The solo/duo gap

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1. Introduction

Psychology has for long been compartmentalized between cognitive studies of individual cognition and socio-cultural studies of group processes. I once wrote (Dillenbourg, 1999) that the Berlin wall between these two streams fell down in the late eighties with the emergence of the distributed cognition theories (Hutchins, 1995; Pea, 1993; Salomon, 1993). Distributed cognition views groups as a cognitive system and hence describes group mechanisms with concepts borrowed from individual cognition (e.g., group memory, shared understanding, group regulation, etc.). Actually, even if the wall fell, one can still clearly perceive the two sides of the former border. This synthesis reviews gaps and bridges between these two sides that can be illustrated by the contributions to this volume.

2. CSCL scripts: instructional design meets collaborative learning

This special issue originates in a workshop that gathered researchers from instructional design and computer-supported collaborative learning (CSCL). This workshop revealed a clear convergence of these two fields around the notion of CSCL scripts. A CSCL script (or scenario) structures the collaborative process in order to promote specific types of interactions. A script segments the task into phases, defines roles and various constraints on the interactions. A well-known script is the JIGSAW script (Aronson, Blaney, Sikes, Stephan, & Snapp, 1978) that

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decomposes the knowledge necessary to solve the task in such a way that a team member cannot solve the problem alone. A second set of scripts, including the 'reciprocal tutoring' approach of Palincsar and Brown (1984), aims at increasing mutual regulation. Other scripts such as the ArgueGraph (Jermann & Dillenbourg, 2003) raise conflicts among team members in order to foster argumentation. Scripts are a modern version of instructional engineering applied to social settings. The design of a script borrows many ideas from instructional engineering: the analysis starts from the specific learning objectives, it analyses the process by which learners may reach these objectives, and it aims to set up the conditions in which these processes are expected to occur.

The similarities between scripts and lesson plans are further increased by the fact that many CSCL scripts include individual phases (e.g., reading papers, writing a synthesis) and/or class-wide activities (e.g., introductory lectures, debriefing sessions). We, thus, refer to these scripts as 'integrated learning' rather than as collaborative in a strict sense. These additional solo or class activities constitute the 'didactic envelope' around the core collaborative activities (Dillenbourg and Jermann, in press).

In other words, my first point emphasizes the cross-fertilization between collaborative learning and instructional design. CSCL scripts should not be viewed as genuine lesson plans; they differ in that social interactions (e.g., argumentation, explanation, mutual regulation) are expected to be the key learning mechanism. Nevertheless, script design shares with instructional design the same quest for pedagogical effectiveness, the same idea of "engineering" learning processes, and the necessity of a detailed task analysis.

Although the workshop contributions that illustrate this convergence have been published elsewhere, this integrative perspective can also be aptly demonstrated by those contributions that focused more on individual learning. Ainsworth and Fleming (this volume), for example, address an interesting related issue. Their REDEEM tool supports instructional design, without integrating collaborative activities. Nevertheless, REDEEM could easily be enriched by group formation mechanisms, such as matching students on the basis of the complementary knowledge (e.g., qualitative versus quantitative) (Hoppe & Ploetzner, 1999) or matching a student who is expert on a topic with a student who faces difficulties on this topic (Ogata & Yano, 2000). These peer formation mechanisms are simple and rather transparent. Transparency is probably an issue Ainsworth and Fleming (this volume) underestimate when observing how teachers use their 'intelligent' tool. They observed that teachers did not let the system "macro-adapt" (choose specific modules on the basis of student performance). Isn't it the teacher's responsibility to macro-adapt? Aren't they supposed to be the drivers? A powerful feature of integrated learning scripts is precisely that they let the teacher maintain her/his role of chef d'orchestre. (S)he does not interfere much within phases (e.g., during peer argumentation), but rather at the macro level (e.g., changing the timing or the order of phases). A challenge for CSCL is to produce flexible environments that allow the teacher to modify a script on the fly without being constrained by the underlying technical consequences.
3. Generalizing experiments from solos to duos

The other studies presented in this issue concern individual learning. Can they inform designers of collaborative learning environments or are they bound to individual settings? How could studies of individual learning fail to inform collaborative learning? When individuals join a group they still carry their individual brain! Hence, how could pair results differ from individual ones?

Let's consider some findings by Keller, Gerjets, Scheiter, and Garsoffky (this volume): two-dimensional representations are reported to be more effective than three-dimensional pictures for knowledge acquisition. Is there any reason to question the generalizability of these results to learning in pairs? A priori no: perception is rather an individual process. Hence, the perceptive performance of individuals-in-duos should be similar to the perceptive performance of individuals-in-solo. The problem is that perception does not occur in a vacuum; it interferes with social interactions. These interferences are obvious if each pair member has a different view of the same three-dimensional object, the pair having then—as a pair—more information than individuals. Difference of viewpoints raises socio-cognitive conflict. Solving the conflict requires to take literally the other's perspective, which leads to a richer understanding of the object. However, the next study shows that the interferences between perception and social interaction do also appear if both members see the same view.

