LMS Openness Perception in educational and technological areas

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***Abstract* — The application of the Information and Communications Technology implies changes in the means that support learning. This leads to the emergence of lot of tools that aim to improve students' learning. One of the most relevant tools are learning management systems. However these tools are on the one hand, mostly focused on the institution and the course and not too much on the learner, and on the other they are very monolithic and closed environments. It is necessary to facilitate the evolution and openness of these platforms in a way they can fulfil students' needs, and to do this a service-based framework is proposed. It has been validated through experiences in educational and technological areas and they were compared with each other. This allow to check that opening learning platforms is possible and not only in technological context but in other areas.**

Keywords: LMS, PLE, Interoperability, Services, Learning, Exportation.

I. INTRODUCTION

Along the time teaching and learning processes, as other areas, are influenced by the contexts in which they are involved. In this sense it should be pointed out the emergence of the Information and Communications Technology (ICT) [1].

The application of ICT, and specially Internet, in teaching and learning contexts implies a revolution in the way in which these processes are carried out. With special attention to the eLearning concept, the proliferation of learning managements systems (LMS) and the definition of contents adapted to these new contexts [1].

However, whilst it represents an important advance in many contexts (for example, the rise of mobile 'apps'), it does not always guarantee success in learning processes [2]. This is mainly due to: 1) Institutional resistance to change regarding the introduction of certain technologies in formal environments [3]; 2) The insistence on the technology application when it is not required or seen as a solution [4]; 3) The need for digital literacy amongst teachers and students, many of whom are digital immigrants and the younger pupil generations are digital natives [5]; 4) And last, but not least, the fact that lots of technological applications and tools are defined without taking into account the final user, which means that adopting and using them can turn into a difficult task [6].

From these problems, a divergence is seen in the technologies that the learners use to learn in non-formal environments and those proposed by the institutions. Given this context two kinds of learning environments are needed.

One of them is the LMS. These environments are focused on the course and provide the teachers with tools which not only support but also extend the traditional concept of classroom and facilitate managerial tasks [7]. These systems also provide students with spaces in which they may perform their academic activities, supplement their lectures and (to a greater or lesser extent) collaborate with other students and teachers. These platforms has become very popular both in academic [8] and professional environments [9]. Nevertheless, they do not solve the problems previously described [10] because: 1) They are not focused in the learner but in the institution and the course [11]; 2) They do not support lifelong learning [12]; and 3) they do not support the integration of new technological trends (such us the use of 2.0 web tools, of new technologies, etc.) [13], and they hardly evolve [3].

Given these reasons students do not use only these learning platforms. They need learning environments more adapted to their needs, open to the integration to any innovative technology and that facilitate the integration of the tools the learners use to learn. That is, learning environments more focused on the student and on their lifelong learning [11].

These are the Personal Learning Environments (PLE) [14]. They facilitate spaces in which the learner can include the tools he/she use to learn and do not implies a link with an institution or an specific period of time [15].

The present paper describes how to open the LMS both to the exportation of functionalities to environments such as the PLE, and to the integration of learners' outcomes carried outside the institution. Specifically a service-based framework to do this is described and also a usage comparison in educational and technical areas.

In order to do this the section 2 describes some related works. Later, in the section 3, the solution defined is presented. After this, the pilots are described and some conclusions are posed.

II. Related Works

LMSs are not easy to open to other contexts and neither is the integration between a PLE and an LMS. This is, among other things, due to [16-18]: 1) LMSs do not normally include interoperability standards; 2) The integration of training activities in the PLE is not satisfactory because they are designed for representation, classification and tracking in other platforms; 3) Problems of traceability of user activity in the PLE and, therefore, also in the formal environment; 4) Single-sign-on implementation problems; 5) Information security problems.

