Chapter 1
Collaborative Learning in Dynamic Group Environments

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ABSTRACT
This chapter is dedicated to Computer-Supported Collaborative Learning (CSCL) employing dynamic groups, where at different stages students work independently, interact with each other in pairs, and conduct joint work in larger groups with varying numbers of participants. A novel Dynamic Group Environment for Collaborative Learning (DGE/CL) that supports students in making informed and intelligent choices about how, when, and with whom to collaborate is introduced. A face-to-face collaborative scenario, where all students are in the same room and can move freely around and interact with each other while using digitally enhanced printed materials with direct point-and-click functionality is considered. Flexible and efficient support for dynamic group management is ensured through the adopted Cluster Pattern Interface (CLUSPI) technology, which, while preserving the original touch-and-feel of printed educational materials, supports additional affordances and allows employment of new, non-traditional paper-based interactions. Possibilities for DGE/CL enhancements with specialized surface code readers and laser-based digital surface encoding being developed by the authors are outlined and references to recent projects are given.

INTRODUCTION
Collaborative learning is a term denoting a multiplicity of educational approaches that stimulate learners to work closely together in joint intellectual efforts. Over the last half-century, collaborative learning has quickly turned into a strong promoter of groupwork in educational institutions at all levels (Gamson, 1994).
Collaborative Learning in Dynamic Group Environments

Small groups with positive interdependence, where students work together to maximize personal and partner learning, have been traditionally used in cooperative learning. However, as discussed by Curtis (2001), cooperative learning has mostly dealt with tasks that are divisible into more or less independent subtasks, where cooperating parties work in parallel to process individual subtasks in an autonomous, independent way. In cooperative learning, the original task is thus solved by simply solving multiple subtasks in parallel.

Collaborative learning, on the other hand, is pertinent to situations where a joint solution to a problem is built synchronously and interactively, which implies discussions between the collaborating parties in the process of task engagement. As indicated by Pressley & McCormic (1995), this yields significant cognitive benefits since interactions and discussions among students have notable positive effects on their learning aptitude. In collaborative learning, participants brainstorm, share information, and learn from each other so their combined collaborative achievement considerably surpasses the simple sum of individual contributions.

Learner groups and groupwork play a central role, both in cooperative and in collaborative learning and attract significant research interest, especially when combined with instructional use of new and emerging educational technologies. In this context, Johnson & Johnson (1996) identify formal cooperative learning, informal cooperative learning, base groups and academic controversies as four major types of cooperative learning. Collaborative learning models, on the other hand, are classified into seven types by Hadwin et al. (2006), based on their group size, temporal limitations, applied representations and collaborative roles.

Our research reported in this paper falls in the domain of Computer-Supported Collaborative Learning (CSCL), although support of cooperative learning, based on the methods that we develop is also possible. The central idea of our approach is to build an educational environment based on truly dynamic groups of learners. This is a challenging task, since traditional group management techniques when applied to dynamic groups incur too high a burden on the instructor and make implementations impractical. The viability of our idea and its practical implementation naturally depends, thus, on technical innovations and recent technological advancements. Our research addresses this issue by proposing a roadmap for the design and implementation of a CSCL system based on the innovative Cluster Pattern Interface (CLUSPI®) technology (Kanev & Kimura, 2005; Kanev & Kimura, 2006) that provides flexible and efficient support for dynamic group management.

DYNAMIC GROUPS IN COOPERATIVE AND COLLABORATIVE LEARNING

In the social sciences, the notion of dynamic groups stems from physiology and is mostly related to social psychology group dynamics and dynamic group therapy (Montgomery, 2002). Group related behaviors such as social loafing, free riding, group immaturity, etc. are also cited by some authors as (group) dynamics (Johnson & Johnson, 1996). In the exact sciences by contrast, dynamic groups are most often employed in distributed computing and communications, where the theoretical aspects of dynamic group management have been relatively well developed (Schiper, 2006). Our objective in this work is to propose a dynamic group framework that would support both the social aspects and the technological aspects of cooperative and collaborative learning activities.

We consider the collaborative learning process as an intelligent social activity, where at different stages students work independently, interact with each other in pairs, and conduct joint work in larger groups (Brine et al., 2006; Turk et al., 2006). Existing collaborative learning methods like JIGSAW (Gallardo et al., 2003), however, rely mostly on pairwork and groups with prede-
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