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Helping Teachers Align Learning Objectives and Evidence: Integration of ePortfolios in Distributed Learning Environments

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Abstract: ePortfolios are recognized as effective tools for formative assessment. Learning outcomes are demonstrated by a number of work samples, which provide a good overview, not only of the acquired competences, but also of the path followed to get there. However, ePortfolios do no provide means for their automatic integration in Distributed Learning Environments, where the work samples (learning evidence) are scattered across a number of systems, such as Virtual Learning Environments and Web 2.0 tools. This paper proposes a scalable approach to tackle evidence collection in DLEs, by aligning the generated artefacts with the pedagogical purpose the teacher aims at. The proposal takes advantage of Learning Design practices, making alignment explicit to guide the technological infrastructure for the automatic collection and organization of pieces of evidence in an ePortfolio and thus reducing the associated burden on teachers and students. The feasibility of the proposal was assessed by means of an evaluation study, in which a University teacher designed and enacted an authentic collaborative learning situation in the context of a master's degree course.
Key Words: ePortfolio, Distributed Learning Environment, Learning evidence, Learning Design
Category: L.0.0, L.1.1, L.3.0, L.3.6

1 Introduction

ePortfolios can be defined as organized compilations of selected digital work samples, called learning evidence [Barberà-Gregori and Martín-Rojo, 2009]. Their ability to show both the process and results of a learning path lets teachers complement traditional summative evaluation with formative assessment and feedback on the on-going work [Barrett, 2011]. This way, two main purposes of ePortfolios can be identified, depending on whether they focus on assessment of learning or assessment for learning. In the first case, students present a compilation of their best work samples, as the final product of their learning path. In the latter, the focus is on the path itself, understanding the ePortfolio as a process, enabling self-reflection and feedback from the teacher and peers. This proposal focuses on the use of ePortfolios as workspaces.

Unfortunately, ePortfolios have not been widely adopted yet. This lack of adoption can be partially explained by technological difficulties integrating ePortofolios within the classroom technological ecosystem. Learning situations, specially at higher education institutions, are usually supported by technology (TEL - Technology Enhanced Learning), combining the advantages of Virtual Learning Environments (VLE) [Dillenbourg, 2000] and Web 2.0 tools in the so-called Distributed Learning Environments (DLE) [MacNeill and Kraan, 2010]. In such distributed environments, work samples are scattered across a number of platforms and tools [Ravet, 2007] [Bubaš et al., 2011]. The coexistence of different technical interfaces brings up an interoperability problem, which teachers usually solve by manually collecting, storing and organizing work samples. This approach is cumbersome, error-prone, time-consuming and does not scale as the number of students increases. Such situation is even worse in collaboraitve learning settings [Koschmann, 1996], in which artifacts are produced and interchanged by groups of dynamic size and composition. This paper focuses on providing the required technological support so that teachers feel free to make their own choices regarding tools and learning flows, rather than using a simplistic setup to avoid the difficulties of managing the plethora of artifacts and platforms in distributed learning environments.

The collection of work samples needs to be guided by a pedagogical purpose. Following the guidelines of Learning Design (LD) [Vignollet et al., 2008], which encourages teachers to make pedagogical decisions explicit, the authors proposed the EADM (Evidence Aware Design Model) [Lozano-Álvarez et al., 2013], a model that supports the alignment of learning objectives and pieces of evidence in a learning activity.

This paper proposes an architecture for the *Automatic Collection of Evidence* (ACE) in distributed learning environments, which takes the relationships between objectives and pieces of evidence in Learning Designs based on the EADM to guide the automatic gathering of work samples from different tools and systems. Both the EADM and the ACE architecture were evaluated on a study at the University of Valladolid, aiming at assessing the feasibility of the proposal on a real setup. The results of this evaluation study are also presented in this paper.

The remaining of this paper is structured as follows: Section 2 provides an overview on how existing solutions tackle the aforementioned integration problem and identifies their limitations, along with current modelling of evidence in different Learnign Design approaches. Section 3 introduces the proposal of an architecture for the Automatic Collection of Evidence (ACE). The suggested setup has been tested on a real course at the University of Valladolid. The main findings of this evaluation experience are included in Section 4, leading to some conclusions on Section 5.

2 Related Work

In order to exploit the benefits of ePortfolios as assessment tools in DLEs, there is a need to bring them together with tools and Virtual Learning environments [Salinas et al., 2011] [Bubaš et al., 2011] [Hämäläinen et al., 2011]. This section analyzes existing solutions in the literature for the integration of ePortfolios in DLEs (Section 2.1) and for the explicit alignment of learning objectives and pieces of evidence in learning designs (Section 2.2).

2.1 Integration of DLEs and portfolios

Different approaches have been proposed in the literature to include ePortfolios in a technology enhanced learning situation. First, ePortfolios are available as standalone solutions. Second, some VLEs include an ePortfolio module, which covers some of the ePortfolio capabilities. Third, some standalone ePortfolios have been integrated within a VLE. The strong and weak points of each alternative are summarized in Table 1 and explained along this section, including examples of each pattern.

