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From the discovery of students access patterns in e-learning including web 2.0 resources to the prediction and enhancement of students outcome

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1. Introduction

This chapter explains a new tracking system for the web 2.0 eras developed based on the knowledge gained about similar systems development (Hijon et al., 2007) and on the approaches for further assessment of interactions data developed, such as visualizations and statistical analysis (Hijon & Velázquez, 2008). Thus, it explains how teachers can benefit from the information it would provide to keep an eye on students while working beyond their reach. The system is been used during the current academic year in our university and some of it is also shown. There is also the description of an assement process teachers can follow through the system to be able to obtain the information needed. Therefore, how the system can be used to gain the knowledge about students' interactions, and ways to predict and enhance their students outcome.

Firstly, there is a review of the state of the art in analysis of interactions, and specially in Learning Management Systems.

Secondly, a there is the description of the problem analysis. Where, there is an explanation of the reasons the host LMS to develop the integrated tracking system for the web 2.0 has been Moodle. And, there is a description of the objectives this tracking system may pursuit, namely: give teachers a more accurate perspective of how their students are working, therefore improve the teacher learning process; also, to improve Moodle analysis of interaction features with open queries, and improve the visualizations of this interactions data providing a 'birds eye view'; of course, offering of interactive visualizations of this interactions data that would be catchy and engaging to encourage teachers analysis. Once decided the host LMS was Moodle, there is an evaluation of new already developed modules for it that may fulfill the desired functionality the new module may include. And finally, there is a clear description of the new system functionality development and the knowledge teachers can easily obtain from it.

Thirdly, there is an explanation of how the system can provide the required knowledge to teachers by simply interacting with the system. Some examples of knowledge gaining and interpretation of data to predict and enhance students' outcome are explained.

Finally, conclusions about using this new module developed for Moodle and the importance of prediction of students' outcome to enhance teaching and learning.

2. Previous Research in Analysis of Interactions

Determining learning behaviour in electronic media is a complex problem. A difficulty is that students mostly use these environments away from the classroom and out of sight of their educators. Without the informal monitoring that occurs in face-to-face teaching it is difficult for educators to know how their students are using and responding to these environments. Educators have had to seek new ways of obtaining information about the learning patterns of their students. This requires the development of effective methods of determining and evaluating learner behaviour in electronic environments.

For example, an analysis of student use of a courseware website by (Peled & Rashty, 1999) found out that the most popular online activities were passive and involved getting information rather than contributing. Their conclusion is that the students were very goal oriented in their use of the web site. Further information can be gained from knowing when students access resources (Sheard, et al., 2005). This can help educators understand student's preferred learning patterns. A study carried out by (McIsaac, et al., 1999). explored interactions of doctoral students with an online environment and they concluded that student interactions were goal focussed. For instance, in a study of student use of a first year geology website by (Hellwege, et al., 1996)., log file analysis showed that students accessed the most recent lecture notes first, picking up a couple of key slides, before returning to a previous lecture. As a result, it was shown that students were accessing resources according to immediate need. In this way, another study (Hijón & Velázquez 2006) of this characteristics showed that the average connections to the CMS was over thirty minutes. Particular navigation patterns may also indicate the lack of, or prominence of, navigational mechanism available.

Analysis of learner interactions may also be used to compare learning behaviours of different groups of students. Some studies have found a relationship between learning outcomes and web site usage. Like (Comunale, et al., 2002) found evidence to suggest that higher course grades are related to more frequent website use or another one that found no correlation (Hernández-García, et al., 2008). Another studies (Dimai & Ebner, 2003), (Downing, et al. 2005) where participation and implication grades are measure through indicators such as emails sent, forum participation, total connection time to the LMS. An example of more subjective measures such as interactions' quality was obtained in (Barbour & Collins 2005). In some empiric studies made it is highly remarkable the importance on time and dedication to the course habits (Nian-Shing & Kan-Min, 2002), the connection time (Kickul & Kickul 2002) and the total number of accesses to the system (Ramos & Yudko 2008) (Moreira, et al. 2005).