In order to facilitate this kind of integration Wilson et al. propose three interoperability scenarios [19]:

1. PLEs and LMSs could exist in parallel, as formal and informal environments respectively, without any interaction or integration of the activity that happens in those contexts.
2. LMSs could be opened up through the inclusion of web services and interoperability initiatives. This integration trend includes: *iGoogle* based initiatives [20]; social networks connected with LMS [21]; PLEs with specific communication protocols [22]. The main difficulties for these initiatives are: institutional barriers to the opening of formal environments and the fact that those initiatives are focused on information exportation and not on interaction exchange.
3. External tools could be integrated into the LMS. In these initiatives, the user might not decide which tools she is going to use and they will be limited to institutional decisions. Some initiatives that can be included this group are: LMSs defined for the integration of external tools [23]; *Google Wave* Gadgets integrated into *Moodle* [24]; initiatives based on tool integration driven by learning design activities [25]; etc. These initiatives pose several problems, such as, integration problems between tools, context integration difficulties, inflexibility for customization by the student and so on. The ones that best overcome these problems are those that define a learning platform starting from scratch or from a previous institutional development. This greatly limits the scope of use of the solution, which will be applied to a very specific context.

Taking all these solutions into account, each with its problems it can be concluded that the integration between the LMS and the PLE is still far from being achieved. The use of web services and interoperability specifications facilitates the opening up of LMSs, but they are very difficult to implement. Given this situation a service-based framework is posed. It facilitates the exportation of functionalities outside the institutional platform and the integration of learners' outcomes in external tools.

III. A Service-Based Framework to Open the LMS

In the introduction has been presented the need to facilitate the exportation of functionalities from the LMS to other contexts and to track the activity that carry out in such contexts from the institutional environment. In order to do this a service-based framework was defined. It uses interoperability specifications to facilitate the communication among the institutional environments and the PLEs. This communication is based on the exchange of interaction and information between both contexts. The description of such architecture can be seen in [26]. It includes two main elements: an institutional environment which can include one or several LMSs; and a personalized environment which combine institutional functionalities with other tools that the learner use to learn. Besides these components, the framework also includes interfaces and mediators to facilitate the integration in the PLE and the LMS of some commercial tools. The framework, in addition to these components, proposes a set of interoperability scenarios to describe the possible interactions among them [27].

From those scenarios the present paper use the first one, that consists of the exportation of functionalities from the institutional environments to personal environments controlled by the learners. To do this the web services included by the LMS are used. Specifically, a tool of the PLE can use the web service interface provided by the LMS to represent a functionality of this platform into the PLE. In example the functionality of the LMS forum, in which the learner participates, can be represented into the PLE. In this way this tool can be combined with others that the learner use to learn and, at the same time, return information about what happens to the LMS.

In order to validate the architecture an implementation of the framework as a proof of concept is developed. This implementation consist of: 1) Several Moodle instances as the institutional LMS, Moodle is chosen because it is very popular (http://moodle.org/stats) and because of the web services layer that includes [28]; 2) Apache Wookie (*Incubating*) [19], as a W3C compliant widgets container to represent the PLE (each widget represents a tool that learner use to learn); 3) Moodle web services layer which facilitates the exportation of functionalities and information from the institutional environment; y 4) BLTI specification (*Basic Learning Tools Interoperability*) to integrate the activity that is carried out in the widgets into the LMS. Taking this into account, for the first scenario, the institutional environment is Moodle, the functionality to export is the forum, that is represented in Apache Wookie as a W3C widget that can be used by the learner with other tools. This implementation is used with students of two subjects of different areas.

IV. The Experiment

In this section are described some of the pilots carried out to validate the described scenario in the service-based framework proposed.

To understand properly this section firstly is described the methodology used. Later is presented the experiences carried out and results and discussions. Finally a comparison between both experiences is discussed.

A. Methodology

The idea behind this experiment is to validate the scenario by taking into account students and teachers' perceptions about it, understanding this issue as something that can be addressed

in a qualitative way. However, to generalize the conclusions it is also interesting to use quantitative techniques so during the experiment both perspectives are used. This is known as mixed research methods and provide a more complete approach to validation [29]. That means to take into account quantitative and qualitative techniques. With the learners are used quantitative techniques (a pilot is carried out and the data is gathered through some surveys). However with teachers is employed a semi-structured interview after their experience with the system, and later they fulfil a survey that includes some open questions that are analysed in a qualitative way. This paper only includes the quantitative results and now are described the techniques used for this.

