

Visualizing and monitoring effective interactions in online collaborative groups

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Abstract

Online education based on small self-managing groups, with slight supervision by a professional tutor, is a strategically interesting methodology for lifelong learning. This solution may combine aspects of cost-effectiveness (reducing tutors' work) with the demands for active and engaging learning methods based on the exchange and sharing of experiences. In such a context, how can information on collaborative attitudes and behaviour be gathered? A typical tool for online learning activities is the threaded web forum. This study proposes a methodology for assessing effective collaborative interactions within the add-on module, Forum Plus, for the Moodle learning management system (LMS). The methodology here presented is able to supply an early overview of the level of effectiveness of the collaborative group and therefore it may provide a useful instrument to guide further qualitative observations conducted directly in the web forum.

Introduction

The idea that knowledge is constructed (or at least encouraged) through dialogue and discussion goes back to the cognitive conflict theory (Doise & Mugny, 1984) and is one of the main concepts taken up by computer-supported collaborative learning (CSCL). The underlying hypothesis is that learning in a collaborative group is essentially based upon interindividual confrontation/clashing with directly opposed standpoints, argumentations, counter-deductions, explanations and in-depth analysis that lead people to restructure their own mindsets.

The theoretical framework of the CSCL approach has emphasized the role of threaded web forums. Even the basic features of this tool offer relevant and peculiar functions

enabling the development of online learning-oriented discussions. The availability of texts to be revised as well as the possibility of re-examining and reinterpreting them, allow users to connect and build ideas, refining them and stimulating deeper reflection (Calvani, 2005; Dillenbourg, 2005; Salmon, 2002).

However, as widely acknowledged in literature, it has to be noted that the threaded web forum presents also some limits and dysfunctions, such as incoherence, dispersion and lack of convergence (Herring, 1999; Hewitt, 2001, 2003, 2005; Suthers, 2001).

Background scenario

Our idea to identify an effective interaction model capable of giving an immediate picture of the effectiveness level of a collaborative group, emerged from the need to find solutions for supporting collaborative groups management. The scenario we referred to can be summarised as follows: we are dealing with an online course addressed to adults within a formal context (eg, a master's degree) and based on collaborative methods (eg, group project works). A rather high number of persons participated in the course for a period of about 6 months. The workgroups are formed in advance and a preliminary training period on technical subjects and relational aspects is delivered to all participants, in order to render them as autonomous as possible. The web forum represents the pivotal tool where the majority of interactions takes place.

In such a context, a tutor could be in charge of supervising a number of groups (10 or more); he/she will need to have a real-time update on the progress of the groups' work, to be able to carry out the necessary actions and to decide which group needs his/her attention.

What tools could be useful for the tutor (and also for the group itself)? Which tools would allow him/her to get a rather precise idea of the collaborative effectiveness of the group's activities?

Our work started off from a research project aiming at improving the standard 'forum' module of Moodle Open Source LMS. During the project, we developed and released an add-on module for Moodle (see further discussion).

At the same time, we worked out a theoretical model for effective collaboration and a procedure to acquire data from interactions and visualize them in a graphical way in reference to the given model.

Methods for assessing effective collaborative interactions

There is a wide range of literature on research methods to analyse online interactions and discussion.

Quantitative methods for content analysis are the ones most widely used (for a review, see De Wever, Schellens, Valcke & Van Keer, 2006; Rourke, Anderson, Garrison &

Archer, 2001). Roughly, they consist in coding single messages and statistically analysing them in order to describe their distribution frequency and identify their relationships.

The social network analysis (SNA), a key technique in modern sociology and anthropology for the study of the social relationships between individuals in a community, has also been used to analyse interaction among members of a virtual community (Cho, Stefanone & Gay, 2002; De Laat, Lally, Lipponen & Simons, 2007; Garton, Haythornthwaite & Wellman, 1997; Mazzoni, 2005; Reffay & Chanier, 2003). However, it seems to be scarcely suitable for a threaded web forum because of the technical features of this tool: participants in a threaded web forum do not interact by sending individual messages to each other and thus selecting the recipient, but by posting their messages in a shared and prestructured area that everyone can access. On the other hand, qualitative methods based on Conversation Analysis (CA), a research tradition that grew out of ethnomethodology (ten Have, 1999; Sacks, 1992; Schegloff, 1989) for the study of actual talk-in interaction, often lead to finding out or discovering relevant sources for case studies. Nevertheless, they require a lot of work and tutors would not have enough time to do it, especially when they are in charge of supervising a number of groups.