A study by (Lu, et al 2000) which analysed log file interactions with different resources on a courseware website found a relationship between frequency of access to learning resources and final exam scores. They content that this provides evidence that the use of relevant Web content improves learning. A more recent study (Gao & Lehman 2003) investigated learning outcomes of students using Web-based learning environments providing different levels of interactivity. Log file analysis showed that the students in the proactive and reactive interactions groups spent more time on task. Interview data revealed that the students in the

interactive groups spent more time reviewing and reflecting and learning content and this resulted in greater learning outcomes. On the other hand, in (Nickles 2005) there is a study of six measures of student behaviour in a CMS which did not consistently correlate with their grades.

Although there have been various gender based studies of the use of the Web, there are a scarcity of studies which report on differences in courseware usage based on gender. A study by (Peled & Rashty 1999) found differences in the type of resources accessed by males and female students. The males used interactive resources significantly more than the females; whereas, females used passive resources more than males. Another study by (Hijón et al., 2008b) found important differences on the students' accesses patterns on the morning and evening courses, also among students with different exam performance and on courses that run over the year or just only a semester to select some of them.

Analysis of learner interactions may also be used to compare learning behaviours of different groups of students. Some studies have found a relationship between learning outcomes and web site usage.

2.1 In Learning Management Systems

Teachers need more and more an aid from the e-learning system that provides information about how students interact with it. Thus, some applications that try to resolve the problem of keeping an eye on the student while working out of sight of the educator have already been developed in different areas of e-Learning, such as. (Ramani & Rocha 2000) describe tools for letting instructors easily view student participation in a Web-based class using charts and graphs to display student participation. (Reffay & Chanier 2002) identify clusters and cliques within the online class. These tools focus not on the individual student, but rather on class activity as a whole. Although both sets of tools are interesting and potentially useful in aiding the understanding of Web Based discussion forums, they aren't build on an analysis of the discussion evaluator's workflow, which is a critical requirement for improving online teaching effectiveness.

In (Mazza & Dimitrova 2005) had developed an Application CourseVis that visualized interactions of students with an e-learning site, and then they moved towards moodle and offered what they have called GISMO which is an application that can be installed into Moodle and shows basically different types of graphical information (bar charts, and matrix visualizations...) basically 2D graphical information about the overall classroom accesses or the detailed information from a specific student. All it is offered are graphs of the accesses, the 2D visualization may have a third dimension that is color (from light to dark shows the quantity of accesses), or shape (bigger circles show a larger amount of contributions from the student). Even though their visualizations are more advance than Ramani and Rocha's, they still lack of interactions and improvement. Thus, in (Hijón & Velázquez, 2008a) important improvements have been obtain by using interactive visualizations to monitor students interactions.

In University of Edinburgh they have made tracking and visualization of student use of online learning materials (Hardy, et al. 2007). Their tracking tools are non-invasive, whilst providing information not available in standard web server logs, the tools also allow the tracking of non-standard page elements such as inlines and allowed a great measure of control over what information is recorded. Their tracking process could thus be divided into two main phases largely independent of each other: data collection and data analysis. The

data captured was for three main types of event: page accesses, the viewing or hiding of inline and the firing-up of popups, each event storing relevant information on the tracking server. Each event had a common data set. User and session identifiers were captured from a WebCT cookie. Information such as the client machine was captured using JavaScript commands and client IP and domain information via the HTTP header. An internal page identifier for the page accessed was also recorded as well as the URL used to access the given page. In addition to this information, page access data was also recorded; the referrer URL which could be used to determine the path a student used navigate through the course; a start and end time for a page access – this time was measured at the client. This provided temporal information as to when the course was being viewed. Inline events were also recorded: an internal inline identifier unique to a given page; the event time at which the inline was revealed or hidden together the even type, which could be one of: reveal, hide, reveal all and hide all. This would provide feedback as to how inlines were used by students.

It is clear the importance of analysis users' interactions in order to improve and facilitate the information offered through a web site. Furthermore, since the analysis of web usage for understanding learners behaviour is an important task in the enhancement of the teaching-learning process, it has already been done by authors trying to find out hints that lead them to the discovery of behavioural access patterns, but as said, it is very difficult and time consuming for teachers to thoroughly track and assess all the activities performed by all students.

Thus, despite there are some research on data generated on e-learning systems, there is still lack of standard methods that provide, first, with the required information about interactions, second, with the overall method to make that the information obtained could be automatically related with additional data on the learning process and stored in a unique database system, and third, that provides methods of treating the information and visualizing it that results in greater and quicker teachers' comprehension of what is happening.

