Supporting Moodle-based lesson of Software Engineering through visual analysis

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Abstract. The literature in educational research has established that monitoring student's learning is a crucial component of high quality education. The effective use of CMS requires that instructors can be provided with appropriate means of diagnosing problems so that they can take actions immediately to prevent or overcome those problems. The aim of this research is to support the comprehension of the evolution of the semantic content within eLearning environments through uncovering by means of visual representations. Therefore, we have carried out the meaning of an eLearning database and represented the more relevant results by depicting them using a visualization based on the tag cloud visual representation. Additionally, we have validated our proposal through a case study and found interesting activity patterns during some time periods also we found out some patterns of time delays, between the writing and reading of some posts.
Keywords: Visualization, e-learning, timeline, tag cloud, Moodle.

1 Introduction

Many universities and colleges around the world, which deliver undergraduate programmes in science and engineering, are currently incorporating virtual instruments as a teaching measurement and analysis tools for student learning. Moodle is a license- free and open-source software platform. It also called Learning Management System (LMS), or Virtual Learning Environment (VLE)).

From the architectural point of view, Moodle is based on a model-view-controller controller. The core system is structured in modules and each of these modules provides a wide set of functions. Each module has a connection and access policy based on their roles. Adding the Web Services (WS) to the Moodle makes it more flexible to control the connecting operation to obtain the optimal service and to reduce the selection service by using accurate attributes from both consumer and service By this method, the Moodle becomes a friendly and easily accessible mechanism to discover, select services and helps to build a high level of trust. This API is the base of developing a set of WS: Moodle-DFWSs. The SOA approach opens a new set of possible contexts of application: the retrieval and display of information from Moodle.

According to [1], Visual Analytics supports the analytical reasoning through interactive visual interfaces. This area has an important limitation towards its implementation within the LMS. The extraction of information from these systems is not trivial and in most cases it means hardcoding the LMS and/or visualization tool. To accomplish this goal, different approaches arise, several of them based on SOA [2]. This article will use the Moodle web services layer [3] as a proxy to retrieval and exchange information.

Munoz-Organero, et al. analysis the effects of motivational states on student performance in an eLearning scenario and figures out the correlation between the student interaction patterns of the VLE and his/her level of motivation. One of these results indicates to the possibility of predicting deficits in autonomous and eLearning specific motivations by analysing the interactions of the students of the VLE. The number of the hitting of reading eLearning content, participating in forums, and a student's updating of his or her profile have been positively correlated with autonomous and eLearning-specific motivations [4]. In the case that subjects related to technical careers, and more of these related to engineering subjects, learning needs to be evolved due to three main factors: Rapidly technology changes, it provides new solutions and we need to constantly update the content [5]. students usually use any kind of web 2.0 tools from different devices and we must try to figure out what method or tool should be applied, also how and when are we going to use it.. Also we have to learn from the previouserrors. We can choose to discard some of the elements or adjust them to better uses so that we can benefit from these changes; the interaction of the students is fundamental. With this in our mind, we are in a time in which the subjects will change and come up with new learning and teaching initiatives.

The Moodle "Reports" is one of such objects that could be very useful in analysing the level of interactivity between the instructor and students during the delivery of a courseware. Nevertheless, after having a brief interactivity and it becomes unusable when representing great quantities of data.Usually,, Tag clouds are created by mapping a dimension that associated with a term in an underlying data to a dimension parameter which determines how the term should be displayed. However, in Moodle, the principal task of tagclouds is Recognition/Matching. Tagclouds can evolve along the changes of the associated data source over time. Although tagclouds seem to invite exposure of their evolution over time, they do not explicitly represent them. **1.**

This paper is organized as follows. In the next section we outline the related work in order to provide context for our description of Temporal Words Clouds, which is followed in Section 3. Section 4 describes the study and results along with the alternative visualizations we used in the study. then We conclude the paper with a principal contributions ,conclusions and suggestions for future work.

