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Docs4Learning: Getting Google Docs to Work within the LMS with IMS BLTI

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Abstract: Google Docs is a well-known suite of online collaborative tools for document processing, spreadsheets, online presentations, drawing and even forms. The last versions of the major open source LMS Moodle, offers weak integrations with Google Docs treating it as a content repository. But these integrations are neglecting the collaborative qualities of the Google Docs suite and its potential as a learning activity within the LMS course. This paper presents an integration proposal that using the IMS Basic Learning Tools Interoperability (IMS BLTI) standard turns Google Docs into an engine that powers collaborative learning activities within the LMS Moodle.

Keywords: LMS, Google Docs, Interoperability, eLearning, Software as a Service, Cloud Computing, VLE, PLE.
Categories: D.0, D.2.2, D.2.11, D.2.12, K.3.1, L.2.0, L.2.3, L.3.0, L.3.5, L.3.6

1 Introduction

One of the acronyms more used recently in the world of eLearning is PLE, which stands for *Personal Learning Environment*. This loose concept shapes a way that long life learners are going to learn: not within a walled garden of the VLE (Virtual Learning Environment) or LMS (Learning Management System) owned and managed by learning institutions, but as a rather self organized set of sources of information, interaction with peers, learning services, tools, contents and social networks [Olivier and Liber 01] [Wilson et al. 07] [Attwell 07].

While this paper is not about PLE's it has a big deal to do with them. The PLE is the goal of how a life long learner should plan, get and organize her learning; the learner is supposed to learn the necessary knowledge, skills and basic digital competences through her formal learning processes. If these processes only happen within the LMS and the basic set of learning tools implemented on its courses, the learner will neither be able to keep her learning activities nor learn how to build a PLE. This is mainly because content and interaction will remain inside the institution's LMS and often will expire shorty after the course is finished [Garcia-Peñalvo et al. 11].

After the social change that has happened in the Internet with the so-called web 2.0, many tools such as wikis, social networks, blogs, mobile applications, virtual environment etc. are being used for learning. New kind of online resources or tools have allowed students with common interests to meet, collaborate and innovate [Brown and Adler 08], [Wesh 09], [Kuswara et al. 11]. For example, consider this - not so fictional- scenario: a subgroup of students of a class are using tools like Instant Messaging, Wikis, GoogleWave or participating in a Social Networking site, while and sometimes for doing homework [Alier et al. 10a]. Students engaged in the usage of all these online tools might get better grades or not, but they will also learn important skills and competences on taking advantage of information technologies to access, share information and collaborate with others to do so. But their teacher may not know about it, because all the information (feedback) she receives is what appears on the LMS's course's logs, and all the tools she is aware are the ones bundled in the LMS [Alier and Casany 10].

Since these tools (wikis, social networks etc.) are already being used for learning, the LMS must face the challenge of adapting to this new era. According to [Craig 07], the new generation of students used to social networking experiences find actual LMS inflexible systems in contrast with Web 2.0 services. LMS will have to: be able to interact with external applications [Sclater 08], go beyond the limitations of the unit/course parading, put more emphasis in the learning and his/her actions and allow networked learning throw easy collaboration and communication tools [Obexer and Bakahria 05]. This interaction will require flexibility and interoperability techniques.

Interoperability between different learning tools is a complex task. One way of facing this problem is to find out ways to integrate external tools inside the LMS. This line of work has to consider three main problems: (1) a technical problem of making learning tools and services interoperable, (2) to make it in a way that has a pedagogical sense and utility for the learner and (3) to convince LMS and tools developers and vendors to comply with the standards proposed.

This paper presents Docs4Learning an open source project that embeds the features of the popular online office tool Google Docs as a learning activity within a LMS course. Docs4Learning works with the most used LMS in the market, since is compliant with the interoperability standard IMS BLTI. The paper is organized as follows: section two presents the related work regarding the current use of Google Docs as a learning tool; section three explains the main characteristics of the standard IMS BLTI; section four presents an overview of Docs4Learning, section five presents Docs4Learning architecture and section six summarizes main conclusions and further work.

2 Google Docs as a Learning Tool

Google Docs (http://docs.google.com) is a sophisticated cloud computing based set of office tools, which implements a web-based collaborative rich environment that provides the most used features of the desktop based office suite.

Google enforces Google Docs for educational purposes [Barr 09] because it allows learners to create and edit documents from anywhere and collaborate with multiple people at the same time. Documents are saved online and can be accessed from any computer with an Internet connection. It is also a tool of collaboration, since

multiple people can work together on the same document. Google Docs saves documents automatically, on a regular basis with enough frequency to let the user forget about saving the content. Each change is tracked as a new revision. The user can see exactly what is been revised, by whom, and when. This feature has been taken from wiki engines (like Wikipedia's Mediawiki engine http://mediawiki.org).

If a teacher is invited to share a document with the student the teacher can review, comment, and grade the student's work at any time. The documents can be made public to wider audiences, like parents, or even publish directly to blogs.