Table 1: Comparative of possibilities for the integration of ePortfolios and DLEs

Integration Approach	Example	Main Advantages	Main Drawbacks
Standalone ePortfolio	Mahara[1]	Simple Flexible Full-fledged eportfolio	Not integrated Time-consuming Error-prone
VLE with an ePortfolio **module**	Sakai ePortfolio[2]	Simple Integrated Internal evidence automatically collected	Inflexible Limited ePortfolio capabilities External evidence manually collected
Standalone ePortfolio **integrated** within a VLE	Mahara + Moodle[3]	Full-fledged eportfolio Integrated Internal evidence automatically collected	Inflexible External evidence manually collected

[1] https://mahara.org/
[2] https://sakaiproject.org/portfolio-tool
[3] Mahoodle: https://docs.moodle.org/27/en/Mahoodle

- *Standalone ePortfolio*: The ePortfolio system is a standalone solution, specifically focused on the purposes of ePortfolios, such as Mahara[4], PebblePad[5], Taskstream[6] or Elgg[7]. They are isolated full-fledged ePortfolios, which means this solution is simple and flexible, as the teacher can use whichever system she prefers. However, the main capabilities of ePortfolios are exploited once the evidence is in the platform. This means that students usually need to add work samples manually to their profiles (or the teacher in their place). When integrating external sources (e.g. embedding a youtube video) additional technical knowledge is required. This cognitive burden may interfere with the assessed learning objectives [Reese and Levy, 2009], in addition to being time-consuming and error-prone. Note that, in this case, the ePortfolio is not integrated with any other system at all. Teachers may use it in conjunction with VLEs or tools at the cost of running any interaction manually.

- *VLE with an ePortfolio module*: Some Virtual Learning Environments include their own portfolio system (Sakai ePortfolio[8], Exabis[9], Desire2Learn[10]), allowing the creation of showcase views of the artifacts generated in that environment. Thanks to this approach, ePortfolios are closely integrated with the structure of the different learning situations, in terms of students, groups, activities, artifacts... However, this pattern assumes the use of a VLE to support learning activities. More specifically, ePortfolios and VLEs are paired, meaning that choosing one forces the other. For this reason, the solution is not flexible enough to be used on a different setup (e.g. another educational institution with a different VLE) and the possibilities to generate different artifacts are restricted to the internal tools of the chosen VLE. In case the teacher decides to exploit external web 2.0 tools, the workload due to manual collection remains.

- *Standalone ePortfolio integrated within a VLE*: In an effort to blend together VLE and standalone ePortfolios, Mahoodle[11] or the system proposed in [Zhang et al., 2007] provide mechanisms to use the result of an activity as input in the ePortfolio and viceversa (a sample in the ePortfolio might be provided to fulfill a given assignment inside the VLE). By doing so, the benefits of the first two approaches are unified: ePortfolio purposes are supported,

[4] `https://mahara.org/`
[5] `http://www.pebblepad.co.uk/`
[6] `https://www.taskstream.com/pub/`
[7] `http://elgg.com/`
[8] `https://sakaiproject.org/portfolio-tool`
[9] `https://moodle.org/plugins/view.php?plugin=block_exaport`
[10] `http://www.brightspace.com/products/eportfolio/`
[11] `https://docs.moodle.org/27/en/Mahoodle`

while closely integrating the system with the structure of the learning situation. Unfortunately, the drawbacks of both proposals are also inherited. Even though the workload is reduced to some extent, as all the evidence generated using internal tools are automatically available, there is still some additional burden, due to the manual collection of pieces of evidence generated outside the VLE. Also, the choice of the VLE and the ePortfolio are limited to the existing integrations. Because of that, the solution is not flexible to support a different setup.

The analysis of these approaches suggests the need of a different solution which includes the benefits of integrating all the available components, but also removes the constraints. That is, the burden associated to the manual collection of work samples needs to be removed, both for internal and external tools, while offering the flexibility to choose among a variety of VLEs, tools and ePortfolios.

There are some examples in the literature, already trying to integrate ePortfolios with a number of web 2.0 tools (e.g. MANSLE[12] or [Oliveira and Moreira, 2012]). However, they only point out the interest of ePortfolios being used in the same scenario than a wide range of tools, rather than providing a technical solution to tackle the problem. Instead, they set up a distributed environment where either the teacher or the student need to explicitly move evidence from one place to another, as in the standalone case.

Therefore, one of the common drawbacks of the existing approaches is the workload of teachers retrieving pieces of evidence from different sources [Balaban et al., 2011] [Sweat-guy and Buzzetto-More, 2007]. This manual task does not scale up on a distributed scenario with multiple sources of pieces of learning evidence, neither when the number of students increases.

To sum up, there is a need to assist teachers in the collection of learning evidence from different sources. In order to guide this gathering of artifacts, an explicit alignment between work samples and learning objectives should be established beforehand.

