Helping Educators Analyse Interactions within Networked Learning Communities: A Framework and the AnalyticsTool System

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Abstract

Networked learning is much more ambitious than previous approaches of using technology in education. It is, therefore, more difficult to evaluate the effectiveness and efficiency of the networked learning activities. Evaluation of learners' interactions in networked learning environments is a resource and expertise demanding task. Educators participating in networked learning communities, have very little support by integrated tools to evaluate students' learning activities flow and identify learners' online browsing behaviour and interactions. As a consequence, educators are in need for non-intrusive and automatic ways to become informed about learners' progress in order to better follow their learning process and appraise the online course effectiveness. They also need specialized tools for gathering and analysing data for evaluating the learning effectiveness of networked learning instructional models. The aim of this paper is to present a conceptual framework and an innovative tool, called AnalyticsTool, which is based on this framework, that allow teacher and evaluator to easily track the learners' online behaviour, make judgements about learners' activity flow and have a better insight about the knowledge constructed and skills acquired in a networked learning environment. The innovation of the proposed tool is that interoperates with the Moodle learning management system and that it guides the educator perform the interaction analysis of collaborative learning scenarios that have been designed following specific learning strategies such as TPS, Jigsaw, Pyramid, etc.

Keywords

Integrated tools, evaluation of learning activities, networked learning

Evaluating learners' activities within Networked Learning Communities

According to modern pedagogical theories, learning occurs not only as a result of learners' direct participation in learning tasks, but also through legitimate peripheral participation in communities (Lave, 1997) in which implicit and explicit knowledge is 'stolen' from the community (Brown & Duguid, 2000). In the era of networked learning, the "network" component plays an important role in the formation of learning communities since it promotes and facilitates collaborative and co-operative connections: between one learner and other learners; between learners and tutors; between learners and learning resources, so that learners and tutors can extend and develop their understanding and capabilities in ways that are important to them, and over which they have significant control (Steeples, Jones, & Goodyear, 2002).

Networked learning communities (NLC) provide socially situated learner support through the active processes of dialogue, collaboration and shared knowledge construction that drive learning in social settings. Forming NLC leads to an array of benefits, such as:

- opportunities for participants to share their knowledge and expertise
- opportunities for participants to discuss, plan, reflect on and explore learning issues
- increased inspiration, innovation and motivation amongst participants
- increased social contact between individuals from differing backgrounds
- a reduction in feelings of isolation (both geographically and emotionally)
- increased access to shared resources.

In a NLC, where individual and collective actions take place, educators face great difficulties in evaluating the broad spectrum of interactions among the interacted participants (student-student, student-educator, student-learning resources) during learning processes (Moore, 1989). It becomes difficult and time consuming for educators to thoroughly capture, track and assess the various interactive learning activities performed by all learners. The need for designing specific tools, which will be based on well-grounded conceptual frameworks, for analysing the grid of all these interactions is emerged as the issue of evaluation tends to be multifaceted and complex for educators (Dimitracopoulou et al., 2006b; Marcos et al., 2005).

Our paper proposes such a framework and identifies specific indicators that can help educators' analyse and evaluate multiple dimensions of interactivity that is developed in a NLC. In this paper, we also present Analyticstool, a tool for the automatic analysis and visualization of data collected during the networked collaborative learning process. This tool is expected to be useful for educators who need to assess the individuals' contributions in a NLC. AnalyticsTool is an interaction analysis tool that automatically gathers, analyzes and visualizes data related to participants' asynchronous interaction in a NLC.

