Visualized Interaction Analysis indicators in Asynchronous Discussion learning activities. Research results and trends

Tharrenos Bratitsis, University of Western Macedonia, P.O. Box 21, Florina 53100, Greece,
bratitsis@uowm.gr

Abstract: This paper discusses the significance of designing and implementing Interaction Analysis tools for Asynchronous Discussion learning activities. The DIAS system, an asynchronous discussion platform with several integrated Interaction Analysis indicators is described and results from implemented research studies are presented. The significance of indicators' interpretation is discussed and generalized, leading one step closer to the formulation of design principles for similar analysis tools.

Introduction

Asynchronous discussion forae are nowadays widely used in formal or informal educational contexts, applying principles of constructivism, emphasizing in social interaction during learning activities (Corich et al, 2004). Research is focusing towards finding methods for supporting Critical Thinking through interactions, occurring within asynchronous discussions, in order to achieve higher quality dialogue and thus enhanced learning (Stahl, 2006). Such a goal requires tools, frameworks and methods for the facilitation of monitoring and/or selfreflection and therefore selfregulation that could be supported by the automated analysis of complex interactions that occur. Computer based Interaction Analysis (IA) is an emerging research field which can contribute significantly in the design and implementation of such tools.

The DIAS system is an asynchronous discussion platform with integrated IA indicators, implemented in order to research the effectiveness of IA tools in collaborative learning settings, through dialogic activities. The rest of the paper is structured as follows; first a brief of the theoretical background, underlying the design of the DIAS system is presented. Then the system's design principles and some of the IA indicators are described. Finally, an overview of the research findings is presented, before a concluding discussion regarding several important aspects of the designing of such tools.

Theoretical Background

Critical Thinking is an intellectual process allowing learners to construct new knowledge through problem solving and collaboration. While implementing discourse activities by means of discussion forae, higher levels of interaction are needed to encourage learners to think critically, as indicated throughout the literature (Gunawardena et al, 1997; Garisson et al, 2001), along with internal reflection. It is often necessary for the learner to externalize his/her thoughts in order to achieve proper reflection, thus promoting message writing in discussion forae as an ideal reflective process. Intensive discussion and social interaction may lead to multiple knowledge construction phases (Schellens & Valcke, 2005). Our main research axis is peer support in asynchronous discussion learning activities, in order to trigger metacognition, which leads to selfregulation, as well as to facilitate the moderator's tasks. Our intention is to build tools by applying Interaction Analysis techniques in discussions' activity data, visualizing and providing quantitative information directly to technology-based activities' participants, in order to self assess their activity (Dimitracopoulou et al, 2005). The IA results are presented in an appropriate format (graphical, numerical, literal), interpretable by the users, providing an insight of their own current or previous activity allowing them to reflect on a cognitive or metacognitive level, and thus act in order to self-regulate their activities. Additionally, IA provides information to the activity observers, in order to analyse the complex cognitive and social phenomena that may occur. The expected outcome is the optimization of the activity through: a) better activity design, regulation, coordination and evaluation by the forum moderator, and b) refined participation and learning outcome for the students through reflection, self-assessment and self-regulation.

The Discussion Interaction Analysis System (DIAS)

While examining Forum and Forum Type software, we found several drawbacks in participants' support. These include minimum analysis information provision, information provided only to a portion of the participants (e.g. the teachers), closed and/or complex, non-transparent analysis systems or even lack of empirical research (Bratitsis & Dimitracopoulou, 2006). This led us to the development of the DIAS system, a fully functional discussion forum platform. We took into account that users involved in a 'learning activity' form various cognitive systems, as individuals (students and teachers in various roles) or members of groups or even communities, thus expressing different needs for support. Different indicators' sets are addressed to students, teachers, moderators (the latter having increased information needs while monitoring, assessing, evaluating), or researchers along with the corresponding *Interpretation Schema* for various discussion strategies or usage scenarios. An Interpretation Schema explains how to combine different indicators, in order to extract additional, more qualitative information. All the indicators are produced by measuring quantitative activity data.

The implemented charts vary from having low (presenting very simple and understandable information) to high interpretative value (providing several aspects of information, which can be different, depending on the type of user who is reading the indicator). Some examples can be reviewed in figures 1 and 2. Specifically, the *User Performance indicator* (figure 1a) displays information regarding participants' writing activity in a single forum and is addressed to the teacher and/or the researcher. For every actor on the horizontal axis, two bars are created. The red bar depicts the number of messages the actor wrote and the blue bar presents information regarding the size of the messages in words. The smallest and the biggest number of the words used correspond to the bottom and top edge of the bar, whereas the small horizontal bar depicts the mean number of words per message. Moreover, the mean and average message size for all the involved actors are displayed (green and yellow lines correspondingly). The User Performance indicator provides a clear picture of the actors' writing activity individually, as well as comparatively. The quality of each actor's activity is better displayed, since the absolute number of messages written does not always present the correct information (e.g. a participant who writes many small and insignificant messages, just to appear very active).

