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Economic Intelligence and Interoperability for an Open Source E-learning Platform

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Abstract—The originality of our study is the grounding of an economic intelligence approach via the production of tailor-made training contents. This is vital for the upskilling of an organisation wishing to take up the challenge of economic intelligence. To do this we sought to increase the interoperability of a free and open source e-learning platform that integrates different applications and results in a seamless interface. Our study first compared seven e-learning systems from which we chose the Moodle platform. Then, with Moodle, we analysed the production process complying to two technical standards SCORM and IMS-LD through standard-compliant content authoring tools, RELOAD and LAMS. The results show that training content can be created as a seamless interface with LAMS-IMS-Learning Design Level A Format on Moodle via LAMS, rather than with RELOAD conform IMS-Learning Design.

Index Terms—interoperability, Moodle, open source, SCORM, IMS-LD, LAMS.

INTRODUCTION

Open source software is becoming increasingly popular, yet interoperability remains a major obstacle to its implementation, including in training and education as indispensable elements of an economic intelligence strategy. This has practical effects on how governments,

companies, and educational institutions attempt to go about their business in a growingly connected and competitive world. As we show in this article, what is at stake is how economic intelligence can be translated into grassroots reality through appropriate collaborative online training via the possibilities of an open source e-learning platform.

With this in mind, we examine the implications of interoperability within the ambit of economic intelligence. To do this, we look at the production of training activities in Moodle, as an open source e-learning platform. Training content and activities were created with two technical standards SCORM and IMS-LD through a standard-compliant content authoring tool, RELOAD, to create a seamless interface for the computer end-user[7].

II. ECONOMIC INTELLIGENCE AND INTEROPERABILITY: AN OPEN SOURCE APPROACH

Coar [5] points out that open source goes beyond a clear and modifiable access to the source code of an information system. It also involves: “free” (no royalties or other fees) distribution in the selling or giving away of elements of the software, distribution of derived works under the same terms as the original software license, integrity of the author's source code, an inclusive licence for authorised users, open to all (groups of) users,

domains of endeavour (e.g. professional, industrial domains), other technology, software and products.

In their paper, *The Total Growth of Open Source*, Deshpande & Riehle (2008) [31] conducted a quantitative study of more than 5000 “active and popular” open source software projects. The researchers analysed the number of total project size (measured in source lines of code), new open source projects, and open source projects to conclude that open source is growing at an “exponential rate”. The total amount of source code and projects doubles about every 14 months (*ibid.*, p. 11). In another study into factors about open source growth in 12 European countries, Ghosh & Glott [17] show that 49 % of local government authorities use open source software, with 70 % of the users intending to increase it use (*ibid.*, p.33-36). Yet, limited interoperability hampers the sustainability of this growth.

In its White Paper, the *Open Solutions Alliance* [23], a non-profit consortium promoting open software business solutions, argues for systems that have a stronger emphasis on modularity and “doing one thing extremely well”. The Paper advances seven recommendations: presentation integration (a web page combining different applications), seamless interface integration (users work through a single window), centralized identity management, flexible infrastructure (avoid dependency on an application server, operating system, portal or database), data management (combined products should have one installer and one point of configuration), applications compatibility (identify non-technical areas preventing applications from working together for users), customising the system (matching applications to the practices of customers and integrators) [23].

Computer specialist, Miller [21], puts forward six “flavours” of interoperability: technical interoperability, semantic interoperability, political/human interoperability, inter-community

interoperability, legal interoperability, and international interoperability. The list is not exhaustive. What imports is that interoperability is not the exclusive domain of engineers. The ultimate question is knowing how to dovetail together these different forms of interoperabilities. It is argued in this paper that the principles of economic intelligence can offer a useful framework to federate the different “flavours” of interoperability.

Given that one cannot study everything at the same time, we have focused on technical interoperability without denying the importance and necessity of other aspects of interoperability. In its narrow sense, technical interoperability is understood as the ability of two or more technical systems or components to exchange and use data [29].