2.2 Aligning Learning Objectives and Evidence

Current approaches for the integration of ePortfolios in DLEs, as presented in Section 2.1, usually imply overloading either teachers or students with the collection of work samples from different sources. One of the reasons to do so is that they are the ones that know which are the relevant artifacts that should become part of the portfolio.

[Barrett, 2011] highlights the importance of teachers providing guidance in the selection of work samples in the initial stages of the construction of ePortfolios. Therefore, the rationale underneath the collection of evidence should be

[12] `http://www.jisc.ac.uk/whatwedo/programmes/edistributed/mansle.aspx`

available to enable an automatic collection of learning evidence. In other words, there is a need to make explicit the alignment between work samples with the pedagogical purpose they serve, which is usually only known by the teacher.

In terms of the lifecycle of a learning situation depicted in Figure 1 [Hernández-Leo et al., 2014], teachers need first to conceptualize the learning objectives they pursue, as well as the flow of activities and resources that will be used to get there (authoring phase). After that, those concepts will be implemented in the second phase, by deciding which students take part in which groups or creating instances of the suitable tools (e.g. new file in Google Documents - implementation phase). Once the technical environment is ready, the learning situation will be enacted and, therefore, the learning evidence generated, ready to be gathered according to the pedagogical decisions taken in the first phase of the cycle (enactment phase).

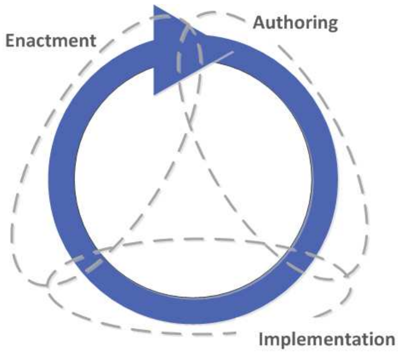

Figure 1: Lifecycle of a learning situation

Learning Design (LD) [Vignollet et al., 2008] [Conole, 2012] has emerged as the accepted approach to make pedagogical decisions explicit and potentially interpretable by machines. Therefore, this is the rightmight be the suitable moment place for teachers to determine what to collect and why. For this reason, it is necessary to understand how existing Learning Design languages establish the relationship between artifacts and learning objectives.

Table 2 compares different LD languages, such as IMS-LD[13], LAMS-LD[14] [Dalziel, 2003], Compendium-LD[15] and Lingua Franca [Prieto et al., 2011a]. Eight criteria have been chosen to evaluate the adequacy of each of them to

[13] http://www.imsglobal.org/learningdesign/
[14] http://www.lamsinternational.com/
[15] http://compendiumld.open.ac.uk/

Table 2: Modeling of learning evidence by different LD languages

	IMS-LD	LAMS-LD	Compendium LD	Lingua Franca
Artifact/Resource	✓	✓	✓	✓
It is an evidence	-	-	?	-
Tool	✓	✓	✓	✓
Locator	✓	✓	✓	✓
Collection timestamp	-	-	?	?
Learning Objective	✓	✓	✓	✓
Relationship evidence - goal	-	-	-	-
Authorship	✓	✓	✓	✓

eventually support the collection of learning evidence, used as the first column of Table 2: decalaration of *work samples*, *identification* of a given work sample as learning evidence, *tool* used in the generation of the artifact (in order to determine de collection method), *locator* of where the work sample is available, *timestamp* when the evidence must be collected, *learning goal(s)*, *relationship* between the learning evidence and the showcased objective, *authorship* (individual or group).

According to this data, none of the alternatives is fully equipped to specify all the required information. Some of the concepts in Compendium LD or Lingua Franca (identified by the symbol *?* in Table 2) may be interpreted for this purpose. As an example, generic *timestamp* in Lingua Franca can be used to determine the collection trigger. However, all the models share a common shortage: the relationship between an evidence and the learning objectives it serves.

This means, on the one hand, that teachers using LD approaches are already providing most of the information required for the automatic collection of learning evidence, but, on the other hand, that some additional data is required to keep track of the pedagogical purpose of the work samples. This information could be used as a guide to collect that specific work sample as a learning evidence. In order to fill that gap, an *Evidence Aware Design Model* (EADM) has been proposed, as depicted in Figure 2.

As detailed in [Lozano-Álvarez et al., 2013], the main focus of EADM is to establish the relationship between learning evidence and the learning objectives they showcase. This also places pieces of learning evidence as key assets for the assessment of competences, either summative or formative. For this reason, the EADM is based on a existing model for the inclusion of assessment in Learnign Design [Villasclaras-Fernández et al., 2009] (depicted in blue in Figure 2). Green boxes and arrows represent the required extension to consider learning evidence in the design of the learning situation.

The relationships between learning objectives and evidence is exploited in the automatic collection of work samples during the enactment, by means of the architecture proposed in Section 3.