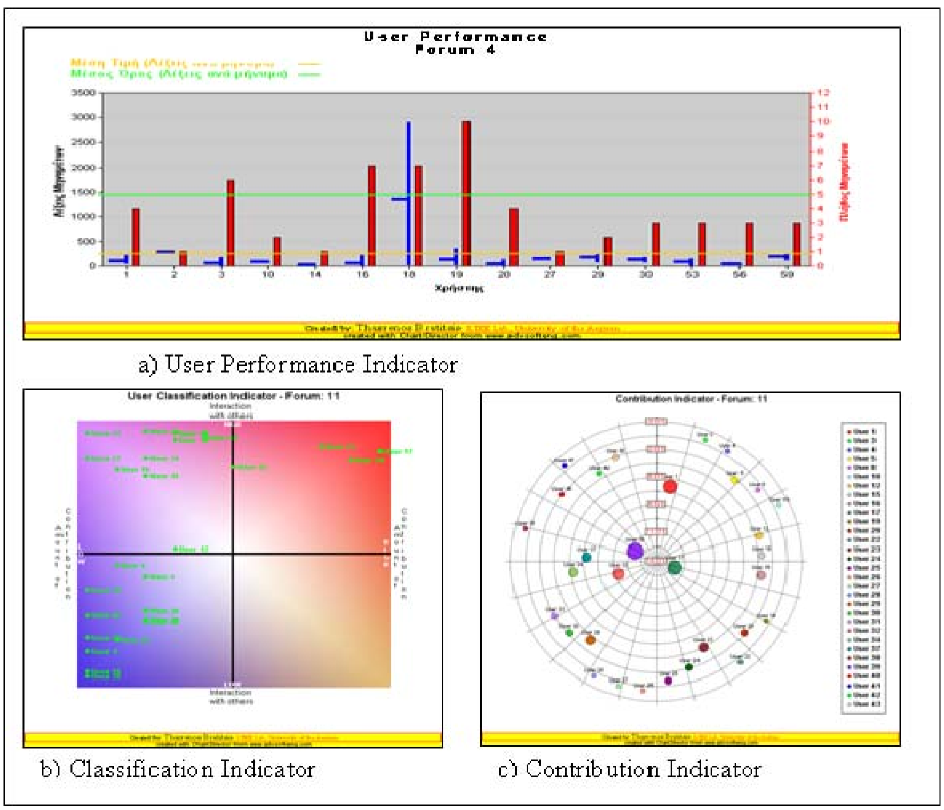

Figure 1. Indicators produced by the DIAS system (1/2)

The *Classification Indicator* (figure 1b) is a XY scattered chart with the X-Axis representing the amount of contribution (messages written as a percentage of the total number of messages) and the Y-Axis representing the amount of Interaction (messages read as a percentage of the available number of messages) by a user. Both Axes are scaled from Low to High. By inspecting this indicator, one may see how active (writing and reading messages) a user is, in comparison with the other users and the mean values of activity (represented by the two Axes' position). The first conclusion is whether the corresponding user has extreme or balanced behaviour (Arrogant: writes many messages but doesn't read other users' messages. Passive: reads many messages, but doesn't write enough). The second conclusion is whether hid/her performance is far ahead from the mean values in any of the two activity constituents.

The *Contribution Indicator* (figure 1c) is a polar diagram, in which all the participants of a forum are arranged in a circular manner. The radial parameter corresponds to the amount of contribution (messages written as a percentage of the total number of messages). Being able to use message types within the DIAS system (e.g. question, answer, argument, etc), the circle corresponding to every participant is relevant to the number of the message types used. By inspecting this indicator, one can compare the activity ratio among all the participants, as well as the quality of their participation, in matters of variety of messages within the discussions. In most cases, unilateral contribution is not expected.

