboratively when present, as we are interested in the script's effect on collaborative learning in particular. Due to student absenteeism, only 9 students in the unscripted and 10 students in the scripted condition were included in our analysis. First results of a MANOVA comparing performance of conditions in the paper and pencil post-test showed significant differences between conditions (Pillai-Spur, $F(4, 14) = 7.35$, $p < .05$). Means and standard deviations of the ANOVAs for each variable are displayed in Table 1. Answers to the multiple choice questions on basic concepts did not show a significant difference, $F(1,17) = 2.26$, *ns*. However, the scripted condition outperformed the unscripted condition on the discrete answer questions about the system's concept, $F(1,17) = 22.16$, $p < .01$. Significant differences between conditions was also found for the open format questions of both problem sets with $F(1,17) = 5.85$, $p < .05$ for the basic concepts and $F(1,17) = 17.01$, $p < .01$ for the system's concept.

Table 1: Means and standard deviations of the paper and pencil post-test, assessing conceptual understanding

	Unscripted condition		Scripted condition	
	M	SD	M	SD
Basic concepts: multiple choice	4.89	1.83	3.60	1.90
Basic concepts: open format	.22	.44	1.20	1.14
System concept: discrete answers	.89	1.45	4.50	1.84
System concept: open format	.44	1.33	5.70	3.59

Discussion and Outlook

The script had a significant effect on the acquisition of the main new concept of the system of equations unit, the intersection point. Particularly interesting are the substantial differences that were found for the open format questions of both problem sets, demonstrating a strong effect of the script on students' conceptual knowledge: After scripted interaction during the learning phase, students were better at articulating their mathematical thinking compared to their unscripted counterparts. It should be noted, however, that students in both conditions had difficulties providing explanations and only reached low scores in the open format questions. The amount of wrong explanations and the number of students who did not even try to articulate their thinking was very high. Thus, it might be promising to extend the learning phase in future studies to increase the script's effect. It remains to be seen if the script's effect can also be found in the Cognitive Tutor tests. Currently, we are analyzing the Tutor log files for variables such as number of errors per problem, time per problem, decrease of error rates over the course of several problems etc. Contrasting this post-test data with corresponding data from the learning phase will inform us on differences in students' learning progress. Results of the Tutor post-tests will be presented at the conference.

Fostering Productive Argumentation in Online Environments: Strategies for Grouping Students in Discussion Forums

Douglas Clark and Victor Sampson
College of Education, Arizona State University

Our ongoing research (Clark & Sampson, 2006, 2007) focuses on fostering productive argumentation in science classrooms through a process that involves (a) providing students with empirical data and scientific ideas about a phenomenon, (b) scaffolding students in the creation of an explanation that articulates their ideas clearly and focuses on the salient issues, (c) organizing discussions around alternative perspectives, and (d) facilitating equitable and productive discourse among the students. This study examines the tradeoffs between organizing debates around students' own proposed explanations versus assigning students to conceptually optimized pre-selected explanations.

Our work adopts a view of argumentation as a process where "different perspectives are being examined and the purpose is to reach agreement on acceptable claims or courses of action" (Driver et al., 2000, p. 291). Hence, our efforts to support and promote argumentation in science classrooms have focused on the development of a CSCL environment where students generate competing explanations for a given phenomenon and then examine, discuss, and evaluate these explanations based on available evidence. We have developed *personally-seeded discussions* to support students in this discourse. These customized asynchronous discussion forums (a) scaffold students as they synthesize an explanation to describe data that they have collected, (b) organize discussion groups of students who have created different explanations, and (c) encourage students to critique each other's explanations and work toward consensus based on evidence available to them. Research that we have conducted over the last four years indicates that personally-seeded discussions are an effective way to foster equitable and productive argumentation between students; which we define in this context as a discussion that incorporates the voices of all students, exposes students to new ideas, and creates a need for students to evaluate the legitimacy of alternative viewpoints (Clark & Sampson, 2007).