3. Problem Analysis

It has been developed an application into the Moodle LMS, called Merlin-Mo, since it is worldwide widespread and offers very good service for e-Learning (Aberdour, 2007) where Moodle scored 79% for its use in Higher Education among the more than 50 open source platforms. A summary of the features that also has leading us to make that decision are: It is fully open source software (a GNU license regulates download, usage, modification and redistribution of the code). It is platform an independent environment, flexible, easy to use, available in multiple languages and open to customization. Its architecture and user interface are focused on "activities" rather than on "Content", so large number of activity modules is available, allowing for a wide range of pedagogical settings. It features a nice user-friendly interface both for students, teachers and administrators. From a technical point of view, it is design with a very strong modular structure, a fundamental module for those willing to integrate additional functions or upgrade existing functions. The community of Moodle developers and users is very lively and is actually offering a very good support through a dedicated web site and a number of specialized web forums. Also, a lot of high quality technical documentation is available. The source code has been judge of very good

quality by programmers. The Figure 1 shows an example of how this new module fits into the Moodle system.

Fig. 1. Merlin-Mo into Moodle

The new module should offer a fully automatic installation in any running Moodle system. Therefore after its installation the module should offer very complete statistics and visualization of students' interactions. Thus, the integration and compatibility should allow using the Moodle database and all the Moodle preset services, such as, administration and security services. Finally, it should be developed under a GNU license, allowing its use by all the developers community and, of course, Moodle users.

3.1 Objectives

The general objective is to offer teachers a more accurate perspective of how their students are working that would result in a better teaching-learning process. Therefore, a partial objective is to improve Moodle analysis of interaction features with open queries that would lead to a precise information gathering. Furthermore, to improve the visualizations of this interactions data providing a 'birds eye view' that would result in a much more easy to follow way for the teacher to do the analysis. Moreover, offer interactive visualizations that would be catchy and engaging, and would lead to 'want to know more' offering nicely built and easy to use interfaces. Finally, and not less important, since Moodle lacks also of statistical analysis it would provide statistical visualizations that would easily give an overall impression of the question placed to the system. Therefore, the list of objectives of Merlin-Mo:

- Detailed data of what students are doing within the course in a selected time period.
- Representation of students work through the year. Obtaining of time graphs with interactions.
- Detailed information about accesses to different resources. As they may be very different in structure and in the way students interact with them, possibility of selection of visualizations; otherwise, the system should offer the most appropriate.
- Analysis of different types of actions a student can do when reaching different resources.
- Easily identification by the teacher of what parts or resources are more and less used, and how are they used.
- Identification of lurkers or proactive students.

- Identification and way of analysis of cooperative students, how they do this participation and cooperation in the different web 2.0 resources Moodle has (eg. Forum, chat, wiki).
- Offering of different interfaces according to the previously selected data, therefore *ad-hoc* interface customization to the user.

The general objective that this module should accomplish into the Moodle system should be the offering of all this new functionality but also the obtaining of a total integration of this module into Moodle, to do it, it would be necessary to obtain the following partial objectives:

- Use of Moodle security system to allow only teachers of the specific course to see the analysis.
- Synchronization of the language and other user settings of this new module with the general configuration settings Moodle offer for users and courses.

3.2 Evaluation of existing applications

Once decided that the Host LMS was Moodle, the applications that should be analyzed were the module for analysis that comes in the standard version, and try to find out new modules, if have been developed, for this LMS. So this was what it was done, firstly deeply analyze the standard Moodle module for tracking students' interactions, finally, check in the already developed modules as add-ons if there were some that covered these functionality.

On the one hand, the module for analysis is very poor; it just offered a data table structure where teachers can ask for hits to his/her courses in a very poor interface. Furthermore, the data is visualized just as a tabular format with all lack on improved visualizations that would include simple or complex graphs, statistics or interactive visualizations that would help teachers on the analysis.

On the other hand, when checking if some modules that covered all or any of this functionality were already developed for moodle, there were found out the followings blocks (as Moodle calls them):

Most Active Users: It is a block that lists the most active users of the LMS along with a ranking. Each user is given a rank according to the number of hits made by him. The rank is simply the Z score of the number of hits made by the user. It just offers a rank with the top ten higher workers within a course. Much more is still needed for a teacher to set up policies that encourage students to learn and participate in different resources.