Scheiter, Gerjets, and Catrambone (this volume) report that frequently using static pictures was more effective than using animations. These results add to a set of contradictory studies where animated pictures occur to be sometimes more effective and sometimes less effective than static pictures (Mandl & Levin, 1989; Schnotz & Kulhavy, 1994). The variables that explain this diversity of results are the type of model (causal versus structural), the degree of abstraction, the level of interactivity...and—this is my point here—the number of learners! Schnotz, Böckheler, and Grzondziel (1999) compared static and animated displays for understanding time zones. They carried out two experiments, the first involving an individual setting and the second a collaborative setting (pairs of learners sitting in front of the same computer). They found that learners in the individual setting who received an animated and interactive display performed better on a transfer test than learners who received the static display. However, this advantage of animated display disappeared when learners were in pairs. The authors interpret the results in terms of cognitive load. The animation imposes a heavy cognitive load for processing the information, which is added to the load of interacting with a peer and with the device. However, we found opposite results (Sanzin, Rebetez, Bétrancourt, & Dillenbourg, submitted): the animated pictures had a positive effect with pairs and not with individuals. These findings are not as contradictory as they seem since our pairs actually declared a lower cognitive load with animated pictures than with static pictures. However, we must acknowledge that, as Scheiter et al., we used the NASA TLX test that measures perceived cognitive load. An objective measure of cognitive load might lead to different results.
In the same study, we (Sangin et al., submitted) also found a strange effect: we provided subjects (i.e., individuals or pairs) with snapshots of previous states of the animation, in order to reduce memory load. While these snapshots benefited individuals, they were detrimental to pairs. We interpreted this as a ‘split interaction effect’, by analogy to the ‘split attention effect’: the pairs would suffer from interference between two interaction processes, social interactions and interactions with the material. These findings raise the issue of the cognitive load induced by collaboration (Dillenbourg & Betrancourt, to appear). Collaboration load combines in an unknown way several factors such as the cognitive load of verbalizing thoughts, the costs of producing utterances in a specific medium (Clark & Brennan, 1991), the cognitive effort of modeling each other’s understanding of the task and the off-load generated by labor division.

The argument presented by Kester, Lehnen, van Gerven, and Kirschner (this volume) regarding cognitive load is very relevant at this point. They discriminate the extraneous cognitive load from the germane cognitive load, a notion borrowed from Van Merriënboer, Schuurman, de Croock, and Paas (2002). The same issue is addressed in collaborative learning. While Clark and Schaefer (1989) pointed out that a shared understanding is developed through the ‘least collaborative effort’, pedagogues pointed out that learning occurs because of the effort towards shared understanding (Schwartz, 1995). This effort corresponds to the interactions, such as rephrasing and explaining, which are necessary to co-construct a shared understanding of the domain. Two students who perfectly understand each other and agree from the outset would have a lower collaboration load but probably also lower cognitive gains.

Without going deeper in these studies, my comparisons stress that the effects observed for individual subjects can rarely be generalized to teamwork because they interfere, positively or negatively, with the multiple cognitive processes triggered by social interactions. Of course, if this solo-duo gap exists for mechanisms that were expected to be purely cognitive, it can only grow for social mechanisms. When Joiner, Nethercott, Hull, and Reid (this volume) investigate personal motivation factors in a social context (they tested five users simultaneously), they have to acknowledge that actual balance of competition and collaboration that spontaneously occurred inside groups did interfere with the individual variables. How could it be otherwise?

A more subtle solo-duo gap can be illustrated in the study of Bartholomé, Stahl, Pieschl, and Bromme (this volume). They study how pairs use the help functions provided by the learning environment. Their experiment involves pairs of subjects, but uses personal features as independent variables: prior knowledge, motivational orientation, self-estimated competence, interest, and epistemological beliefs. One could object that help-seeking is a very social process and that this requires an analysis of interactions among peers. For instance, one could expect that mutual help within the pair would reduce the frequency of using the system help. Actually, Delievre, Depover, and Dillenbourg (to appear) observed the opposite results: pairs triggered the system help more frequently than individuals did! My point is not to analyze this surprising result in detail, but to use it to illustrate my main argument summarized below.
Since no operational model of social interaction is available, we can hardly anticipate how social interactions will interfere with individual cognitive processes and, hence, we ignore how results of experiments on individuals can be generalized to group learning. We have to continue conducting experiments in both settings. The optimistic conclusion is that the contradictions between the empirical results of solo- and duos studies contribute to understand the tight coupling between individual cognition and social interactions.

References