As discussed above, the current study investigates the tradeoffs between organizing debates around students' own proposed explanations versus assigning students to defend conceptually optimized pre-selected explanations. In particular, we investigate and compare the impacts on student argumentation of two different strategies for organizing and scripting discussions around alternative perspectives. In both interventions, students first create their own explanations to explain the phenomenon under investigation. The software then uses these proposed explanations to automatically sort students into discussion forums with students who have proposed different explanations (and are therefore likely to have different perspectives on the phenomenon). The treatment groups differ in terms of what happens after this sorting process.

> *Personalized Explanations Treatment*: In the personalized treatment group, the students' proposed explanations from the sorting step become the seed comments for the discussion. Because students are sorted into groups with students who proposed different explanations for the phenomenon, some range of explanations is represented, but that range is not necessarily controlled or optimized.
>
> *Range of Explanations Treatment:* In the range intervention, students are sorted into groups using the same procedures, but the seed comments for the discussion come from a predetermined list of sample explanations generated specifically to represent a range of the critical student misconceptions identified through earlier research. In this approach, students are automatically assigned to defend one of these specific explanations.

In both treatments, students are instructed to critique all of the explanations. Students are further instructed to reply to the comments addressed to them and to focus on evidence. Students are asked to compare their explanations, take into account all of the arguments and evidence, and revise their final answers accordingly. The goal of this scripting strategy is to encourage students to view explanations as objects of cognition (Kuhn, 1993) that need to be critiqued and revised before they can be accepted. In sum, the personalized strategy focuses on engaging students own ideas (while potentially not presenting as optimal a range of explanations to spark discussion) and the range strategy presents an optimal range of explanations from a conceptual perspective but omits the personalization of the discussion (i.e., the students are discussing generic explanations rather than one another's explanations as the seed comments).

Data and Results

To evaluate the relative impacts of the range and personalized strategies, we have been (and continue to) randomly assign students within classrooms to one of the two conditions within a standard WISE project investigating thermodynamics (*Thermodynamics: Probing Your Surroundings*, http://wise.berkeley.edu). In this project students investigate the concepts of thermal equilibrium, thermal conductivity, and the difference between heat and temperature by collecting real-time data and interacting with simulations (see Figure 3) before they participate in the online asynchronous discussion forum. Data is logged on our servers as teachers naturally come to the WISE website and run the project with their students.

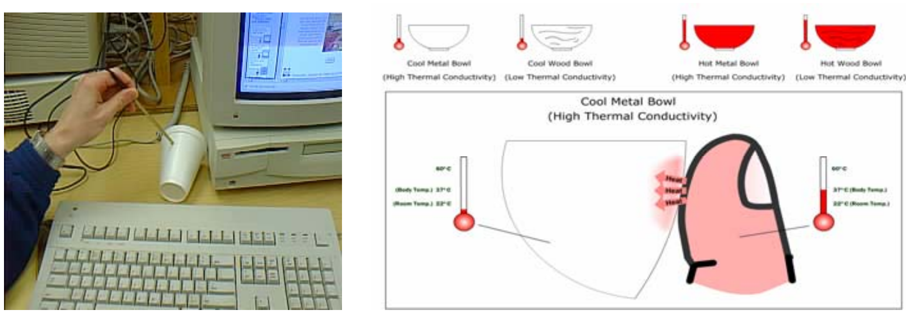


Figure 3. During the online project, *Thermodynamics: Probing Your Surroundings*, students collect real time data (left) and interact with simulations (right) to learn about the thermodynamics.

In this study, as discussed above, students in each class are sorted into discussion groups by the software so that a range of different perspectives is represented in each group. At this point, the software randomly divides the groups within each classroom between the two conditions. This approach allows us to collect data from a variety of classrooms and schools without the intrusiveness of a formal intervention and provides a window into the overall effectiveness of the two treatment groups in an authentic context. Also importantly, this approach maintains the methodological advantages of random assignment *within* classroom rather than *by* classroom.