Inactive users: this block shows the teacher users who haven't logged in to their course for a set amount of days. Teacher can also choose to display this information to students or not. It gives the teacher a good vision of who are the inactive users within a course. It is a good feedback from the LMS but not enough.

Online users' Google map: this block displays who are the users currently online. It is very useful when teaching e-Learning, not so necessary on hybrid learning. It uses the geographical information from users' profiles to display the locations of online users on a Google map. The geocoding of locations are cached in the Moodle database and updated when cron runs. As its precedent, it may be very useful in e-learning, where students can be geographical far apart, but no so necessary in blended learning.

Raw records count: It is a simple course report that generates one list with the number of records in the log for each student in the course. The data table can be exported to ODS, Excel and CSV. The module improves a little bit the information that standard Moodle

offers, since it adds totals to the tabular information it already offers. Thus, it is better than do not have any type of summary about the tracking information teachers need, but is indelible not enough.

Register: Register activity organizes logs of courses in sessions; each session has login and logout. If register is in a normal course, it will calculate only logs from that course, if it is in a metacourse, it' will calculate all logs of courses in that category. Login is the first log for the course (or of categories) if there are not any other logs before the timeout period, "register activity" creates a logout. The module improves the information standard Moodle had up until now by offering sessions analysis, not only accesses or hits. After all, it is a step further on this analysis since it offers a new concept, but the information is displayed in the same tabular format, and represents nothing much.

3.3 Module for Students' Interactions Assessment

A new module for the Moodle LMS has been developed that covers all required functionality explained before in the objectives section.

The new tracking and visualization system of students' interactions for Moodle LMS has been divided into two main applications. Both of them, represent different types of information, offer interfaces designed ad-hoc to the selection of the information required, and present the data visualizations in a much different way. The Figure 2 shows the main interface of the new module called Merlin-Mo.

Fig. 2. Main Interface of Merlin-Mo

Once the tracking system is reached just be clicking in the Moodle menu option, the user has two main options: on the left hand side, the Ad-Hoc Interaction Assessment System (AIAS), and on the right hand side, the Preset Interaction Assessment System (PIAS). In the first one, teachers can find a wide open interface to place queries to the system about how their students are working, also, in some cases, the way to represent the information can be selected. In the second one, there is a complex analysis easy to do, since queries and interactions can be selected through a guided interface that would offer the visualization that best suits the data. Following to this, there is a detailed explanation of each system.

Ad-Hoc Interaction Assessment System

The partial functionality derived from the objectives, within the tracking system, this application fulfils are the following: Detailed data of what students are doing within the course in a selected time period; Visual representation of the students’ amount of work through the year; Obtaining of time graphs with interactions; Detailed information about accesses to different resources. As they may be very different in structure and in the way students interact with them, possibility of selection of visualizations; otherwise, the system should offer the most appropriate. Analysis of different types of actions a student can do when reaching different resources. Easily identification by the teacher of what parts or resources are more and less used, and how are they used.

The information can be represented in two different ways, in 2D tables and in 2D graphs depending on the query data to be shown and on the user preferences.

The main interface of the system is shown in Figure 3, where user can identify three sections:

Fig. 3. Main Interface of AIAS in Merlin-Mo

The first section asks the user to fulfil some values in five different boxes that would dynamically generate the following interface. Therefore, this interface uses the values that have been selected or left by default. In this sense, the “M” stands for multiple values that would be able to be chosen afterwards, this is to say, more than one course, student, part/topic, action or date; and “S” stands for “simple” values, this means, just one value would be selected in the next interface. The five boxes stand for the five different dimensions users can ask for, those are:

Course: Stands for the courses the teacher would like to ask for, of course, it only includes courses the user role is teacher, this means that he/she is authorized on that course.

Student: represent the students enrol in the course/s previously selected.

Part/Topic: allows the selection of a resource included in the course, it could be either a type of document (word, adobe, excel...) or a forum, chat, wiki... related to the whole course or specific chapter in it.

Action: includes all actions students can do within the LMS, this is: view, add, update, etc.

Date: permits the selection of a time period in the analysis. As explained before, if “M” is clicked on this interface, a date range can be selected in the following interface, otherwise, only dates as constant can be selected, as “last week”, “last month”, “today” and so on. As a result of the user selection in every box, the interface would allow those values to be picked afterwards, and what is more important, it would offer the user to pick between one type of representation or another, depending in the number of variables selected, the system would dynamically offer only tables, or both, tables and graphics.