2 Related work

Currently, the increasing use of new technologies to support learning has fostered the creation of tools that help extract information that is not available at first sight. This is essential for the improvement of the learning process from the point of view of decision makers, content providers, teachers and students, all of whom will benefit

from the use of effective analytical tools for current e-learning platforms. For a better comprehension of the related works, were classified into two categories: tag cloud and supporting eLearning.

Tag Clouds.

The particular purpose of a tagcloud is to present a visual overview of a collection of text. By this criterion, the first example may seems to be the outcome of an experiment carried out by social psychologist Stanley Milgram in 1976 [6]. Milgram asked people to name every landmark in Paris, and then created a collective "mental map" of the city by using font size to show how often each place was mentioned. Tagclouds support the navigation of the underlying items, automatically serving created tables-of-contents or indices into a block/batch/set of content. And, much as a table of contents or index can do for a book, a menu of categories can do the same for a website, they provide many ways for users to form a general impression of the underlying set of content and "gist" which is the book or site about. Nowadays, among high-profile websites exists a considerable research which can improve tag cloud layouts: Flickr,Del.icio.us; TagCrowd; Tagline Generator; Tag Cloud Generator; Wordle; Manyeyes. Tagline Generator allows people to generate a sequence of tag clouds which are associated with time from a collection of documents; a dynamic slider control is used to navigate the time points, but only one tag cloud can be shown at a time. Additional enhancements include the use of spatial algorithms to pack the words within a tag cloud into a smaller area, and it also cluster algorithms so tags which are used together or have the similar meanings will be placed near each other. Kaser and Lemire organized tags in nested tables for HTML based sites by using an Electronic Design Automation (EDA) packing algorithm [7]. In the work presented by Torniai et al. the tag cloud employs the size and colour of tags to convey the information describing the tags popularity and relevancy to the teachers, respectively [8]. Seifert et al. proposed a new algorithm to address several issues found in the traditional layouts [9]. It creates compact and clear layouts by reducing whitespace and featuring arbitrary convex polygons to bond the terms. Tree Cloud arranges words to a tree to reflect their semantic proximity according to the text [10]. Research efforts that attempt to understand the effectiveness and utility of tag clouds generally fall into one or two categories; those which investigate the visual features of tag clouds and those which compare tag clouds with different layouts. Bateman et al. compared nine visual properties of tag clouds for their effects on visual search for tags [11]. Their results show that font size and font weight have stronger effects than others such as colour intensity, number of characters, or tag area. Rivadeneira et al. conducted two experiments [12]. In the first study, they examined the effect of font size, location, and proximity to the largest tag, asking participants to recall terms (for 60 seconds) that were previously presented in tag clouds (for 20 seconds). In the second study, they investigated the effect of both font size and word layout on users' abilities to form an impression (gist). From both studies, in accordance with previous research, a strong effect of font size is shown. Halvey and Keane compared tag clouds with traditional lists (horizontal and vertical), each with regular vs. alphabetical order by asking participant to find a specific tag [13]. They found that lists perform better than tag clouds and alphabetical order accelerates the search speed.

In usage, tag clouds can evolve to the associated data source changes over time. Interesting discussions around tag clouds often include a series of tag clouds and considering trends of their tags over time. This very desire of studying the trends and understanding how text content and topics evolve over time has been the purpose of other visualizations, for instants, the commonly used line graphs and bar charts. However, despite of the significant amount of researches on tag clouds, there were not so much researches on how to visualize trends in tag clouds. Parallel Tag Clouds (PTCs) is designed to provide an overview of a document collection by incorporating graphical elements of parallel which coordinate with the text size encoding of traditional tag clouds [14]. Meanwhile PTCs do show the multiple clouds simultaneously, they do not explicitly represent the trends, thus comparing multiple tag clouds to ascertain trends places the cognitive demands on person. Bongshin, et al. integrate sparklines into a tag cloud to convey trends between multiple tag clouds. Also they makes controlled study to explore the efficacy of temporal representation on tag cloud to see SparkClouds [15]. The first attempt to use the tag cloud view as a part of the coordinated multiple views (CMV) system was by Matkovic, et al. [16], the tag could was used to identify the months in which the immigrants succeeded most (most landings). Weiwei, et al. introduces a visualization method that couples a trend chart with word clouds to illustrate temporal content evolutions in a set of documents [17]. To convey the evidence of change across multiple tag clouds better, we developed a new breed of tag cloud that integrates wave graph and bar graph into a tag cloud.