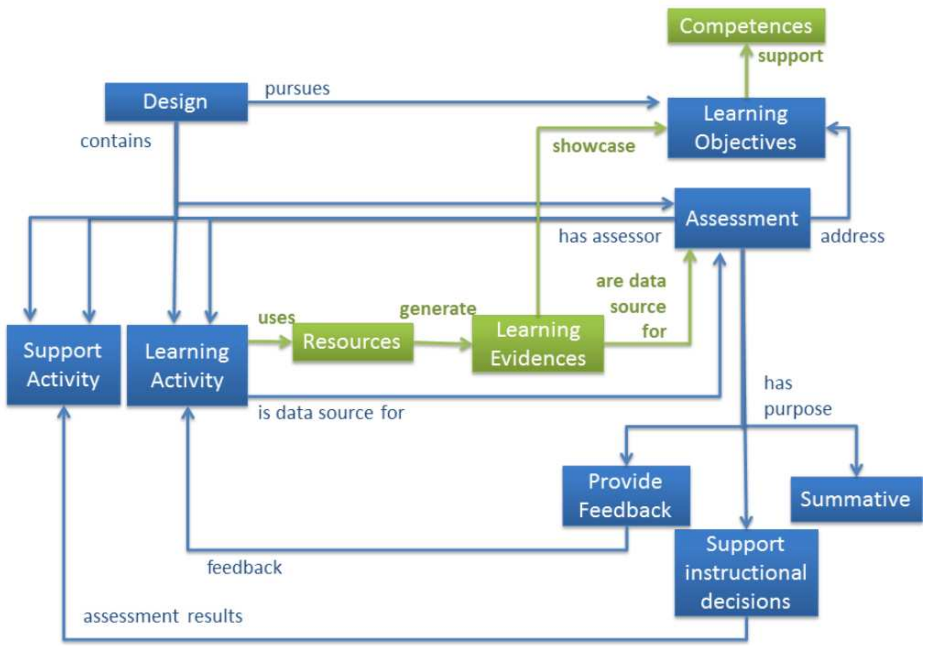

Figure 2: Evidence Aware Design Model

3 Architecture for the automatic collection of learning evidence

Section 2 analyzes existing solutions in the literature for the integration of ePortfolios in DLEs. None of the studied approaches completely removes the workload associated to the manual selection and collection of work samples in a distributed environments. The analysis also served to identify the requirements of a system to support the envisioned integration, such as the need to be scalable and flexible to be deployed in different learning situations.

The system must support an heterogeneous setup. That is, it has to be able to interact with a number of different interfaces, in order to integrate LD authoring tools, VLEs, learning tools and ePortfolios. The integration of those systems will ultimately ease the assessment of competences in Technology Enhanced Learning.

With these goals in mind, Figure 3 proposes a solution capable of consuming information from different authoring tools (that is, different learning design representations), collecting pieces of evidence from different VLEs and external tools and injecting those work samples in different ePortfolio managers: *ACE*, *Automatic Collection of Evidence*.

This architecture tackles the collection problem by establishing the technological links between all the involved platforms (i.e. integrating their different interfaces). With this technical setup in place, and using the pedagogical decisions by the teacher as input (in the form of a learning design), the solution is able to retrieve the right work samples from the suitable tools at the designated timestamps. Being an automated process, the solution scales up to big groups of students, where manual selection and collection would be an impediment.

Additionally, an adapter-based pattern [Gamma et al., 1995] has been chosen to support flexibility. This means that the architecture is applicable in a wide range of scenarios, independently of what specific authoring tools, VLEs, tools or ePortfolio systems the teacher chose, as the corresponding adaptor will guarantee the right interaction between the system of interest and the whole solution.

Altogether, the ACE supports the whole lifecycle of a learning situation, detailed in Section 2.2, as follows. During the design phase, most of the information that will guide the automatic collection of pieces of evidence is generated. For this reason, the *Evidence Organizer* must be able to read and interpret information coming from different Learning Design models (1)[16]. *LD Adapters* have the purpose of mapping their own representation to the EADM presented in Section 2.2.

In some cases, the information in the learning design will not be sufficient to perform the automatic collection of pieces of evidence. For example, the location of some work samples may not be available until the design is instantiated (e.g., because the work sample is an on-line resource that has to be created during the activity). This instantiation might have been done manually by the teacher or the system administrator; or automatically, thanks to one implementation engine (e.g. GLUE!PS [Prieto, 2012]). In any case, the suitable adapter is responsible of ensuring that the information gets into the *Evidence Organizer* (2).

Collection jobs are defined based on the information in the learning design and stored in the *Evidence Manager* (3). At the designated timestamp, a timer triggers the retrieval of the suitable work sample (4). Using the information previously loaded in the *Evidence Organizer*, (namely, the locator and the tool type) the *Evidence Collector* will be able to invoke the suitable API (5). Each external tool or VLE has their own adapter, capable of returning the sample of interest on demand.

Finally, once the learning evidence is back on the *Evidence Manager*, the *Evidence Injector* populates the profile of the student on any ePortfolio system of choice, using the retrieved artifacts (6).

