Experimentation of a Multidimensional Model for Tracking Interactions Between Learners During an Online Collaborative Work

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Abstract—The development of e-learning systems has started a revolution for instructional content delivering, learning activities, and social communication. Although the benefits of e-learning have been discussed in various previous studies; it is a critical issue of better understanding the reasons why some learners are isolated during the e-learning experience. This paper proposes a multi-dimensional model on tracking interactions between learners via four dimensions: (1) an affective, (2) a participative, (3) an interactive and (4) a technical one. Tracking course learner's behaviour within the learning environment can provide the tutor a large set of indicators. The main objective of this study is to provide the tutor the opportunity to rebuild the working groups based on theses different indicators. The analytical results strongly support the appropriateness of the proposed model through tutor's satisfaction. The findings of an empirical study of 12 work-based teams are discussed.

Keywords—E-learning, Indicators, Traces, Online collaborative work, Sociograms

1 Introduction

In online learning platforms, learners must discuss, collaborate, negotiate meanings and reach an agreement in order to reify a shared product that is the expression of the group's achievements. Theses collaborations activities aim at producing the work requested by their tutors. However, tutors often struggle to track learner/group progress or to detect learners/groups experiencing difficulties [1]. In order to have, a deep understanding of the learning process, tutors are required to go beyond the surface level of interactions in order to understand the affective, the participative and the interactive processes involved. As computer conferencing systems usually record and maintain a history of the events occurring during the learning process, a wealth of information that can be analyzed is available. In such environments, the tutor usually gets fewer feedback on the progress of the session than in a classic conventional learning situation. On the one hand, the teacher has great difficulties to perceive the activity and to detect learners and working groups that are in difficulties. On the other

hand, the distance required from him an extra effort; he must try to understand, decipher, to reconstitute a learner activities puzzle without all the data. Also, by elaborating sociograms, tutors can measure the cohesion of a group learning and assess the degree of collaboration and trust within these groups to see if learners collaborate in the best possible way [2][3].

In our last study [4], some learners did not produce nothing due to an absence of a cohesion in the group. These include the problems of the affective dimension of learners, convergence problems and those of perception of the group.All these factors can negatively affect the process of discussion, sharing and collaboration. According to these problems, a good climate of affection in promoting teamwork is strongly recommended, also the organizational culture, which behavior and promotes trust should be encouraged in teamwork by elaborating sociograms in order to have information about emotional states, feelings and learners affects. Our approach focuses on finding a better climate of trust and affection in promoting teamwork by elaborating sociograms and analysing traces. Also to produce and exploit indicators in order to help and assist tutors to rebuild the groups are not homogeneous.

2 Related works

Several research studies have focused on visualization techniques and applied this in various domains [5], including automotive industry [6] and finance [7]. In this paper, we focus on the Intelligent Tutoring System (ITS) domain. The literature on ITS has several platforms and tools for the use of individual and collaborative learning, for example: CAMera [8] analyzes user activities and provides simple metrics of events, such as mouse clicks. The system relies on Contextualized Attention Metadata (CAM) [9] that captures user interactions with tools and resources. Moodog [10] visualizes metrics of students' online learning activity logs in Moodle using bar charts. Sugawara and Arai [11] have developed a visualization module, named Collabo-MAP, which provides NetCommons with a tool for graphically mapping student-student and teacher student interactions in online forums. Dawson [12] have developed the SNAPP tool designed to provide educators with real-time evaluative data to better support student learning. Santos [13] provides a tool, which performs calculations starting from the interactions and the degree of involvement of each learner in training. All these studies show the importance of methods and the context of the development of indicators from traces of interactions related to the learning activity.

3 Methodology

All the dimensions included in our model are worth investigating when the purpose is to validate the overall learning experience, but this does not compulsorily imply the use of all three dimensions. Depending on the specific aims of the analysis, the tutor can decide which dimension or the dimensions are most relevant for the experimentation. Results of our last experiment show that some learners may produce nothing if there is an absence of cohesion within their groups. These issues include the affective

dimension of learners, convergence problems and perception of the group that we have eliminated from our methodology in our last study [4]. All these factors can negatively affect the process of discussion, sharing and collaboration.

