Towards a Flexible Model for Computer-based Analysis and Visualization of Collaborative Learning Activities

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Abstract: The definition of appropriate interaction analysis methods is a major research topic in Computer Supported Collaborative Learning. Analysis methods can be totally or partially supported by computer-based tools that provide for better and more efficient analysis processes. The current research in this field shows that most interaction analysis tools have been based on unstable prototypes, and are highly dependant on the learning environments and research goals for which they were defined. As a consequence, it is not possible to use them in authentic CSCL settings with real users. The goal of this European Research Team therefore is to utilize the synergies of experience in manual interaction analysis with computer-based analytical methods. In this article we present an approach that embeds standardized computer-supported techniques into a semi-formal analysis process model which can be utilized and adapted in a flexible way according to the cases and environments to be analysed.

Introduction

The definition of appropriate interaction analysis methods is a major research topic in Computer Supported Collaborative Learning (CSCL). These analysis methods support the understanding of collaborative learning activities. Such an understanding is the basis for those functionalities that might be offered by an enhanced CSCL environment, including, for example support for students' and teachers' self-regulation, teachers' supervision tasks, the generation of feedback and the design of instructional support measures for enhancing collaboration skills, as well as the assessment of learning experiences and further data gathering. All these functionalities are important for the design of enhanced learning environments that go beyond the communication and information sharing support that current CSCL tools provide.

Analysis methods can be totally or partially supported by computer-based tools that provide for better and more efficient analysis processes. The definition of these computer-supported analysis tools is attracting more and more researchers, but current research in the field is mainly based on unstable prototypes applied to isolated experiences (Soller, Martínez, Jermann, & Muehlenbrock, 2005). As these prototypes are usually not designed for general use beyond the scope of a given research project, their usability is normally very low. Therefore, it is necessary to work on analysis tools that can be applied easily by different real users in different authentic collaborative learning settings. This entails also the cooperation between researchers in collaborative learning and computer scientists in reifying the expertise of human analysts as computational representations.

The overall aim for elaborating an analysis process model common to researchers in the field of CSCL is to reach a higher degree of generalization and comparability. Such a common framework would support the integrated analysis and the standardized exchange of data across analysis methods, tools, research teams, and learning environments. In addition, such a standard analysis process model would enable us to systematically compare the outcomes of individual studies as well as the research models themselves in order to improve the research design. Still, the proposed framework is intended to be flexible enough as to consider qualitative and contextual differences of individual research groups.

The CAViCoLA Process Model

The common analysis process model has been derived from four empirical research designs which have been conducted by four different research groups in Germany, Greece and Spain (Martinez, Dimitriadis, Gómez-Sánchez, Rubia-Avi, Jorrín-Abellán & Marcos, 2006; Meier, Spada & Rummel, accepted; Harrer, Zeini & Pinkwart, 2006b), one of them conjointly between two research teams (Harrer, Kahrimanis, Zeini, Bollen & Avouris, 2006a).

These teams collaborated on the conceptual and technical integration of their research approaches in the European Research Team "Computer-based Analysis and Visualization of Collaborative Learning Activities"(CAViCoLA) within the Kaleidoscope research network. A graphical overview of the combination of different analysis methods and their facilitation by a unified data format (CAViCoLA Common Format) can be seen in Figure 1.