The data collected by the servers includes: (1) the initial explanations that students submit, (2) full transcripts of the discussions, and (3) the final explanations that students submit after leaving the discussions. We therefore have a pre/post measure of students' proposed explanations as well as the actual discussion transcripts. The initial data suggests that (1) students engage in higher amounts of discourse in the personalized condition as measured by the number of comments made and the average length of comments and (2) students are more likely to select the normatively "correct" explanation subsequent to the discussion in the personalized condition.

These initial findings suggest that organizing discussions around students' own proposed explanations is more valuable than organizing discussions around optimized sets of candidate explanations even though the latter approach guarantees a more thorough presentation of key ideas. These findings further suggest the relative importance of student ownership and motivation in argumentation environments in comparison to the careful orchestration of the conceptual components within the argumentation environment. The full presentation of our data will outline the details of these relationships and their implications for the design of learning environments at the interface between technological and social supports.

The Teacher's Side of CSCL Scripts

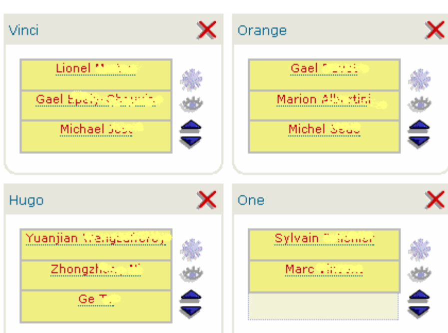
Pierre Dillenbourg, Fabrice Hong, & Taiga Brahm
CRAFT, Ecole Polytechnique Fédérale de Lausanne, Switzerland; SCIL, University of St Gallen, Switzerland

Integrated learning scripts (Dillenbourg & Jermann, 2007) do no only include group activities but also integrate individual activities and class-wide activities. These activities occur in the classroom space and are orchestrated by the teacher. This contribution addresses the general issue of the teacher's role in CSCL activities in a concrete case: how the ManyScripts environment enables teachers to design a script, prepare a session and orchestrate the activities in real time.

Preparing a script instance

This works stems from our European research team (1) on formalizing CSCL Scripts. Most macro-scripts can be described from a small set of elements: a script is a sequence of phases, groups are structured with roles associated to different resources and modes of interactions. The script description scheme (2) would support a top-down approach to script authoring, focusing on a language able to model a large variety of scripts, as it was developed by the COLLAGE group in Valladolid or by the COLLIDE group in Duisburg (3). This approach raises the various difficulties that authoring tools encountered over the previous decades: the tool is powerful but it is not easy for a teacher to come up with an innovative scenario that can be expressed within such a constrained language. Instead, we implemented a bottom-up approach, in which teachers start from an existing script, modify some parameters and edit the content. The philosophy behind this is that the authoring tool is not pedagogically neutral but conveys instead a specific pedagogical model.

Currently, the environment, called ManyScripts, supports editing the script called 'ConceptGrid'. This script is a sub-class of the class of script referred for many years as "JIGSAWS". The 'ConceptGrid' unfolds as follows: 1) Groups of students have to distribute roles among themselves. Roles correspond to theoretical approaches of the domain under study. In order to learn how to play their roles, students have to read n papers that describe the theory underlying their role. 2) Each group receives a list of concepts to be defined and distributes these concepts among its members. Students write a 5 lines definition of the concepts that were allocated to them. 3) Groups have to assemble these concepts into a grid and to define the relationship between two concepts that are neighbours on the grid. The key task is to write 5 lines that relate or discriminate two juxtaposed concepts: if Concept-A has been defined by Student-A and Concept-B by Student-B, writing the Concept-A/Concept-B link requires Student-A to explain Concept-A to Student-B and vice versa. 4) During the debriefing session, the teacher compares the grid produced by different groups and asks them to justify divergences. To use a ConceptGrid script in her course, the teacher has to decide about the group size (number of roles) and edit the contents of the script: she defines the roles, the papers to be read for each role and the sets of concepts to be defined and assembled in a grid by the student groups. The result is what we refer to as a script instance, e.g. "ConceptGridBiology2.1".



