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▶ To cite this version:

Arnaud Lelevé, Patrick Prévot, Hcene Benmohamed, Mehdi Benadi. Generic e-lab platforms and e-learning standards. International Conference on Computer Aided Learning in Engineering Education (CALIE 2004), Feb 2004, Grenoble, France. hal-00188638

HAL Id: hal-00188638
https://hal.archives-ouvertes.fr/hal-00188638

Submitted on 21 May 2015

GENERIC E-LAB PLATFORMS AND ELEARNING STANDARDS

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KEYWORDS: **Distance learning, Remote and Virtual Laboratory**

Abstract

As E-Learning is currently developing worldwide and offering a growing range of e-training vectors such as multicast course, virtual classroom, ... and other theoretical medias, electronic laboratory seems to have a less fast development. However, neither technical nor scientific education could be given without practical experimentation.

This paper proposes a start of reflection on how E-Labs could comply with emerging e-content standards. In order to be realistic, we base this reflection on a real E-Lab. platform, TIPY, previously made from scratch, which permits us to focus on how this integration could be realized. In the long run, we should profit from current intensive E-Learning standardization process to propose a reusable generic platform to be homogeneously integrated in modern Learning Management Systems.

INTRODUCTION

Development of e-learning in public and commercial sectors, this latter decade, highlights a revolution of ways of learning, in initial and long life training.

One can consider a variety of *e-training* types, based on standard ways of teaching: on-line multicast course (often presented as a videoconference), interactive virtual classroom (for tutored exercises), self-training (students build their own knowledge from offline courses and independent tutorials), *e-projects* (big real cases to be solved into a team), role playing (cooperative games where students are dived into and have to solve together a realistic situation), and remote experimentation (manipulation of a remote system as in laboratories).

For our part, we are interested in remote laboratories which are a sort of teaching particularly dedicated and essential to scientific and technical training. It is the best way for the student to give meaning to theory thanks to realistic approach. It is also a way to get accustomed to using (industrial) systems they will have to deal with in the future. Remote Laboratories find their best usage when requiring a complex (when no realistic simulation exists) and/or expensive (mass spectrometer, industrial automated system, …) device. From another point of view, it is generally a situation where students are fewer, therefore closer from teachers (meanwhile they are at long distance), which permits richer exchanges.

Our main goal is to provide to authors and instructors a tool associated to a generic core level, able to dynamically create, manage and execute remote experimentation scenarios from any scientific discipline. By using this generic core, remote/virtual lab. scenarios corresponding to specific experiments will be indexable, sharable and linkable to other pedagogical objects (courses, contextual help, tutorials, …) by mean of standard learning data exchange mechanisms (*LOM, SCORM, ...*). This generic tool, by nature, should be used for virtual laboratories as much as for remote ones.

In order to feel the predominant difficulties one encounters when developing such a platform, we first built a remote lab platform as presented in (Lelevé et al. 2003b) in automation discipline. This platform is used locally by students and as an experimentation platform for our needs. We are now working on making this platform generic.

The object of this paper is to present how we foresee generic electronic lab. platform collaboration with standardized LMS (Learning Management System). The first intention is to leave learner and e-content managament to LMS, which is their speciality, while we focus on electronic lab. specificities. Implications of this study are very interesting: an author will then be able to share and port his scenarios to other electronic lab. compliant platforms as it is already the case for e-courses. He will also be able to pick resources in a breeding ground, such as differents kinds of exercises to include in his scenarios.

We will present at first general aspects concerning electronic (remote and virtual) labs. TIPY remote lab. presentation will be depicted as we use it as a local reference in this study and we will then expose how we foresee how standards can help us in e-lab conception.

E-LABS

The term "*E-Lab.*" gathers "*remote laboratories*" and "*virtual laboratories*". Difference between both terms is presented in next section.

Remote & Vitual Laboratories

Remote laboratories represent the translation of *in-situ* laboratory experiments to distance learning. This is why one uses "*remote laboratory*" naming. This is different from "*virtual laboratories*" where a simulation commonly replaces the real system. Remote laboratories offer remote access to real laboratory equipments and instruments. Virtual laboratories typically resort to simulation software such as Matlab+Simulink in case of (Bonivento 2002) or LabView for (Salzmann 1998) or specific applications. Yet, one has to take care that such softwares can be also used for real system control. One can find remote (or virtual) laboratory experiments in various scientific and technical topics such as automatic control in (Chiculita 2002), electronics, chemicals and mechanicals in (Esche 2002) and robotics in (Bicchi 2001).

