A PROPOSAL OF A VISUALIZATION TOOL IN MOODLE’S WIKI TO MEASURE PARTICIPANTS’ INTERACTION APPLYING GRAPH THEORY AND SOCIAL LEARNING ANALYTICS TECHNIQUES

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Abstract

Learning Management Systems (LMS) are widely used in all levels of education. In the last decades, the LMS usage have been increasing, leading to massive data creation. This massive data generation created a considerable potential for these systems and it has aroused interests in many stakeholders involved in educational process. Different techniques have been applied in educational data analysis. Recommender systems and analytics systems are widely used in educational business as well as in other different business fields. Social Learning Analytics (SLA) is one of the techniques developed to support the learning improvement process. SLA is concerned on how users build their knowledge in networks, interacting with other users and with the environment.

Some SLA tools have been developed during the last years, following the growth of this field of studies. The tools are concerned with data analysis and data visualization and they help teachers and education institutions to improve their students learning process.

This work proposes a SLA tool based on a reference model instantiation, along with the application of graph theory and SLA techniques. The system architecture relies on the main elements in this reference model The Generic Framework model, proposed by Greller and Drachsler in 2012, that considers six critical dimensions for Learning Analytics (LA): stakeholders, data, objectives, instruments, external constraints and internal limitations.

Each of the dimensions can be instantiated in several different ways depending on the scenario of application. It is possible to convert concrete user cases into a model instantiation. Since SLA is a LA subarea, it is possible to instantiate a SLA scenario in the reference model. The model establishes relationships between the critical dimensions, making it possible to identify and react to impact caused by changes in any of the dimensions.

Basically, in the instantiation proposed in this work, the stakeholders are the students, teachers and tutors, and they generate interaction data by using the LMS (publishing posts, questions and answers). Social Network Analysis (SNA) algorithms will be the instruments to achieve the objective of identifying students disconnected from the course network.

The user’s interaction data will be collected from the Wiki’s logs inside the LMS Moodle and data processing will performed by the tool. The data will be available and shown through a visualization tool integrated to the LMS.

The application of SNA algorithms, as a SLA technique, allows the logical and visual identification of the users’ participation in the course social network through the identification of connections between students and other entities. The connections representation and visualization will be achieved through a graph structure. A graph structure is a suitable representation for relationships between entities, in a context that the entities are represented by nodes and the relationships are represented by the edges.

1 INTRODUCTION

Data analysis techniques have been widely used in different study fields. In the business and in the academy, data analysis gives relevant information from raw data. In education, the data generated by students, teachers and tutors can potentially guide the actions to be taken to improve the learning process. Currently, there are several techniques for analysis of different kinds of data, each of the techniques has a different context of application.

Social Learning Analytics (SLA) is one of the different techniques for analysis of education data. Ferguson et al. (2013) state that SLA study how learners build their knowledge in groups, in their
social and cultural environments. Currently, the technology makes the interaction thru social networks much easier than 20 years ago.

Currently, social media platforms are part of population day by day. The social media and participative culture origin innovative ways of learning, that are very important for the learning process. In this context, several proposes and techniques have been used for educational data analysis. Academic analytics, action research, educational data mining, recommending systems and personalized adaptive learning are some of these techniques, which are older than SLA.

Besides data filtering and processing, visualization is another important phase for data analysis. Currently, many learning managements systems (LMS) use plan graphs for representing data. When the representation of links between different entities is needed, the utilization of graphs is a suitable representation.

This work is a proposal of developing a tool for the visualization of the interaction between the users of a collaborative environment (wiki) in a LMS, by using Graphs theory and SLA techniques, such as Social Network Analysis (SNA). This tool should make the tracking of users’ collaboration easier, it also should make it easier to identify interaction and participation problems.

2 METHODOLOGY

Extensive researches have been done to have a tool proposal developed. The main techniques of educational data analysis, focusing in LA and SLA, have been reviewed. Besides this, some data visualization techniques have been reviewed, with emphasis on graphs data representation. Following, a set of questions was elaborated to guide the next steps of the research.

Based on the initial researches and on the response for the guiding questions, a conceptual map was elaborated. The conceptual map content leaded to more detailed researches on the key concepts. Highlighting the core terms helps on identifying new references and continue to improve the research.

The extensive researches helped on identifying the best techniques to be applied to this work. After the selection of SLA, identifying a suitable framework helped on guide the tool proposal aligned with LA concepts.

3 RESULTS

The research’s results were organized in topics, focusing on LA and SLA concepts. During the researches some frameworks have been evaluated, and the Generic Framework, proposed by Greller and Drachsler (2012) was selected as basis to the work development.

3.1 Learning Analytics

According to the 1st International Conference on Learning Analytics and Knowledge (LAK), Learning Analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs. Academic analytics, in contrast, is the application of business intelligence in education and emphasizes analytics at institutional, regional, and international levels.

Not so long ago, for universities and companies alike, gathering data on their users met with substantial limitations in terms of cost, time requirements, scope, and authenticity of the data, as this was typically done using questionnaires or interviews with a selected representative number of stakeholders. (Greller, Drachsler, 2012).

SLA is based on LA and focuses on how learners build knowledge together in their cultural and social settings. In the context of online social learning, it takes into account both formal and informal educational environments, including networks and communities. (Buckingham and Ferguson, 2012)

3.1.1 A framework for Learning Analytics

The development and implementation of a Learning Analytics tool requires the development of a model. Besides technical questions, such as educational sets or algorithms comparison, other questions influence the acceptance and impact of SLA. The Generic Framework proposed by Greller and Drachsler (2012) proposes the adoption of six critical dimensions for LA: participants, objective, data, instruments, internal limitations and constraints.
The various dimensions on this framework are abstract concepts that can be instantiated in different concrete forms depending on the needs of the project.