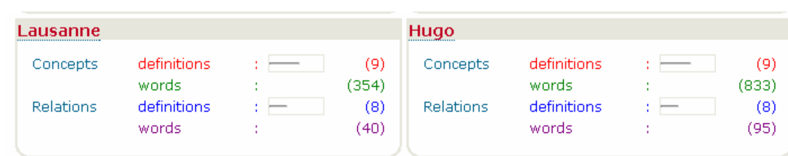


Figure 4b (above). Global look at group work

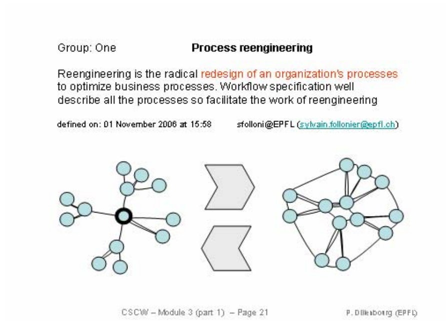
Figure 4a (left). Coping with irregular groups

Preparing a script session

The same script instance may be run several times, for instance if "ConceptGridBiology2.1" is used in two different classes, respectively in winter and summer terms. Hence, the teacher has to prepare two sessions of the script instance, the "ConceptGridBiology2.1.oct06" and "ConceptGridBiology2.1.march07". Setting up a session may sound trivial: the teacher has to provide student names, form groups (or let them do it) and set up the start/end dates for each script phase. This simplicity does not match what happens in actual university classes: some students joint the course late, some drop out, … A common bit tricky problem is when the number of students is not a multiple of the group size. What does the teacher do if 11 students have to be distributed into groups of 2? The ManyScripts environment offers two 'flexibility' options: to handle extraneous group members (groups of 3,4,4) or to handle missing members (groups of 3,3,3,2) as in figure 4a. The system copes with these situations as follows. A team with a missing member/role X may reuse definitions produces by the role-X members of any other team in the class and session. If a team has an additional group member, he or she plays the role of a 'joker' allowed to off-load the work of any other group member; the team is free to decide how to share the workload.

Orchestrating a session

When the script is running, the teacher has the possibility to change some parameters such as the group composition or deadlines up to a certain level. The ManyScripts environment enables the teacher to follow the evolution of teamwork at a high level of aggregation as in figure 4b. More importantly, the 'teacher cockpit' enables the teacher to explore the contents produced by group along different axis: per construct concepts grids, per group, per concept or per relation between concepts. Teachers may use the cockpit for grading the groups' work and, more importantly, for preparing the debriefing phase, i.e. when the teacher discusses the group productions with the whole class. The debriefing can be prepared in different ways. The teacher may annotate with her own colour codes the different productions (Figure 5a). Hence, when she uses the cockpit during the debriefing lecture, she may easily find the definitions she wants to refer to in her comments. Alternatively, she may simply integrate the student productions within her presentations as in figure 5b.



Figures 5a and 5b. Teacher reusing group productions by annotating them within the ManyScripts environment (left) or by integrating them into her lecture presentation material (right).

Experiments

This new release of the ConceptGrid is now being used in an EPFL course, through 4 successive iterations. It is also used in a course for educational management at the University of St. Gallen. The different sessions will be evaluated and compared using content analysis. In addition, a questionnaire will be used to capture students' reactions, and the teachers using the grid will be interviewed. Results will be reported at the conference.

Concluding Remarks

The research presented in this symposium differs to a large extend in terms of addressing micro- and macro-scripts and in terms of presenting hypotheses testing as well as design studies. As a whole, however, the symposium provides a guideline of how to implement (scripted) CSCL in the classroom, how to orchestrate individual and collaborative learning activities, and what effects on learning processes and outcomes to expect of it. Overall, the presented research shows that CSCL may neither unfold its full potential when no structure is provided to the individual and collaborative learning processes (see Fischer et al., 2007) nor when learners are confronted with too much, badly timed or the wrong kind of “support” (see Dillenbourg, 2002). A major focus of future script research therefore is to introduce flexible scripts that can be adapted and modified by both, teachers and learners.

