Building a Tool for Analyzing Interactions in a Virtual Learning Environment

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Abstract: This article presents the development of the framework Social Map, implemented in a virtual learning environment (VLE). The tool aims at mapping the interactions of the participants of a course in the form of graphs or sociograms. The methodology used was descriptive, theoretical, and practical and the graphs generated from the interactions of two undergraduate classes and one continuing education course were analyzed. Data from the Social Map, and a punctual analysis of the interactions and relationships, enabled the teachers to rethink educational activities in VLEs. Based on the indicators obtained from the map, the aim is to build more consistent teaching practices for activities in the virtual, especially concerning the social aspects. It is also a way to highlight peculiarities hitherto little-discussed regarding distance education.

1 INTRODUCTION

This article aims to present the development of the framework Social Map, which shows, in graphs, information concerning student interactions obtained in a virtual learning environment (VLE) know as ROODA.

The research has an interdisciplinary character as it brings together the fields of Sociology, Information Technology, and Education. Piaget's ideas (1973, 2005) laid the foundations for the study of social interactions in Education and underlie the VLE used in this research. The investigation also relies on Behar's studies (2009, 2013) to understand the process of teaching and learning in Distance Education (DE) and the construction of teaching strategies applied in the virtual. Regarding sociology, the research draws on Moreno's theory (1954) when dealing with sociometric analysis, known as the mapping process of interactions and presented as sociograms.

Data processing contributes to the investigation with regard to the concepts addressed in graph theory (Wasserman, Faust, 1994) and the study of techniques for computational implementation.

In this sense, studies in different areas of knowledge subsidize the proposal of a computational solution that tries to ensure, particularly in the field of distance education, teaching and learning that allows the teacher to get sociometric information about students, for it considers that such information should be taken into account in the process of distance teaching and learning

The research question of this study refers to the way the teacher can view the student(s) VLE social behavior(s). It proposes the building of a feature that maps and presents, in the form of graph, the interactions established by a particular student or a group.

Thus, the investigation followed two lines of work: one focused on the social aspects of theoretical character and another on the planning, implementation and validation of the framework Social Map in the VLE. The project dedicated to the development of the Social Map feature began in 2013 with the SocialAffective Research Group (http://www.ufrgs.br/gpsocioafeto/) at the Federal University of Rio Grande do Sul (UFRGS), Brazil.. This feature collects data from interactions held in the VLE communications features, and presents as sociograms relations between the actors of the discipline and/or course. Sociograms are viewed from the GraphViz tool, free software to represent information in graphs. These graphs are presented to

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the teacher in PDF or image formats that can later be saved on the computer.

As for the theory, the social characteristics which could be the basis for the development of the research and the improvement of the Social Map feature were discussed. In order to do so, Moreno's ideas (1972) and the literature referring to the distance mode (Behar, 2013; 2009) were used as resources to list the features.

The evaluation and the improvement of the digital resource considered the observation and analysis of the social mapping resulting from the tool application in two undergraduate and one continuing education course.

To understand the trajectory used in the construction of the Social Map tool, this paper presents, in section 2, the theoretical framework. Section 3 presents the methodology used in the investigation. Section 4 includes the process of implementation, validation and the results of the Social Map. Finally, in section 5, the final considerations are made

2 THEORETICAL BACKGROUND

In distance education, the main protagonist of the teaching and learning process is the student (Behar, 2009). For Piaget (2005), mutual respect, autonomy, and cooperation are characteristics of a socially and morally developed subject. These elements are built along the stages of life promoted by interactions with others, with objects, and with the environment.

Etymologically the term interaction (inter + action) includes the concepts of reciprocity, in which at least two elements (they do not need to be of the same nature) are involved; and contact, an encounter that causes changes in the participating elements. For Piaget (1973) it is in the interactions that the subjects will build knowledge, for "social life is one of the essential factors in the formation and growth of knowledge" (Piaget, 1973, p.17).