The Forum Plus and its functionalities

The Forum Plus (also named Discussion module) is an additional module for Moodle (<http://moodle.org>). We developed it with the aim of enhancing the standard 'Forum' module with some features, mainly inspired by CSCL systems, to improve the metacognitive, monitoring and reflection capabilities of collaborative groups. The module includes three sections:

1. Forum Plus
2. Reflection Board
3. Planner

Forum Plus

The Forum Plus component of the module provides basic and enhanced communication features. Besides the typical collaboration functions commonly present in the majority of forum platforms—including the Moodle Forum—we enriched the basic module with new elements to enhance the visualization of the web-forum structure, we introduced a 'social space representation' and also provided a sort of meta-communication support by adding yet another criteria for characterizing forum messages, the Thinking Type. Threads and messages posted by the users are characterized not only by title, author and content, but also by thinking type labels (TTs) that are added as a property of the message. Each TT is described by a title (ie, hypothesis, synthesis, conclusion, etc.), a incipit that appears at the beginning of the message, when a TT is associated to it, and an icon that graphically identifies the TT inside the threaded forum visualization.

The use of this type of scaffold is now widely spread and strengthened in the field of CSCL. They have been implemented in a number of platforms, such as CSILE (Scardamalia & Bereiter, 1994), FLE3 (Leinonen, Virtanen, Hakkarainen & Kligyte, 2002), Shadow netWorkspaces (Jonassen & Remidez, 2005), AcademicTalk (McAlister, Ravenscroft & Scanlon, 2004), InterLoc (Ravenscroft & McAlister, 2006).

Reflection Board

The Reflection Board is the component in the enhanced collaboration module responsible for monitoring the knowledge construction process. Each activity on the forum is tracked by adding data to the Moodle log according to the standard Moodle logging mechanism. We added some options such as tracking attachment download, messages mark, TT insert.

Planner

The Planner is the component in the Enhanced collaboration module that provides coaching features. Through the Planner, teachers can define specific rules to activate warning, signalling and notification to the whole community.

We enhanced the presentation structure of the Moodle Forum module by adding advanced search features and multiple ordering options: messages can be searched and ordered by author, title, date and TT. We also added the possibility for a teacher to mark significant messages posted by students and visualize them in another report.

Among the features described earlier, the most relevant to our research project is represented by the thinking type labels (TTs) (see Figure 1). The TTs contribute to explicitly organize the various stages of the learning process taking place in the forum. Number and types of TTs can be defined and easily authored by the web forum moderator. The peculiarity of our approach, from a technological point of view, consists in having implemented them in an e-learning general-purpose and open source platform. Moreover, in Forum Plus, they are intended to be used not only as a means to guide the conversational exchange during the learning process, but also to obtain indicators to monitor the effectiveness of the dialogical interactions between adult persons engaged in online project work.

Forum Plus is available as an add-on module in the main site of Moodle (<http://moodle.org/mod/data/view.php?d=13&rid=354>). Since its first release in 2004, the module has been downloaded by about 1000 users. Some of them gave comments and hints, others asked for further implementations. A detailed description of the Forum Plus project can be also found in Calvani, Fini, Pettenati, Sarti and Masseti (2006) (see also: <http://www.corsolte.net/forumplus>).

What effectiveness indicators may be used to assess collaborative interactions?