The second and third sections are preset queries that, for its importance, have been already formed and are offered to the user without more interaction than just by clicking. The first of them shows the list of resources accessed and activities done within a course detailing the number of accesses. As it can be observed by the icons on the section, the information would be displayed in a sector graph representation and in a tabular linked chart. The second of this section, offers the overall results of students passing the course; thus, it offers the teacher the big picture of results, more detail can be obtained in the following results section. In this last case the information would be displayed in a sector representation.

When user fulfils the first section, it offers a second interface based on the options the user has previously marked, this is to say, the multiple or simple values for each part or dimension he/she has clicked on would be dynamically rearrange the data to be shown in the second interface. Therefore, bellow each element it would appear “M” or “S” respectively indicating values that could be chosen (see Figure 4) as well as the visualization type to choose from depending also, on the values selected in each dimension; in this example, user can pick from tabular, graphical or the combination of both representation.

Fig. 4. Second interface generated for AIAS in Merlin-Mo

In the second interface generated only selected students were picked from the marked course (the interface has been generated to allow multiple values for “Course” and “Students” options); no restrictions were marked on the part/topic and action, which means “all topics” and “all action” options and “last month” where marked in the Date option (only simple values were allowed on this options); both types of the possible representations have been marked, graphs and tables. Therefore, results of the query after the user has filled the options appear when users click on the wand icon, Figure 5 shows them.

Fig. 5. Example of Results generated in AIAS interface

Further information about each register listed can be obtained just by clicking, either on the student name or in the action, which would automatically expand the data details about students and the specific action, respectively. Therefore, when clicking on the student name, the system would lead to more information about the student, and the clicking on the specific action and implicit part would show specific details that register about.

Preset Interaction Assessment System

This module of the tracking system offers a system with a different interface, also easy and intuitive, and would offer the user a richer visualization of students’ interactions. This part includes interactive visualizations allowing them to represent more variables in the same visualization, which leads to two general objectives: one is the obtaining of a wider analysis and interpretation of data; and the other one is the higher teacher engaging with the analysis since results should reorganize or change by interacting with them.

The partial objectives this module tries to fulfil are:

Offer the possibility of analysis of students’ interaction data grouped and also individually. It would be very important if it could be tracked either way in the same visualizations or graphs. Evolution of students (as before, individually, grouped or both ways) acceding to selected course resources through a time period selected, offering visualizations that differ from the traditional table representation. Study of the overall class results at a birds eye view first, what would offer a very good overview to the teacher; and secondly, possibility to “dig into data” to know more about what students have performed one way or the other. Since teachers usually teach more than one course, it would be important being able to compare course performance in different views and courses, which would possibly result in the obtaining of different access patterns. Students’ analysis of interactions along arrange of courses. And also the offering of data for comparing, studying and analyzing students’ performance through different academic years. Grace comparison through visualizations that would promptly give results to teachers within a course.

The module is divided in little applications that display a second interface depending in the functionality and the users’ desire for analysis. These interfaces have been created to easily divide different functionality offering a modularity that would result in usefulness, easiness of use and user satisfaction. The main interface of this application is shown in Figure 6 where the information to be shown is grouped as follows:

Visits: it offers the information about students’ accesses to the resources of a selected course.

Social Network Discussions: visually represents in a social network how students write posts in forums within the course. It should offer the social network of the conversation among them identifying threads of discussions clearly identifying who is who so teachers can make decisions of amount and quality of work done by them.

Participation: represents how students cooperate and participate in tasks that implies “learning by doing” more than simply “passively listen and reading”; this is to say, participative activities such as writing on a chat, wiki, forum, as resources of the Web 2.0 that clearly implies participation.

Most common route: who being a teacher would like to know what is mostly done by students when entering the site? It would be important towards where to set an important announcement in the LMS or getting to know, how quick a message is gotten to most of the students. It is a way, of kind of knowing what path and what delay have teachers’ messages into the LMS.

Performance: quantitative feedbacks for teachers are the course results, which are measured by the grades students make in the course, after all. Offering a clear way of representing them as tree view visualization with the identification of the students would be a good “big picture” of results as well as detailed information when needed.

