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Heterogeneity of learning material in synchronous computer-supported collaborative modelling

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Abstract

This paper examines the effect of heterogeneous resources, available to students, during computer-supported collaborative problem solving. A study of collaborative modeling has been conducted in the frame of an authentic educational activity in a secondary school. The students involved were provided with sets of primitive resources of varying degrees of heterogeneity to be used during synchronous computer-mediated modeling activities. Analysis of students' peer interaction and of the produced solutions revealed that, contrary to our expectations, the group with heterogeneous resources produced solutions of similar quality to those of the reference group, although they were more active, they exchanged more messages, they were involved in deeper discussions and collaborated more for building the constituent parts of the solution.

Keywords: Computer-mediated communication; Cooperative/collaborative learning; Human–computer interaction

1. Introduction

Modern approaches in teaching and learning put emphasis on problem solving activities that involve collaboration. It seems that there is a wider acceptance of the fact that these approaches encourage construction of knowledge and building of meaning. The main benefits of collaborative learning are related to the active character of the learning process, the deep level of information processing and the requirement of deep understanding from the students involved (Dillenbourg, 1999; Scardamalia & Bereiter, 1994). Through such approaches, skills of critical thinking,

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communication and coordination can be developed and conscious knowledge construction mechanisms can be built (Stahl, 2002; Steeples & Mayers, 1998).

Network-based computer systems offer new possibilities in this context and at the same time raise new questions related to the feasibility and effectiveness of distance collaboration. Also questions relate to the factors that affect collaboration, the role of the symbolic and physical tools that support human activity and communication in this context as well as the role of human interaction and peer support during collaborative learning (Gassner, Jansen, Harrer, Herrmann, & Hoppe, 2003; Martínez, Dimitriadis, Rubia, Gómez, & de la Fuente, 2003; Suthers, Hundhausen, & Girardeau, 2003). In computer-supported collaborative problem solving, knowledge building takes place through student peer interaction, interaction between the students and external representations, between students and teachers or students and software agents. Communication often takes place through specially designed tools, which should remain transparent in order not to interfere with students' problem solving activity (Reiser, 2002). Synchronous communication, for instance, can take place through exchanged text messages using chat tools (Baker, Hansen, Joiner, & Traum, 1999) and through shared activity boards, in which problem solutions are constructed. The collaborating partners share this way representations of cognitive artifacts, supporting common understanding.

In this context, special interest has been recently shown on the investigation of the conditions under which computer-supported collaborative problem solving can be effective. Investigation of these conditions often involves design of collaborative learning environments, e.g. environments, which provide learning resources and in particular primitive entities that can be used in the process. In most cases these primitive entities belong to a pre-determined closed set. Examples of these primitives can be abstract objects, like rectangles, ellipses, squares, different statement types, etc., as it is the case in Belvedere (Suthers & Jones, 1997), COLER (Constantino-Conzalez & Suthers, 2001), C-CHENE (Baker & Lund, 1997), Modeler Tool (Koch, Schlichter, & Trondle, 2001). These can take on a special meaning for the students during problem solving. Common understanding among collaborators is based on the existence of these common basic primitives and the solution is built using these shared available resources. This is one of the mechanisms provided for scaffolding the collaborative activity. These common primitives are the items about which the users argue and discuss before converging to a commonly acceptable solution (Suthers, 2000). According to Stahl (2002) the students can start their argumentation only after they have built a common understanding of their meaning and use it in the modeling activity.

However this "closed environment" assumption is not always true. Today collaborative problem solving activity can take place within *open systems*, which permit additional resources to be built or sought by the students themselves. In addition, pedagogical motivations often encourage this "open" approach. As a consequence the building blocks are not shared among all the partners who therefore need to negotiate the available resources before even start getting engaged in problem solving. The collaborators search for primitive entities in a wider space like the Internet or even build new entities themselves during the process. This is the case of ModelsCreator 3.0 (MC3) (Fidas, Komis, Avouris, & Dimitracopoulou, 2002) the environment used in our study. MC3 permits synchronous distance collaboration for building and exploring models made out of an open set of primitive entities. These entities represent concepts with properties and visual behaviour. In this environment a student before entering in a specific collaborative modeling