Google Docs implement a document editor, an online spread sheet, a presentation tool, a drawing tool, and with Google Forms the teacher can even easily create self-grading quizzes [Barr 09].

Google Docs is a free service, there is a paid version though, and it can be a substitute for an office suite. Using Google Docs, documents become ubiquitous, so the student can access the document from school and from home.

2.1 Proposals using Google Docs as learning tools

There exist several proposals on the use of Google Docs as learning tools. These proposals are oriented to use Google Docs functionalities in support to the learning process, coordination and communication between teachers and students. However, all these proposals are not integrated with a LMS since they are learning tools used instead of or in addition to a LMS.

[Blau and Avner 09], from the Open University of Israel, implemented an experiment with one hundred ant eighteen students to test the difference between sharing and collaborating on a written assignment. The experiment was conducted using Google Docs tools. The results of the study indicate that students believe that collaboration is very important: students think that a document that was written collaboratively has higher quality than a one written alone. Regarding psychological ownership, students believe that editing the document resulted in a lower level of psychological ownership whereas publishing it resulted in higher levels of ownership. Suggested improvements from other students did not lower the sense of ownership.

[Delgado 11] documents the success experience of using Google Docs in the Universitat de les Illes Balears, in the past two years as a normal tool to encourage the personal and collaborative learning as well as online communication.

[Marin and de Benito 11] created an *Institutional Personal Learning Environment* (iPLE) to answer some of the next research questions: 1) how can an iPLE simplify the organization of the student's personal knowledge, 2) which methodologies are more suitable to integrate an iPLE with a LMS, 3) which is the role of the teacher in an iPLE environment and 4) which are the pedagogical principles that the iPLEs environments use. A course based on the use of some Google Applications was designed to answer these questions. Google Groups was used to allow students discuss on forums about the student's personal experiences using the LMS. Google Docs was used to create a template to evaluate different LMSs in a workshop where each student evaluates a single LMS and they share their evaluations. Google Sites was used to create the main entry point to the course and to create collaboratively a glossary of words related to e-learning tools. Google Calendar was used to schedule the course.

Although the experience seems to be very interesting, the main drawback is that this work is more descriptive that analytical, since experience conclusions are missing.

[Pastor 09] presents a tool based on Google Docs that facilitates teachers to interact and share documents with students, and to students it allows to do online tests and exams very quickly. This experiment was conducted using Google Spreadsheet to design tests and a pilot was tested in a subject of Economics in the University of Valencia. The institutional LMS was a poor usability. Teachers report difficulties to create assignments to students. The new tool based offered several advantages to teachers in comparison with the institutional LMS. It was easy to use (for both teachers and students) and it was not restricted to the enrolled students. Flexibility, usability and collaborative characteristics of Google Docs were determinants for the teachers and students valuation of the new system.

2.2 Proposals extending LMS with Google Docs

Other research approach in this field is to address the transformation of a traditional LMS into a more collaborative platform using or integrating Google Applications as learning tools.

A more complete analysis of several approaches to integrate external tools to VLEs may be found in [Alario-Hoyos et al. 10]. However, in this section we distinguish these proposals more related to Google Docs integration.

[Schaffhauser 11] presented OpenClass, a new kind of self-service LMS delivered from the cloud. OpenClass has no hardware, licensing or hosting costs. This LMS integrates seamlessly with Google Applications and enables collaboration and communication between students. OpenClass offers single sign-on from Google Applications and a fully hosted environment so that schools do not have to make further data center investments to use an LMS. The main features of OpenClass are: 1) it provides a collaborative space for students, 2) it has the ability to create and edit course content directly from within the platform and 3) it has a deep integration with Gmail, Google Docs and other Google tools.

[Course Director 11] is another LMS based on *CloudCourse* from Google that integrates with Google Applications. Its main features are: 1) it provides online courses to share information with other students in Google Sites, 2) it allows the submission of coursework to Google Docs, 3) it provides online tests using Google Docs and discussion groups for each course in Google Groups and 4) it has timetables in Google Calendar.

CourseDirector and OpenClass proposals are very recent solutions developed by Google. Therefore, it is too early to evaluate their impact and use in the education community in front of a more established and popular experiences using LMSs such as Blackboard, Moodle or Sakai [Aberdour 07] [Wexler et al. 08]. However, they are proposals that follow a Cloud Computing philosophy, which may be the next generation of Learning Management Systems.

[Lago et al. 11] presents a solution to integrate digital pens with a LMS, using Google Apps. A digital pen looks and feels like a normal ballpoint pen. Therefore, student's handwriting can be captured, stored and sent in a safe way to the LMS where students can manage it, share these notes and complete an existing document.

Once digitalized, documents can be shared and edited collaboratively by students using Google Docs.

[Wagner 11] presents Haiku, an LMS that allows searching Google Docs files from within the LMS. It integrates Google Docs into the LMS and allows students upload Google Docs file assignments. Students can work alone or collaboratively using Google Docs. But, it is not an Open Source proposal.