The domain of economic intelligence is often seen as a relatively new area at the crossroads of different disciplines [2] and this may explain why definitions vary. However, Gorla [16] traces the origins of economic intelligence back to the 1950’s and lists more than 20 different terms that can be linked to it starting from “business intelligence” to “strategic intelligence”. Ben Fadhel & Ghassen put forward a synthetic definition of economic intelligence as an informational process that allows an organisation to be constantly informed so to act strategically when interpreting, anticipating and creating data [2]. In this way economic intelligence enables optimal decision making in a given time framework.

The link between well managed interoperability and reflective economic intelligence, in the context of this paper, focuses on exploiting different data sources in the empowering of users, in a training context. This is a key element of economic intelligence in understanding emerging challenges of an economic environment and to act, if possible, ahead of rival organisations [22]. Yet, little seems to be explicitly said or studied in the economic intelligence literature of how to empower personnel (and students) to harness

emerging data that give an organisation that all-important competitive edge.

A point in case is the IE-Lobbying.info [30], a collaborative website aimed at gathering data on competitive intelligence, public affairs and lobbying in the European Union, which refers to “business intelligence” as extrapolating information from indicators and making accurate forecasts about future trends or economic conditions. It goes on to say that when forecasts are done and used proactively, an organization can make decisions before the competition does [18]. This is all well and done in principle, but in practice how is this translated into everyday practice? In effect, when examining the online resources of bodies like IE-Lobbying.info, little mention seems to be made of the role of, for example, training personnel as a way of making economic intelligence a systematically hands-on, grassroots reality.

Given this, one of the aims of this paper is to show how one can adapt a well known online training tool in terms of some key economic intelligence principles [14].

III. WHY CHOOSE MOODLE AS AN E-LEARNING PLATFORM?

In the field of e-learning, interoperability plays a central role. For e-learning experts Bouthry and Jourdain [4] a viable online training system needs to be interoperable; reusable for different aims in different applications, products and contexts through different access modes; accessible enabling users to search, identify, access and receive content in a distributed way; durable despite technological changes; and adaptable to personalise pedagogic content. On this point, there is then consensus between the profit-making approach of the *Open Solutions Alliance* and Bouthry and Jourdain [4]. Their recommendations form the backbone of our approach to evaluating elearning platforms, which constituted the first part of our study.

This first part of our study compared seven

well-known free, open source e-learning platforms: Claroline, Ganesha, Acolad 3D, Dokeos, Moodle, Spiarl and LAMS (see Table 1 below). All seven platforms are used in training and education for various types of training activities, and are based on internet technology satisfying current technical norms that needs neither a lot of broadband, nor the installation of special software. This is an important aspect in economic intelligence that seeks to collect and organize a variety of data from different interoperable sources.

One result of the study highlights the importance of being able to create training contents and their attendant scenarios. The other result led to the conclusion that a LAMS integrated-Moodle complied to the demands of e-learning and training and education systems.

Moodle (*Modular Object-Oriented Dynamic Learning Environment*) runs from a computer server and users access it through a web browser. It manages and creates training resources through automated tests, record-keeping facilities, tracking what users do in the system. As of November 2009, Moodle had 43,670 registered sites and 2,980,157 courses with 30,459,200 registered users in a total of 209 countries [19].

When Martin Dougiamas [6] created Moodle in 2001, he had in mind a learning-through-others (socio-constructivist epistemology [8] by encouraging users to create resources and sharing it with others (social-constructionism, [20]. The 20 different types of “activities” of Moodle are organised into “sequences” and “groups”. Each activity leads on to another for users to share experiences, co-construct resources and establish personal learning paths.

Moodle is based on five basic learning principles [20]. First, the collaborative nature of the system means that users can be both “tutors” and learners to and of each other.

Second, humans learn by creating representations of their knowledge and sharing them through socially constructed

tools and negotiating processes by constructing content with or for others. Learners can control and create content via tools like forums, wikis, glossaries, databases, messaging.