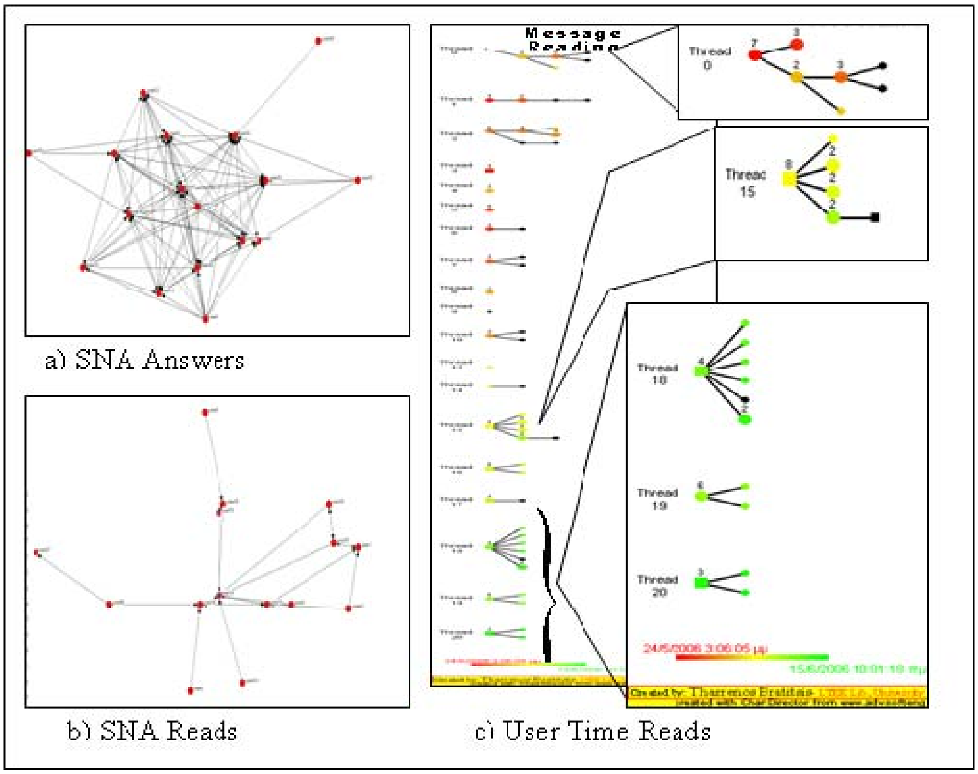

Figure 1. Indicators produced by the DIAS system (2/2)

SNA Answers Indicator (figure 2a): The DIAS system can produce social matrices according to Ucinet DL format and Agna matrix format for further processing. For N users, the Answers social matrix is a NxN matrix. The number placed in the cell designated by line A and column B is equal to the number of messages written by user A as answers to messages of user B. By quickly inspecting the SNA diagram deriving from the social matrix, one can see whether a certain user is isolated or holds a central position within the discussion. Furthermore, this diagram can show if he/she is exchanging information with other users or not, by posting answers to them. Additionally the number of other users who have posted answers to the corresponding user can be detected, revealing interesting information. For example a very active user may be isolated in this diagram, thus not contributing to the quality of the discussion and the overall collaboration (no one is posting answers to him/her). This could indicate low argumentative value of this user's messages, off topic writing, arrogant behaviour or lack of knowledge regarding the topic. In any of these cases, the moderator may diagnose a problematic situation and act accordingly.

SNA Reads Indicator (figure 2b): This diagram is similar to the previous. In this social matrix, the numeric value in a cell designates the number of messages written by user B, that user A has read. This diagram indicates the amount of collaborators whose messages a certain user reads and consequently his/her involvement in the collaborative discussion activity. Apart from the amount of messages read, this diagram additionally shows the dissemination of these messages to the according amount of authors. In combination with the Answers SNA diagrams, the moderator can see whether User X is participating in a closed user group, interacting heavily inter se and lightly with the rest of the users. This may designate undesired behaviour regarding the collaborative activity.

A more sophisticated diagram is the *User Times Read Indicator* (figure 2c). The vortices representing messages are coloured, according to the time a user has read the corresponding message. Unread messages are coloured black, whereas messages written by this user are represented by small rectangles. If he/she has read a message more than once, then the corresponding vortex or rectangle is bigger, with the number of readings adjacent to it. On the lower end of the diagram, a gradient color line shows the time period correspondence. This indicator shows in detail a user's extend of embroilment with a discussion and whether he/she is active mostly in earlier or later phases of the discussion activity. This could be the case of a user who simply agrees or disagrees with other users' arguments but doesn't contribute with new information and ideas, which may be confirmed by further inspecting his/her messages.

Finally, customizability, flexibility and interoperability are considered to be crucial characteristics for independent analysis tools, such as DIAS. More related information can be found in Bratitsis & Dimitracopoulou (2008).