In order to validate the scenarios in a quantitative way quasi-experimental design is used [30]. This is because in this experiment pre-established groups of students (class-groups) were used, so it was not possible to have a complete randomized group of people and therefore a control study approach was not possible with either.

Quasi-experimental design implies the definition of a scientific hypothesis, from which a dependent variable is derived. Such a variable operates through several assertions that are proposed to the students of both the experimental and control group (independent variable). The students grade these assertions by using a five-value levels scale (1=strongly disagree, 2=disagree, 3=indifferent, 4=agree, 5=strongly agree). In both groups the same tests are applied, a pre-test at the beginning of the experiment and a post-test after it, but the students from the experimental group tested the forum widget in the PLE, while the people in the other group did not. After running the experiment, data is analysed by using probabilistic techniques to validate the scientific hypothesis.

The scientific hypothesis will be accepted if the results of the pre-test are similar in both groups (which proves that both groups have a common knowledge and background) and the results of the post-test between the people involved in the experimental group and the control group are different (those who have tested the tool should answer in a different way).

Specifically for the current scenario the scientific hypothesis considered is: “The exportation of functionalities from a learning platform and its use in other contexts facilitates learning personalization and therefore helps the student to learn”; from this is derived the independent variable: ”The learning improvement attained from the exportation of LMSs functionalities (as *Moodle* forums) outside the institutional environment, and its combination with other online tools”.

To operationalize this dependent variable, some assertions (also called items) have been proposed to the students and they have graded their agreement by using five value levels:

- I1. I usually use Moodle forums in my subjects.
- I2. I just use Moodle forums because in the institution the participation is mandatory.
- I3. I use other online tools to learn that are not included in Moodle (Youtube, Wikipedia, other forums, Slideshare, etc.).

And in the postest:

- I4. Moodle Forums are adapted to the way in which I learn and to my necessities, which increase my motivation.
- I5. The participation in forums related with my subjects helps me to understand better the contents.
- I6. The possibility to participate in my subjects Moodle Forums and combine them with other tools (such as Youtube, Wikipedia, other forums, etc.) helps me to learn.

In order to check if there are differences among the pretest and postest results two statistical tests are applied, Student’s T test and the non-parametric Mann-Whitney U test. The second one is applied to further validate the results of the first, because the lower limit for the application of Student’s is around 40 persons. In addition Mann-Whitney U test is suitable when the scale used to measure students’ perception is not exact (it is an ordinal scale).

For the Student’s T-test per each assertion a null hypothesis is set that is H_0: $\mu_E = \mu_c$, which means that both experimental and control groups have a similar average value. Null hypothesis is accepted if the bilateral significance of the item is under 0.05; if not, it is rejected. However the Mann-Whitney’s U test is based in a range comparisons between the experimental and the control group and in this case the null hypothesis is H_0: $\overline{R_E} = \overline{R_C}$ (the range of the experimental group is equal to the control group). As in the other test the signification should be greater than 0.05 to accept the null hypothesis.

B. Pilot context

In order to validate the service-based framework several pilots have been carried out. In this case two pilots are carried out, one based on an implementation of the framework in a context related to technological studies and other in educational context.

In the educational area the pilot is carried out with students of the third course of Education Degree of the subject Evaluative Research in Education and the ICT master. From the first group participated 51 students with a user-level knowledge of the technology. During the subject they learn concepts related to evaluation and the application of different methodologies. The results of this group were compared with 22 students of the “ICT Education Master: Analysis and Design of Processes, Resources and Teaching Practices” (ICT Master), they form the experimental group. This master aims to train experts to analyse, design and manage processes, resources and technology based teaching practices. Students have a different background but most of them with an educational base. That is. both groups have a similar context, although the Master TIC students are more related with the use of technology training activities.