Third, humans also learn by observing the activity of peers. This can be done by looking at the “participants” page, the “Online Users block”, or the “Recent Activity block”. This is a traditional feature of many e-learning platforms.

Fourth, humans can learn from each other by understanding the contexts of others. To do this the system offers user profiles, a compendium of forum posts, blogs, overall activity reports, user log reports and questionnaire/survey module.

Finally, a learning environment also needs to be rapidly adaptable to the needs of the participants in changing contexts. Users can modify and structure activities at will, and fine-tune many aspects of appearance and

behaviour, at site, course and activity levels. This can be done through learner “gradebooks” that are automatically maintained, and navigation in the system is automatically generated. External systems can be integrated so Moodle can operate with other systems; it is on this point that we focussed our study.

Hence, as an e-learning platform, Moodle allows bottom-up approach to accessing, managing, sharing and creating training content with other users (Harmelen 2006). That said, it is flexible enough to integrate the best of a bottom-up collaborative approach with the convenience of a more top-down approach that provides ready-made resources [20].

What are the disadvantages of Moodle? Despite attempts to be interoperable, it has certain technical limits. First, Moodle is not directly operable with the specification of IMS-LD. Second, although, Moodle uses an authoring system like LAMS, it only accepts IMS-LD Level A data that needs to be opened by the user in one window before opening Moodle in a different window. Based on these points we launched our study.

The study had an additional challenge linked to the training of future technicians and engineers for the aero-space industry. The downloading and display of data from satellites (e.g. Landsat TM images of 30m resolution) is particularly problematic. Satellite data are enormous in size and beyond existing compression techniques. The data also demand band rate width and storage capacity, beyond those available to many users.

This initial study of different e-learning platforms led to our main study of making the open source Moodle more interoperable.

IV. CONTEXT OF OUR MAIN STUDY

Our study highlights the lessons learnt in creating and giving access to training contents

TABLE I
COMPARATIVE STUDY OF ELEARNING PLATFORMS

Tasks of e-learning platforms	Claroline	Genesys	Acolad 3D	Delos	Moodle	Spirit	LAMS
General description							
Learner role							
Use of self-evaluated activities	YES	not informed	YES	YES	YES	not informed	YES
Access to exercises and other web sites	No	not informed	no	not informed	YES	YES	YES
Direct management of the time table	YES	YES	YES	YES	YES	YES	YES
Online registration	YES	YES	YES	With param	YES	With param	YES
Short description of the aims, modes, of each lesson	YES	not informed	not informed	YES	YES	YES	YES
Easy access to course supports (exercises, quiz, ...)	YES	YES	YES	YES	YES	YES	YES
Number of maximum platform users	Unlimited	Unlimited	Unlimited	11	Unlimited	Unlimited	Unlimited
Number of learners per working group	depends on the tutor's objectives	depends on the tutor's objectives	30 in a class group but 12 in a seminar group	Not informed	depends on the tutor's objectives	1 tutor up to about 16 learners	Unlimited according to the tutor's objective
Tutor role							
Use of self-evaluated activities	YES	NO	YES	YES	YES	NO	YES
Individual follow-up of regular learners	NO	NO	not informed	not informed	YES	NO	YES
Programme planning and marking of exercises			YES	YES	YES	YES	YES
Creation of enhanced quiz			YES	YES	YES	YES	YES
Exercise tools (glossary, white board, ...)			YES	YES	YES	YES	YES
Communication tools (messaging, chat, list of connected learners)	YES NO	YES NO	YES not informed	YES not informed	YES YES	YES NO	YES YES
Author/Designer	Open University	Open University	Open University	Open University	Open University	Open University	Open University
Availability	OpenSource	OpenSource	OpenSource	OpenSource	OpenSource	OpenSource	OpenSource
Copyright license	CC BY	CC BY	CC BY	CC BY	CC BY	CC BY	CC BY
Interoperability	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Conformity to SCORM and IMS-LD norms	SCORM	SCORM	SCORM	SCORM	SCORM & IMS-LD	SCORM & IMS-LD	SCORM & IMS-LD
Interoperability with relation to IMS-LD	NO	NO	NO	NO	NO	NO	NO
Substrates	multilingual	multilingual	multilingual	multilingual	multilingual	multilingual	multilingual
Country	France	France	France	France	France	France	France
Implemented functions							
Graphic display	NO	NO	NO	NO	Graphic display some learners	NO	Graphic display learners
Importation of the IMS-LD package	NO	NO	NO	NO	Importation of the IMS-LD package levels B & C	NO	Importation of the IMS-LD package levels B & C
Non implemented functions							
Importation of the IMS-LD package	NO	NO	NO	NO	Importation of the IMS-LD package levels B & C	NO	Importation of the IMS-LD package levels B & C
Inclusive access for unpecialized teachers	YES	YES	YES	YES	YES	YES	YES