Endnotes

(1) The European Research Team COSSICLE (http://www.iwm-kmrc.de/cossicle/fr_index.html?news)
(2) http://www.iwm-kmrc.de/cossicle/resources/D29-02-01-F.pdf
(3) http://www.collide.info/

References

Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *Journal of the Learning Sciences, 4*(2), 167-207.

Andriessen, J., Baker, M., & Suthers, D. (Eds.). (2003). *Arguing to learn. Confronting cognitions in computer-supported collaborative learning environments*. Dordrecht: Kluwer.

Baker, M. (2003). Computer-mediated argumentative interactions for the co-elaboration of scientific notions. In J. Andriessen, M. Baker & D. Suthers (Eds.), *Arguing to learn: confronting cognitions in computer-supported collaborative learning environments* (Vol. 1, pp. 1-25). Dordrecht: Kluwer.

Berg, K. F. (1993). *Structured cooperative learning and achievement in a high school mathematics class.* Paper presented at the Annual Meeting of the American Educational Research Association, Atlanta, GA.

Clark, D. B., & Sampson, V. (2006, April). Characteristics of Students' Argumentation Practices When Supported by Online Personally-Seeded Discussions. Paper presented at the annual meeting of the National Association of Research in Science Teaching, San Francisco, California.

Clark, D. B., & Sampson, V. (2007). Personally-seeded discussions to scaffold online argumentation. To be published in 2007 in the *International Journal of Science Education.*

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL?* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Dillenbourg, P., & Fischer, F. (2006). Computer-supported collaborative learning: The basics.

Dillenbourg, P., & Jermann, P. (2007). Designing integrative scripts. In F. Fischer, H. Mandl, J. Haake & I. Kollar (Eds.), *Scripting computer-supported communication of knowledge - cognitive, computational and educational perspectives* (pp. 275-301). New York: Springer.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*(3), 287-313.

Fischer, F., Kollar, I., Mandl, H., & Haake, J. (Eds.). (2007). *Scripting computer-supported collaborative learning*. New York: Springer.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Kobbe, L., Weinberger, A., Dillenbourg, P., Harrer, A., Hämäläinen, R., Häkkinen, P., et al. (in press). Specifying Computer-Supported Collaboration Scripts. International Journal of Computer-Supported Collaborative Learning.

Koedinger, K. R., Anderson, J. R., Hadley, W. H., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. *International Journal of Artificial Intelligence in Education, 8*, 30-43.

Kollar, I., Fischer, F., & Hesse, F. W. (2006). Collaboration scripts - a conceptual analysis. *Educational Psychology Review, 18*(2), 159-185.

Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education, 77*(3), 319-337.

Leitão, S. (2000). The potential of argument in knowledge building. *Human Development, 43*, 332-360.

Rummel, N., & Spada, H. (2005). Learning to Collaborate: An Instructional Approach to Promoting Collaborative Problem Solving in Computer-Mediated Settings. *Journal of the Learning Sciences, 14*(2), 201-241.

Slavin, R. E. (1993). Synthesis of research on cooperative learning. In A. E. Woolfolk (Ed.), *Readings & cases in educational psychology* (pp. 170-178). Needham Heights: Allyn & Bacon.

Stegmann, K., Wecker, C., Weinberger, A., & Fischer, F. (2006). Collaborative argumentation and cognitive processing - An empirical study in a computer-supported collaborative learning environment.

Strijbos, J. W., Martens, R. L., Jochems, W. M. G., & Broers, N. J. (2004). The effects of functional roles on group efficiency: Using multilevel modeling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35*(2), 195-229.

Teasley, S. D. (1995). The role of talk in children's peer collaborations. *Developmental Psychology, 31*(2), 207-220.

Toulmin, S. (1958). *The uses of argument*. Cambridge: Cambridge University Press.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education, 46*, 71-95.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*, 548-573.