On the other hand an experience has been carried out in a technological context with students of the Adaptation Course to Computer Science studies and a postgraduate master. Specifically in the pilot participate 20 students of the subject Project Management of the Adaptation Course. They constitute

the control group. These students have an extensive knowledge related with technology and they are not trained in pedagogical issues during the career. This control group has been compared with 7 students from the Intelligent Systems Master (IS Master). These postgraduate learners are trained in issues such us semantic web, visualization of information, robotics, etc. That is to say, they have a similar background to the students of the control group, but delve in other issues.

The results of both experimental groups were compared with their respective control groups and also with each other. This is done in order to see the utility of the exportation of functionalities from the LMS to other contexts and also the possible different perception of students from different areas.

C. Discussion and Results of the pilot in Education Area

In the ICT master Mann-Witney U and Student's T test are applied because the sample of the pilot has 73 students and in this way the application of the latter test is possible. The results are similar in both tests so just this last one is shown.

The results for the Student's T per each assertion in which the dependent variable is operationalized are seen in Table I. Each row represents an assertion (identified by an id in the DV column) and includes the average value for the experimental and control groups ($\overline{X_E}$ and $\overline{X_c}$), the standard deviation for the experimental and control groups (S_{X_E} and S_{X_C}), the contrast variable (t) and the bilateral signification (ρ).

TABLE I. RESULTS FOR THE STUDENT'S T TEST IN EDUCATIONAL AREA

Pretest results of the Student's test						
DV	$\overline{X_E}$	S_{X_E}	$\overline{X_c}$	S_{X_C}	t	ρ
I1.	3,32	1,086	3,10	1,005	0,838	0,405
I2.	3,32	1,171	3,02	1,208	0,978	0,332
I3.	4,73	0,550	4,57	0,539	1,147	0,255
Postest results for the Student's T						
I4.	3,41	1,054	2,80	1,132	2,139	0,036
I5.	3,77	1,066	3,20	0,960	2,278	0,026
I6.	4,32	0,995	2,57	1,118	6,333	0,000

With these values it can be seen that with regard to the I1, I2, and I3 assertions the students both from the control and the experimental group have a similar knowledge. This is because the bilateral signification of each item is greater than 0,05, which means that both groups have a similar perception about the use of Moodle forums in a university context. It should be noted that both the control and the experimental groups have very high average values with regard to the issue related to the necessity to use additional learning tools of those provided by an LMS.

Regarding with the postest items the bilateral signification in all the assertions is lower than 0,05, so the null hypothesis is rejected and, therefore, people in control and experimental groups have a different perception of them. It should be noted the difference in average values related with the possibility to combine the forum with other tools they students use to learn (2,57 for the population of the control group and 4,32 for the experimental group). This is because while Moodle does not facilitate it while by using the framework this is possible.

Since the results of the prestest are similar for the experimental and the control groups and different in the postest, it can be assert that, from students' perspective, the scientific hypothesis is valid.

D. Discussion and Results of the pilot in Technological Area

In the pilot carried out in the technological context there is a sample of 9 students of the IS Master as the experimental group; and 20 from the Project Management as the control group. This means that the population for the pilot is only of 29 students so the statistic test to apply was U Mann-Whitney because is specially suited for small groups and experiments with data gathered through an ordinal scale.

The results for each question are seen in Table II. Each row represents an assertion (identified by an id in the DV column) and includes the range values for the experimental and control groups ($\overline{R_E}$ and $\overline{R_C}$), the contrast variable (U) and the signification of the item.

TABLE II. RESULTS FOR THE MANN WHITYNEY U TEST IN TECHNOLOGICAL AREA

Pretest results of the Mann-Whitney U test				
DV	$\overline{R_E}$	$\overline{R_C}$	$\overline{U}$	***Signification***
I1.	18,21	12,53	40,50	0,092
I2.	17,43	14,20	66,00	0,816
I3.	13,64	14,13	67,50	0,871
Postest results of the Mann-Whitney U test				
I4.	21,29	11,45	19,00	0,004
I5.	17,79	12,78	43,50	0,116
I6.	20,43	11,75	25,00	0,009

In the table it is shown that the experimental and control groups have very similar range values for the pretest, so the signification is greater than 0,05. This implies that both groups have a similar background and perception about the use of Moodle forums in the University.