Any method for analysing collaborative interactions presumes an implicit model aiming at answering questions such as: what elements of a collaborative process might be



Figure 1: A screenshot from Forum Plus in Moodle

Several icons are present in Forum Plus: some icons represent the TTs, others refer to the state of the messages. For example, in this figure, the small trumpet stands for Proposal, the open hand for Greetings, the swing for Encouragement, the thumbs-up for Agreement, the open envelope for read message and the closed envelope for unread message.

considered as relevant to its effective working? How can these elements be identified and represented?

Our purpose is an attempt at identifying a model that would help us answer these questions in a reasonable way by considering just the quantitative indicators, thus getting a rapid procedure to represent collaborative interactions.

Before proceeding we need to clarify what we mean by 'effective interaction' when talking about collaborative processes. We just use it as a conventional notion for describing collaborative interactions and without presuming that an effective group might achieve better and more original results (or greater productivity) compared to a 'less effective' group. The dynamics of the creative production of ideas represent an extremely complex field, which cannot be reduced to any quantitative indicator. A group could be 'effective' according to our model and yet could concretely remain on the level of banality in terms of qualitative originality in the outcomes produced. On the other hand, the presence of strong, highly creative individuals could allow the group to produce highly original results with low scores in effectiveness as a collaborative group.

However, the effective interactions described through our model should be able to capture some relevant features of the process such as a good social atmosphere, group involvement and consideration of the other members and of the collaborative process ecology. All these elements can be regarded as positive features in themselves and are normally correlated to the best satisfaction of the participants and to a positive

perception of the collaborative process. A correlation between these factors and the good quality of the final outcome might also be hypothesised, but this still has to be verified.

The effective interaction model

Our model aims at selecting a set of variables that can be translated into quantitative indicators easy to acquire and process, thus giving the possibility to present an overall and immediate picture of the effectiveness level of the collaborative process.

The set of variables we identified refers to two main dimensions, ie, participation and cohesion.

As for the first dimension, the intensity with which the individual members participate in the group's activities and their proactive commitment seems to be a good starting point to be considered (even though we can not assume a linear relationship such as 'the greater the participation, the greater the effectiveness'). This factor also suggests a 'minimum threshold' below of which there are no possibilities for collaboration at all. Therefore it seems acceptable to include an indicator describing members' participation in its quantitative dimension (*extent of participation*).

Besides the global participation of the group members, it would be significant to consider also the participants' attitudes towards proposing new ideas to be discussed in the group. Therefore we may also include the members' propensity to start up a discussion by presenting ideas, cues and hypotheses (*proposing attitude*).

An interactive process however, though very intense on the whole, could also result to be not well-balanced because of the hoarding and marginalizing phenomena that often characterize online discussions. In an 'effective' collaborative group all members should participate in a similar degree without monopolizing behaviour. The factor we are introducing here is therefore *equal participation*.

Related to participation, another factor may regard the variety of conversational roles taken on by the members of the group. A good group should be one in which dialogic roles are played in a flexible way with participants rotating their roles. This seem to be indicative of the attention paid to the whole group's process of critical-collaborative knowledge construction and can also be correlated with the achievement of good argumentative standards (Calvani, 2005; Dillenbourg, 1999; Soller, 2001). This factor may be called the *extent of roles*.

Our reflections on collaborative effectiveness could not neglect the pace of interactions in time. A regular and constant participation may be considered an indicator of the individual's ability to be primarily concerned with the groups needs rather than with personal issues, thus also avoiding the risk of dispersion and fall of cognitive tension (*rhythm*).

As stated earlier, another section regards a set of indicators referring to the concept of cohesion. The consideration members show towards one another is crucial in increasing the reciprocal trust and the sense of belonging as well as the perception of positive interdependence between members of a group. It also supports the construction of a common ground of knowledge (Baker, Hansen, Joiner & Traum, 1999; Clark & Brennan, 1991). Therefore an important factor is whether participants mutually read their contributions (*reciprocal readings*).

The development of interaction chains is another factor strictly related to social cohesion. This refers to the dialogic sequence made up of contributions 'built' on other contributions through direct answers. Such a similar connection points out the participants' purpose to create interdependence and intersubjectivity. The *depth* reached by a discussion thread in terms of hierarchic levels (ie, the development of the discussion through a sequence of reciprocal answers) may therefore reasonably represent an important element of group cohesion (Wiley, 2004).