The innovative feature of AnalyticsTool is that it can be used to analyse data of asynchronous networked learning interactions that occurred within the Moodle learning management system (LMS) which is the most popular open source LMS. A teacher, using Analyticstool, can import data from the various fora that had been used for supporting the learners' tasks within a course into the tool, which will, then, be organized and structured in such manner that can be analyzed at various levels. The analyzed data can also be exported in appropriate formats so that it can be used as input to the SPSS statistical package or other tools such as the NetDraw software for further analysis. Another innovative feature of Analyticstool is that it guides the teacher in performing specific analysis of the data collected according to the teaching strategy followed in his/her course. For example, if a teacher uses the Think Pair Share (TPS) learning strategy (Palloff & Pratt, 1999) in a course, AnalyticsTool will automatically create the most appropriate statistical tables and diagrams indicators for this strategy, which will be related to the quantity and quality of participation and collaboration among learners.

The structure of this paper is as follows. First we will discuss an interaction analysis conceptual framework on which the AnalyticsTool system is based. Then we will analytically present the system via an example of its application in a learning scenario of collaborative problem solving according to the TPS strategy. Finally concluding remarks and futures research plans will be given.

A conceptual framework for assessing learners' behavior in a NLC

According to Dillenbourg (1999), the key to understanding collaborative learning is to gain an understanding of the wealth of interactions among the individuals. This is why various indicators and specific tools that can analyze the grid of all these interactions have recently proposed. Interaction Analysis (IA) indicators deal with a) the process of the activity (individual, group, or community), b) the interaction product, c) the quality of collaboration and d) the formed social context (Dimitracopoulou et al., 2006a). The associated IA tools either inform learners about their learning progress (for self-regulation purposes) or help instructors/researchers evaluate and assess the collaborative learning process and products.

Various techniques have been appeared in the literature for evaluating the collaborative learning process and products. Several publications with overviews of such techniques can be found in the literature (e.g. Daradoumis et al., 2006; Dimitracopoulou et al., 2006b). The evaluation of collaborative learning has to be performed at least at two levels, separating the process (or group functioning) from the product (or task performance) of collaboration (Collazos et al., 2002; Daradoumis et al., 2003; MacDonald, 2003; Hakkinen et al., 2003).

Based on this trend, we have developed a multi-method research framework to study learners' behavior in a NLC processes by making use of descriptive statistics, social network analysis (SNA), content and context analysis (through coding teaching and learning activities) as a way to find out "what they are talking about", and "why they are talking as they do". These methods are used to triangulate and contextualise our findings (De Laat et al., 2006). Our framework is conceptualised in a layered manner. High-level generic group activity indicators are further decomposed into more specific ones that highlight aspects of the collaborative learning processes.

Figure 1 illustrates the fundamental axes of our proposed conceptual framework. The proposed framework tries to analyse the interaction holistically, thus covering the three types of interaction defined by Moore (1989): learner-content interaction, instructor-learner interaction, and learner-learner interaction. It also tries to give a holistic view of the learning outcomes and learners' perception of the pedagogical model based on which interaction occurred. Details about the proposed framework can be found in (Petropoulou et al., 2007).