on Moodle in accordance with interoperability standards and the educational context of French-speaking learners of Space and Technology sciences in Africa and the Middle East. To be clear on this point, without this interoperability learners have limited, if not, no access to data needed to develop their skills. Without such regular upskilling, the grassroots implications of economic intelligence can be questioned. In the light of this, it is vital to identify the salient features of the socio-cultural context because the success of an e-learning system is ultimately judged in how it satisfies the informational needs of users in a given situation. This is one of the central tenets of economic intelligence [3].

In our case, learners in space and technology sciences need to be able to produce and appropriate training activities using satellite data (e.g. satellite images, satellite database, and geographical database). However, in many North African and Middle Eastern countries access to data-intensive material, like satellite data, through the Internet is severely handicapped by factors like bandwidth availability. Even if one manages to download satellite images in off-peak periods, there remains the major problem of finding an appropriate physical means to store the mass of downloaded data. Interoperability of available downloaded data is one way to circumvent this problem. This would also be true in the business sector using similar data needing a lot of bandwidth and digital storage space.

In our aim of making the concept of interoperability a sustainable hands-on tool, a major challenge is how to use a free and open source system, like Moodle, that is not directly compatible with the specifications of IMS-Learning Design (see below) tool. Moodle, however, accepts imports from a learning authoring tool called LAMS (see below), and this is compatible with IMS-Learning Design (LD) Level A. This technical sleight of hand to access Moodle with IMS-LD means that learners need to open up a

LAMS before using Moodle. In doing this it reduces ease of access for users. Ease of access constitutes one of the seven of the principles of the *Open Solutions Alliance* [28], *i.e.* the “seamless interface integration” recommendation.

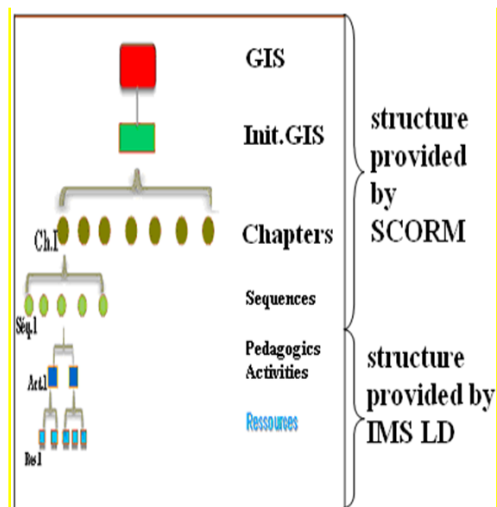
Objectives

The four key tools used in the main study, Moodle, SCORM, LAMS, and IMS-LD, underlie the training objectives of the study.

First, Moodle focuses on active learner participation with the system and collaboration with other learners (see above).

SCORM (*Sharable Content Object Reference Model*) presupposes that “learning” occurs through the sequencing of training contents, and not the inherent quality of an individual training content [27]. SCORM operates by making learners take a predetermined series of paths when navigating through training contents. This means that the structure of “lessons” regroups various elements in a “module”, and various “chapters” from an element. A chapter (Ch.) provides a series of training “sequences” (Seq.) with one or several “resources” (Res) linked to each sequence (see Fig. 1).