With this architecture in place, restrictions on the choice of learning tools

[16] Numbers in brackets correspond to the sequence of events included in Figure 3

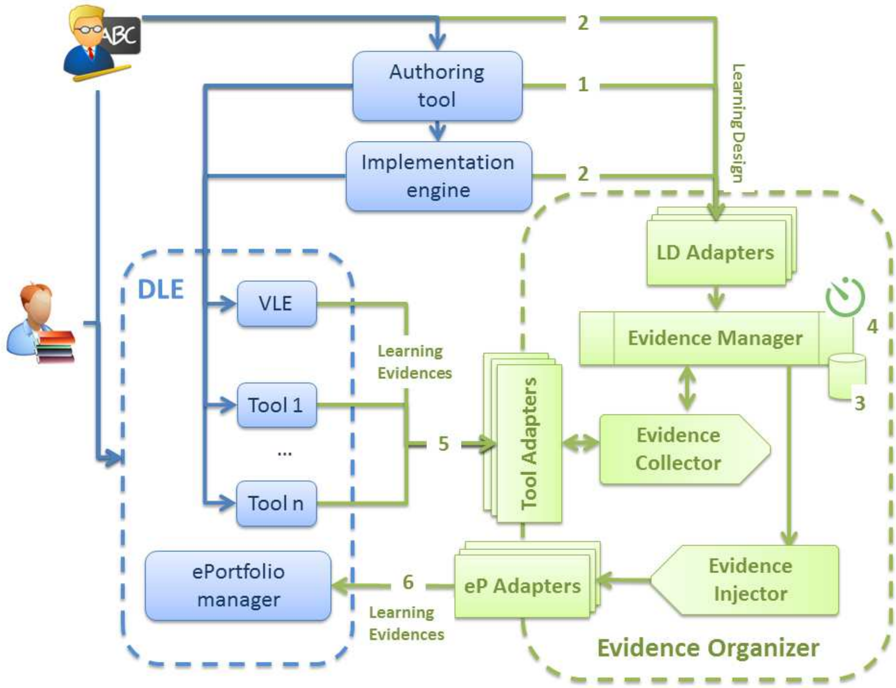

Figure 3: Architecture for the integration of ePortfolios in DLEs (ACE - Automatic Collection of Evidence)

and environments to use, imposed by some of the alternatives in Section 2.1, are removed. ACE will hold a number of available adapters, ready to be used for the integration of standard systems. In case the teacher decides to use a different solution, the development of an adapter will lower down integration costs, as adding that single module will enable connectivity to every other tool or ePortfolio system.

4 Evaluation of ACE on an authentic learning setting

This Section describes the evaluation study that took place from April to May 2014 in a course on educational research belonging to the Master's Degree for Pre-Service Secondary Education Teachers, MASUP32[17], at the Universiy de Valladolid, involving an expert teacher in collaborative learning.

[17] *Investigación educativa en el ámbito de la Tecnología y la Informática* - Educational Research in the field of Technology and Computer Science

The following subsections detail the context in which the evaluation took place, the methodological guidelines followed during the study, its preparation, the evaluation experience itself and the main findings.

4.1 Evaluation Context

The original learning design of MASUP32, previously enacted in 2013, encourages students to work collaboratively on a set of different individual, group and class-wide activities around an educational research project. By doing so, students acquire a fair range of competences, such as identifying educational challenges and suggesting innovative solutions, writing and reviewing academic material, being able to work collaboratively in groups and publicly defend their work. The relation of activities, the tools used in them and their authorship is detailed in Table 3.

Table 3: MASUP32 Activity Layout

Activity	Description	Authorship	Tool
1.1	Individual project proposal	Individual	Google Docs
2.1	Research-Action project proposal	Small group	Google Docs
2.2	Research-Action plan draft	Big group	Google Docs
2.3	Peer-review	Big group	Media Wiki
2.4	Response to reviewers	Big group	Media Wiki
2.5	Research-Action plan final version	Big group	Google Docs
3.1	Oral Presentation	Class	Google Slides
3.2	Peer Evaluation	Class	Media Wiki

From a technical perspective, the learning situation was supported using MediaWiki[18] as the focal point containing all the learning resources and the description of the learning activities. Google Documents[19] and Google Slides[20] were used to hold the results of each activity. Feedback resulting from the peer-review task was included as a new wiki page.

Altogether, around 40 artifacts were generated in three weeks, for a single teacher to collect and evaluate, in a 12-students class. Most of them were stored as Google Documents, but they needed to be embedded in MediaWiki for peer-reviewing. Also, the teacher had to export Google Slides and access MediaWiki pages to assess the work of their students.