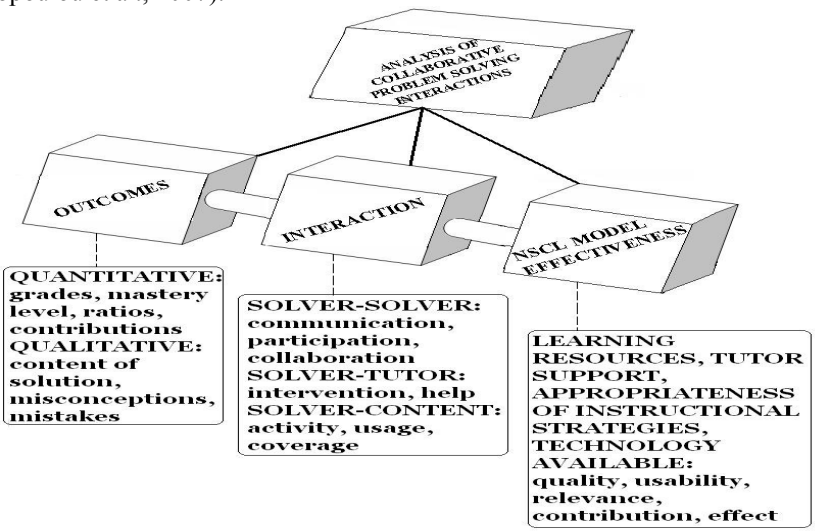

Figure 1. The proposed conceptual framework consisted of three main axes

The outcomes of the problem solving process in a NLC refer to the deliverables of individual or group action (e.g. learners' assignments, solutions to given problems, etc.). Both quantitative (i.e. time needed for solving a problem) and qualitative aspects (e.g. type of misconceptions and/or mistakes, etc.) of the problem-solving outcomes should be accounted for. The second axis refers to the specification of the effects of particular categories of interactions within a collaborative problem solving learning community. These interactions can be classified as Learner-Learner(L-L), Learner -Tutor (L-T) and Learner -Content (L-C) ones. All three types of interaction play a key role in a community problem solving (Harry et al., 1993). So they need to be captured and analyzed accordingly. Specifically, in terms of L-L interactions we propose the evaluation of the descriptors of participation behavior such as the total number of messages that the learners exchanged each other (per week/per day), the evaluation of the level of communication behavior, e.g. the total number of follow-up postings as well as the evaluation of the type and the quality of collaboration by measuring indicators such as the mutual engagement of participants in a coordinated effort to solve a problem, learners' motivational and emotional support to their peers, etc. Concerning the L-T interactions various issues should be measured such the moment and type of tutor's intervention. The L-C interactions are mainly illustrated by the solver's navigational behavior with the online learning resources (hits, navigational paths, etc.). The third axis of our proposed framework refers

to the effectiveness of the applied pedagogical model for building and running/maintaining the collaborative problem solving learning community. The applied model is considered to be influenced by a number of variables (Retalis et al., 2006; Avouris et al., 2003; Gunawardena et al, 1997). The effectiveness of the applied pedagogical model is tightly coupled with the quality of problem-solving resources, tutor support, and appropriateness of instructional strategies according to problem-solvers and technology available. The evaluation of the applied pedagogical model should include the measurement of the:

- Relevance of the instructional model to the learners' body
- Effect of the instructional model to learners' styles with respect to educational settings, problem-solving strategies, assessment methods, etc.
- Contribution of the problem-solving resources to the acquisition of knowledge and skills with respect to their problem-solving objectives

The AnalyticsTool System

The AnalyticsTool system is an interaction analysis tool for the automated collection, analysis and visualization of data that concern the behavior of participants in an asynchronous NLC. The tool has been developed based on the measurable analysis indicators aforementioned. Its basic operations are portrayed in Figure 2.