Sakai project [Sakai 10] and Moodle project [Moodle 10] are also working in its integration with Google Applications. Sakai has recently published a document where people of its community can add which Google tool could be integrated with Sakai as well as its requirements. Moodle in collaboration with the partner *Moodle Rooms* also integrates Google Docs in the LMS. The main features of this integration are: 1) automatic creation of users in Google Apps when they are created in Moodle, 2) single sign-on, 3) a Gmail bloc in Moodle that displays the latest Gmail messages on the Moodle front page, and 4) a Google Application block on the Moodle Front Page that displays links to the Google start page, Google Docs, Google Calendar and Gmail.

The current integration of Google Docs with Moodle is very limited. Moodle 2.0 integrates Google Docs through a repository API [Alier et al. 10b]. This means that when the user wants to upload a document he/she can choose Google Docs as a source for this document on Moodle's file picker. So, Moodle 2.0 is using Google Docs the same way it uses any other file storage system. Therefore, this mild integration does not take advantage of the characteristics and advantages of the Google Docs Application. In this sense, 1) visibility of the process of creation of the document is lost, 2) it is not possible to benefit from a collaborative and concurrent edition of documents, 3) it is not possible that teacher participates correcting and hinting elements in the student's document, 4) it is not possible to use quick quizzes created by the teacher or the students with forms, 5) it is not possible to track and organize cumulative project data on documents and spread sheets, and 6) a lot of uses we have not devised yet.

Our proposal to integrate Google Docs into Moodle is designed so that the main functionalities and inherent characteristics of the Google Docs are preserved and exploited. Basically, Google Docs integration must maintain and preserve the collaborative power of these tools maintaining its functionality. This is done, designing its integration following a 'software as a service' approach. But to avoid making a specific point-to-point integration between both systems, it is designed using the IMS BLTI protocol to be more extensible and to allow integrate any kind of external learning tool into Moodle (or any other LMS). In this way, we may solve some of the above limitations.

3 IMS BLTI

IMS *Global Learning Consortium* (IMS GLC) (http://www.imsglobal.org/) is a well-known international organization working since 2005 in standards towards interoperability and integration of learning services and systems. Today, e-learning process and educational contents standardization is still an open issue [Varlamis and Apostolakis 06]. Major vendors, open source organizations and learning institutions are present on the IMS board of members and enforce the compliance with the

standards proposed. Standards like the widely adopted standard for quizzes and tests QTI [IMS-QTI 06].

IMS GLC has published several specifications related to the integration of external applications into LMSs. The *Tool Interoperability* (TI) specification was presented in 2005. IMS TI is a standard to integrate external applications into the LMS using *Service Oriented Architectures* (SOA). A new version of this standard started to be defined as *Learning Tools Interoperability (LTI)* in 2008. Meanwhile, Dr. Charles Severance in 2007 proposed a simplified version of LTI named *SimpleLTI* [IMS-GLC 09a] that became a temporal solution to integrate simple applications. Afterwards, IMS Global Learning Consortium improved SimpleLTI and released it as the IMS Basic LTI on 2009 [IMS-GLC 09b] that today is becoming the final official version of LTI [IMS-GLC 11].

3.1 IMS Tool Interoperability

The goal of the IMS Tool Interoperability (IMS TI) is that after an external application is integrated into the LMS, this application looks like a LMS native tool to the user. IMS TI is based on a client/server architecture where client is the LMS and the server is the external application.

The basic idea of IMS TI is that the LMS has a proxy tool that provides an endpoint for an externally hosted tool making it look like it is running within the LMS. The proxy tool also provides to the external application information about the individual, course, tool placement, and role within the LMS course. In a sense the proxy tool allows a single-sign-on behind the scenes using web-services and allows an external tool to support many different LMS's with a single instance of the tool.

IMS TI specification can be combined with other standards such as:

- *IMS General Web-Services*: a standard that defines a layered architecture to implement web-services in e-learning.
- *Simple Object Access Protocol (SOAP)*: a XML-based transport protocol used by web-services.
- *IMS Question & Test Interoperability:* a standard that defines how external tools must return results to the LMS.

The first Draft of the IMS *Learning Tools Interoperability* (LTI) is the evolution of IMS TI. IMS LTI was developed under supervision of Dr. Charles Severance (former lead developer of Sakai project http://sakaiproject.org/), and focuses on the process on how a remote online tool is installed on a web based learning system. In other words, LTI solves the problem of how will the teachers and the students reach an external application (tool) from within the LMS.

Similarly as the IMS TI, the IMS LTI has the same purpose that the LMS has a proxy tool that provides an endpoint for an externally hosted tool and makes it appear as if the external tool is running within the LMS [Alier et al. 10a].

