Integration of ePortfolios in Learning Management Systems

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Abstract. The LMS plays a decisive role in most eLearning environments. Although they integrate many useful tools for managing eLearning activities, they must also be effectively integrated with other specialized systems typically found in an educational environment such as Repositories of Learning Objects or ePortfolio Systems. Both types of systems evolved separately but in recent years the trend is to combine them, allowing the LMS to benefit from using the ePortfolio assessment features. This paper details the most common strategies for integrating an ePortfolio system into an LMS: the data, the API and the tool integration strategies. It presents a comparative study of strategies based on the technical skills, degree of coupling, security features, batch integration, development effort, status and standardization. This study is validated through the integration of two of the most representative systems on each category - respectively Mahara and Moodle.

Keywords: eLearning, ePortfolios, LMS, Interoperability.

1 Introduction

In recent years, eLearning has assumed an important role in schools and companies. The main objective of this educational model is to enhance the teaching/learning process by using the Internet for delivering educational activities. Learning Management Systems (LMS) are specialized systems developed for managing these educational activities, which include the distribution of educational content, the synchronous and asynchronous communication with students and the assessment of students' skills based on assignments and tests. Nevertheless, in order to provide a positive learning experience the LMS must be effectively integrated with other specialized systems typically found in an educational environment such as Repositories of Learning Objects or ePortfolio Systems.

However the growing importance and benefits of ePortfolio systems as a mean for gathering students' achievements and for evaluates student's progress also poses

several interoperability issues. For instance, it is important that the evidence of students' work does not disappear, or becomes unusable, when they move to another institution. In this scope, interoperability specifications supported by both ePortfolio systems and LMS are part of the solution.

The goal of this paper is to gather information on how to integrate an ePortfolio system with an LMS. To accomplish it, we identify three integration strategies, namely, the data, the API and the tool integration. Based on these strategies we present a comparative study on ePortfolio interoperability. This study is validated through the integration of two of the most representative of each category - Mahara and Moodle. In this scope three scenarios of integration were explored and for each one we chose a strategy appropriated to its requirements. The outcome of this work should be of interest to anyone defining a strategy for a similar integration.

The remainder of this paper is organized as follows: Section 2 traces the evolution of eLearning with emphasis on ePortfolio systems. In the following section, we detail the different strategies for the integration of ePortfolio Systems in LMS presenting the main advantages and disadvantages of each strategy. Then, we present a case study reflecting the integration of two of the most representative LMS and ePortfolio systems. Finally, we conclude with a summary of the main contributions of this work and a perspective of future research.

2 ePortfolio systems

An LMS is a software application for the administration, documentation, tracking, reporting of training programs, classroom and online events, and training content [1]. There are open source systems, such as Moodle, Sakai, .LRN or Dokeos, and commercial systems such as WebCT/Blackboard or Desire2Learn. The content delivered by an LMS can be created, obtained, gathered or evaluated in several types of systems such as Learning Objects Repositories, ePortfolio systems, Authoring Tools, Specialized Evaluators or Quizzes.

An ePortfolio is the product created by the student, which contains a collection of digital objects (artifacts), combining various media (audio/video/text/images) [2], articulating experiences, developments, achievements and learning. Its primary aim is to collect evidence for summative assessment, to demonstrate achievement, to record progress and to set targets [3]. The main motivation to integrate an ePortfolio system into an LMS is to use it as an assessment tool.

According to JISC [3], the construction of ePortfolios in the learning process contributes to: (a) improving self-understanding and understanding of the curriculum; (b) engaging and motivating students, both individually and as part of a community of practice; (c) personalizing learning; (d) supporting learning models appropriate to a digital age and (e) promoting reflective practice. These contributions are shared by students, teachers, parents and administrators. For students it shows their accomplishments and encourages them to take responsibility for their work. For teachers it provides a framework for organizing the students' work and facilitates the students' information for assessment and decision making. For parents it offers an

insight into what their children do in school. For administrators it provides evidences that teacher/school are being met.

In short, the ePortfolio enables the students to construct a structured collection of their knowledge, skills and competencies [4], allows learners to trace the development of their thinking and learning over time and to show those competencies both to teachers and employers, providing digital resources relevant to their own study (personalised information) and links to other learners (for collaboration and feedback) [5].

Helen C. Barrett [6] organizes the ePortfolio tools in two categories: individual and institutional. Both are presented in Table 1.

Table 1. ePortfolio tools by categories.