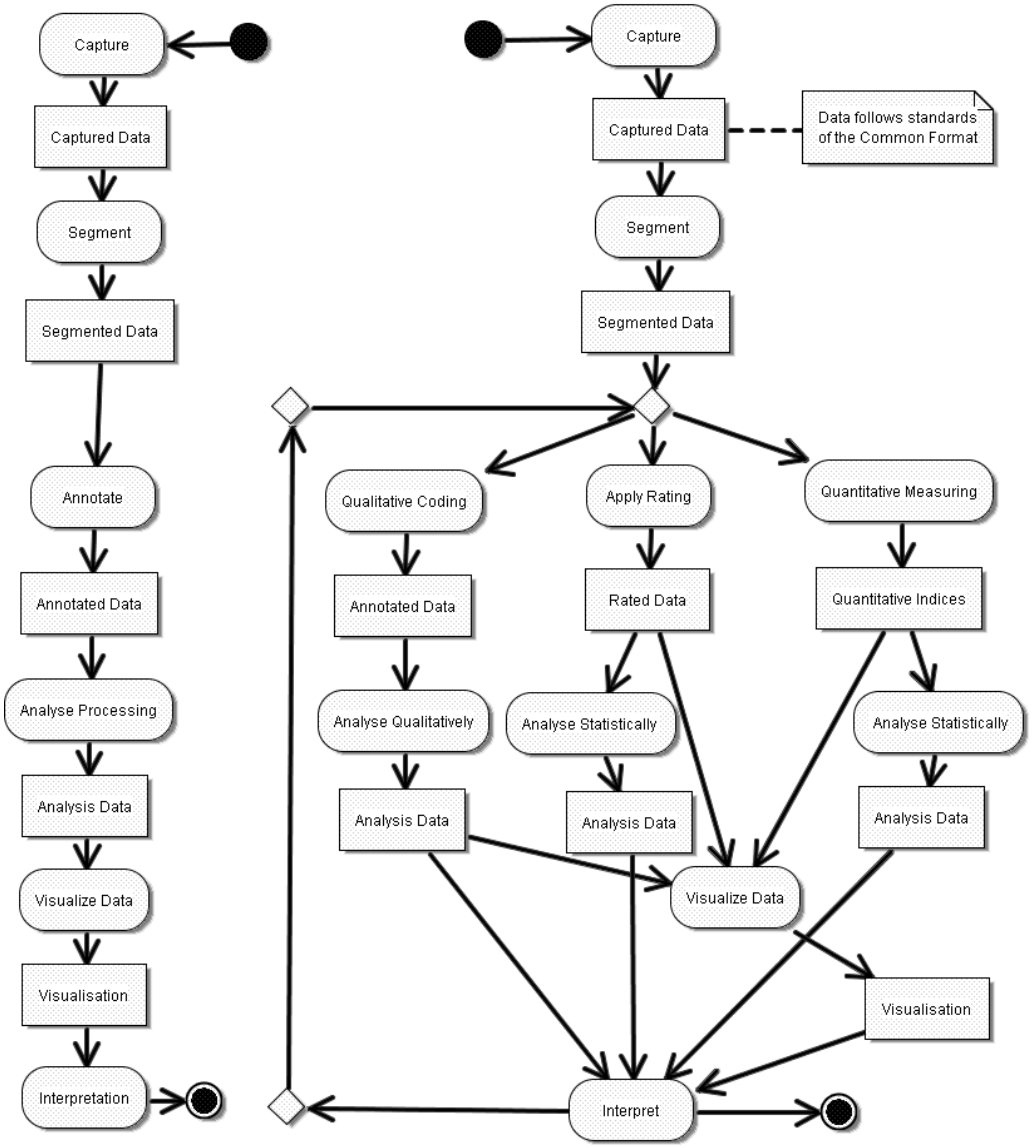

Figure 1: Graphical Representation of the CAViCoLA Process Model

The left side of figure 1 shows the generic process sequence used within the European Research Team. On the right side the CAViCoLA process model combines several quantitative approaches, such as interaction analysis of the participants' actions in time, analysis of group structures in learning communities (Social Network Analysis and statistics; Harrer et al., 2006b; Martinez et al., 2006), and a rating scheme for assessing the quality of the collaboration process (Meier et al., accepted). This is complemented by qualitative methods, such as content analysis, observations, questionnaires, focus groups and category building (Harrer et al., 2006a; Martinez, 2006). All these analysis methods follow the classical procedure of *data capturing*, *data segmentation*, *preprocessing* (e.g. annotation and measuring), qualitative, statistical and social network *analysis*, and potentially *visualization* to support *interpretation*(see left). The overall approach follows the classical idea of the triangulation of results

(Denzin, 1980) that is visible in the different analysis paths in the right side of fig. 1. Since the interpretation of the research findings is important in the refinement of the process model, the feedback loops facilitate the incremental aspect of the model, such as the iterative cycle process within Grounded Theory (Strauss & Corbin,1990) for qualitative approaches or the building of indices (Inglehardt, 1977) for quantitative designs. For example, the annotation process described in Harrer et al. (2006a) is based on iterations from open coding to annotating data, which was focused on related studies (e.g. Gunawardena, Lowe & Anderson 1997) and internal discussions between the research teams in Germany and Greece.

To facilitate the flexible combination of different analysis tools during the process, we defined a standardized data format that captures the relevant information of collaborative learning activities. This allows the analysis of several types of captured data, such as the different learning environments used by the partners, e.g. Synergo (http://www.synergo.gr), FreeStyler (http://www.collide.info), Discussion Forums (e.g. phpBB), BSCL-Synergeia shared workspaces (http://bscl.fit.fraunhofer.de/), with the same interoperable set of analysis tools. Among these analysis tools are applications for the qualitative coding of observation data captured by video, for the generation of logfiles capturing user interactions in CSCL systems, and for gathering sociometric data. The logfiles captured are also used for replaying, interpreting, and annotating collaborative workspace activities: this has been done in previous research of the partners and is currently used in the European research project ARGUNAUT that uses the standardized data format to support the moderator of electronic discussions in analysis and annotation.

Perspectives

In future work we plan to conduct multilateral and cross-national studies between the partner sites that will use the proposed analysis model for CSCL activities and take advantage of the standardized data format for interoperable and flexible usage of diverse analysis tools. This will also facilitate further evaluation of the model that can lead to its further refinement. Some phases of the model, like the analysis and visualization phases which depend on the interoperability of tools that provide automated analyses, can also be further formalized in more detail. For instance we are working on approaches for the visualization of the dynamics of social networks and the graphical representation of dimensions of collaborative processes using semantic differentials.

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