Also, some aspects related to the conversational development path directly involve the group's cohesion. As is commonly known, online discussions may risk to be fragmentary and lacking in argumentations and critical developments; thus it seems important to point out that the proposal of new ideas should always be followed by a group discussion in which participants express their critical evaluations and argumentations. We called this factor *reactivity to proposals*. The relevance of this factor has been also underlined by Jeong (2003, 2005), who analysed the sequences of the messages in threaded web forums.

Finally, it has to be noted that a final report giving the gist of collaborative activities in a web forum is rarely produced by a group. On the contrary, a discussion should always include a conclusive phase of integration and synthesis of ideas through the search for agreement/consensus of diverging standpoints taking into account the various contributions. Therefore another element to consider regards evaluating whether summarizing contributions are present (*conclusiveness*).

In synthesis the model defines the following indicators (Table 1) grouped in two sections (participation and cohesion), for each of which an index is foreseen:

How can information about these indicators be gathered? Some of the them, such as *equal participation*, *rhythm* and *depth*, can easily be calculated by processing data related to the posted messages. Reciprocal reading can be derived through the corresponding feature we implemented in Forum Plus. Other indicators such as *extent of roles*, *proposing attitude*, *reactivity to proposal* and *conclusiveness* can easily be calculated and assessed by means of TTs (for more details on data processing see: <http://www.corsolte.net/forumplus>).

Representing collaborative interactions

On the basis of indicators described, we developed a procedure to gather the interaction data of each group and then represent them on a graph so as to obtain an immediate idea of the group's effectiveness.

Table 1: Indicators of the effective interaction model

Indicators for participation	
Extent of participation	Amount of active participation of group members
Proposing attitude	Amount of proposing contributions
Equal participation	Homogeneous level of participation in the interactions
Extent of roles	Amount of dialogic roles assumed
Rhythm	Regular participation in interactions in time
Indicators for cohesion	
Reciprocal reading	Reciprocal readings of contributions
Depth	Development of dialogic sequences of discussions
Reactivity to proposals	Responsiveness to contributions where new ideas and proposals are presented
Conclusiveness	Contributions integration and discussion synthesis

This first investigation was based on a sample consisting of 24 learning groups attending the online course 'Methods in Online Learning and Teaching', delivered by the Laboratory of Educational Technology (University of Florence) in 2006–2007. Each group was made up of 5–6 members and led by a coordinator selected by the members of the group. The period of time considered was 15 days.

The model aims at indicating a flexible methodology suitable to the type of discussion. Up until now this model has been used with internal parameters. This means that the reference in relation to which the more or less 'eccentric' nature of the specific group is assessed is derived from the context. The raw values of the distribution of each indicator have been calculated for all the groups, and quartiles have been derived from the global data. The points were attributed as follows: 1 point to the values lower than or equal to the first quartile, 2 points to the values lower than or equal to the second quartile, 3 points to the values lower than or equal to the third quartile and 4 points to the values higher than the third quartile. The result is a radiant graph that gives a global and easy-to-analyse representation of the group's behaviour.

As it can be observed (in Figures 2 and 3), the graph represents the reference grid at four levels (quartiles) where two graphs overlap: the one representing the 'average' of the whole universe (ie, all the groups), which is indicated by a dotted line, and the one representing the specific group under observation, which is indicated by an unbroken line.

The more the values of the specific group expand towards the outside, the higher is the 'effectiveness' achieved by the considered variable. On the contrary, a grid that retracts towards the inside indicates low effectiveness. So, for example, looking at the graph in Figure 2, we can observe that the values of this group are notably above the normal average (except for the extent of roles, which is equal to the average): this graph seems to mark out a group with a particularly successful effective process, at least in terms of the model.