From our point of view, simulation is complementary with real experimentation as it can precede an experimentation in order to train a learner to risky actions. As a whole, they are essential when the simulated system is not reachable by students : microscopic or macroscopic phenomena, destructive process, … Indeed, professional plane pilots have been using simulators made of physical simulators (a real scale cockpit with same equipment as in planes) merged with a computerized simulation of the rest of the plane and the environment.

In fact, we think that, as far as possible, e-lab. conceivers should merge virtual and remote laboratories so that, on one hand, they permit learners to closely compare reality and theory and, on the other hand, improve real system time sharing by allowing learners to work while the platform switches experiment context for next player. However, this presupposes an efficiently defined time sharing protocol but results in an increase of productivity of the system (offering more crowdy remote lab. sessions with a thiner granularity).

Anyway, we consider that the generic platform we are conceiving should host both virtual and remote laboratories in one hand and propose simulation tools as a resource in remote laboratories in the other hand, to foresee both simulation usages.

Electronic Laboratories vs classical e-learning contexts

The main difference between virtual classrooms and remote (resp. virtual) laboratories reside in the need of manipulation of a real (resp. virtual) system, always at distance. Besides learner management and classical communication tools one can find in online educational contexts, remote/virtual lab. conceivers have to provide means to learners and instructors to create

again (even more) facilities to experiment they had in local context. We could put side by side e-labs and remote shared groupware usage: the main difference resides in the remote target materiality and in the risks (material, human, economic, environmental, …)
Manipulations have to be synchronized with scenarios followed by learners, anytime, in both ways (proper system context restoration, automatic enabling or disabling functionalities according to learner level, online and realtime configuration, … and in the other way, scenario has to dynamically evolve according to manipulation results).

Remote Lab. 4 dimensions :
In order to make a complete remote lab experimentation, we identified 4 strongly linked dimensions, which we presented in (Lelevé et al. 2003a) and whose items have to closely interact between them:

Remote (resp. virtual) manipulation dimension includes necessary functionalities (from physical devices (resp. simulators) to software and HMI) to manipulate the remote (resp. virtual) system regarding distance drawbacks and multi-user access. Teleoperation research literature, such as (Safaric 2001) and, for simulations, (Pernin 1995a), provides a rich resource to help conceiving this dimension functionalities.

Educational dimension corresponds to the educational point of view : scenario authoring, e-content and learner management, instructor supervision, learner tutoring and evaluation. TIPY platform (depicted in next section) is based on a generic educational skeleton, which could be reused in any discipline as long as authors need to guide step by step their students. In this context, in order to compensate for the instructor distance, we proposed in (Lelevé et al. 2003a), the concept of a dynamic scenario which would evolve in real time, according to the results of student experience as he advances, and to author's preset evolution rules (based on spent time and current learner level). Figure 1 depicts such a scenario.

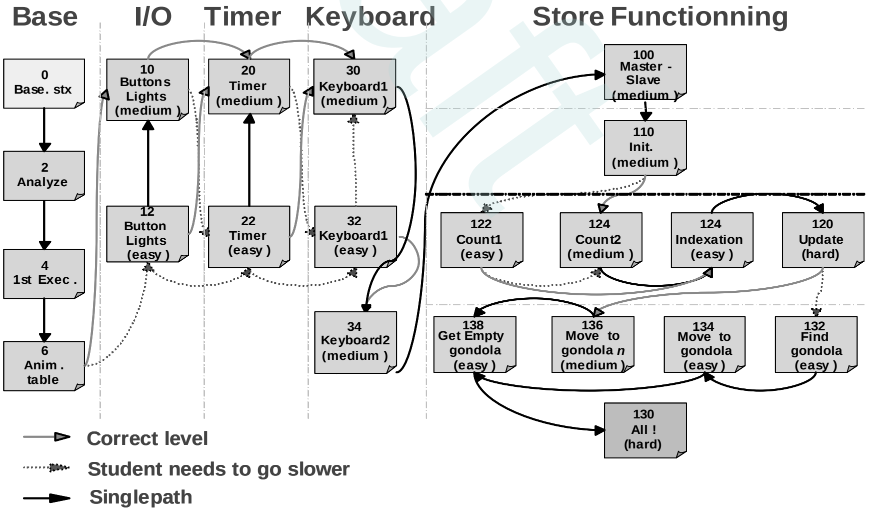


Fig 1: Scenario example (industrial system programming Remote-Lab. for TIPY)

Communication dimension deals with communication between users: learners, instructor and technician (if any). As in any web-based training system, the quality of the communication between learners and instructor is essential. Yet Remote/Virtual Labs do not need specific communication mecanisms compared to virtual classroom contexts. E-Lab. Platform will just have to provide mechanisms to synchronize communication between instructor and learner currently using the system.