Fig. 1. Basic structure of an LMS based e-learning system



This approach allows learners to bookmark

their progress between work sessions. It also ensures that learners' test scores have an acceptable level of "acceptability".

Third, LAMS (*Learning Activity Management System*) is an authoring tool, a designing platform of training activities, and a platform for learners to perform group- or individual-tasks (e.g. quiz, surveys, forums, tests, wikis) with tracking facilities available for tutors. The system has a graphic interface to help organise training tasks. For example, when learners have successfully finished a training sequence they go on to a next sequence, an indicator light then changes from blue to red to signal which activities have been completed.

Finally, *IMS-LearningDesign* (a metalanguage tool for modelling "learning" processes) provides an overall regrouping structure in linking training activities to appropriate resources. This encourages a flexible approach to learning and training [15] & [1]. In this way both SCORM and IMS-LD allow training content to be coherently structured in terms of both technical specifications norms, and training standards.

B. Hypotheses

For ease of access, it is important that learners have access to training content in Moodle via only a standard Internet browser (e.g. *Firefox*, *Flock*, *Internet Explorer*) and that they not be burdened with having to open up a LAMS prior to Moodle. Our research question can be formulated in the following way: Can Moodle be made more interoperable in accepting IMS-LD data, even if, at first glance, Moodle and IMS-LD are inoperable? This led us to our two-fold working hypothesis:

Hypothesis 1. Training activities created with LAMS-IMS Learning Design Level A Format are useable with LAMS, and thus in Moodle (Release 1.9).

Hypothesis 2. Training activities created with RELOAD, conform IMS-LD, are useable in Moodle.

To test our hypothesis, our method applied the well-known interoperability specifications of SCORM and IMS-LD that enables reusability of training contents in different environments (Madjarov 2005), notably in Moodle and LAMS.

RESULTS AND DISCUSSION

The main challenge of the study was to find a way of making Moodle accept data from IMS-LD. Our tests confirmed *Hypothesis 1* (training activities created with LAMS-IMS Learning Design Level A Format are useable on Moodle via LAMS), and disconfirmed *Hypothesis 2* (concerning training activities created with RELOAD conform IMS-LD). We also successfully tested an open source IMS-LD engine called, CopperCore, on a virtual JAVA machine to enable IMS-LD to run in Moodle.

That said, the setting up such an environment is no easy task, essentially, because one has to work in a linear "command-line" mode format rather than a more globalising, "graphic" mode of configuration. We created SCORM friendly training contents and IMS-LD friendly training activities. We used a SCORM approach to integrate IMS-LD elements given that Moodle is not directly compatible with IMS-LD. This involved studying the possibility of creating both training content and training activities into one SCORM friendly package. This turned out to be a success, making Moodle more accessible (see Fig. 2).

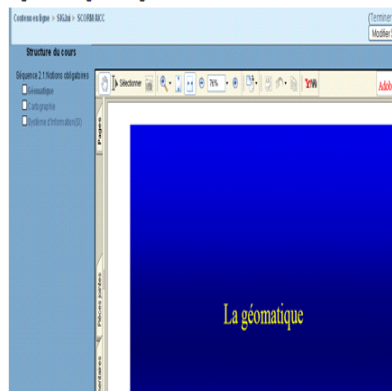
In a questionnaire survey, 12 experts (lecturers, researchers, engineers) in Space and technology Sciences validated our solution. Practically all the experts suggested that the approach could be used in a blended-learning approach [7]. Such an approach is one way of

assuring reuse of existing resources. As Labour & Kolski [13] highlight, however, resources used in blended learning brings with it different modes of organising training and learning processes that the system needs to take into account. Marrying the binary limitations of a computer system with the complex phenomena of encouraging knowledge acquisition involves ongoing critical reflection and field tests.

This form of blended learning is no easy task especially when taking on board the challenges of economic intelligence, notably in training personnel to implement an agreed strategy that encourages a given behaviour or interpretation of a message within a target sector.