The IMS LTI architecture focuses on the launch phase of external tool from the LMS. The launch accomplishes several things in a single web-service call:

- Establish the identity of the user.
- Provide directory information (first name, last name, and e-mail address) for the user.
- Indicate the role of the current user as administrator, instructor or student.

- Provide information about the current course where the proxy tool is being executed, such as course identifier and title.
- Other hints as display size.

3.2 IMS Basic LTI

While the IMS LTI specification is in progress and has not been made public, IMS GLC published Basic LTI (BLTI) as a standard [IMS-GLC 09b], and has made it part of IMS Common Cartridge 1.1 [IMS-CC 11] content packaging standard. Common Cartridge solves two problems. The first is to provide a standard way to represent digital course materials for use in online learning systems so that such content can be developed in one format and used across a wide variety of learning systems. The second is to enable new publishing models for online course materials and digital books that are modular, web-distributed, interactive, and customizable.

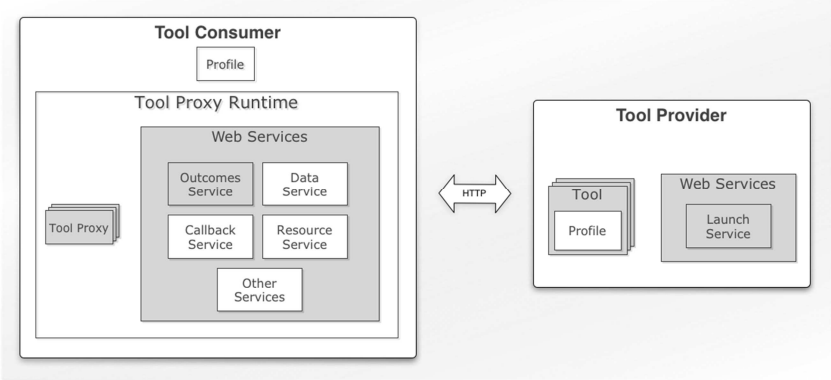

Figure 1: Simplification of LTI architecture: BLTI architecture (in gray)

BLTI contains the core functionalities that LTI aims for but some components and web services were not included [Fig.1]. BLTI defines a protocol with two actors, the tool provider and the tool consumer. Web based learning tools need to implement the BLTI provider to be BLTI compliant. In our case, the Tool Consumer is the LMS and the Tool Provider will be an external tool. The provider has to implement the Launch Service to allow the consumer to invoke it remotely. The Tool Consumer needs to implement a couple of components to be BLTI compliant: The Tool Proxy and the Outcomes Service. Tool Proxy is a generic player of BLTI activities that can interact with any Tool Provider and to embed its interface inside the LMS. Outcomes Service is the component that allows the Tool Providers to send grades back to the LMS.

BLTI Launch process is shown in [Fig.2]. An LMS user access to a one of his courses and selects a BLTI tool (1). Tool Proxy sends the required information to the Tool Provider Launch Service (2). Once the request is validated, the user is redirected to Tool interface (3).

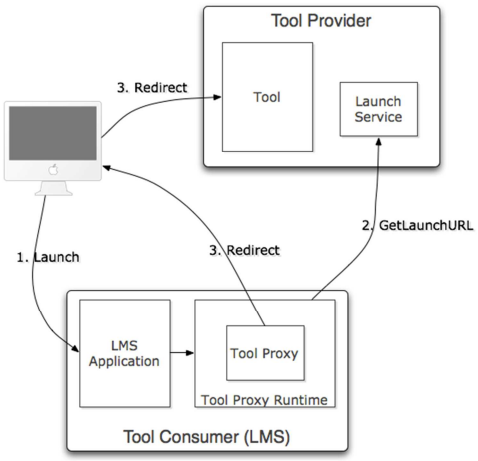

Figure 2: BLTI Launch process diagram.

BLTI Consumers must also implement BLTI Outcomes Service. This service allows external tools (Tool Providers) to send and retrieve grades to/from the LMS. [Fig.3]. ToolProviders can invoke Outcomes Service, for instance, to send a new grade (1), the Tool Proxy Runtime delegates this work to the LMS core application (2) and it sends a confirmation response back to the Tool. This process can be launched by the teacher, using the grading interface of the tool, or can be launched automatically in a self-correction activity like a quiz.

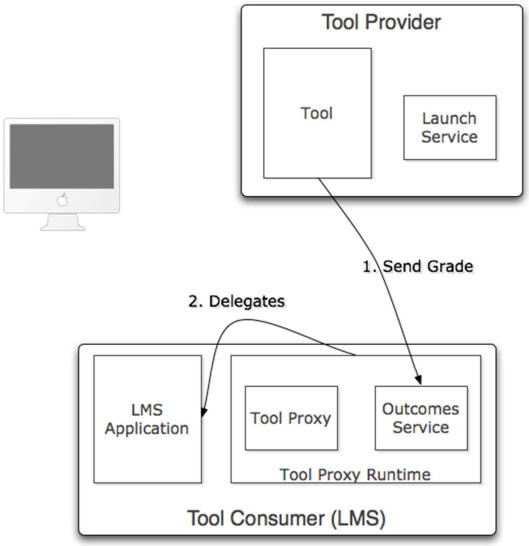

Figure 3: Tool and BLTI Outcomes Service interaction diagram.