Administration dimension features schedule management for remote lab. sessions (for instructors and learners) and security management / access control: only registered learners can access reserved remote lab. scenarios and interact with remote systems. Some functionalities may be hidden from learners according to scenario requirements and learner level.

TIPY REMOTE LAB. PLATFORM

This platform, presented in details in (Lelevé et al. 2003b), consists of a "*basic*" environment to create E-Lab (remote or virtual) scenarios, tightly guiding learners in their knowledge construction through experimentation. It provides authoring and management tools and can host several remote systems (and several scenarios per system) even if, currently, only one system is provided (an automated vertical store presented in figure 2) with a few scenarios consisting in teaching learners how to program and pilot an industrial system. Open technologies (*PHP / Apache, MySQL, Java* and *VRML*) make it possible to install the platform under Windows® or Linux environments.

System:

Figure 3 shows TIPY platform architecture. Web and Application Server hosts the platform application while PLCs (Programmable Logical Controller) provide resources specific to this remote system (remote control and visualization).

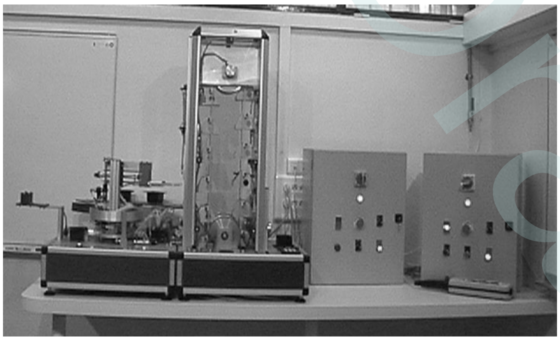


Fig 2: Automation platform: a vertical store

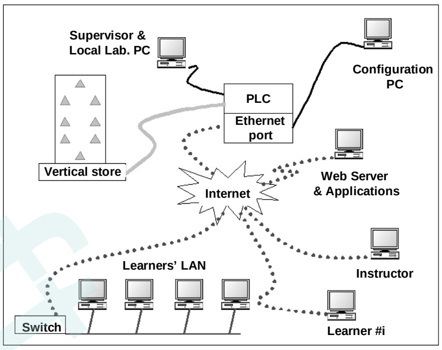


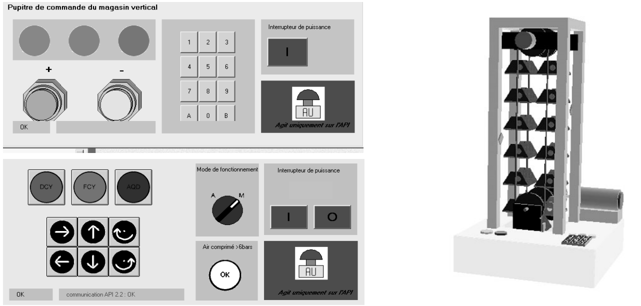
Fig 3: TIPY Architecture

Philosophy

1. Platform administrator registers one or more (real or virtual) experimentation systems, seen as resources (how to exchange data with each system: video, control, …),
2. authors create scenarios related to a registered system such as the one showed in figure 1,
3. instructors, learners and/or administration team schedule e-lab. sessions,
4. during a session, each learner follows author instructions, step by step, whose order may vary according to learner level and evolution during the session.

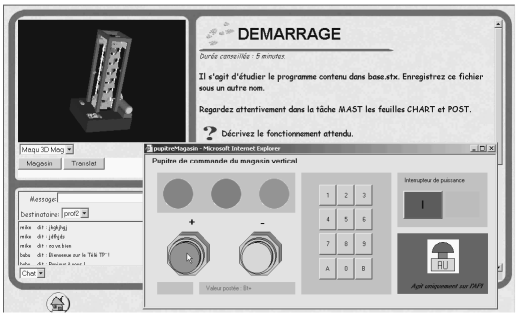
In TIPY, learner evaluation consists in comparing the time spent on each step with time proposed by the author, and testing the answers from each step Multiple Choice Question. This first simple approach is to be enhanced to become more flexible and efficient, notably by using indicators based on learner level tendency.