Individual		Institutional	
Authoring tools	Web Services	Software – Server	Hosted Services
Mozilla Composer	Google Docs	Elgg	Digication
Dreamweaver	Zoho Writer	Mahara	iWebFolio
Microsoft Office	Wikispaces	OSPI	Epsílen
Adobe Acrobat		Moofolio	Goole Aps for Education
Movie Maker		MyStuff	

In the individual category, we can use authoring tools for author portfolios offline (requires web server space to publish online) or web services to create online and publish a presentation portfolio allowing interactivity (Web 2.0). In the institutional category, we can use a software-server approach when an institution uses its own server to provide space for hosting portfolios or hosted services.

In a survey [7] conducted on eLearning systems usage by Portuguese Higher Education Institutions (HEI), no one indicated to be using an ePortfolio system. This fact allows us to conclude that the dissemination of these tools in the educational institutions, at least in Portugal, is still low. This is in part justified due to the lack of standardization of ePortfolio, which renders them difficult to integrate with other systems. In recent years, the development of common standards to represent ePortfolio content, such as IMS LIP [8], IMS ePortfolio [9], Leap2A [10], is being promoted by organizations concerned with ePortfolio interoperability.

The IMS LIP describes the characteristics of a learner, goals and accomplishments. The description is a collection of information about a learner (individual or group learners) or a producer of learning content (creators, providers or vendors). An update (version 1.0.1) was released in early 2005.

The IMS ePortfolio specification was completed in 2004 and represents a profile of existing IMS specifications, namely Content Packaging and Learner Information Package.

The Leap2A is an outcome of the JISC CETIS (JISC Innovation Support Centre - Centre for Educational Technology and Interoperability Standards) project called InterOperability Project. LEAP2A is a simple ATOM based standard for exchanging learning ePortfolio data.

The following table summarizes these standards and for each one we present the support status of the two of the most representative LMS and ePortfolio systems.

Table 2. LMS/ePortfolio support for ePortofilo content standards.

	Moodle	Blackboard	Mahara	PebblePad
IMS LIP	Yes	Yes	No	No
IMS e-Portfolio	Yes	Yes	No	Yes
Leap2A	Yes	Yes	Yes	yes

The previous table shows that the ePortfolio standard most used is Leap2A. Beyond Mahara and PebblePAD, other ePortfolio systems support Leap2A such as ePET, MyProgressFile and Passportfolio. On the other hand, the IMS standards due to its complexity and robustness are partially supported.

The Leap2A is a lightweight ePortfolio standard that uses an XML manifest file (leap2a.xml) wrapped with other resources inside a zip file. The manifest is based on Atom syndication format. Atom was designed for exchanging the blog feeds but fits also for exchanging the portfolio information. In the Leap2A, the Atom is extended because Atom's vocabulary is not enough for representing all information stored in ePortfolio systems. The following example shows a XML excerpt of the Leap2A manifest representing a meeting:

```
<entry>
  <title>Agenda</title>
  <id>portfolio:meeting/123</id>
  <updated>2007-11-19T01:00:00Z</updated>
  <content type="text">
    Meeting with John
  </content>
  <link rel="leap:is_agenda_of" href="portfolio:meeting/45"/>
  <rdf:type rdf:resource="leaptype:entry" />
</entry>
```

Information in Leap2A is grouped into items, each represented as an Atom entry with additional LEAP specific metadata. Each item has a Leap2A type or class, and the type affects which literal attributes, relationships or categories that may be associated with the item [10].

These ePortfolio standards are widely used in several interoperability specifications [11, 12, 13] and projects [14, 15, 16]. One of such projects is PEACE (Project for ESEIG Academic Content Environment). This project aims to integrate an ePortfolio system (Mahara) with the institution's LMS (Moodle) as part of a learning environment composed by several services targeting the new Web 2.0 paradigm [4, 16].

3 Integration strategies

In this section we present the most common strategies for integrating an ePortfolio system into an LMS, namely the Data, the API and the Tool integration strategies.

3.1 Data Integration

Data integration is the simplest and most popular form of integration in content management. This type of integration uses the import/export features of both systems and relies on the support of common formats as shown in Fig. 1. For instance, an ePortfolio system may import data (blog and forum contributions by students, course materials and assignments uploaded by teachers) from LMS to avoid the burden of entering this data manually.

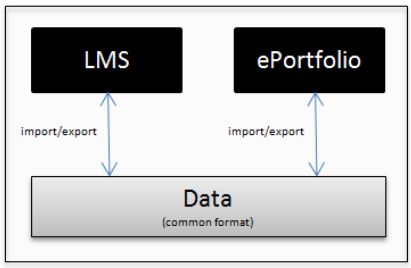

Fig. 1. Data integration.