Supporting eLearning .

Due to the limited space, some experiences in other papers which deal with the analysis of information generated by the CMS through visual representations are listed and briefly explained below. The reviewed works focus on different aspects of online learning and some basic concepts will be explained. Each message has a sender, date, and topic. A set of posts on the discussion topic, comprised of an initial post and all its responses is called a thread. The person who sent the initial message in a thread is called the originator. Mazza and Milani [18] showed the instant in which users enter the platform and a representation of the frequency of reading and writing in the fora, as well as the thread originator. In [19] the visits and posts over time for each person in a CMS were shown, while in [20] the authors presented the mapping of temporal relations of discussions on software, aimed at helping analyse the discussions of the temporal aspects of online educational course. Finally, Mazza and Dimitrova [21] suggested a scatter-plot-based representation of the online discussions and a matrix to visualize the students' performance on quizzes related to domain concepts. Another group of works dealt with the use of visualization instead of information analysis, as part of the learning process or as a supportive resource for coursework [22]. Dichev et al. [23] make use of ontologies and propose the display of thematic maps with the support of semantic information, in addition to their interactive administrations. In our previous work [24], we have proposed interactive visualizations of the social networks that are formed among the participants based on an activity on the educational online platform. the review of the search patterns in the interaction of the learning networks was referred to [25]. Finally, a work which was closely related to the present article is [26], addressed the display of narrative

structures and the learning style of students in the systems of e-learning and also the use of a simple time line for selecting the narrative structures. On the other hand, outside of the field of educational computer science, the visual representation of evolution over time has propitiated numerous works, to some extent, share similar features with our work. Apart from examining the representation of timelines, the ways of interaction with the user have also been the object of study. In addition, [27] reviewed the different available techniques of temporal visualization and classified them. Finally, another work by [28] reviewed different ways of displaying temporary data according to the features each one has.

3 Description of Temporal tag cloud

Visual representations help users to quickly perceive salient aspects of their data. Augmenting the cognitive reasoning process with perceptual reasoning through visual representations permits the analytical process to become faster and more focused. The main goal of the visualization is to provide a compact representation of the overall use of the forums' interaction on VLE, thus providing an overview of the eLearning platform interest, activities and its evolution over the time.

Usually, a tagcloud presents a certain number of most often used tags in a defined area of the user interface. A tag's popularity is expressed by its font size (relative to the other tags) Sometimes, further visual properties, such as the font colour, intensity, or weight, are manipulated (for an overview see [11]). Next to their visualization function, tagclouds are also navigation interfaces as the tags are usually hyperlinks leading to a collection of items they are associated with. However, tagclouds are not only used to display tag sets but are also increasingly applied in other contexts and for various data sets, for instance, in the areas of information visualization or text summarization (cp. [29]). Furthermore, several layout variations emerged on the basic design principles of tag clouds. Most popular is the 'classic' rectangular tag arrangement with alphabetical sorting in a sequential line-by-line.

Fig. 1. Representation of a single tag on Temporal tagcloud

Representation of tagcloud.
The goal of the representation for each tag is to represent not only how much it is highlighted, but also the evolution of this representativeness over the time. Fig. 1 provides an overview of a tag with its three main components: the bar-graph, wave-graph representation and the tag. The bar-graph and wave-graph representation depicts the significance of document content, represented by a word, over time. The size of the font word represents the meaningful of the word on forum activity of the VLE. The curves that shown in the Fig. 1 present the significance of the word, which is depicted on background, extracted from a stream of forum posts. The thin lines that grow up from the bottom of the word to the top, are the representation of the bar-graph. To further improve readability of the meaning of the curves and the bars, they

are assigned with different colours depending on their activity, green for update-post, red for read-post, and blue for add-post. The x-axis encodes the time and the y-axis encodes the significance of the word clouds. The interactive visual tool can be used to analyze the usage of a CMS over time. Later, this view can be adapted to the user's requirements, so she can explore all the available discussions, forums, courses and users data, going from the overview to the detail of a given person, course or discussion within a period of time.