This autonomous platform was a first completed sketch, made from scratch. In spite of its relative simplicity and thanks to its full range functionalities (from system registration to tutoring), it permitted us to emphasize arising difficulties when conceiving such a system.



Remote Input/Output Resources Visualization Resource

Fig. 4: Samples of resources



DEMARRAGE

Durée conseillée : 5 minutes.

Il s'agit d'étudier le programme contenu dans base.stx. Enregistrez ce fichier sous un autre nom.

Regardez attentivement dans la tâche MAST les feuilles CHART et POST.

? Décrivez le fonctionnement attendu.

Message:

Destinataire: prof2

mike dit : jhghjhgj
mike dit : jdfhjds
mike dit : ca va bien
bubu dit : Bienvenue sur le Télé TP !
bubu dit : Bonjour à vous !

Valeur postée : Bt+

Fig 5: Screenshot of TIPY learner interface

PROVIDING LMS COMPATIBILITY

Goal of this study

In a complete e-learning platform, electronic laboratories will have to merge into a global and homogeneous LMS. The goal of this work consists in leaving traditionnal e-content and learner management to the LMS part in order to focus on electronic specific to e-lab. parts and so avoid functional redundancy. First elements of reflections are proposed in next paragraph.

Sharing functionalities between specific E-Lab platform and host LMS

A main goal of LMS is to manage learning resources (learner preferences, level and grants in one way, test results, scoring, reports, … in the other way) so as to be homogeneous for every course, virtual classroom, or electronic lab. This implies that a specific client-server protocol between electronic lab platform and the LMS has to be respected. AICC (*Aviation Industry CBT Committee*) and ADL (*Advanced Distributed Learning*) SCORM have been the first to provide specifications for such a protocol.

A second role for LMS consists of broadcasting e-content. Before leaving scenario management to LMS, one has to ensure that this latter proposes necessary functionalities. As they are not conceived to integrate e-labs, one has to think scenarios the same way as online courses are made: a set of steps with multiple paths and prerequisite constraints. This way, it should not present any difficulty to integrate e-lab simple scenarios on standard LMS platforms. Yet TIPY is based on dynamic scenarios (paths vary in realtime according to learner results): not every LMS features such mechanisms (just think of AICC), so one has to do odd jobs to feature this functionality while keeping such an LMS standard compliance.

Furthermore, by leaving electronic lab. scenarios management to the LMS, we provide their portability in the same LMS family as long as we ensure they deal with a remote system or a simulation which provides compatible functionalities. This strong condition imposes to tag scenarios with complementary metadata (compared to classical e-content metadata such as authors, versions, summaries, objectives, prerequisites, …), which means defining or extending metadata description sets for such pedagogical remote systems and simulations. This also requires using an abstraction layer to prevent from low level incompatibilities and presenting compatible functionalities — OROCOS project (www.orocos.org) is an example for robotic devices and MARS (Pernin, 1995b) for simulations.

Currently, IEEE LOM (Learning Object Meta-data) seems to be the most broadly accepted standard and is included in IMS and SCORM. In TIPY, in order to enhance learner evaluation at each step, we propose to leave the freedom to scenario authors to choose the kind of exercise best fits to each step, by giving him the ability to fish into an compatible exercise repository (such as IMS Question & Test Interoperability Specification). At this time we could not check a dynamic scenario could be implemented with IMS. Moreover, specific non-linear scenarios (such as those one can create with MARS) may be even more difficult to suit. Will we have to propose extensions to gain all the LMS integration advantages we presented ?

CONCLUSION

To be efficient in scientific and technical disciplines, Web Based Training platforms have to provide an homogeneous set of E-Learning resources (from e-courses, to e-labs, via virtual classrooms and e-projects). As theoritical content related resources benefit by an advanced research which has led nowadays to commercial products and emerging standards. Despite numerous independent realizations, E-Labs have not yet reached this stage but they can take advantage of this current e-content standardization movement to leave researchers focusing on how to homogeneously integrate specific e-lab platforms in standard LMS. We presented in this paper thoughts from a current study on how to harmonize specific e-lab functionalities with modern standardized LMS. This will permit us to focus on e-lab specific parts while supplying a good interoperability of e-lab platforms.

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