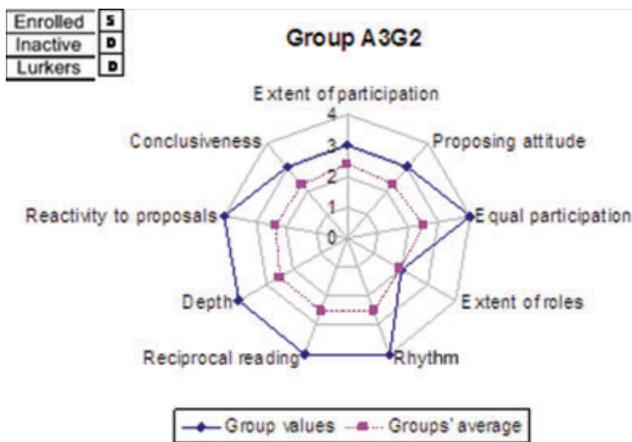


Figure 2: Graph of an 'effective' group

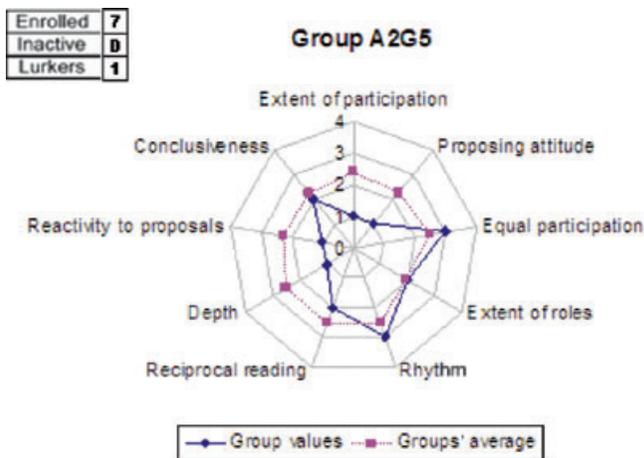


Figure 3: Graph of an overall 'scarcely effective' group

The graph in Figure 3, on the other hand, shows a group that stands out for its indicator values meaningfully below the average (except for the equal participation and rhythm variables): such a graph could induce the tutor/supervisor to start a more direct observation of what is happening inside this group.

The variety of configurations that the graphs can take on allows us to identify the behaviour of the different groups on the basis of their typology, or to group them in relation to recurrent similar typologies.

In-depth analysis of ineffective interactions

To render our work more concrete we will now try to put ourselves in the shoes of a tutor who is looking at a graph like the one represented in Figure 3. Alerted by the presence of such low values, he could be induced to deeply analyse what is happening in the group, by looking directly at the web forum and taking into consideration the web forum structure, the authors of the messages, the TTs used, the sequence of the messages and also their content itself.

In our case, if we check inside the web forum of Group A2G5, at first sight it appears not to be very deeply developed, as actually shown in the graph. The opening messages normally engender answers on the second level at most and these answers never engender other replies. This suggests that the discussion remains on a rather superficial level.

The overall sociorelational climate results to be poor with few greetings and reciprocal encouragements (except for the coordinator). This can quite rapidly be inferred by the low use of TTs of relational nature: the TTs 'Greetings' and 'Encouragement' are respectively used only once. Moreover, the coordinator and a member of the group (ie, the most active participants) send several messages to the group asking for more participation. For example, halfway through the course, C. wrote:

Transcript n. 1, 18/02/2007

Subject: Other possibility

TT: Proposal

'To come to an agreement I'd propose an alternative solution: I'd work on the wiki structure to organize an online area for science teachers [...] and you'd work to fill in the section dedicated to the web sites for the various subjects [...]. What do you think?

However, apart from D. (the coordinator), where are the others? The deadline for organizing the project is this coming Sunday!!

C.'

Feelings of isolation and defection can clearly be perceived at the end of the quoted message. Likewise the coordinator (D.), who appropriately plays her role by trying to organise the group's activities, bitterly concludes the first phase of the collaborative work and asks for more participation in the next phases of the work:

Transcript n. 2, 25/02/2007

Subject: End of the first phase

SD: Synthesis

'Well, I'll try to summarize our work..