3.1 The Affective Dimension

It is no surprise that many non-motivated adult learners abandon prematurely their e-learning experiences. A frequently neglected issue in e-learning developments is the affective dimension. According to Hollander [14], relationships such as sympathy, antipathy and indifference can be measured using a questionnaire. Analysis of the results allows modeling a system (the group and its members). This system is established from a questionnaire called the Sociogram. From the sociogram data one can derive an index of cohesion and indexes of exploratory and avoidance behaviors. The questionnaire for learners is based on three questions:

- Who is the first person with whom you would like to work?
- Who is the second person with whom you would like to work?
- Who is the person who you would not like to work with?
- The sociogram should be used in conjunction with training rules work teams:
- Above all, we decide the size of the groups.
- We begin by placing the isolated individuals, ideally with their first choice. Otherwise, they are placed with their first two choices. Never put more than two isolated in each team.
- Then, we place the learners who received only one choice. If the choice is reciprocal, the learner is placed with the individual who makes this reciprocity.

We continue the distribution on the basis of learners who receive the smallest to the largest number of choices. Ideally, we try to satisfy mutual choice first.

At the end, we can measure the cohesion index of groups (Ancelin Schützenberger, 1972):

$$\text{Cohesion} = \frac{\sum C}{n(n-1)/2} \quad (1)$$

Where n is the total number of learners and *C* is the number of mutual choices.

3.2 The Participative Dimension

To investigate the participative dimension, we have implemented these indicators:

- Indicators of active participation, which includes the number of messages sent by individual participants, the number of documents uploaded the number of chat sessions and forums attended, etc.
- Indicators of passive participation, which include the number of messages read, the number of documents downloaded, etc.

3.3 The Interactive Dimension

To investigate the participative dimension, we have implemented these indicators:

- Indicators of Passive participation before posting, which is the number of relevant messages read by a student before posting his/her own, the number of documents downloaded before posting, etc.
- Indicators of References to other student's messages, which is the number of answers to other student's messages, the number of implicit or explicit citations of other student's messages, etc.

4 Experimentation

4.1 Constitution of groups

The 50 learners involved had to carry on the Moodle platform a OOP PHP project. Learners had at their disposal the questionnaire cited previously to be submitted to the tutor. The goal of this constitution is to form groups composed of members who get along with each other, this affinity will probably improve the morale of the whole class and thus its productivity.

Table 1. The distribution of learners in groups according to the result of the sociogram

Groups	Members	Cohesion
Group 1	Alaoui M. - Aghmane A. - Chourak H. - Bergam A. - Gorfti M.	67 %
Group 2	Fofana K. - Nkou G. - Mboutsou M. - Azouzou A. - Taouch M.	67 %
Group 3	Dib Z. - El Fanoui R. - El Khiati M. - Lamarti Z. - El Attar K.	80 %
Group 4	Hilia O. - Zegriri Y. - Tizani M. - Takadoum Y. - Boujenane K.	53 %
Group 5	Lafquiri L. - Lafquiri I. - Riffi K. - Benhata R. - Latrach I.	67 %
Group 6	Hamzaoui K. - Askour H. - Guerroumi M. - Khouader S. - Nmili G.	73 %
Group 7	Riad A. - Ahalouan S. - Berrada I. Jouan E. - El Kourssi C.	47 %
Group 8	Oussi A. - Tazi M. - Bensaid H. - Maaiden M. - Jilali A.	40 %
Group 9	Mkhaikh Y. - Zidani E. - Bita I. - Chaouy F. - Annabe A.	60 %
Group 10	Jebari W. - Saidi T. - Khiara I. - Kacimi M. - Hilali A.	53 %
Group 11	Chami S. - El Meslouhi N. - El Malki A. - Serhani M. - Rguibi A.	53 %
Group 12	Erraji N. - Mrabet M. - Benhlima M. - Lhannouni N. - Tourgi A.	47 %

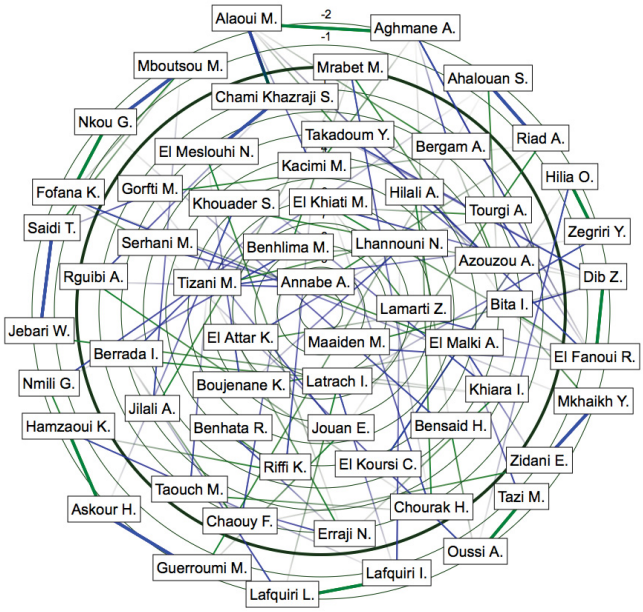

Fig. 1. Sociogram of learners who had mutual choice concerning the first and second question