Interaction may constitute intrapersonal or interpersonal level. The practice of conversation (and social relations formed from it) supported by digital technologies can be mistaken for a message flow where there is not necessarily a conversation or social interaction (often referred to as interactivity). It is understood that interactions in technological spaces are based on a dialogue that modifies the subject, the other, their messages and their interrelations (Longhi, 2011).

According to Moreno (1972), sociometry is the mathematical study of the psycho-sociological properties of the population by putting into practice an experimental technique based on quantitative methods. According to the author, sociometry is a strategy for understanding the structure of a group.

One of the techniques of Sociometry is the application of sociometric tests that enable the visualization of the similarities and differences between individuals that make up a group. Investigating interpersonal relationships in groups, Moreno (1972) found that there are two main ones: the relationships of attraction and repulsion. From these are drawn many others. For example, the investigated subjects express: a) their choices regarding the colleagues that would like (or not) help to perform a certain activity; b) the colleagues that do better (or worse) at playing a certain role in the group. Based on their choices, the mutual relations of the subjects investigated are identified and presented as a graph, known as sociogram, which, according to Moreno, reveals even the "invisible".

The sociogram shows the position occupied by the individual in the group and the core of relationships that form around him or her. This core of relations is the smallest social structure that Moreno defines as social atom (Moreno, 1972). While certain social atoms are limited to individuals who participate in it, some of these individuals can relate to parts of other social atoms, and so on, forming complex chains of interrelations, which the author calls sociometric networks.

Then, through a sociogram, which is a structured visual representation of a network, the social position of each participant in a learning community and the relationship with the rest of the group can be seen. Through the choices made, it is possible to determine who in the social atom is the most privileged and those who exert reciprocity; which individuals are rejected for not fulfilling reciprocity; and which are isolated for not showing their preferences.

Sociograms are graphical representations, in the form of a network, of the relationships in a group of individuals. More than one method of presentation, sociograms constitute a method of exploration, as they enable the identification of sociometric facts and the structural analysis of a group.

Moreno (1972) defined a set of symbols (geometric shapes, such as circles, triangles with single or duplicate edges, and straight lines with continuous or broken lines, presenting or not arrows in red or black), manually drawn representing the

genre of the subjects investigated, the role in the group, the attractions and the repulses, indifference and unilateral or bilateral relations.

In the 1960s, Moreno's sociogram incorporated formalisms of graph theory which gave it a mathematical rigor (Wasserman and Faust, 1994) and it started to be described by computer algorithms with graphical display on various devices. Currently, sociograms are recognized as social networking diagrams.

The network (or graph) consists of a finite set of nodes of the actors (individuals, groups, or organizations) and edges (or arcs) indicating the connections among them. When reading a graph, the main focus of analysis is the pattern of the connections regarding the distance and physical location of the nodes. Thus, the analysis of sociograms enables the verification of how individuals relate, the choices they make and the reciprocity among them. The distance and physical position of the participants provide information about the leaders, the isolated ones, and the subgroups (or social atoms). In this study, these definitions were termed as social characteristics. The definition of the social features demanded the need to know the peculiarities of each VLE interaction feature. The aim was to identify how each clue could support the mapping of social relations. This way, the primary features outlined are: Collaboration, Popularity, Isolation, Mediation, Subgroups, Social Detachment, and Indifference.

3 METHODOLOGY

The investigation starts from the problem of how to map the social interactions in a VLE so as to display them in the form of graphs (sociograms). The research is characterized as descriptive, theoretical, and practical as it dedicates to the (re)construction of ideas and improvement of theoretical principles, mainly those related to studies of sociometric aspects (Moreno, 1972).