[18] `https://www.mediawiki.org`
[19] `https://docs.google.com/`
[20] `http://www.google.com/slides/about/`

4.2 Evaluation Method

The key research question guiding this evaluation study can be stated as follows: *To which extent is it possible to help teachers in the collection of learning evidences, so as to ease the integration of ePortfolios in distributed learning environments?*

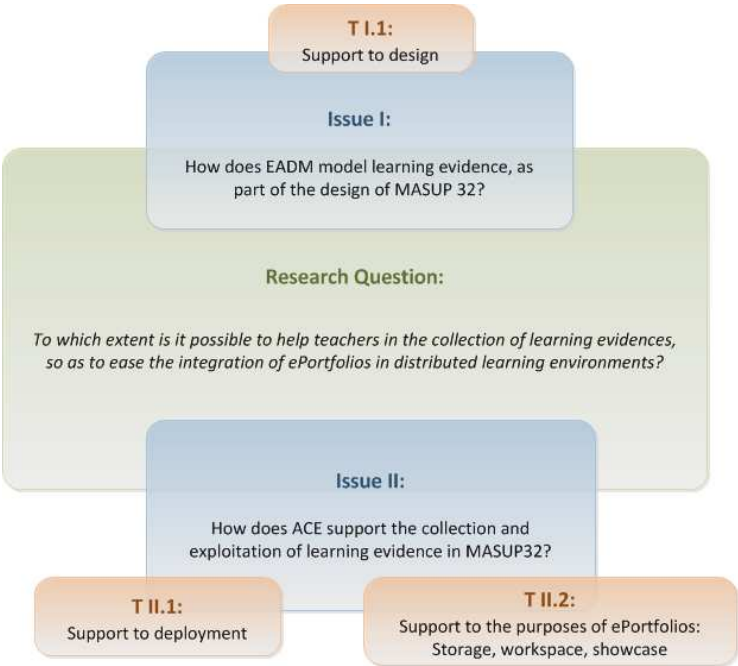

Figure 4: Anticipatory data reduction: research question, issues and topics

To handle this question, an anticipatory data reduction process [Huberman and Miles, 2002] was used during the evaluation design (see Figure 4). Thus, the research question is divided in two main issues, which track evidence modeling (*How does the EADM model learning evidence, as part of the design of MASUP 32?*) and evidence collection and exploitation (*How does ACE support the collection and exploitation of learning evidence in MASUP32?*) separately. Three topics provide the main directions in which to evaluate the aforementioned issues by means of informative questions: support to design, deployment and the purposes of ePortfolios.

The schema *research question - issue - topics - informative questions* also guided the data collection during the evaluation, consisting of different data sources and techniques, as depicted in Figure 5: interviews, teacher-generated artifacts, time measures, direct observations and questionnaires. Direct observations were carried out in collaboration with expert observers.

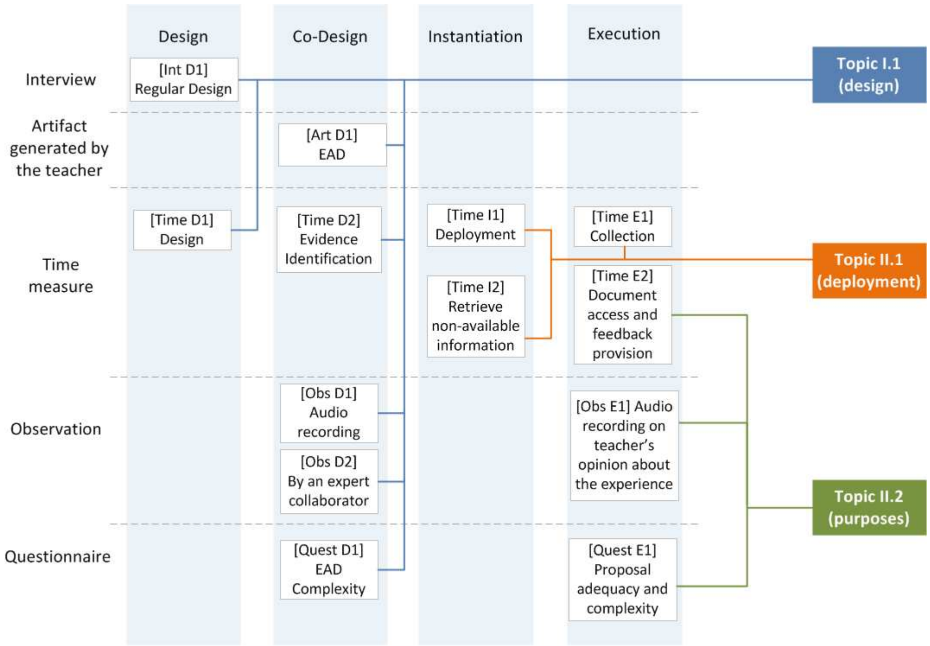

Figure 5: Evaluation Data Gathering

4.3 Evaluation Preparation

Considering the technical setup of MASUP32, the ACE architecture was configured as shown in Figure 6. The teacher used Web Collage [Villasclaras-Fernández et al., 2009], as she had previous experience in using this tool for designing collaborative learning situations. The resulting design was implemented by GLUE!PS [Prieto, 2012], so a single LD-adapter was enabled, in order to interpret the information provided as a Lingua Franca file by that platform, according to the EADM.