3.1.2 Generic Framework applied to Social Learning Analytics

Each application requires a different instantiation of the framework. The main concern of a SLA tool is the interaction between the participants of a learning environment, it leads the dimension’s values to features related to the interactions between the users and between users and respective environments. The values assigned to each dimension are detailed in the Table 1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Students, teachers, tutors, wiki components (pages, topics, comments).</td>
</tr>
<tr>
<td>Objectives</td>
<td>Enable visualization of interactions among students in a Wiki, identify connections between network components, identify influential components and topics, and identify isolated students to bring them back to the discussion.</td>
</tr>
<tr>
<td>Data</td>
<td>Student Interactions and LMS forum postings. Relevant indicators: Posts posted, answered. Time scale: What is the time interval for application of the analysis.</td>
</tr>
<tr>
<td>Instruments</td>
<td>The main instruments of analysis are SNA techniques and graph theory.</td>
</tr>
<tr>
<td>Internal limitations</td>
<td>The students’ interest in actively participating in the wiki, which influences the generation of data; The lack of certainty that educational institutions and tutors provide the data needed for analysis.</td>
</tr>
<tr>
<td>External constraints</td>
<td>The way the generated data generated will be analysed by the instructors of the courses. How generated data will be used by the instructors.</td>
</tr>
</tbody>
</table>

3.2 Social Network Analysis (SNA)

There are several LA techniques described in the literature. Regarding SLA, most of the techniques are related to network evaluation, since the social concept has interaction as start point and the interactions are well represented in network structures.

Buckingham and Ferguson (2012) present the general SLA foundations, reviewing some of the factors that reinforce the current importance of social learning. They mention five different SLA categories: social network analysis, discourse analysis, content analysis, disposition analysis and context analysis.

SNA allows the identification, through the interactions between the participants, of which connections most influence the learning. Some of the benefits proposed by the work for the teachers are: identification of students "disconnected" from the group; Identification of the main holders of the information; Indication of the extent of the community being developed based on the classroom;

3.3 Data representation

There are several forms of representing data. The graphs are suitable structures for representing social interactions. A graph can be defined, in a simple way, as a set of vertices linked thru edges. In a social structure the entities can be represented by the vertices, and the links between these entities can be represented by the edges.

The data, obtained from Moodle’s wiki logs can be converted into graph structures, making it easier to represent and manipulate this data. This process consists in several steps from the getting the raw data from the wiki, to converting it in a structured representation. Wild (2016) proposes a consistent process to transform raw data into useful information, and it has been adapted to this work requirements in Figure1.

1 Raw data filtering – This step consists in getting raw data and removing the unnecessary information.
2 Incidence matrix generation – The data is organized into an array, which contains the identifiers of the messages represented in the columns and the users represented in the rows. The incidence matrix facilitates the obtaining of the connections between the different users of the social network in question, therefore, the motivation in using such a data structure.

3 Conversion:
   - The matrix can be converted to a directed graph
   - The matrix can be converted to a non-directed graph

4 Actions are taken based on the graphs:
   - View action: the user will be able to see a graphical representation of the network.
   - Measurement action: Thru graph theory algorithms, it will be possible to measure different aspects of the network.

5 Based on the actions, the user can decide whether to start the process over.

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Pardo (2012) proposes the SLG (Social Learning Graph). This structure is defined as a graph $G = (V, E)$, where $V$ is the set of vertices and $E$ the set of edges. The vertices of the graph can represent any entity in a learning environment. This includes people (students, teachers, administrators), resources (documents, multimedia resources), resource sets (lessons, modules, courses), tools (text editor, forums, wikis, task submission systems) or even spaces (classrooms, laboratories).

Each node can have an attribute classifying its type, based on the categories cited. Nodes have a set of attributes represented by pairs (name, value) and can also include references to other nodes, allowing the creation of multi-nodal structures, such as groups of students.

The edges may reflect the various relationships between the entities represented by the nodes. Relationships between people, resources and tools can be symbolized by edges. The edges may have weights to represent details about the relationship and may be directed in the case of non-mutual relations. The figure 2 represents a SLG, in a visual structure. The U vertices represent users and the M represents messages.
3.4 Wikigraphs tool proposal

The tool Wikigraphs might allow users to identify and measure the interactions between wiki’s users. These interactions generate log files. These files contain raw data, and must be read and organized by an SLA tool so that it can represent useful information. After being read and organized, they must be stored in a structured way in a database.

The stored data is handled through the SLA tool and must be presented to users in a readable way in a presentation layer. Thus, the use of APIs allows the connection between the visualization layer and the control layer represented by the tool. Figure 2 shows a high-level representation for Wikigraphs’ architecture.
4 CONCLUSIONS

In the last decade, several techniques have been developed and applied in education data analysis. Different techniques have been developed: academic analytics, action research, educational data mining, recommendation systems, personalized adaptive learning and learning analytics. Social Learning Analytics (SLA) is a new approach if compared to the other cited techniques. When developing a tool to identify and evaluate connections between entities, techniques such related to SLA field play an important role. Applying these techniques make it possible to represent, identify and measure the relationship between the entities.

For connection representation, the use of graphs as data structure brings a suitable representation. In this context, Social Network Analysis techniques make it possible to evaluate several aspects of the network and visualization techniques make it possible to show the social network structure. All these components are linked thru a reference model. The fact that the model can be instantiable shows its flexibility and that it can be used in different contexts and with several techniques of Learning Analytics, in this case for SLA.

This proposal will be implemented using the moodle’s Wiki as source of information. During the tool development, new questions and new constraints will emerge and actions will be taken to have these questions and constraints solved.

REFERENCES