The BLTI consumer is already implemented in the major LMS, both open source and proprietary (Moodle, Sakai, OLAT, Angel, WebCT, Blackboard and others). The authors of this paper have implemented BLTI consumer for the Moodle versions 1.9, 2.0 and 2.1 (http://code.google.com/p/basiclti4moodle/). Moodle adopted this development and included it as native BLTI consumer as a module since version 2.2.

4 Docs4Learning overview

The Docs4Larning project aims to develop an interoperable software connector between a LMS and Google Docs to embed the main functionalities of Google Docs as a native activity of the LMS within the virtual classroom. Let's consider for example, a typical case of the completion of an exercise proposed by a teacher to its students, that informally described, it corresponds to the following steps:

1. A teacher sets up a writing activity inside the LMS course. This activity must be done with a text editor, for example the Google Docs editor.
2. When students enter in the activity, a document is created within their Google Docs account, and each student is ready to begin working on the document. This document ought to be shared with the teacher, because the teacher wants to observe student's progression and participation through the "Revision history" view. The teacher may be also interested to make contributions to the document.
3. When students consider the assignment is completed they can "deliver" the document to the teacher, creating a PDF copy of the current version of the document and submit it to the teacher. Students will keep the living version of the document and they can, if they whish, to stop sharing the document with the teacher, since s/he already has the PDF version to evaluate.
4. The teacher evaluates the document and the student's activity. S/he makes some assessments to the student's work and sends the grades to the grade book of the course in the LMS.

This storyboard describes the most typical and common way that students and teachers interact to complete an activity assignment. However, one specific characteristic of this behaviour is that activity should be performed in a collaborative way. Students must collaborate in the elaboration of the document, and the teacher may also participate with students during this elaboration. At the end, the teacher evaluates the activity result: the document and the participation of each student in this activity.

Two of the most important requirements we identify in this use case are that the document must be elaborated in a collaborative way and that all participants must easily share the document. Therefore, to perform this activity in an LMS, we have considered Google Docs as a good candidate to be the collaborative document editor to be integrated to the LMS. In fact, there can be other candidate editors like wikis or other text editors with some level of sharing. But, in the current days, Google Docs is one of the most widespread and popular collaborative editor used in learning environments, it is easy to use, it allows edit different kinds of documents, and it provides an Application Programming Interface (API) that facilitates to integrate to a LMS or to any other tool.

In a learning environment using a LMS, more complex use cases may be identified. All of them also include the collaborative edition of documents. For example, a single document should be edited by a small sub-group of students and shared to the rest of the classroom that must review the document following a workflow, as a peer reviewing of documents protocol. But, in the current state of our project we have focused to solve the main issues related to the Google Docs integration in a LMS, and considering the above simple use case behaviour. More complex use cases are not implemented yet.

5 Docs4Learning Architecture

In this section, we describe the architecture of the connector between the LMS and Google Docs. We make first a global description of the system from a functional point of view, then we describe our proposal more technically, and finally, we summarize the main security issues we have considered.

5.1 Global view of the Docs4Learning system

The integration we propose of Google Docs into a LMS is based on the definition of a component between the LMS and Google Docs (the Mediator) which responsibility is to mediate and coordinate the communication and interaction between both systems.

Mediator also implements all the use cases and user interfaces explained in the storyboard described at the beginning of fourth point.

The user interacts directly to the LMS to create, edit, modify or delete a document using the Google Docs editor in a transparent way. The user does not require access to a web browser to access the Google Docs account, so it is embedded in the own interface of the LMS.

The Mediator is a java based web application. It implements the BLTI protocol performing as Tool provider. The LMS needs to implement a BLTI consumer. The LMS consumer allows the creation of activities within the LMS courses that are representing the tools outside the LMS. When a user accesses a BLTI activity, the consumer interacts with the tool, sending the necessary data back and forth so the user can interact with the tool as if it where a LMS native activity.

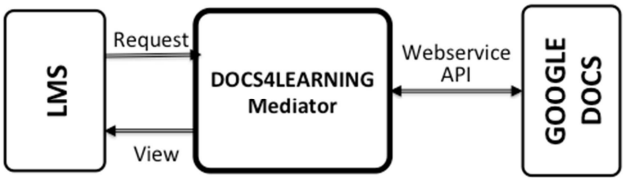

Figure 4: Global view of Docs4Learning system

As [Fig. 4] shows, the LMS sends this request to the Docs4Learning Mediator that communicates with Google Docs allowing modification, creation or deletion of documents. When the performed action requires showing some data to the user, a

view is generated by the Mediator and is sent to the LMS that shows data to the user. Communication between the LMS and the Mediator is based on the BLTI protocol meanwhile the communication between the Mediator and the Google Docs is made by means of web service invocations to Google Docs API. That is how tasks such as creating and sharing documents, launching the Google Docs user interface and binding it to the LMS can be performed.