Additionally, the suitable tool adapters were also enabled to retrieve the generated artifacts. In this case, one to get Google Documents, another to retrieve Google Slides and one more to export MediaWiki pages as PDF files. Finally, an

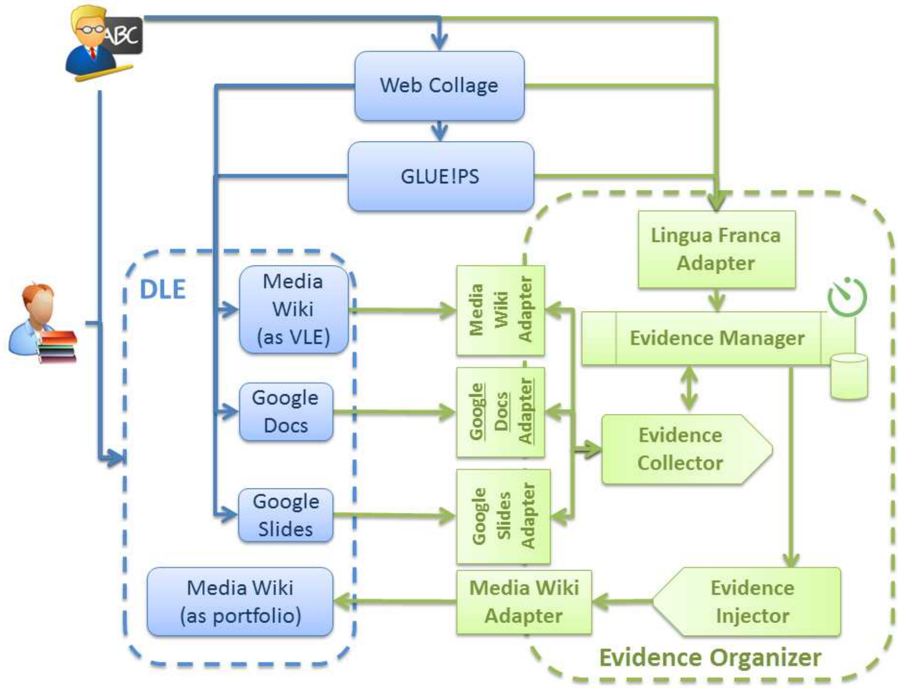

Figure 6: Implemented prototype for the support of MASUP32

adapter to inject pieces of evidence into MediaWiki was also included, so that the teacher had an easy access to the students' collection of work samples in that platform[21].

All these adapters helped the core of the ACE (*Evidence Manager*, *Evidence Collector* and *Evidence Injector*) interact with the tools supporting MASUP32.

4.4 Evaluation Happening

As mentioned in Section 4.3, the learning design was provided following the *Lingua Franca* proposal. An interview with the teacher of MASUP32 ([Int D1][22]) served to clarify the expected activity and resource flow of the learning situation, as well as the main competences that students were supposed to acquire along the course.

[21] Semantic wikis are good candidates to support ePortfolios, as suggested in [Schaffert et al., 2006]

[22] Data sources are identified along the text using the labels in Figure 5

Still, some information was missing in that model, as mentioned in Section 2.2. Specifically, pieces of evidence needed to be highlighted over regular artifacts. Also, learning objectives were lost along the way, as the authoring tool allows the specification of objectives per activity, but does not allow relating them to specific resources. In order to get this information, a co-design session with the teacher took place, in which forms were fulfilled ([Art D1]). Once made explicit, it was possible to extend the Lingua Franca file with those details to conform with the EADM. Right after this co-design session, the teacher was asked to complete an online form to provide feedback on the co-design sessions ([Quest D1]).

The course officially started on April 2014. All the design information had been loaded into the *Evidence Manager* by then, so that, at the designated timestamps (approximately, each two days), the automatic collection of pieces of evidence was launched to retrieve the corresponding Google Document, Media Wiki page or Google Slides presentation, by means of the suitable adapter, presented in Section 4.3.

On each iteration (enumerated in Table 3), the teacher was incrementally presented the collected pieces of evidence in MediaWiki, which played the ePortfolio role. This served to ease formative assessment while the situation was taking place, as well as to show the learning path of each student, from the beginning till the end of the learning situation MASUP32.

At the end of the course, an online form ([Quest E1]) was provided to the teacher to structure the overall feedback on the experience. This questionnaire was complemented with an interview with the teacher, where the main issues pointed out in the questionnaire could be clarified.

4.5 Findings

This section organizes the main findings of the MASUP32 evaluation experience around three axis (the three topics in Figure 4): design, deployment and support to the assessment purposes of ePortfolios.

4.5.1 Support to Design

Before running the evaluation study, the teacher of the course reported some problems on the orchestration of the original design ([Int D1]), such as spending too much time accessing and evaluating students work. Also, students wrote different versions of the same artifact, which means it was difficult or impossible for the teacher to retrieve the status of a work sample at a given past moment, once the students had rewrote the artifact in the next iteration.