Research Results' Overview

Four case studies implementing a different educational activity approach have been designed *in situ*, constituting the core teaching method for the corresponding semester courses. Similar data collection and analysis methods were used, including questionnaires, experimental (allowed to review IA indicators) and control groups (not reviewing indicators) monitoring and semi-structured interviews with every participant. Some of the questions asked aimed at: (a) *Detecting the most/least popular indicators and the latent reasons*, (b) *Detecting and explain user behavior alterations due to the indicators' presence*, (c) *Measure the frequency of reviewing the indicators*, and (d) *Distinguishing users' information preference* (individual or group data, personal or related to others' actions?). During interviews, *all the system's indicators* were reviewed and discussed upon, in order to examine their transparency. Additionally we intended to record utilization ideas and initial reactions to the indicators' information – "*What do you understand by observing this diagram*?", "*Would this affect you and in what way*?", "*Do you think this information is important and why*?". The most powerful indicators in matters of explanatory value were correlated with the discussions' actual content, in order to examine possible relations.

Examining the "*influence of IA indicators on the users*", we came to the concrete conclusion that they operate as a very powerful motive for participation. Users being positively surprised by the dynamics of the presented information were very enthusiastic and eager to use the IA indicators during the discussion activity (94 out of 98 agree). Regarding "*how often did the users review the indicators*", almost 60% did so every time they connected and 80% at least 2-3 times per week. Researching the "*kind of information users were interested in*", 70% of them preferred comparative information, in order to assess their actions in regard to those of their collaborators. Individual indicators were less preferred (50% of the users), mostly for confirming their impression of their personal activity. Another important issue for the IA field is "*how users decode visualizations*". Apparently, that most of the indicators were adequately transparent. Using simple diagrams, such as bar-charts, XY-charts and scattered charts facilitates understanding, since everybody is familiar with them. A careful choice of colors may be an additional facility. For example, a gradient transition from blue to red color in the background of the *Classification Indicator* (Bratitsis & Dimitracopoulou, 2006) indicates the desired area for a user to be placed upon. Additionally, through the interviews, we decided that instructions are necessary in order to better utilize the IA indicators. In some cases, users understood the main concept of a diagram, but were unable to "read between the lines", detecting more refined information. Furthermore, combinations of different indicators, in the form of an *Interpretative Schemas*, should also be provided, as it is difficult for a simple user to think of all the possibilities, regardless of his/her role.

Another, equally significant issue is "*how the indicators affect the users and the learning process at extension*. *Do they help users develop their selfregulation processes? Do they help monitor and assess dialogic activities?*" Apart from functioning as a strong participation motive, which one could ascribe to the users' sensation of being monitored by the teacher, results of further analysis of users' actions were very encouraging. For example, postgraduate students who understood SNA diagrams were tighter connected with their collaborators, than just reading and writing more messages (in some cases at the expense of content quality). They tried to truly interact with more collaborators, which resulted in more profitable conversations. Another example is the effect of the Tree Structure indicator (Bratitsis & Dimitracopoulou, 2008), which shows the number of threads within a discussion forum that an individual user has participated in. Students reviewing this indicator participated in more threads than those who didn't. These simple examples lead to the conclusion that IA indicators *do affect users and the learning process at extension*. Their effort to improve their interaction status within the discussion activity consequently increased the prerequisites for high order thinking and learning. Higher interaction facilitates critical thinking and sustains effective discussions (Palloff & Pratt, 1999; Garisson et al, 2001; Schellens & Valcke, 2005). In matters of "*facilitating understanding and assessment of discussions activities' goals*", the indicators helped students to evaluate their participation and see if they respected the discussion and the collaborative process. For example, in a multiple phase activity, some students admitted that various group activity indicators assisted them in better noticing increased activity periods, thus distinguishing the emerged course phases. In that manner, they assisted them in understanding the effective activity planning and indicated how and when they should act. More ideas generated by students (while using the indicators on their behalf) clearly showed that specific indicators improve monitoring of the process and better assessment of the current situation.

Discussion

The main conclusion is that the use of IA indicators in asynchronous discussions is an engaging and efficient approach. The overall impression was very positive and we were able to observe shifting in users' behavior, as they appeared more active and productive. Some indicators were more preferred than others, regardless of the teaching settings, whereas some of them are better utilized under specific context and activity settings. For example SNA diagrams seem more appropriate when heavy interaction among smaller groups is pursued, whereas Activity Indicators (Bratitsis & Dimitracopoulou, 2006; 2007, 2008) seem more appropriate in cases of open ended discussions with a large number of participants. We consider that a large number of case studies are necessary in order to extract concrete results for that matter. The complexity of the IA process evaluation and the variety of the produced diagrams, indicate that this method is useful for medium and large-sized groups of students, as it is easier to review the actual messages for groups of less than 5 or 6 people. Having produced several Interpretative Schemas, which were positively evaluated by the participants (Bratitsis & Dimitracopoulou, 2006; 2008), we were very surprised to see that users came up with new ideas for utilizing indicators. New indicators were built in the process, as new needs were expressed. This seems to be a perpetual process, which may lead to the creation of an "Idea Repository". Detailed instructions are required, if we wish users to exploit the indicators. Otherwise, the produced diagrams would seem like an additional workload, with no clear meaning. Consequently, users would avoid taking them into account