Course Comparison: visualizes different access pattern of different students groups. It could compare two different shifts of the same course, e.g. morning and evening one; or the same students acceding totally different courses in the same academic year or different. As seen, the possibilities are endless, but the wider the system, the wider the sample and therefore, the analysis and results.

Fig. 6. Main Interface of PIAS in Merlin-Mo

When clicking on the second option, “Social Network Discussion”, the system offers the possibility of analysis of how are the students participation in a particular forum associated

to a course selected. Figure 7 shows its interface. Firstly, on the left hand side a course must be selected, and also a forum from the ones created within the course (usually there are more than one). Secondly, on the left hand side, information about the different representations has to be picked either a Social Network display, containing how each student has answered to others or has started a thread; or a Radial Graph that always sets in the centre the student that has been clicked on.

Fig. 7. Second interface generated for PIAS Social Network Discussions in Merlin-Mo

In this second interface of the PIAS system, named ‘Social Network Discussion’, the user has to select a course and a forum within the course, in this example the selected course was ‘Software Engineering I’ and among the forums to pick, the one on ‘Design Patterns’ have been clicked; Then, two visualizations can be selected, by clicking on the first one, ‘Social Network’ or ‘Radial’ that show differently the links among students participating in the discussion. The Figure 8 shows the first representation where the students are the nodes. Then, the user can move the image throughout the screen; pick on a node (student) that would highlight in red, as well as the nodes connected to it that would highlight in orange. This is particularly useful when the network is very crowded and it is difficult to detect relationships.

Fig. 8. Visualization of Social Network Discussions on PIAS in Merlin-Mo

In the third interface of the PIAS system, “Participation”, the selected course was ‘Software Engineering I’ and the selected chat within the course is the ‘Chat de Dudas’ one (see Figure 9).

Fig. 9. Data Mountain Vis. Of Participation in chats on PIAS in Merlin-Mo

In this case results are shown in a Data Mountain visualization, where the x-axis offer the time frame those chat messages have taken part (in the example, two months, April to June) and the y-axis the amount of messages. As everyone knows, chat messages can be either read or written; the top centred interactive boxes allow the user to see both (as in the example) or only written messages or read ones. Also, on the top left side, a specific student can be selected, and the interactive graph would show the chart of only that student. The third interactivity option within this visualization is than by clicking on any coordinates of

the ‘Data Mountain’ data clicked highlights offering detailed information about that specific dot (or student).

In the fourth interface of the PIAS system, named ‘Most Common Route’, user has to select a course and a student or group of them registered on that course. Figure 10 shows the results of the most common route follow by the sample students into the Software Engineering Course. As it is shown on the graph, each node acceded is labelled by the resource type (chat, survey, forum, etc) and the name within the type and course. When the chart is too crowded and want to look for something that identifies a node, the window on the left bottom part can help us to do so by highlighting the matches.

Fig. 10. Visualization of the Most Common Route through a course on PIAS in merlin-Mo

In the fifth interface of the PIAS system, named ‘Performance’, user has to select a course and an exam result to analyze on that course. Then, he/she would have to pick among the possibilities of representation. First option is represented on Figure 11 for ‘By grade’ visualization that offers a Congress Visualization with the overall of the exams the course had on the x-axis and the grades on the y-axis. These results can be modified by selecting a specific student on the left bottom window, or a specific exam on the right bottom window.

Fig. 11. Congress Vis. of the Performance in all exams within a course on PIAS in Merlin-Mo Second option is represented on Figure 12 for the ‘Social network’ one that offers a the representation of the final exam results on the selected course.

Fig. 12. Visualziation. of the Performance in the final exam of a course on PIAS in Merlin-Mo

As it can be seen each group of student obtaining the same grade are grouped together by the linking to the node containing their grade. Then, users can pick on a node and it will be highlighted as well as the linked ones, which results in a really easy understanding of the results when the network is too crowded or some grades or students want to be looked at; other options like zooming permit the enlarging of the images as well.

4. Prediction and Enhancement of Students Outcome

From the correct interpretation of the information the system provides to the teachers, those can predict and therefore enhanced their students’ outcome. Examples of the questions teachers can make to the Merlin-Mo system are:

4.1 Do students have different access patterns if they are in the morning or in the evening courses? Is there a difference that is common to all the morning/evening courses?