To design the communication between both systems, we have considered applying the Mediator design pattern [Gamma et al. 94]. The purpose is to define a component that encapsulates interaction and communication between the LMS and the external application (Google Docs in this case). The Mediator promotes maintaining a loose coupling by keeping them apart from referring to each other explicitly. In our proposal, communication between Moodle and the Mediator is always based on BLTI protocol, meanwhile communication protocol from the Mediator to any other external application may vary to the interoperability requirements supported by the external application. In this sense, our Mediator will facilitate the integration of any external application to any LMS that supports the BLTI communication protocol.

The LMS Administration interface, shown in [Fig. 5], includes a panel to define and pre-configure the generic BLTI activity. Then, teachers may include an instance of such activity type in his/her course as a Google Docs activity, like any other Moodle activity.

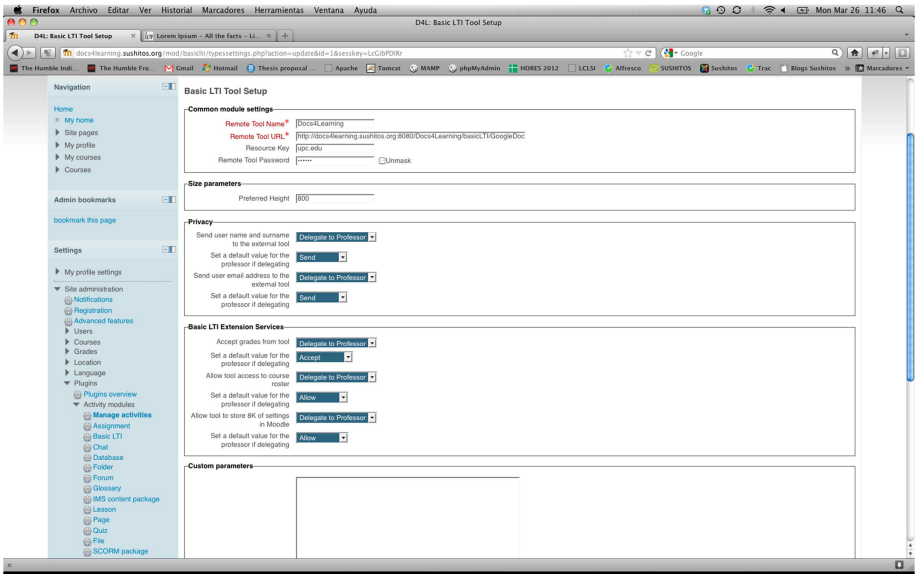

Figure 5: BLTI activity setup interface

After that, in the LMS interface the Google Docs activity appears as any other activity available to the user as it is shown in [Fig. 6].

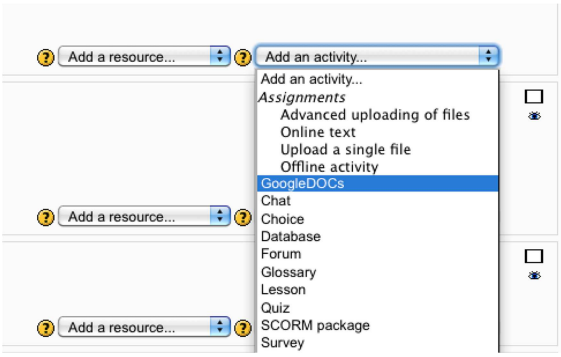

Figure 6: Google Docs activity as a LMS activity

The teacher may create a new instance of the BLTI activity inside a LMS course. In our case, s/he creates a Google Docs activity with its description and other information, using the interface shown in [Fig. 7]. In fact, this creation consists on an instantiation of an abstract BLTI activity previously configured by the LMS Administrator shown in [Fig. 5].