We claim that proper interpretation of the visualized indicators is a core issue when designing such tools. While many systems provide simple statistical or even more complex diagrams, interpretation is the key factor when attempting to utilize such information in order to enhance learning. The latter is achieved by enhancing interaction, collaboration and facilitating the moderator's work. What this paper has tried to emerge is the fact that simple ideas deriving from the initial point of view when collecting and trying to analyze simple data may lead to very interesting research questions and findings. The field can be vast (Dimitracopoulou & Bruillard, 2006) and foster innovative ideas. The power of visualized indicators has been outlined in the literature (Mazza & Milani, 2005). Especially the research area of implementing supporting, evaluating and assessing tools for CSCL systems in order to enhance the process and the learning outcome has a lot to gain by such approaches. A clear focus of analysis points of view, solid questions' formulation, imagination in designing and many case studies is all that is needed. An additional positive outcome of such approaches could be the analysis of students' behavior, under different teaching settings. Thus models of the expected user behavior may be constructed. Other indicators of the DIAS system can be used towards this direction, if used in a reverse engineering approach, likewise. Using them to study behavior, user modeling may occur, thus designating expected action patterns in future teaching activities. One of the research objectives with the DIAS system has been to designate the proper indicator set for the different needs of the users, depending on the cognitive structures they form, their various roles and the various teaching settings (Bratitsis & Dimitracopoulou, 2007; 2008). Additional, secondary questions could be answered, concerning the effect of the participants' age, sex, cognitive level or background on the way they are influenced by the indicators' values. Even the selection between absolute numbers and percentages can be considered as an open question for further investigation. Having accomplished that (as part of the future designed work), the same reverse engineering approach for user modeling can be followed for constructing models, which can be used to select the appropriate teaching approach in the future and thus lead to adaptable tools, automating the supporting process.

References

Bratitsis, T., Dimitracopoulou, A. (2006). Indicators for Measuring Quality in Asynchronous Discussion Forae. *The 12th International Workshop on Groupware*, CRIWG 2006, Spain: Springer Verlag, 54-61

Bratitsis, T. & Dimitracopoulou, A. (2007). Interaction Analysis n Asynchronous Discussions: Lessons learned on the learners' perspective, using the DIAS system. *Int. Conference CSCL 2007*, New Jersey, USA

Bratitsis, T. & Dimitracopoulou, A. (2008). Interpretation Issues in Monitoring and Analyzing Group Interactions in Asynchronous Discussions. *Int. Journal of e-Collaboration*, IDEA Group Inc, 4(1), 20-40

Corich, S., Kinshuk, Hunt, L. (2004). Assessing discussion forum participation: in search of quality, *International Journal of Instructional Technology and Distance Learning*, 1 (12), 3-12

Dimitracopoulou, A. Bruillard, É. (2006). Enrichir les interfaces de forums par la visualisation d'analyses automatiques des interactions et du contenu, *Revue STICEF*, Volume 13, 2006, ISSN : 1764-7223.

Dimitracopoulou, A et al. (2005). State of the art of Interaction Analysis for Metacognitive Support & Diagnosis. IA *JEIRP Deliverable D.31.1.1*. Kaleidoscope NoE. Available online at: www.noe-kaleidoscope.org

Garisson, D.R., Anderson, T., Archer, W. (2001). Critical thinking, cognitive presence and computer conferencing in distance education. *American Journal of Distance Education, 15*(1), 7-23

Gunawardena, C.N., Lowe, C.A., Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing, *Journal of Educational Computing Research*, *17*(4), 397-431.

Mazza, R., Milani, C. (2005): *Exploring Usage Analysis in Learning Systems: Gaining Insights from Visualizations*. Workshop on Usage Analysis in Learning Systems, 12th International Conference on Artificial Intelligence in Education AIED, Amsterdam.

Palloff, R.M., Pratt, K. (1999). *Building Learning Communities in Cyberspace: Effective strategies for the online classroom*, Jossey-Bass Publishers, San Fransisco.

Schellens, T., Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavio*r, *21*, 957-975