Multi-Dimensional Tracking in Virtual Learning Teams An Exploratory Study

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ABSTRACT

We present a shared workspace application for co-constructive tasks with functions for tracking, analyzing and feeding back parameters of collaboration to group members. The interdisciplinary approach is based on an integrative methodology for analyzing collaboration behavior and explicit surveyed data of group members' attitudes. In an exploratory study, we examined the influence of the feedback function, with the long term perspective of enriching collaboration processes in real communities of learners.

Keywords

Co-Construction, Motivation, Learning Communities, Shared Workspaces, Action Analysis

MULTI-DIMENSIONAL TRACKING IN VIRTUAL LEARNING TEAMS

Collaborative learning can be organized and orchestrated in a number of ways. For instance, Learning Communities (LCs) are groups that focus on building shared knowledge and, in doing so, also gain individual knowledge. Learning communities that work together for weeks and months must maintain a certain level of coherence and stability. This means that, in addition to task completion, psychological factors concerning the well-being of the group as a whole and the well-being of their individual members have to be considered. From a social psychology perspective, McGrath (1991) suggested in his TIP theory three success factors for learning communities, i.e. *production function*, *group well-being*, and *member support*. These factors are even more important in virtual groups that communicate via low-bandwidth channels e.g. discussion boards. In particular, social cues are lost when communication is limited to media that do not convey non-verbal information about other users' behavior and appearance. In our approach, we experiment with techniques to (a) dynamically *elicit* emotional and motivational state of the group members and (b) to *feed* this information *back* to the group by making use of *visualization* techniques for highlighting trends over time and for pointing out individual deviations from the group average. Although our long-term goal is the support of learning communities, we based our first exploratory study on ad-hoc groups that worked together for only a number of hours. In this study we were mainly concerned with methodological considerations: How can implicit and explicit collaboration parameters be tracked, used in order to analyze interaction and, by means of feedback, be used to support collaborative learning?

Supporting and analyzing co-construction in replicated shared workspace environments

We seek to advance the state of art of computer science methodologies with respect to computer-based analysis of cooperative activities in the context of CSCL and knowledge communication (Dillenbourg, Baker, Blaye & O'Malley, 1995). The focus is on the analysis of *directly observable* operations on visual objects in shared workspace environments, which support both spatial metaphors and direct manipulation. The analysis of activities is making use of the logic of the problem space, thus leading to principles of "operational semantics" for the analysis and support of collaboration. For our study, the application EasyDiscussing provides a shared workspace with a set of typed cards that can be dragged from a palette and dropped at an arbitrary position within the workspace. In addition, there is an overview panel, a chat interface with typed contributions, and a feedback component to visualize quantitative measures such as the number of each user's contributions in the chat and the shared workspace. All user actions in every component of this application are logged to an XML-based protocol that represents the type of action such as adding, deleting or changing nodes or edges together with further parameter that represent the objects involved, the user, and the time and date among others. The analysis of the user activities is based on performance oriented recognition of activity and interaction (Muehlenbrock, 2001). In a user interface with mainly free text input, an activity is analyzed concerning the *sequence* of actions involved, the *context* of their application (i.e. same object, connected objects, etc.), the *users* involved (same user, different users, etc.), and the contribution's *type* (e.g. question and answer). Patterns of activities have been defined formally for an automatic analysis. For instance, the activity "node_reference" is performed by a group of users if one user adds a node to the shared workspace and another user subsequently adds an edge that is partially based on this node (and could not have
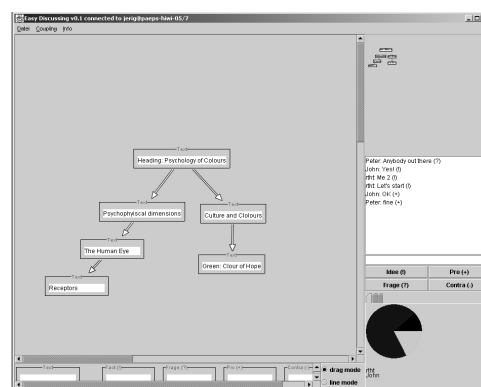
been created without that node). Another type of interaction ("node labeling") is signaled when some user adds a node and a different user puts in some text. For our study, 18 activities including variants have been defined. A sample analysis of a multi user session shows that 88 sequences can be recognized, and seven sequences involved more than one user and hence are interpreted as some interaction. In addition, the analysis indicates that one of the three users is a frequent initiator of activities, whereas another user tends to complete the interaction.

A first analysis of socio-emotional and task-analytic parameter feedback

In an explorative study we examined parameters influencing group processes during a co-constructive learning task using the shared workspace EasyDiscussing. The main idea of the study is the investigation of how groups can be affected by feedback of their own socio-emotional parameters and what kind of interaction patterns take place during a co-constructive design task. We use a combined top-down/bottom up analysis: On the one hand, we collect data by using traditional psychometric methods. On the other hand, the collaboration platform itself allows a detailed tracking of user behavior and a semantic analysis of interaction patterns during collaboration. Nine subjects (= three groups) participated in an experimental condition with the tracking of interaction as well as motivational and emotional parameters directly displayed as graphical feedback to each group. Three other groups in a control condition did not get any automatic feedback about interaction, motivational and emotional parameters. The task for all groups was the same: To collaboratively re-design a linear text into a didactically structured online-text. This design task had to be fulfilled by using EasyDiscussing tool and online learning resources. All subjects had to perform a multiple-choice pre- and a post-test regarding knowledge about didactical screen design. The results of subjects' performance in pre- and post-test concerning domain knowledge revealed no significant differences but both groups mastered the post-test significantly better than the pre-test. There were also no significant differences between both groups regarding the emotional state and motivational parameters, but interaction of repeated measurement and motivation became significant. A more detailed view on subjects' discussion structures showed a more frequent use of *pro* and *contra* postings in the experimental group. The automatic detection of interaction patterns in subjects' discussion yielded a significant difference in the number of dyadic interactions. A view on correlations between participation in dyadic interaction revealed significant correlations between use of the pre-structured argumentative icons of "pro" (0.82, $p<.05$) and "contra" (0.71, $p<.05$). In addition, we found a significant correlation between initiating a dyadic interaction and the use of questions (0.74, $p<.05$).

Summary and further work

In this paper we stressed the role of external representations as a result of a group's natural interaction. Overall we could show some effects of tracking parameters of group interaction and feeding them back to the group members. Further experiments and analyses are needed to investigate the role of this kind of protocols in detail and improve the quality the feedback. From a methodological perspective, our experiment is an example of what can be achieved by combining different analytic measures to gain more insight into group processes. The technical prerequisites are flexibly definable shared workspace environments, mechanisms for logging and analysis, and appropriate feedback techniques including visualization.

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