These systems support two types of common formats: generic (e.g. HTML files) and ePortfolio specific (e.g. Leap2A files). The former are useful since they are widely available, but they lack domain specific semantic data provided by the latter. For instance, if we add a post in a Moodle forum it should be included in the Mahara ePortfolio as a blog post and not as a non-editable HTML artifact. This requires the use of a common ePortfolio standard so that Mahara (or any other ePortfolio system) can understand the meaning of the content and decides its final format.

3.2 API Integration

An Application Programming Interface (API) allows client applications to use directly the functions of an eLearning system. These APIs foster client application development through data encapsulation and behavioral reuse. This clear separation of interfaces specification from their implementation and data formats allows tool vendors to develop new versions without affecting current clients [17].

The major LMS vendors include APIs to allow developers to extend their predefined features through the creation of plugins. Blackboard uses the Building Blocks technology to cover the integration issues with other systems allowing third parties to develop modules using the Building Blocks API.

The new Moodle version (v. 2.0 released in November 2010) includes several APIs (Fig. 2) to enable the development of plugins by third parties to access repositories and portfolios such as the **Repository API** for browsing and retrieving files from external repositories; and the **Portfolio API** for exporting Moodle content to external repositories.

These two APIs are based on the File API - a set of core interfaces to allow Moodle to manage access control, store and retrieve files. The new File API aims to enhance file handling by avoiding redundant storage. This feature is achieved since every file in Moodle 2.0 is saved into a file pool (a directory in `moodledata`) with a filename that is calculated as a SHA1 hash of the file content. If a file is copied (e.g.

course cloning) no file duplication happens, just a new record in a special table of files is created.

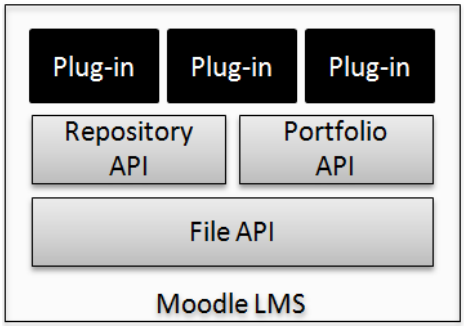

Fig. 2. Moodle File API.

In order to ensure a bidirectional communication between a LMS and an ePortfolio system it is required to use both APIs to create plugins. For instance, in the Moodle LMS, the Mahara support is guaranteed only in one way by the implementation of the Portfolio API.

The Portfolio API is a core set of interfaces to publish files from Moodle to external repository systems, mainly ePortfolio systems. In this approach, the ePortfolio system appears seamlessly as a folder when students want to save content such as a file, snapshots of forums or blogs and assignments.

At time of writing this paper, Moodle 2.0.1 (January 2011) includes in its release package several plugins for ePortfolios such as Mahara, Flickr, Google Docs, Boxnet and supporting different formats such as Leap2A and HTML. Regarding the Repository API the same release package includes support for the repositories Alfresco, Boxnet, Dropbox, Flickr, Google Docs, Merlot and Picasa.

3.3 Tool integration

The IMS Learning Tools Interoperability (IMS LTI) provides a uniform standards-based extension point in LMS allowing remote tools and content to be integrated into LMSs. The main goal of the LTI is to standardize the process for building links between learning tools and the LMS. There are several benefits from using this approach: educational institutions, LMS vendors and tool providers by adhering to a clearly defined interface between the LMS and the tool, will decrease costs, increase options for students and instructors when selecting learning applications and also potentiate the use of software as a service (SaaS). The LTI has 3 key concepts as shown in Fig. 3 [18]: the Tool Provider, the Tool Consumer and the Tool Profile.

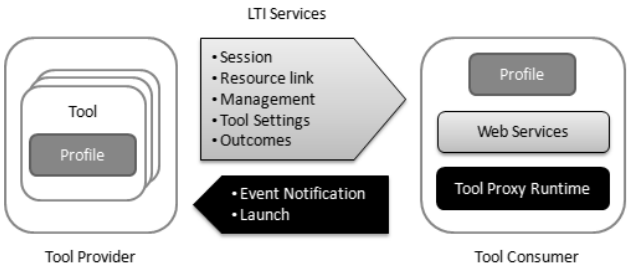

Fig. 3. IMS Full LTI.

The *tool provider* is a learning application that runs in a container separate from the LMS. It publishes one or more tools through tool profiles. A *tool profile* is an XML document describing how a tool integrates with a tool consumer. It contains tool metadata, vendor information, resource and event handlers and menu links. The *tool consumer* publishes a Tool Consumer Profile (XML descriptor of the Tool Consumer's supported LTI functionality that is read by the Tool Provider during deployment), provides a Tool Proxy Runtime and exposes the LTI services.