Regarding to the signification of the postest assertions, for the I4, I6 items is lower than 0,05 so the null hypothesis is rejected and for the I5 as it is greater than 0,05, so it is accepted. This means that for the rejected items the perception in experimental and control groups is different. The fact that the I5 item was accepted is because the posed assertion can be answered in a similar way by the students that has experimented with the system (experimental group) and those that have not (control group).

Given this data, and as in the previous pilot, the scientific hypothesis is accepted.

E. Comparison of Results

Once the pilots have been completed the results of the experimental groups of both pilots (the students of ICT Master and IS Master) are compared in order to obtain conclusions that could depend on the framework application area. It is necessary to take into account the context of each group, because both are postgraduate degrees in which technology has an important impact, in IS Master as the base of the degree and in ICT Master as the tool to apply.

In order to compare the results it is necessary to take into account the sample size. In this case are involved 29 students, 7 from the IS Master and 22 from the ICT master, so the statistic test to apply is the non-parametric Mann-Whitney U test. The results of such test are shown in the Table III.

TABLE III. PRESTEST AND POSTEST MANN WHITNEY U TEST RESULTS

Pretest results of the Mann-Whitney U test				
VD	$\overline{R_{ICT}}$	$\overline{R_{IS}}$	$\overline{U}$	***Signification***
I1.	14,48	16,64	65,50	0,121
I2.	13,86	18,57	52,00	0,534
I3.	15,70	12,79	61,50	0,308
Pretest results of the Mann-Whitney U test				
I4.	12,57	22,64	23,50	0,004
I5.	14,07	17,93	56,50	0,261
I6.	14,27	17,29	61,00	0,353

As in the table can be seen the results for the pretest assertions have similar ranges so the signification is greater than 0,05 and the null hypothesis is accepted for them. That means that there is not a significant difference about the use that both groups make of the forums and their opinion about the use of more tools that those provided by the LMS to learn.

In the postest it should be pointed out that both groups have different perception regarding with the assertion I4. That is the way in which forums are adapted to the needs of the learners. This can be because the groups have a different idea of what personalization means. For the IS Master group it is more related to personalization provided by the framework that allows to export functionalities to other contexts where they can combine them with others they use to learn, while for the ICT Master students it can be understood as how the forums can be adapted to their specific needs. For the rest of assertions the results are similar with a signification lower than 0,05. This means that independently of the context of the students involved in the test, they perceive the exportation of the forum as a way to facilitate learning and they find useful to combine it with other tools they use to learn.

V. CONCLUSIONS

The present work has posed the necessity to export functionalities from institutional environments such as the LMSs to other contexts where the student decides the tools he/she uses to learn, that is, the PLEs. In order to implement such exportation a service-based framework approach is described. It will use web services and interoperability specifications to facilitate the communication between these two environments. Given this framework it is necessary to validate how it works, and to do so several pilots were carried out.

From these pilots it is possible to assert that, from the students' perspective that is gathered through self-evaluation tools, the exportation of functionalities from the institutional environments to other contexts facilitates the personalization of their learning environments and, therefore, helps them to learn. This assertion is reinforced both in education and technological contexts. It also should be noted that most of the students of these two areas use more tools to learn than the merely provided by the institution, so it is possible to conclude that personalization is needed and possible through PLEs such as the used in the controlled context used in the pilots. Personalization is possible and it helps students to learn. This fact will attempt to be proved in a qualitative way as future works.

From the comparison of the results for students of the technological and educational areas, it can be concluded that despite both groups have a different knowledge background they have similar results both in the postest and the prestest, with the exception of how they understand personalization. This implies that the framework can be applied in both contexts in a similar way.

Finally it can be say that LMSs openness is possible and for educational and technological areas it can facilitate students learning.

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