4.2 Evolution of groups

During the five first weeks, learners often log in to the platform and participate in the discussion forum and chat sessions following the indicators: "Number of chat sessions attended" and "Number of forums attended. From the fourth week, we have seen a large number of messages exchanged on the forums and the internal mail of each group described in Figure 2. Thus, we could detect learners who can play the role of leaders in their groups based on the indicators: "Number of answers to other student's messages" and "Number of documents shared".

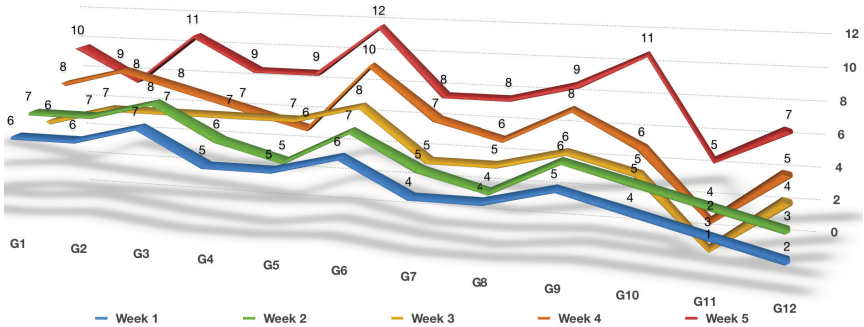

Fig. 2. The Number of messages exchanged on the forums and the internal mail for each group

Based on the four last indicators, it was found that learners as: (Dib Z. & El Fanoui R., Group 3); (Hamzaoui K. - Askour H., Group 6); (Alaoui M. - Aghmane A., Group 1); (Fofana K. - Mboutsou M., Group 2); (Mkhaikh Y. - Zidani E., Group 9); (Hilia O. - Zegriri Y., Group 4); dominate and monopolize the interactions (with a percentage of 65%) in their groups and share a lot of information with their colleagues. These students play the role of orchestrators within their groups. Figure 3 shows us the performance of all groups by calculating the average of quantitative indicators cited above. The histogram indicates that there is heterogeneity within some groups, especially the groups 7, 8, 11 and 12.

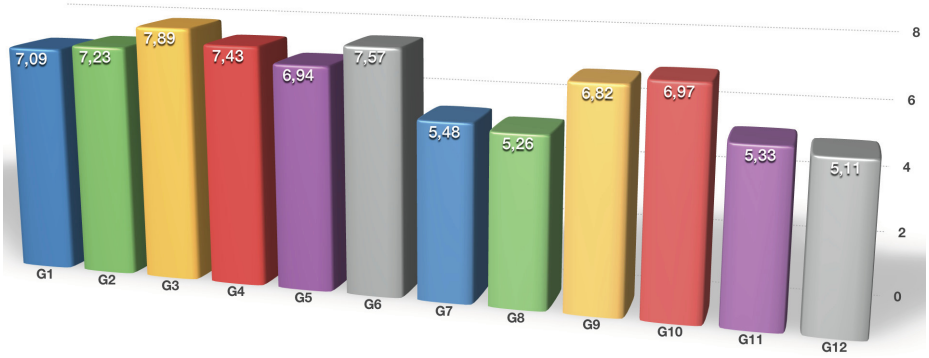

Fig. 3. Average of quantitative indicators of each group in the first five weeks

4.3 The reconstitution of groups

By the end of the fifth week, we have made a new reconstruction of the groups considering the heterogeneity of some of them. The constitution was done in an automatic manner according to our algorithm [15]. Table 2 shows the distribution of learners after the reconstitution of groups. We noticed that the leaders have played well their roles of orchestrators within their groups, and this is due to the large number of shares and documents deposited in the forum and the internal mail in their new groups as described in Figure 4.