A subset of the full LTI v1.0 specification called IMS Basic LTI exposes a single (but limited) connection between the LMS and the tool provider. For instance, there is no provision for accessing run-time services in the LMS and only one security policy (OAuth protocol [19]) is supported.

For instance, to export content from Moodle to Mahara using the Basic LTI the teacher (or LMS administrator) must first configure the tool (Mahara) as a Basic LTI tool in the course structure. When a student selects this tool, Moodle launches a Mahara session for the student. The web interface for this session can either be embed in Moodle's web interface as an *iframe* or launched in a new browser window.

3.4 Comparison of the integration strategies

In this subsection we present a comparative study on the ePortfolio integration strategies in LMS. This study is summarized in Table 3 and can be used as a guide in the selection of an integration strategy.

Table 3. Comparison of ePortfolio integration strategies.

	Data Integration	API Integration	Tool Integration	
			bLTI	fLTI
Technical skills	No	Yes	Yes	Yes
Degree of coupling	No bounding	Tightly	Loosely	Tightly
Security	To implement	To implement	OAuth	
Batch integration	No	Yes	No	
Development effort	-	Some	Little	Great
Communication type	Bidirectional	Bidirectional	Uni	Bi
Status (# implementations)	-	Many	Many	Few
Standards	Web/image/video formats	Leap2A, HTML	Leap2A, HTML	

Data integration is the best option when the development effort must be kept to a minimum or no one with technical skills (specially programming skills) is available, since the other two strategies require them. This strategy has also the advantage of not coupling the two systems and enabling a bi-directional communication.

API integration is best suited when batch integration is required since the other two strategies involve the use of the GUI of both systems. For instance, if the work of the students of a given set of courses must be copied on a regular basis from the LMS to their portfolios then the API strategies are recommended. The major drawbacks of this approach are the amount of development required and the tight coupling between the LMS and the ePortfolio system, since special plugins must be implemented and APIs are vendor specific. Finally, this strategy enables bidirectional communication, although the current version of Moodle (2.0.1) does not implement yet the API repository, thus rendering in practice the communication between LMS and Mahara unidirectional.

Tool integration is arguably the best choice in general since it provides a good balance between implementation effort and coupling and security. This is especially true if only unidirectional communication is required and Basic LTI is used. This tool integration flavor is simple to implement and is already supported by most LMS vendors. If bidirectional communication is required then full LTI is needed but in this case the implementation is harder and few LMS vendors support this flavor of the specification. In both cases, tool integration has the added value of providing some basic security features based on the OAuth protocol aiming to secure the message interactions between the Tool Consumer and the Tool Provider.

This comparative study was based both on the available documentation and on the authors experience in using the different strategies to integrate Moodle with other systems, in particular the development of a Moodle plugin using the Repository API [20] and the basic LTI runtime to link Moodle with other eLearning systems [21].

4 Case study

This section presents an example of integration of an ePortfolio system into Moodle LMS as part of PEACE (Project for ESEIG Academic Content Environment), an ongoing project of the School of Industrial Studies and Management (ESEIG) of the Polytechnic Institute of Porto (IPP) [16].

This case study is related to the *social part* of the PEACE project that implements a platform for creating students' controlled personal learning networks (PLN) integrating their personal learning environments (PLE), ePortfolios, Web 2.0 (applications, services and people interactions) and LMS, as shown in Fig. 4 [4]. This environment is developed using an open source application to create ePortfolios and social networks – Mahara – integrated with the Moodle LMS.

