Analyzing Learners' Self-organization in Terms of Co-construction, Co-operation and Co-ordination

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1 Context: A Collective Mediated Challenge

We define a *pedagogic collective challenge* as a CSCL learning situation where: (1) the problem is designed to make learners practice some target domain-related and/or meta-cognitive competencies; (2) a group of learners is involved, as a team, in the solving of the problem; (3) the solving requires the learners to join their forces; (4) the problem and the setting are designed to create a positive tension that motivates learners. Such challenges aim at enhancing learners' motivation in involving themselves in the collective solving and, within this process, in knowledge generative interactions such as conflict resolution, explanation or mutual regulation [1].

We use as a case study a problem entitled "the race with no winner" (and the Flash simulation) defined by a community of practice dedicated to the use of simulations in mathematics and physics [5]. The simulation embeds 10 cars that can be put on a track. The cars have different behaviours (e.g., speed or dynamics). Learners must first test all the cars (with the simulation) in order to collect the data necessary to the establishment of a relation between the departure position of every single car and its arrival on the arrival line. This requires solving equations to determine speed, duration and distance. When the learners are ready, the tutor puts one of the 10 cars on the track and designates 2 others. The learners have to put these 2 cars on the track in order for the 3 cars to arrive on the arrival line at the same time. When done, the simulation is run to check their solution. There are thus 3 phases: (1) preparing the data (measuring and calculating the data related to the 10 cars); (2) calculating where to put the 2 cars after the tutor has selected his car and has put it on the track (this is to be done in a limited amount of time, on the basis of the behaviours of these cars as calculated at the previous step); (3) simulation to check if it is a success or a failure.

2 Issue: Supporting Learners' Self-organization

A collective learning situation such as a pedagogic collective challenge is made up of two overlapping systems of activities: the collective problem-solving and the organization of this collective problem-solving. It corresponds to a particular case of collective *work situation*, i.e., a situation where the learners are mutually dependent in their work. Actors engaged in such interdependent processes must address an overhead activity, that of articulating (dividing, allocating, coordinating, scheduling,

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meshing, interrelating) their respective activities [4]. This meta-level overhead activity aims at maintaining a more-or-less stable pattern of cooperative arrangement.

The notion of *learners' self-organization* denotes the meta-level activity that a group of learners engaged in a CSCL setting may engage in so as to maintain, within the reference frame that is externally defined by the setting, a more-or-less stable pattern of collective arrangement [2]. "Self" is meant to highlight that, in such a context, part of the organization is set by the setting (here, the challenge) and part is related to emergent features of learners' enactment of the challenge at run-time.

In our case study, learners only have limited amount to calculate where to put their cars (phase 2; in our experiments we gave them 20 minutes). Therefore, in phase 1, they must not only prepare all the useful data (i.e., calculate the different cars behaviours), but also organize themselves for the second phase: identify what are the different tasks to be achieved during phase 2 (acquire x, measure y, calculate z), and decide how to organize themselves (who will achieve each subtask, when and how). As we observed it in our experiments, they naturally engage (however, to different extents) in adopting a more or less explicit strategy and setting up a form of monitoring and regulation of the process: they self-organize themselves.

Our research aims at designing a computer-based system that can (1) support learners in self-organizing themselves in the context of on-line mediated challenges and (2) provide tutors with means to analyze this organization and engage regulation actions. This requires, as a preliminary step, identifying a theoretical basis that helps analyzing the challenge enactment in a way that denotes self-organization issues.

3 Model, Results, and Directions for Design

In order to analyze self-organization issues we propose to use J. Bardram's model (Fig 1). This model aims at perceiving breakdowns that may appear during collaboration, as a way to help in understanding the collaboration dynamics [3]. It stresses the dynamic transformations that may appear in a collective activity between the co-ordination, co-operation and co-construction levels. We present here below these different levels and their instances in our case study, as shown by the exploratory experiments we conducted.

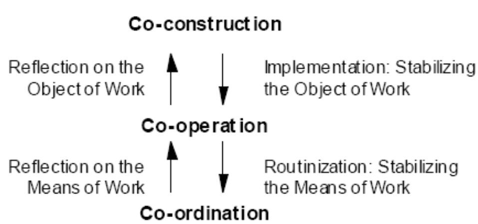

Fig. 1. Bardram's 3-levels model [3]

The co-construction is the level where actors focus on conceptualizing or re-conceptualizing their own organization and interaction in relation to their shared objects. In our case, the experiments corroborate the classical issue of common ground: it is of crucial importance that learners develop a common vocabulary to reflect both on organizational issues (e.g., subtasks) and domain-related issues (e.g., data to be acquired). A specific phase/place allowing the elaboration (and, in case of difficulty or breakdown, revision) of a common view and vocabulary, and of the general scheduling of subtasks, is required. Drawing learners' attention to this phase, proposing adapted means and allowing/facilitating tutor's monitoring and regulation of this phase are critical to enhance the chances students involve in communication, argumentation, analysis or reflection related to both (1) the problem-solving strategy and division of labor and (2) the domain-level issues (here, mathematical issues).

The co-operation level is an intermediate level where actors are active at considering the shared objective. This enables them to relate to each other and make corrective adjustment to their own and others' actions according to the overall collective objective. In our case, this level relates with how to achieve what has been planned: the role of each member (task attribution, task decomposition if necessary), the means to achieve the tasks (e.g., a tool to help in editing and structuring the data), the sequencing, etc. Organization must be made visible and presented in a way that allows learners and tutors to understand it to its details.

The co-ordination level is the level where actors concentrate on the task they have been assigned. Their work is related to a common goal, but their individual actions are only externally related to each other: they realize the global task from the point of view of their individual activity. In our case, each learner is confronted with personal tasks: measuring distance or time, calculating speed, applying mathematical procedures, etc. Tasks, rules or roles have been fixed at the preceding level (and learners can come back to this upper-level by a bottom-up transition). Learners' work is both separated but coordinated with that of other learners.

Bottom-up transitions are related to an analysis of the object or the means of the work, which can occur in relation with a breakdown or an explicit shift of focus. Top-down transitions are related to the solving of problems and contradictions, and conduct to a stabilization of the object and means of the work. Transitions from one level to another can originate from two sources. Learners can spontaneously go from a level to another in relation with a difficulty they encounter, or by a voluntary shift of focus. Such transitions correspond to self-organization dimensions as defined previously. In our case another origin for transition appears: the learners' process is monitored by the tutor. He can launch regulation actions such as drawing learners' attention to the fact they should shift from a level to another (i.e., interact about a feature of another level than the current one) in relation with a problem encountered by a learner or by the group, an anticipation of a breakdown, a pedagogical opportunity, etc. This requires means to detect such issues.

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