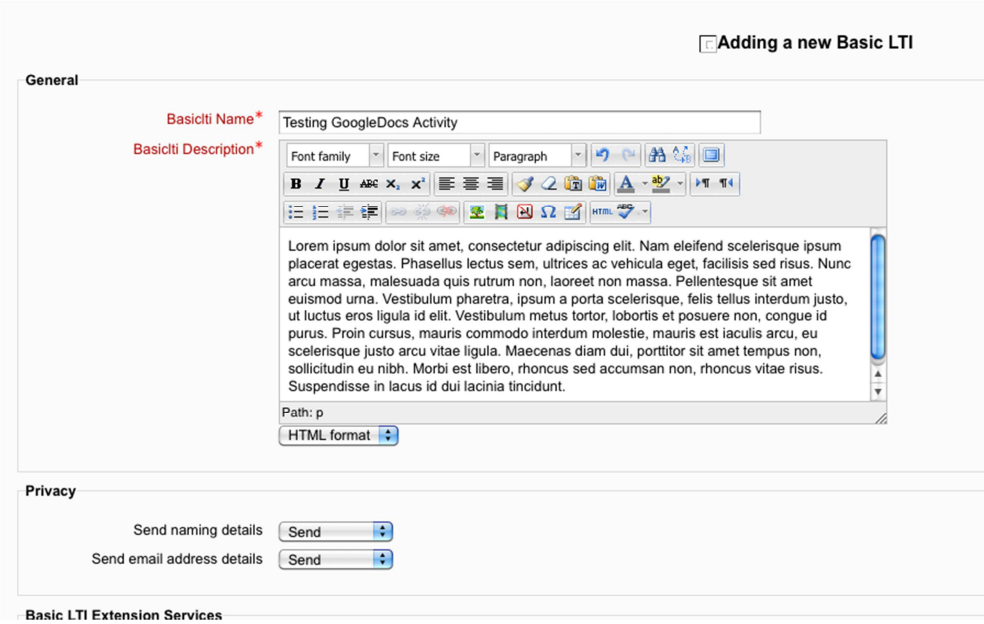

Figure 7: Google Docs activity creation interface

Students access the Google Docs activity to edit and modify a document in the LMS interface, in a similar way they edit a document using the Google Docs application in a web browser interface. [Fig. 8] shows how a student sees and can

modify the document inside the LMS interface. Docs4Learning Mediator embeds Google Docs editor inside Moodle interface, adding some information and controls related to the e-learning purposes that Google Docs doesn't provide. In this way, a student may interact with Moodle using left-side menu, s/he may interact with Google Docs modifying the document, or with the Mediator to submit his/her document.

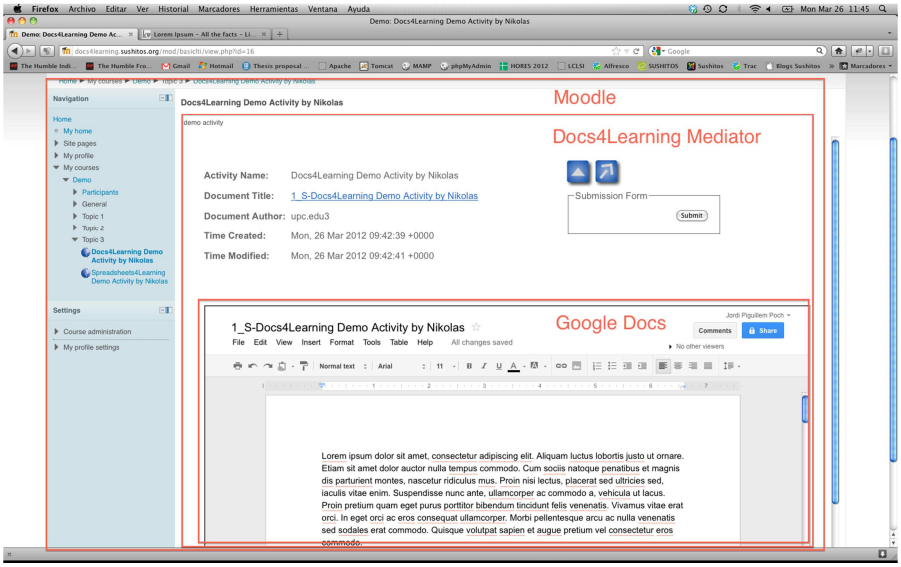

Figure 8: LMS student interface embedding Google Docs editor

5.2 Technical Architecture

From the technical point of view, the first time a user may execute the Google Docs activity from the LMS, s/he must subscribe to the Google Docs and authorize the Mediator to access his/her Google Docs account. After that, the user may use Google Docs in the LMS installation. Communication between the LMS and the integrated tool is implemented using the IMS BLTI specification and web services through the Mediator.

In the LMS, a proxy implements the BLTI protocol, which is necessary to integrate external learning tools into the LMS [Alier et al. 12]. The Mediator acts as a BLTI provider. The basic web-service to invocate the Google Docs from the LMS is the launch service.

The Mediator is a Java implementation based on the Spring Model-View-Controller (MVC) framework [Johnson et al. 05]. [Fig. 9] shows a more detailed architecture of the Mediator, its components and the communication with Google Docs and the LMS.