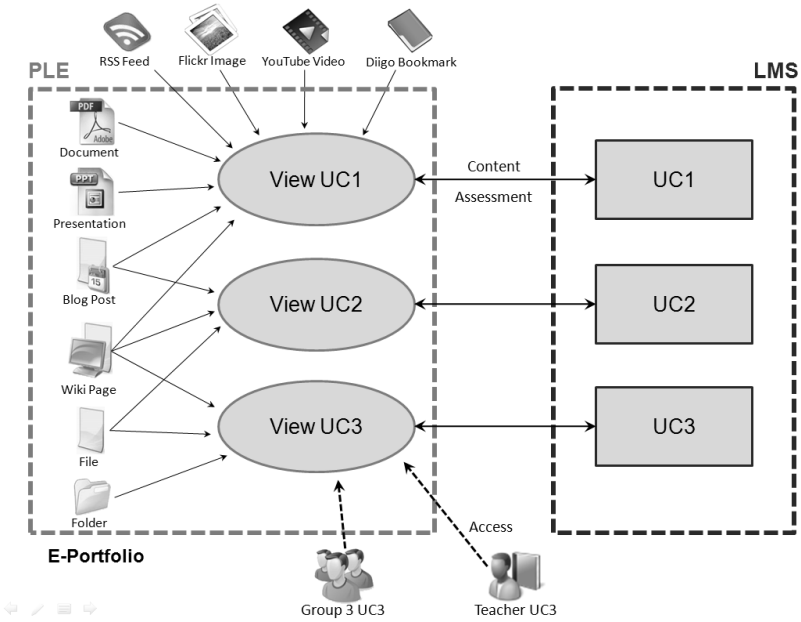

Fig. 4. Integration of ePortfolio, PLE and LMS [4]

Mahara and Moodle share the identity of the student via Lightweight Directory Access Protocol (LDAP) so that a student has a single set of authentication data (login and password) on both applications (Single Sign-On). Thus, a student authenticated in Moodle can automatically access his/her Mahara profile without needing to login again. If the student has not yet created a profile in Mahara, it is created automatically on first access based on data from his/her Moodle profile.

We identified three scenarios where the integration between both systems is relevant. For each scenario we chose one of the strategies presented in the previous section according to the requirements of that particular scenario. These scenarios are:

1. the manual and sporadic copy of a single resource from Moodle to Mahara (or vice-versa);
2. the automatic and periodic export of new students work from Moodle to their Mahara accounts;
3. the visualization of a Mahara portfolio from a Moodle user profile.

In the first scenario a student needs to export a single resource (e.g. a work in the PDF format) from Moodle to a specific view in his Mahara portfolio. Given the sporadic nature of this use case, we selected the data integration strategy. In this strategy files sharing is based on the import/export features of both systems. In this case, the student exports the resource in its native format from Moodle and imports the same resource in Mahara. Both systems support a wide range of file formats such as HTML, PDF, image and video formats.

In the second scenario, the goal is to implement a mechanism to periodically (e.g. annually) export the work of all students to their respective portfolios to have their academic record in Mahara. The purpose of this export is twofold: to have the academic work produced in Moodle organized by student rather than by course, and

to incentive students to maintain their own portfolios by populating them with work they have done in Moodle. In this scenario, we must use batch integration since any manual/graphical interaction would be time-consuming and error-prone. This is a clear case for the API integration strategy since this is the only one that supports batch communication. This is achieved by overriding the methods `prepare_package` and `send_package` of the `portfolio_plugin_base` class included in the Portfolio API. The former prepares the package for sending, writing out a metadata manifest file and zipping all the files in a temporary folder. The latter sends the package to a remote system based on a XMLRPC request. A script calling these methods in sequence is invoked periodically by `cron` - a system command that runs predefined tasks on a computer at regular intervals.

In the third scenario, the goal is to present the portfolio of a student embedded in the Moodle profile. Tool integration is the ideal strategy for this scenario, although in the near future this approach will provide only partial integration since none of the systems supports full IMS LTI. The current version of Moodle supports only IMS Basic LTI that is currently being developed also for Mahara. This approach gives to the student a perception that only one system is running since the Mahara view is embedded in Moodle's graphical interface avoiding the need to open both systems.

5 Conclusion

This paper presents and compares three strategies to integrate an ePortfolio system into an LMS, namely the data, the API and the tool integration strategies. The comparison is based on the technical skills, degree of coupling, security, batch integration, development effort, communication type, status and standardization, required by each strategy. This study is validated through a case study conducted in the scope of the PEACE project that aims to implements a platform for student controlled personal learning networks. In this study, we particularized on the integration of two of the most representative LMS and ePortfolio systems – respectively Moodle and Mahara. Three scenarios of integration where explored; for each one we chose a strategy appropriated to its requirements.

The main contribution of this work is a survey of the most popular integration strategies currently available for the systems under consideration, and criteria for selecting the most appropriated for a given situation. Although the survey and the test case focused on ePortfolio systems and LMSs, many of issues and solutions discussed here can be adapted to other types of eLearning systems. Thus, we expect this paper to be of interest to anyone concerned with eLearning system interoperability.

As part of the PEACE project, our plans include the support for bidirectional communication between Moodle and Mahara, as soon as the Repository API for Mahara is available. This will enable to browse and to retrieve files from Mahara and integrate them into Moodle resources. In a near future, we also plan to implement batch integration to automate the copy of Moodle students' work to their respective portfolios.

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