Thus, in order to meet the proposed objectives, the study was developed in four stages, which were carried out in a recursive sequence:

1) construction of the theoretical framework on the themes: social aspects (Primo, 2008; Piaget, 1979) Sociometry (Moreno, 1972), educational (Piaget, 1973; 2005; Sacerdote, Fernandes, 2013; Lima, Meirinhos, 2011) and Distance Education (Behar, 2009);
2) planning and implementation of the Social Map feature, whose interactions analysis module was built in its own environment and the GraphViz library (http://www.graphviz.org) was incorporated into the display module;
3) validation of the Social Map feature in undergraduate and continuing education courses offered at UFRGS;
4) consolidation of the social characteristics based on the theoretical framework and on the results obtained in the application analysis. Such a step may require improvements in the implemented feature.

The Data collection instruments used were three: a) participant observation; b) data collected through the productions in the features of the VLE, and c) graphs of the interactions generated by the framework Social Map.

4 TRAJECTORY AND RESULTS

Data from this project are presented in the form of graphs generated by the framework Social Map where it was possible to analyze the social interactions of students in two undergraduate courses and one continuing education course in addition to validating the developed resource.

The Social Map implemented in the ROODA VLE is a feature that allows, from the interactions of users in communication tools in the VLE, the generation of sociograms where links, influences and preferences present in the social group formed by disciplines and courses can be identified. Such feature is accessible in the moment, only to the teacher of the course

The ROODA VLE allows various forms of interaction among participants: through exchanges of messages on forums, chat, or e-mail; comments on the inclusion of materials in the library and comments on certain forums messages, lessons and activities. All these interactions are captured, analyzed, and extracted in a text format file and then sent to the Graphviz to generate the graph, which enables us to see how interactions among participants in a class, for example, can be seen.

In computational terms, the sociogram construction process begins in a PHP class where the constructor method established settings to generate the social map. To this end, the following settings must be supplied by the user:

- Analysis period: sets the length of time that teachers want to see the interactions carried out;
- Colors of the participants: the teacher can specify colors for each user profile (monitor/tutor, teacher, and student). By default, the color

orange represents teachers, lilac represents the students, and gray represents the monitors (or tutors);

- Interaction method: defines the type of visualization of the interactions (bonds of a participant with the class/group, all the students, students and teachers, students and monitors, all participants);
- Layout of the sociogram: depicts the format of the sociogram. It has two types: graph showing the interactions in a network (Figure 1) and graph that shows the interactions in a circular manner (Figure 2). The maps of Figures 1 and 2 were obtained from a distance course supported by the ROODA VLE.
- Level of relevance: the teacher can assign different levels of importance for each feature analyzed. These important levels directly influence the thickness of the edges that connect the nodes. The levels range from "Not applicable" to "extremely important".

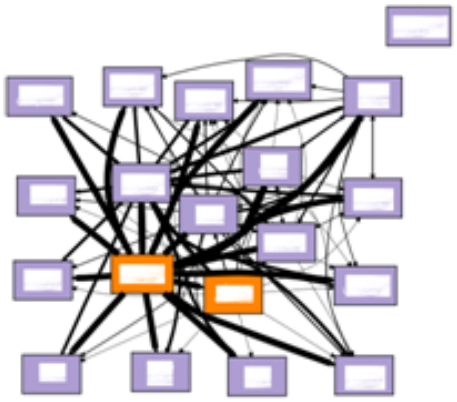

Figure 1: Layout of the Social Map in a network.

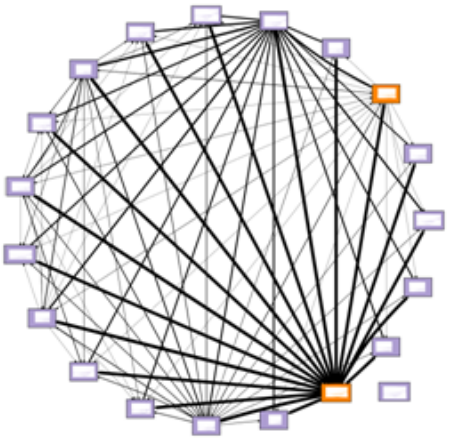

Figure 2: Layout of the Social Map in a circular shape.