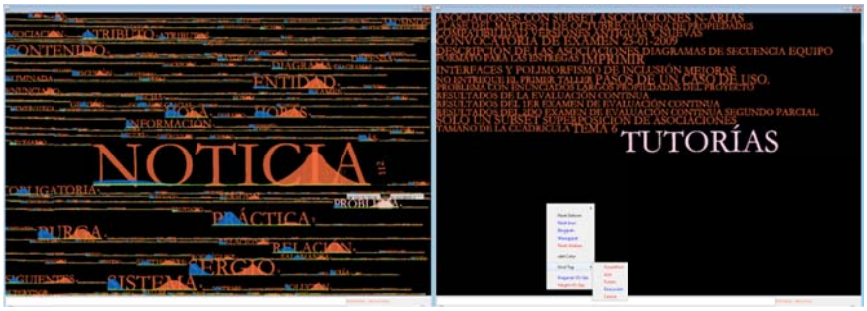

Fig. 2. On left, Global view of temporal tagcloud of forum posts. On right, Global view of temporal tagcloud of discussions

The interactive visual tool can be used to analyse the usage of a CMS over time. Also, shows the most relevant words from the forums' activity. Here the user can chose, through the contextual menu interaction (see Fig. 2 right), to view among the keywords: the users, the courses, the discussions and the subjects of forum posts and the obtained from the analysis of all the semantic content of all forum posts exchanged in the platform. One of the interested visual analytic technic used on this work is the semantic zoom. A physical zoom, on the one hand, changes the size and visible detail of objects. A semantic zoom, on the other hand, changes the type and meaning of information displayed by the object [30]. The Temporal tagcloud allows both types of zooming, but the emphasis is on the different shapes that are formed depending on the chosen degree of detail, i.e., semantic zoom in the mouse double click interaction over the word. When the users use the semantic zoom, depending on the context, the tool selects for analyse the forum-posts related with the word zoomed. For example, in the case of the user makes semantic zoom on a word, the tool takes all forum posts that contends the specific word selected to do the reconstruction of the temporal tagcloud. Furthermore the user can choose what he wants to see. He can draw or hide every element of the representation on the visualization. For example, notice the difference between Fig. 2 left, where all elements are showed, and Fig. 2 right which have only represented the tags.

4 Case study

This paper is based upon the study of "view, update and post" statistics obtained through the real time "Reports" from the logs of the Software Engineering course during the academic year 2008-2009 and 2009-2010, we are considering 88100 log

entries. In both courses the subject has been developed in the first semester of the academic year (September to February) and had an average of about 160 students. With that information which is intended to conduct a study to determine the moments of greatest activity in platform and how often and for what purpose they are using the forums. That is why we are going to apply the Temporal tagcloud on the data. Regarding the forum analysis, we are going to consider 51 forums, with 114 discussion threads, 172 posts and 26979 forum accesses. That would mean 2907different words with respect to a total of 9332. The result of the application of Temporal tagcloud is shown in Figure 2.

Fig. 3. View of tag "problema".

Monitoring a specific theme, forum, discussion or course, the user, as a normally conversation or discussion, tries to maintain the track of all discussions, forums and posts that they make. In the Figure 2, we could see the most used words in a bigger size. From this figure we could obtain several conclusions related to how the forums are used: Informative use. The forum is used to inform students about events related to the subject, such as: announcements, schedule changes, dissertation defence, list of assignment submisions and so on. The follow words must be highlighted in this sense: Noticia, Aviso, Defensa, Convoca, Examen, Hora, etc; Modelling Discussions. Considering issues and tools related to Software Engineering subject such as: Discusión, Entidad, Relación, Base, Datos, Diagrama, Atributo, Modelo, SET, etc. Doubts Resolution. When the forum is used to answer questions relating to different areas of the subject. For example: USAL (Universidad de Salamanca), semana, problema, prácticas, duda, forma, despacho, entrega, solución, etc.