Table 2. The distribution of learners after the reconstitution of groups

Groups	Members
Group 1	Riffi K. - Aghmane A. - Chourak H. - Bergam A. - Gorfti M.
Group 2	Berrada I. - Nkou G. - Mboutsou M. - Azouzou A. - Taouch M.
Group 3	Serhani M. - El Fanoui R. - El Khiati M. - Lamarti Z. - El Attar K.
Group 4	Hilia O. - Kacimi M. - Tizani M. - Takadoum Y. - Boujenane K.
Group 5	Lafquiri L. - Lafquiri I. - Alaoui M. - Benhata R. - Latrach I.
Group 6	Lhannouni N. - Askour H. - Guerroumi M. - Khouader S. - Nmili G.
Group 7	Riad A. - Ahalouan S. - Fofana K. - Jouan E. - El Kourssi C.
Group 8	Oussi A. - Tazi M. - Bensaid H. - Zidani E. - Jilali A.
Group 9	Mkhaikh Y. - Maaiden M. - Bita I. - Chaouy F. - Annabe A.
Group 10	Jebari W. - Saidi T. - Khiara I. - Zegriri Y. - Hilali A.
Group 11	Chami S. - El Meslouhi N. - El Malki A. - Dib Z. - Rguibi A.
Group 12	Erraji N. - Mrabet M. - Benhlima M. - Hamzaoui K. - Tourgi A.

Figure 5 shows the performance of all the new groups by recalculating the average of quantitative indicators cited above. The histogram indicates that there is an improvement and an evolution compared to the first constitution of groups. It shows also that there is some kind of stability and homogeneity between groups, this is due to the role played by the presumed leaders, especially the learners (Dib Z., Hamzaoui K., Fofana K. & Zidani E.).

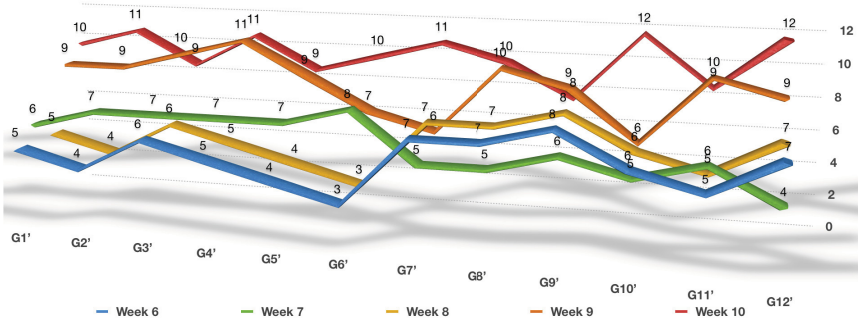

Fig. 4. Number of messages exchanged on the forums and the internal mail for each new group

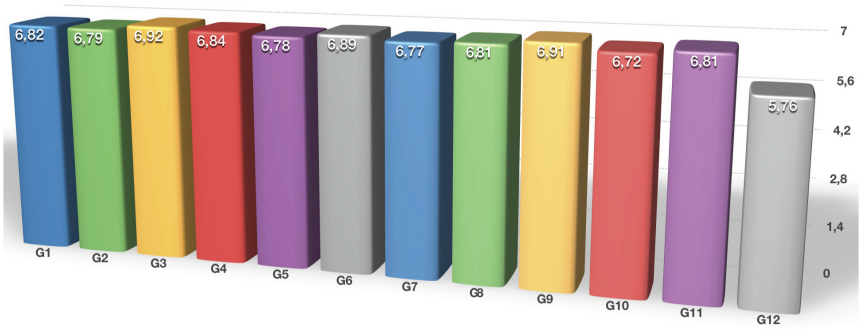

Fig. 5. The Average of quantitative indicators of each group in the last five weeks

5 Conclusion

Our work aims to find cohesion and a significant motivation within a group through an online learning platform. The number of chat sessions, of forums attended, of documents uploaded and downloaded, of answers to other student's messages and of messages sent by individual learners can lead to fruitful collaboration, which is synonymous with good quality work. Such indicators allow detecting learners and groups who face difficulties and give an idea about learners who can play the role of a leader within a group. This work allowed us to test our algorithm from a functional and technical point of view and also identifies real variables from a collaborative online learning. It also allowed us to evaluate the affective dimension with the elaboration of sociograms.

To conclude, even if the approach proposed here may assist the tutor to rebuild the groups that face difficulties, new indicators should be worked out not only to enrich our approach, but also to pursue different analysis objectives and suit different learning contexts.

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