The first phase has just finished. I must say that personally I didn't find it very profitable. There have been few proposals and substantially nobody has expressed his/her opinions about C's proposal, and yet she left her post in the forum three days ago [...]

I invite you to participate and contribute more often than usual.

D.'

The graph of Group A2G5 also shows a low degree of proposing attitude and consideration of contributions by others. Actually, only the two most active participants use the

TTs' 'proposal', 'enrichment' and 'evaluation', the rest of the group (ie, five members) nearly exclusively use the TTs' 'agreement' (seven times out of a total number of nine sent messages) or 'disagreement' at most (only once).

The reading of the content of the messages as well confirms this trend. It emerges that only the two most active participants take part in the discussion in a deeper way by evaluating proposals and suggesting alternative hypothesis. The rest of the group limits itself to sending very short reply messages (two or three lines at most), communicating a banal agreement without discussing proposals by others or presenting personal proposals. Just to make an example, we report a sequence of exchanged messages, while specifying that only half of the group gave feedback to the proposals formulated by the coordinator:

Transcript n. 3, 14/02/2007

Subject: Sciences Lab

TT: Proposal

"We'll work on the construction of an 'Online Sciences Lab'. In this regard we'll have to decide what school level to consider for our lab. [...]. I'd propose to discuss first this issue. The second issue to talk about would regard how to implement our project. To be easily usable, I think we should build a repository of web sites providing a learning activities lab., and organize it by topics and school levels [...].

Please, let me know what you think about it.

D."

Transcript n. 4, 18/02/2007

Subject: D's proposal

TT: Agreement

'I agree with D's idea to create a websites repository with science learning resources. It appears to me to be both feasible and useful [...].

S.'

Transcript n. 5 del 18/02/2007

Subject: D's project proposal

TT: Agreement

'D's proposal to build a websites repository with science learning resources is a good idea. As I'm teaching in the junior high school, I'd like to develop the project for this target [...].

Bye

K.'

With these few notes we tried to show how such a graph could support a tutor in the direct observation of what is really happening in a group. The main problems that are indicated by the graph of Group A2G5 regard the scarce participation as well as the low degree of proposing attitude and reactivity to proposals by others. In-depth analysis through direct observation of the web forum corroborated this diagnosis and this could induce the tutor to operate in two directions. On one hand, he could try to improve the socio-relational climate by sending encouragement messages to the group and, at the same time, individually verifying whether some obstacles prevent anyone from participating in group activities. On the other hand, he could invite the participants to take a

more critical attitude towards the emerging ideas, suggesting—if necessary—to rotate the role of evaluating proposals and ideas around the group.

Conclusion and future development

Our aim was to supply institutions interested in online collaborative groups for education and training with the possibility of monitoring/supporting effective interaction with a 'slight' supervision on the part of the institutions themselves. A tutor in charge of supporting a wide number of collaborative groups needs to rapidly gather information about the collaborative attitudes and behaviour present in the groups themselves. The institutions also need to evaluate the results of their training activity, including the groups' collaborative effectiveness.

The majority of online collaborative work cannot be dissociated from the web forum structure. Well-structured activities of online project work may be carried out in small collaborative groups, and visualized through the use of online tools adequately equipped with effective interaction management scaffolds and other monitoring instruments.

We equipped the Moodle web forum with adequate functionalities typical of the CSCL approach and also developed a model for data processing and representation enabling to supply an overall visualization of group effectiveness.

The comparisons conducted up till now between automatic data processing and qualitative observations have shown significant confirmations. This leads us to hold that the methodology we described in this paper could concretely be useful as an instrument able to provide an early guidance for the supervising activity of an instructor or a tutor.

However, some further developments still have to be achieved. On the technological level, the procedure of data visualization still needs to be completely computerized within the web Forum Plus module. On the methodological level, further investigations based on larger samples will be necessary. This would allow us to better integrate the quantitative and qualitative analysis and to study the possible correlation between our assessment model of collaborative effectiveness and other types of subjective (participants satisfaction) as well as objective (group performances) assessments.

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