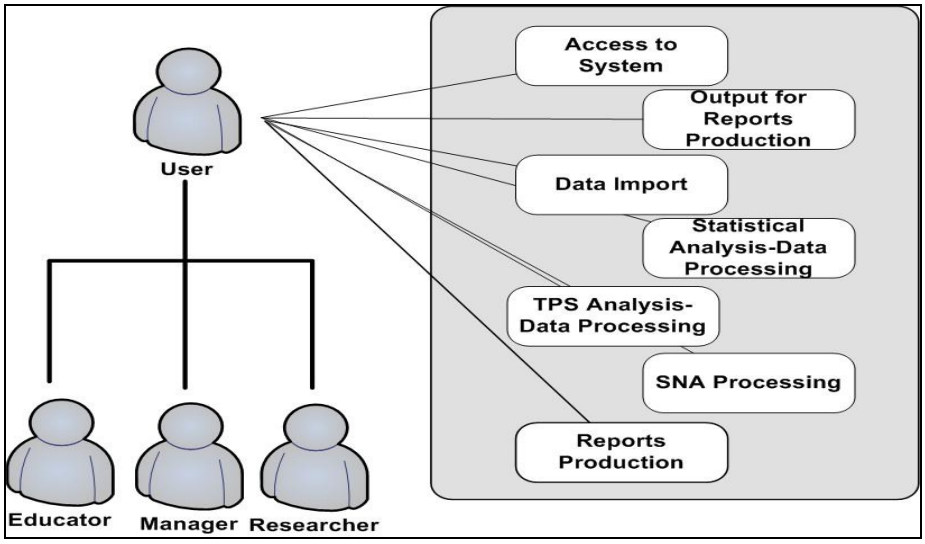

Figure 2. Use Case Diagram of AnalyticsTooL

Two are the main innovative features of the AnalyticsTool. First of all, it interoperates with the Moodle Learning Management System. Moodle generates log-files through which information about the activity of the members can be obtained. The information retrieved from Moodle can be treated as relational data and stored away in a case-by-case matrix to analyse interaction patterns using the AnalyticsTool system. These data is organized and structured suitably so that a first level analysis can be achieved. The data can be exported in a suitable coded form, so that it can be further processed further with the help of more specialized tools (eg NetDraw, software for analysis of social networks).

Secondly, the tool can guide the educator during the interaction analysis process. If the educator structures the learning tasks in a NLC according to a pedagogical strategy such as Jigsaw, TPS, etc., (Palloff & Pratt, 1999) the tool can propose to him/her a series of diagrams and tables that show the results from an analysis of the indicators that best fit to the strategy followed. An example of this feature is shown in the next section.

Example of the AnalyticsTool utilization– The Case of TPS Strategy

AnalyticsTooL has been used for analysing the learners collaborative tasks occurred in a NLC. These tasks had been designed based on Think-Pair-Share Strategy. According to the TPS strategy (see Figure 3) the educator gives to the learners a problem/question. Each learner has to reflect upon the problem and submit to the forum his/her answer. Of course questions and remarks about the problem can be asked via the forum while learners try to solve it. Often the students share resources that could help their peers find the solution to the problem. Having the students think about the problem (Think phase) and repor their solutions (first report), in an asynchronous web-forum, they form groups (Pair phase). During this phase, members of each group exchange their solutions, give explanations, and negotiate their thoughts in order to jointly create a new deliverable which will be an elaborated version of the problem solution. Finally, all the deliverables are shared (Share phase) in order that the learners peer review them and ask for clarifications, explanations and so on. The TPS strategy encourages the active participation of members, the collaboration, the investigation of a subject from various angles, the critical thought and the group attainment of knowledge.

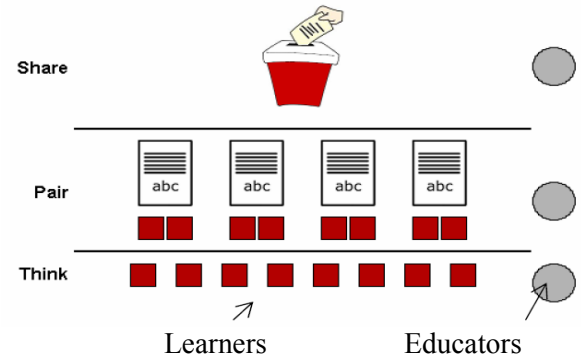

Figure 3. – Graphical representation of the TPS strategy

AnalyticsTool can help an educator perform the interaction analysis for this specific collaborative strategy. More specifically, the tool can specifically produce reports on indicators such as:

- **A3** - Actor's degree centrality (SNA)
- **B1** – Work Amount (quantification of the amount of work, message dimension per user)
- **B2** – Argumentation (measure of the initiative work that has been done in the team – message annotation)
- **B5** – Collaboration (interaction base message characterization)
- **D1** - Average Number of Contributions (calculate the participation percentage per team in a certain course and team argumentation in a certain time period)
- **E3** - Participation Count (number of posted messages a user has done in a certain course and period)
- **F3** - Number of Messages per Participant (number of posted messages a user has done in a certain course per Forum and period)

Moreover, the results of the analysis of these indicators can be shown per phase. For example:

- **At Think Phase:** The tool produces statistical tables and bar-charts for B1 indicators (case a). The teacher can see the total number of messages sent per learner and the total time he spent on this activity at a glance (Figure 4).