Regarding the design of the learning situation, the teacher was able to make explicit all the required information to model learning evidence in the design templates used for that purpose, during the co-design session ([Art D1]). The purpose of this phase is to encourage the teacher to identify pieces of learning evidence and to establish a relationship between evidence and learning objectives. In that sense, the main impact in MASUP32 was the fact that the teacher realized that the existing learning objectives (inherited from the course description in previous years) were not completely accurate. As a result, she redefined the learning objectives and adjusted the learning design accordingly. That is, by trying to obtain the information to guide automatic collection, an explicit alignment between design and generated artifacts was achieved, which was perceived as a positive effect by the teacher ([Quest D1]):

> *I had to reflect on the learning objectives of each phase, reflected on the collected pieces of evidence. As a result, the final learning design was more accurate towards the intended learning objectives, as well as more coherent in aligning those objectives with the tasks to be completed by the students.*

4.5.2 Support to Deployment

As far as the deployment of the learning situation is concerned, this experience served its purpose of setting up the basic configuration for the solution, letting some adapters use the implemented framework. Specifically, connectors with a VLE (Media Wiki), two external tools (Google Documents and Google Slides) and one ePortfolio (MediaWiki) were used.

One of the main benefits of automatic collection at the designated timestamps is the ability to freeze and store the work sample the way it was at a specific moment, protecting it from incoming changes. That is, snapshots of each sample are taken as pieces of evidence of the learning process by the student, rather than only being able to access the result of the whole process. This was one of the sources of excessive workload identified by the teacher in the initial interview ([Int D1]), which was overcome during the experiment [Quest E1]):

> *It is specially suitable for summative assessment, as I have everything I need at a single click, without worrying about forgetting anything.*

However, a fair point was made by the teacher during the final interview ([Quest E1]). It is not easy to find the right balance between the level of control provided through a well defined design, and the possibility to let students choose their own learning tools. In the case of MASUP 32, some students decided to use Prezi[23] for their public presentation, instead of Google Slides. Those pieces of evidence were out of the automatically collected area, so the teacher had to manage them manually. A mechanism should be provided for the evidence

[23] `http://www.prezi.com`

manager to accept this kind of input to continue the injection flow towards the ePortfolio.

4.5.3 Support to the purposes of ePortfolios

The storage and showcase purposes of ePortfolios have been matched. However, according to the teacher ([Quest E1]), the gathered information lacks of context, such as the activity they were generated in or the rubric to be applied. Luckily, this is only a presentation issue, as all the additional required details are available in the initial Lingua Franca file, so it can be processed and shown to the teacher afterwards. This will be one of the design guidelines in the next iteration of the solution.

The teacher expressed that she saved time in the collection of pieces of evidence (turned automatic) ([Time E1]), as well as in accessing and reviewing the work samples ([Time E2], [Quest E1]):

> *Regarding presentation, (...) it is easier to handle PDF than poorly formatted wiki pages.*

On an improvement note, the lack of contextualization of the work samples in the ePortfolio made her run additional checks on the context of each piece of evidence. This fact cluttered the time savings due to automatic collection, but, as mentioned before, it is only a presentation issue, easily improved in the next evaluation study.

Altogether, comparing the proposed solution with the alternatives in the literature (Table 1), the automatic collection of evidences in the ACE architecture, guided by the information in the EADM, reduces the workload associated to the retrieval of both internal and external work samples. Once automated, the process is less error-prone and time-consuming, and a positive impact in learning design emerged, by forcing the teacher to align learning objectives and evidence, towards a more coherent design.

5 Conclusions and future work

This paper tackles the problem of integrating ePortfolios in Distributed Learning Environments, where pieces of learning evidence are scattered among different tools and systems, burdening the teacher with the management of those work samples. This manual approach does not scale up, and becomes a problem in very distributed configurations or when the number of students is high.

In an attempt to guide automatic collection of pieces of evidence, an Evidence Aware Design Model (EADM) is used, for teachers to specify what, where and when to collect. Based on this information, an adapter-based architecture (ACE) has been proposed, to collect the artifacts from different sources and inject them on the ePortfolio system of choice. This architecture removes the workload associated to manual collection, as well as provides the required flexibility to use this solution in the integration of any authoring tool, VLE, external tool and ePortfolio of choice.

Both EADM and ACE have been evaluated on an authentic case, where MediaWiki, Google Documents and Google Slides were used to support a collaborative pattern.

During this evaluation experience, the viability of the solution has been confirmed. Also, some additional considerations have been identified for the approach to reach the expected time savings and usability.

Therefore, future effort will be put into keeping the evidence in its context (activity, group authorship, evaluation rubric...), so that the teacher has all that information at hand when running the assessment of the students' work. It will also be necessary to balance controlled designed scenarios and, at the same time, respect the students' choice when it comes to learning tools.

These ideas will be applied to another evaluation study on a more complex case, for a deeper assessement of the research question.

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