Teachers can ask the system the option “subject Comparison” in the PIAS interface and select two courses, one taught in the morning and the other one in the evening. The system would offer the comparison between the access patterns of students in the morning classes, usually full time students, to the ones in the evening classes, usually older and with other concerns in their lives than just attending university.

Teachers can also ask the system for “performance” also in the PIAS interface on the same courses. And probably different accesses patterns are found between the course shifts, such as those in the morning/evening sessions work harder, possibly because they have more spare time, or fail also more, probably because they do not make the most of their time. Or that the ones in the morning/evening sessions get better grades, probably because they are more brilliant students, or with better skills, hence most of them also have jobs outside university.

All in all, possible conclusions of this partial analysis is that students in the morning/evening classes get better grades, probably because they are more brilliant students, or with better skills, hence most of them also have jobs outside university. Therefore, teachers and educators should set out policies to prevent the morning/evening class from absenteeism in the final exam when detected, and both booster motivation and enhance attitudes towards the course; by handing out more assignments and practical exercises during term time, and periodic refreshers to keep them up to date with class.

4.2 Do students that have a similar exam performance have a similar access patterns to the courses? Can it make a difference among them? Is there a difference if the course last only one semester? And if it is the first or the second semester?

Teachers can ask the system for “performance” and “participation” in the PIAS interface in different courses, for instance, when considering first/second semester courses or courses that run over the year, it can probably be observed that the amount of access of the groups tends to rise towards the end of the course, and therefore the exam. Teachers can find out how different grades groups increase their participation differently when they obtain different grades (*pass*, *good* and *very good* grades). Probably the ones that get *good* grades are the ones that, as time passes, most increase the amount of work done in the course. Those students who are *absent* probably do not show such a dramatic improvement.

Probably results such as, students that pass are more constant in keeping up with their work as the year goes by, than those that do not pass. Or, students that pass work harder over the year, increasing the amount of work done towards the final exam than the rest. Finally, if there is a higher percentage of *absenteeism* in the morning/evening probably explains that they are less/more motivated or have more time to expend studying.

To prevent failures and abandoners, teachers and educators should encourage students to start working sooner on the course and to maintain the amount of work done constantly, since it may lead them to get a better exam performance.

4.3 Do students tend to work more in peak periods? When are them? Are they similar among different courses and/or shifts? Does the exam performance make a difference among them?

Teachers can ask the system for the detailed amount of access by student within a course using the AIAS interface in Merlin-Mo and setting a concrete range of time. To make a comparison among the exam performance, the “performance” in the PIAS interface can contribute.

There may be found a tendency in several courses to work more towards the exam dates or at the end of the academic course, which would result in a better performance in second semester courses or courses that run over the year.

By looking at the access data from the first stages of the course, different groups of students can be identified; therefore teachers can put in place measures to prevent *absent* students from not taking the final exam and potential failing students not doing as much work as is required to pass.

Teachers pace or course plans could probably be changed in order to ask students to do some extra work, such as: assignments, midterm exams, etc, during the first stages of the course, since it has been corroborated that during the first months of the course, or the first part of the year (whatever is first), less work is usually done.

5. Conclusion

Firstly, a new software module for analysis of students’ interactions has been developed. It largely enhances the standard Moodle reports. The module, called Merlin-Mo, covers all the initial functionality required to meet users’ needs. It offers very good and easy to use interfaces that enclose potent search engines into the data model to look and organize dynamically data about interactions. Data is treated with useful statistical and interactive visualizations that generate good and easy to understand representations of data to help teachers in the process of analyzing students learning patterns. The module has been developed following Moodle standards to obtain a perfect automatic integration into a running Moodle LMS. Merlin-Mo module has been developed to support two languages, English and Spanish; those and other server settings are automatically adopted from the host Moodle user settings. Lastly, it has also been adjusted to be seen in the main market browsers.

Furthermore, teachers can predict and enhance students’ outcome by analyzing how students acceded the different parts of the courses, where significant differences can be observed. By adopting policies that prevent from wrong students behaviors on early stages much better results can be obtained. To help in the analysis of learning behaviors using the system many, the results can be analyzed grouped in three general types of access’ patterns, namely: differences among morning and evening sessions, amount of accesses by exam performance, evolution of the access patterns through out the year.

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