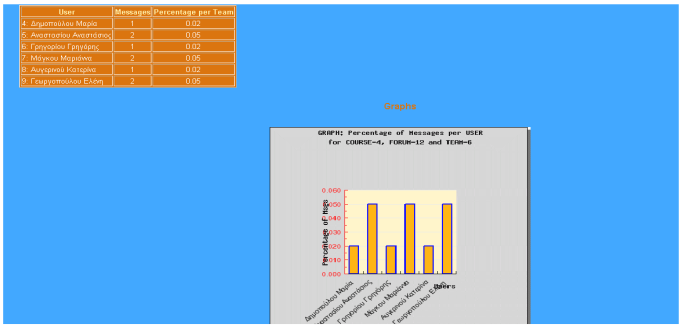

Figure 4. - Total number of messages per Learner

- **Pair Phase:** The tool produces statistical table and diagrams for indicators B2, D1, that relate to the product of activity, the degree and the quality of learners' participation in the same team, the type and the quality of collaboration and communication among teams as well as the total time that users spent for this particular activity. For example the tool calculates the most active discussion during a course and a forum along, with the most active student of this discussion and the type of messages that this student has sent. A bar-chart is produced in which the students with the stack of their messages along with their categorisation (new proposal-question-justification), per course, forum and separate discussion. Thus, the educator has a holistic picture of the essential work made by each learner in the particular discussion (Figure 5).

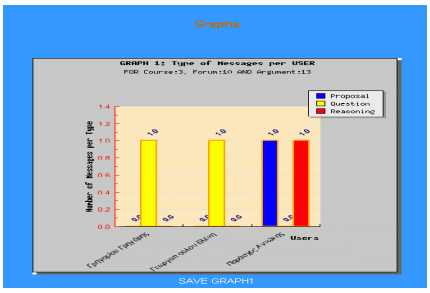

Figure 5. – Semantic Annotation of messages per Learner

- **Share Phase:** The tool produces graphical representations for indicator B1 as in the Think phase per learner and for a specific forum (e.g. for the one that has been opened for this phase as shown in Figure 6).

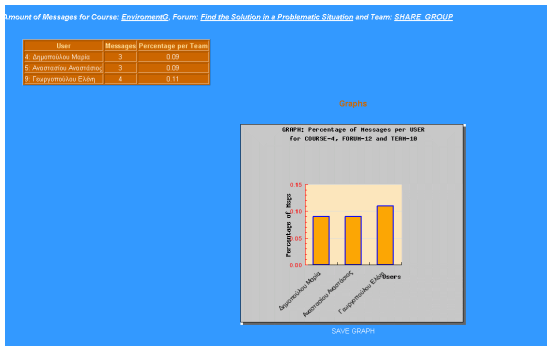

Figure 6. – Average number of messages per Learner per Forum

Concluding remarks

The educator who creates collaborative learning tasks needs frameworks and tools that will enable him/her to quickly and accurately evaluate learners' behavior as wellas to timely offer scaffolding when needed. The AnalyticsTooL system, which has been presented in this paper, is based on such a framework and tries to address this need. It also goes one step further by guiding the educator in analyzing and visualizing data of learners' behavior according to collaborative learning scenarios that follow specific strategy. A very innovative aspect of Analyticstools is that it interoperates with the Moodle LMS. We plan to continue this work by designing experiments where the AnalyticsTooL will be utilised in realistic networked learning scenarios that will be designed based on a mixture of strategies. Such an experiment will be performed at an adult e-learning course on e-tutoring which is currently running at the General Secretariat of Adult Education of the Greek Ministry of Education.

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