For mapping the interactions, SQL queries to the database where all the AVA information is stored in physical tables are made. These SQL queries return the data to the PHP class, which processes these data and transforms them into information ready to be displayed. Processing consists in counting the interactions between users for features such as forum, chat, contacts and comments on library materials and webfolio. After this count, a text description in DOT file is sent to GraphViz, which is responsible for the generation of the graph, according to the description.

The information analyzed always takes into account the chosen class. Thus, the results in the Social Map can be different for the same student, when a different class is chosen.

Each tool analyzed receives an interaction weight, which interferes with the thickness of the lines connecting the nodes. In the case of a large number of interactions, for example, the line width is greater. This tells the teacher which students (and monitors/tutors) had a greater number of interactions during the selected period.

To improve the Social Map feature in the VLE, the analysis of the interactions of two undergraduate courses at UFRGS were used. One was offered in the classroom mode (Figure 3) and the second in the distance mode (Figure 4).

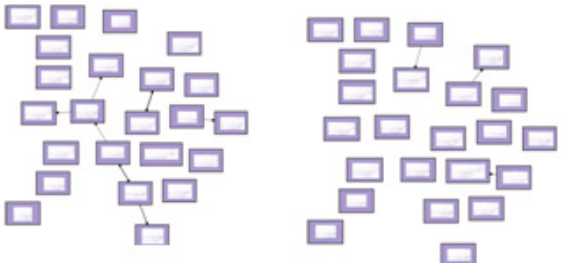

Figure 3: Classroom course.

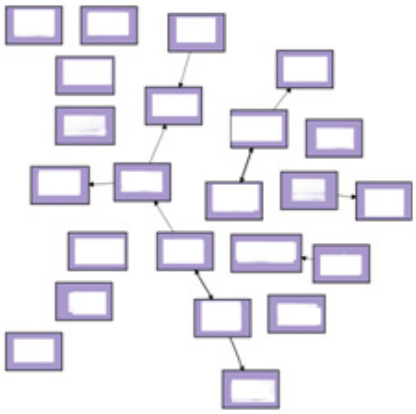

Figure 4: Distance Course.

In Figures 3 and 4, nodes in orange represent the students, the teachers are lilac and the monitors/tutors are gray, for each discipline and/or course.

In the Sociogram in Figure 3, taken from the discipline taught in a classroom, the interactions are directed to the classroom teacher, showing a lack of interaction among students. In Figure 4, although with a lower number of students, it is possible to notice a larger number of interactions among students themselves and between students and teachers.

It should be noted that the evaluation of these sociograms did not take into account the pedagogical strategies undertaken by the course teachers, only the graphical potential of the Social Map as a source for teachers to examine and perhaps rethink their courses. The extracted visual data suggest several questions about the social interactions that take place in VLEs.

Thus, the sociograms generated point to the need for further investigations that include, in addition to quantitative data, qualitative data in terms of social relations in order to automatically display possibilities for educational activities for teachers of distance education. Therefore, new perspectives suggest some improvements, as it will be presented.

5 FINAL CONSIDERATIONS

The present study showed the planning, the development and the implementation of the Social Map framework for the mapping of social interactions. From the extracted data, the teacher can analyze the possible social characteristics that are present in interactions from the VLE communication features.

For future research, the aim is to discuss and develop, alongside the technological process, pedagogical strategies that might help the teacher in the pedagogical use of the Social Map. To improve this framework, the following actions are being taken: (1) building dynamic graphs in order to improve the visualization of results; (2) inclusion of new social features (or modifying existing ones) to better understand the relationships that are formed in a VLE; (3) studies to make available the maps for the students; and (4) in computational terms, performance and application studies in other distance learning platforms;

The main contribution of this paper is to present the Distance Education teacher information on some social features that can be recognized in a virtual learning environment. From the graphical view of these characteristics, the pedagogical practices may be redirected in order to individualize assistance to students. The expansion of communication between teacher and students is also envisaged as a contribution.

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