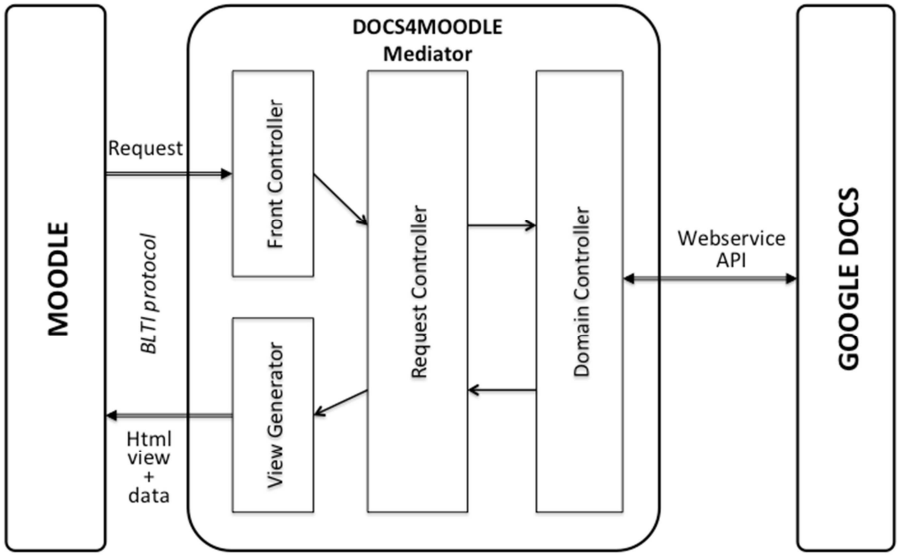

Figure 9: Technical Architecture of Mediator

The MVC is designed around a DispatcherServlet, which in our case it corresponds to a Front Controller. This component receives all requests from the LMS and the web browser and dispatches them to the appropriated handler to manage its resolution.

There exists one specialized Request Controller for each kind of use case; for example, a controller to grade students' activity and another to embed Google Docs like it is shown at [Fig.9]. There is also a Request Controller specially designed to dispatch BLTI Launch Requests. Therefore, after receiving a request, the Front Controller identifies the kind of the request and delegates the control to the corresponding Request Controller.

Logic how to manage a request and data to be retrieved as result of the request are defined as actions or commands into Domain Controllers. There are several Controllers, each one designed to deal with one element of the data model (documents, grades, users, etc.). Then, the Request Controller invokes the appropriated action/s of the corresponding Domain Controller/s to resolve the request. When the Documents Controller needs to access Google Docs to fulfil the request, it uses a private Domain Controller (Google Docs Controller) that encapsulated all the logic to interact with Google Docs Web Services.

The View Generator receives from the Domain Controller through the Request Controller some data to be shown to the user in the LMS interface, and how it must be displayed. In this sense, the View Generator composes an Html View (with all data), which is sent to the LMS.

The fact of using BLTI for Google Docs integration with Moodle allows that any other BLTI compliant LMS to being able to use Docs4Learning tool.

5.3 Security Issues

Privacy and security is a very important requirement in this project. We need to be sure that the student's Google account password is unknown to the Mediator and the LMS. And we need to be sure that Google Docs does not receive information concerning academic matters. Google just needs to handle the data inside the document within the Google Docs terms of service. All this data is not stored in the Mediator since it is provided by the LMS only each time it is necessary.

The connection between the LMS and Doc4Learning is signed using OAuth 1.0 protocol [OAuth 10]. The connection between Docs4Learning and Google Docs is signed using OAuth 1.0a because it is needed to retrieve third-party identity from Google Docs. Additionally, administrator and teacher can limit the information of the student that the LMS is going to provide to the BLTI Tools. In the most restrictive case, the tool sees the student identified by only a number.

Before editing documents and fully using Google Docs activities, the teacher and the student will be asked by Google to authorize the Mediator to access its Google Docs service. This is also done using the OAuth security protocol. Therefore, the Google's account remains a secret between Google and the user.

6 Future work and conclusions

Google Docs is a cloud computing based set of office tools that implements a web-based collaborative rich environment providing the most popular office features of the desktop based office suite. Recently, Google Docs is becoming used as a powerful learning tool because it allows learners to create and edit documents from anywhere and collaborate with students at the same time.

There are several proposals to integrate such set of tools into e-learning environments like LMS. But, in some cases, this integration loses some useful characteristic of Google Docs, for example, its inherent collaborative power.

In this paper, we propose the Docs4Learning integration, which consist on integrating the Google Docs suite of tools (text editor, spreadsheets, presentations, painting tool, forms, etc.) into Moodle. This integration is based on using the IMS BLTI protocol to communicate Moodle (the LMS) to a mediator that handles the communication with Google Docs (the external learning tool). However, in our integration approach we avoid missing functionalities or useful properties provided by the external tool (Google Docs). Even though, in this first step we only show the text editor integration, our design is extensible since it facilitates the integration of all the Google Docs suite tools.

As a further work, we first want to make some pilots to validate functionality and performance of the complete version of Docs4Learning prototype. Moreover, we need to start experimenting with different ways of wrapping these tools for different educational purposes with educational communities. So, we need to work along with teachers and students to communicate and teach how to use these tools and to learn how to improve them.

Even though BLTI allows this integration, for more elaborate uses of the architecture, it is necessary to propose and define some additions to the IMS BLTI standard in form of extensions.

Finally, we see that other web 2.0 cloud services can be useful in learning environments like LMS and PLE, so they can be transformed into learning activities and be included in the toolkit that LMS can offer.

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