Ben Fadhel & Ghassen [2] summarise the operational aspects of economic intelligence in a threefold way: acquiring the latest strategically relevant information; protecting strategically important data; and propagating strategically useful messages or behaviours.

Fig. 2. Using training content in Moodle/SCORM



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Fig. 3. Blended learning

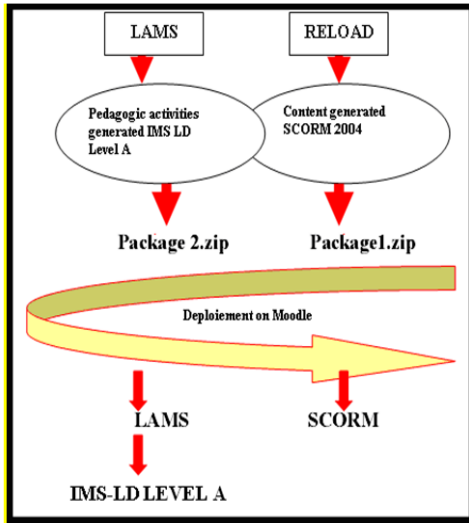


Our solution involves using SCORM-friendly training content in the authoring tool RELOAD and its deployment in Moodle, while on the platform LAMS, an IMS Learning Design Level A Format approach is applied for use in Moodle [7]. The overall solution is presented in Figure 4 below. Tutors and training content creators can visualise the solution via a graphic interface.

An avowed limit of this paper is not having discussed the different learning and training (pedagogic) styles and methods that our adapted Moodle can encourage [13]. Clearly the ultimate test of such a system depends on its pedagogic relevance in terms of learners needs in a given changing context. An economic intelligence strategy is particularly useful tool in understanding and taking into account these changes to decide what adaptations must be made to training programmes. Not to directly link practical

grassroots application to an economic intelligence approach *via* education and training programmes, we argue, is not only short-sighted but counter-productive.

Fig. 4. Proposed Solution for making content more interoperable in Moodle



The adaptations needed, in terms of an economic intelligence approach, can, in part, be facilitated by using appropriate tools. It can thus be argued that IMS LD level B and C is more conducive to a clearer socio-constructionist approach than the IMS LD level A that was used in our study. This is indeed one aspect that needs further development. However, the socio-cultural realities of many North-African and African education and training context is such that a historically transmissive approach, which allows for some “individualistic-constructivism”, is still prevalent. In terms of this, the IMS LD level A choice was deemed a useful starting point to usher in a, no doubt, modestly non-threatening but certain step in the direction of increased user empowerment [13]. Further development of the study also involves looking at tools like the *Reload ld editor*, notably version 1.2.3 features and *ldplayer*, notably version 2.1.3, that can enhance the overall teaching and learning

experience.

VI. CONCLUSION

In this chapter, we explored ways of sharing web-based resources with free and open software that is compliant to international norms of interoperability and a socio-constructivist training principles. To do this we found a novel way of making an open source e-learning platform, like Moodle, more interoperable in creating and presenting training content and training sequences that can be reused as autonomous applications.

Our solution is based on a relatively simple method in using as much as possible standards and open source tools coherent with concepts associated with economic intelligence. Our study showed that many of the existing solutions about Internet-based e-learning content raise the issue of interoperability. It also showed that an e-learning system can be made up of different independent applications even if for the user it appears as seamless.

In describing how training content can be produced and dynamically communicated on an e-learning platform, we took an example from a training sequence for future aero-space technicians and engineers on a Moodle and a LAMS. This was conform to technical and training norms and standards that allows learners to learn in different ways.

This prototype is undergoing further tests and evaluation to test its efficiency from a communicational point of view between the different actors of the training context. The aim of the evaluation will allow French-speakers in Africa to do online courses in aero-space science and technology from their desks at work or at home. This can be done as part of an economic intelligence strategy that combines current activities and projects with appropriate training content.

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