Also, the users need to review, update and to monitor the most frequent discussions, posts, specific problem or student. Theoretically, the increase should be focused on the months of October and November and may be included a part of December. This is because they are the busiest months and when the Workshops take place. In Fig. 2 left and Fig. 3 can be seen that each tagcloud can show (see the "problema" tagcloud) the specific period of time on wave-graph through the mouse move interaction. Moreover, with the same behaviour interaction, the bar-graph permits to the professor see the specific date of the activities. Therefore, it shows that periods of increased activity in the courses commented correspond to the months of classroom teaching, with particularly representative peaks around the dates of the workshops. This makes sense since the students had to use the platform for the delivery of their solution proposal and because these exercises later will be commented in the forums. **2.**

In Fig. 1, we could observe this phenomenon with the word practice. Taking into consideration adding posts (in blue) we could see that the information of the Practice is added at the beginning of the course. Considering update posts (in green) we can see that there are very few updates in Practice information. Regarding to read-post, given its rightward shift on the word symbolizes that first appears midway through the

course and stands towards the end, having a greater frequency near the end of teaching period. This comes from two factors: At the beginning of the last two months of the course we use the platform to provide students the wording of the mandatory practice that they must submit at the end of teaching period and before the test. Therefore that is the reason for the appearance of this word so late in the course; The highest frequency of occurrence of the word is near the end of the course.

Fig. 4. Global view of temporal tag cloud of forum posts after of it makes semantic zoom on "tutorias" discussion

As a part of monitoring a specific theme, course, forum or discussion, the users can need to find and go directly to the most significant discussion. This can be done it drought the contextual menu (see Fig. 2 right) and select on the menu kind tag, and then discussion. The result of this is showed on Fig. 2 right, where we can recognize like the most relevant discussion is "tutorial". Then the user can make shift and click over the tag having as an outcome the webpage of the discussion. Other common case on this scenario is when a professor tries to understand the semantic content of a single forum, course, user, or discussion. For this the user needs to goes, through the contextual menu, to the representation of a kind tag that he wants, on the case of this example "tutorias" discussion. Then use the semantic zoom on the specific discussion tag, and finally, change the representation to forum post kind tag. As a result we can see on Fig. 4 that the discussions have a different group of significance tags. Following the same idea, if the user wants to know what is the outline of a semantic content in a specific period of the time. Then she/he can select a specific period of the time, through Ctrl+ double click over the period that she/he wants (showed in Fig. 3).

5 Contributions and conclusions

Based on our research, this work is one the first to generate a visualization that uses tag clouds to depict evolving text content over time. As a result, our work offers unique contributions:

The possibility to use the some tasks of the tagcloud: depending on the context, tagclouds can support user tasks ranging from locating specific items or groups of items, providing an overview and general impression. Following is a list of tasks that temporal tagclouds can support: Search: Locating a specific term or one that represents a desired concept (or determining that it is not there); Browsing: Using tagclouds as a means to browse, often with no specific target item or topic in mind.

Impression Formation or Gisting: Looking at the tagcloud as a means to form a general impression of the underlying data set or entity associated with it; Recognition/Matching: Recognizing which of several sets of information or entities a tagcloud is likely to represent; Understanding evolution of the tag: understanding topic trends for two or more continuous time points. **Time-based tag cloud layout** that balances semantic coherence of content and spatial stability of the visualization to help users easily perceive content updates.

Should be added that the visualization tool is continually evolving and throughout the writing of this article, there are new features. Including synonyms and plurals binding (with the use of ontology) and the representation of the space of words at a forum or course, but for this case study were not considered.

6 References

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