Chapter 7
An Overview on Adaptive Group Formation Technique and the Case of the AEHS MATHEMA

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ABSTRACT

This chapter presents the adaptive group formation and/or peer help technique implemented by various systems so far, and particularly, by web-based adaptive educational hypermedia systems (AEHSs). At first, some concepts about group formation and peer help are described, and a general description of the MATHEMA is made. Subsequently, the overview of the adaptive group formation considers extensively how several systems have implemented this technique so far. A comparative study of the presented systems with the MATHEMA is performed and conclusions are drawn. The systems that implement the adaptive group formation and/or peer help technique are the (M)CSCL, AELS, and AEHSs. In presentation of the adaptive grouping algorithm of the MATHEMA, the following are described: (1) how the priority list is created; (2) how the learners are supported in selecting their most suitable partner; (3) how the negotiation protocol works; and (4) how the peer groups are automatically linked up for a collaboration agreement using a peer-to-peer communication tool.

INTRODUCTION

Adaptive Educational Hypermedia Systems (AEHSs) combine ideas about hypermedia and intelligent tutoring systems (ITS) to produce applications whose content is adapted to each student's learning goal, knowledge level, performance, background, interests, preferences, stereotypes, cognitive preferences, and learning style, and they are stored in the learner's model. A number of research groups have independently realized that a hypermedia system coupled with an ITS can offer more functionality than a traditional static educational hypermedia (Brusilovsky & Peylo, 2003). AEHSs can be considered as a

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solution to the problems of traditional online educational hypermedia systems. These problems are due to the static content, the "lost in hypermedia" syndrome and the "one-size-fits-all" approach. In Web-based AEHSs, several adaptive and intelligent techniques have been applied to introduce adaptation, such as curriculum sequence, adaptive presentation, adaptive navigation support, interactive problem solving support, intelligent analysis of student solutions, example-based problem solving support, and adaptive collaboration support or adaptive group formation and/or peer help (Brusilovsky & Peylo, 2003). According to Brusilovsky and Peylo (2003), a real AEHS should carry out all the above-mentioned techniques. Some examples of AEHSs are the AHA! (De Bra & Calvi, 1998), TANGOW (Carro, Ortigosa, Martin, & Schlichter, 2003), CA-OLE (Santamaria, 2006), and MOT 2.0 (Cristea & Ghali, 2011).

According to Brusilovsky and Peylo (2003), the technologies for adaptive group formation and/or peer help attempt to use knowledge about collaborating peers (most often represented in their student models) to form a matching group of kinds of collaborative tasks.

One major goal of learner-centeredness is to give active and collaborative learning environments (Lambert & McCombs, 1998). The learner-centered characteristic refers to students' independent learning by doing, combining personalized and collaborative learning, encouraging student interest in problem-solving and critical thinking, monitoring the development of students' knowledge and skills by the teacher, and the adaptability to each student (Jamal & Tilchin, 2016; Doyle & Tagg,2008). Dillenbourg (2002) defined collaborative learning as a situation in which two or more people learn or try to learn something together. Also, he supports that the decision on forming homogeneous or heterogeneous groups will primarily depend on the aim of collaborative learning activity (Dillenbourg, 2002). Heterogeneous groups that keep the differences between group members high, but not extreme will allow students to learn from each other. Collaborative learning can also enhance motivation when students care about the group they become more engaged with the task and achieve better learning outcomes (Slavin, 2010).

Recently, the nature of collaborative learning and the dynamics of group interactions in learning environments have gained much interest. The *group productivity* (the ability of a group to solve a problem) is determined by how well the group members work together. The *group effectiveness* is defined as both high performances of group members and their quality of work life (Cohen, Ledford, & Spreitzer, 1996). One way to enhance the effectiveness of collaborative learning is to structure interactions by engaging students in well-defined scripts. A collaboration script is a set of instructions prescribing how students should form groups, how they should interact and collaborate and how they should solve the problem (Dillenbourg, 2002). The group effectiveness is influenced by the task, traits, and skills (Vosniadou, 2008), as well as by the *willingness* and the *ability* of the group members to work efficiently together (Hersey & Blanchard, 1988).

Several studies have been conducted to find out how learning is improved by collaborating in learner dyads. Various studies have shown that problem solving which requires some kind of transfer can be improved after knowledge acquisition in pairs (Olivera & Straus, 2004). Hausmann, et al., (2008) suggest that the dyads solve more problems and request fewer hints during physics problem-solving than individuals. Research of Chester (2009) showed that the physics achievement of cooperative learning dyads was significant. Tao (1999) suggests that the rich collaborative talk of the dyads shows that peer collaboration provided students with experiences of co-construction and a conflict that is conducive to successful physics problem-solving. In addition, students' success in physics problem-solving depended not so much on their ability but on how they interacted and whether and how they invoked the relevant physics principles and strategies.

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