ECP-2008-EDU-428037

Curriculum Integration Report

Deliverable	*D6.6*
Dissemination level	*Public*
Delivery date	*2 December 2011*
Status	*Final*
Author(s)	*David Boehringer, Roger Watson*

e*Content*plus

This project is funded under the *e*Content*plus* programme[1],
a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable.

[1] OJ L 79, 24.3.2005, p. 1.

Contents

1. Introduction

In 2009, when the project was planned, this deliverable was expected to:

- summarize the experiences made within the consortium in disseminating online laboratories in the project partner's universities;
- lead to a set of instructions for integrating online laboratories into curricula;
- give indications for the portal services needed to support this.

In practice integration of online laboratories into curricula proved to be a time consuming process. We observed an extremely slow rate of uptake of the new media within faculty teaching, which still depends almost entirely on the individual teachers' opinion about the usefulness of online laboratories. Under the circumstances outlined above this deliverable cannot claim to present a "guideline for curriculum integration" that has been proven to be widely accepted in the partners' institutions. Instead it tries to show the status of the dissemination of online laboratories in education, as well as highlighting the cases where dissemination has been successful, resulting in successfully integrated content.

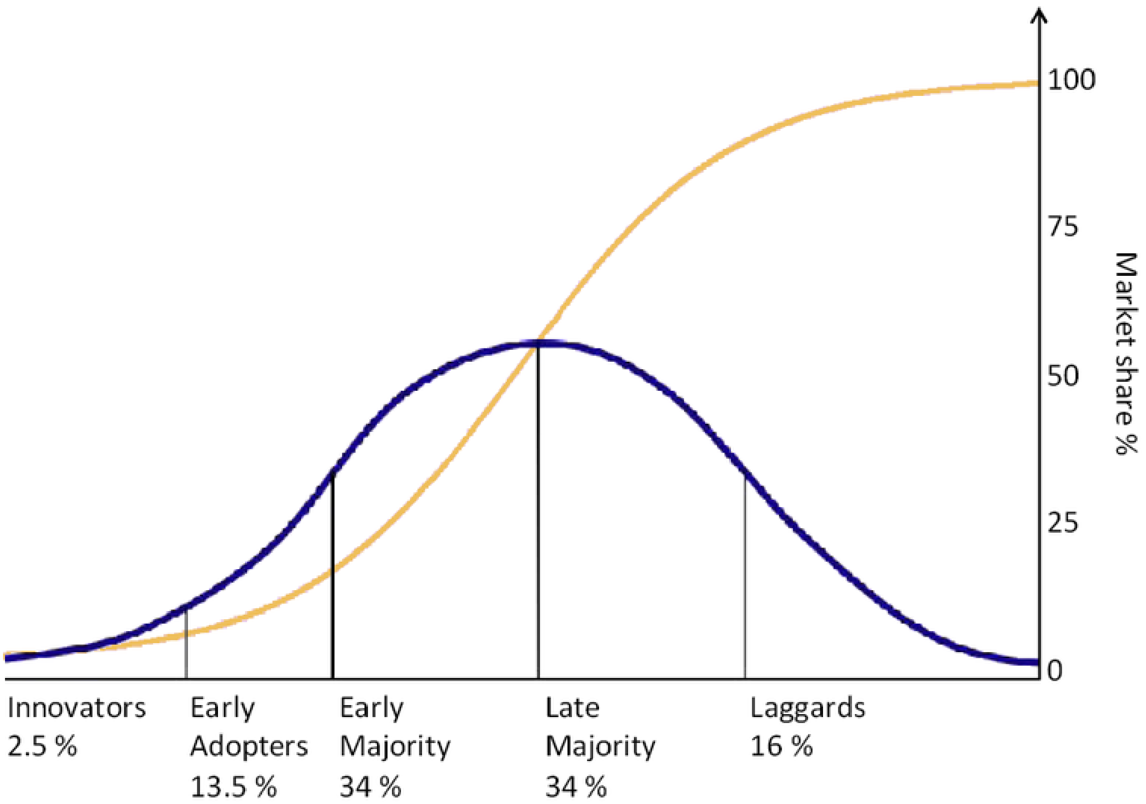
It must be made clear that "integration into curricula" is not connected with any written curricula in universities. The written curricula are usually kept very generic to allow teachers to choose the teaching methods and media for themselves. Furthermore, the decision on curricula is a lengthy process which should not be concerned with simple changes like the introduction of online laboratories instead of (or additional to) other learning content. When we use the term 'integration into curricula' we therefore mean the integration into the regular teaching of an individual lecturer, i.e. the repeated use of online laboratories year after year.

The importance of 'integration into curricula' was already made clear in the "Description of Work" (p. 3):

> "Since integration in curricula takes a very long time this will be an ongoing process over the next years. But integration in curricula is the best, if not the only forceful measure for the sustainability of eLearning … documentation and how-tos of the curricular integration [is thought to be] a great help for others who want to use the experiments in their education".

2. Status of Integration of Online Laboratories into University Courses

The spread of eLearning is often – and most convincingly – explained in terms of the "diffusion of innovations" as explained by Everett Rogers. Rogers defined five different categories of adopters (Innovators, Early Adopters, Early Majority, Late Majority, Laggards) and plotted the adoption of an innovation over time in an S curve (resembling a logistic function).



While not all of Rogers' definitions are transferable to any analysis which attempts to predict the spread of online laboratories in university teaching, the mentioned categorization is a helpful indicator of the stage in the diffusion process which has been reached.

In our experience, the diffusion of online laboratories is still at the start of the early adopters stage. Innovators are represented by the university teachers who have developed online laboratories themselves whereas the early adopters are the first teachers to use others' materials in their classes. A greater momentum towards diffusion to a majority could arise either from collective decisions of a faculty to use this kind of media or via higher-level decisions by deans to introduce it. This has happened in the diffusion of Learning Management Systems in universities, which have now become almost universal, albeit rarely used other than for the distribution of documents and eMail notifications. Interactive learning modules, social interactivity in learning, or online laboratories, are much more demanding for academic teachers and hence much less widespread.

Convincing an early adopter means convincing an individual teacher to adopt their teaching methods to make use of the new media available. The key indicators identified by Fred Davis' 'technology adoption model' are 'perceived usefulness' and 'perceived ease of use', complemented by 'social influence' (i.e. peer environment pressures) as defined in the 'unified theory of acceptance and use of technology'" (Venkatesh). Clearly, social pressure has not yet become a factor in the diffusion of online laboratories. Hence the following discussion will focus on 'perceived usefulness' and 'perceived ease of use'.

Usefulness

From the perspective of an assistant professor who is still seeking a permanent post, time investments in teaching are not generally a very good investment. Scientific reputation and a strong publication base ("publish or perish") are far more important than effort (or success) in teaching. The fact that online labs represent an innovative technology might nevertheless provide some attraction to teachers, adding to their reputation of being innovative.

Having established that the appeal to teaching staff is somewhat limited, any viewpoint on the usefulness of online labs must therefore be substantiated by other means. It has not been conclusively shown that online labs improve students' learning outcomes, although there is some evidence that they may be a good compliment to physical labs (Euan Lindsay). A more persuasive argument is that a lack of interactivity in science and engineering courses could be compensated for through the use of online experimentation. In our experience this problem was most apparent for very large classes, i.e. more than a hundred students. Under these circumstances, possibilities for interaction between student and teacher are severely limited; hence online experiments offer the possibility to engage them directly with the material of interest. By using remote experiments, at least some level of laboratory experience can be facilitated which would otherwise be completely absent. Teachers can also hope to increase the learning motivation of the students.

One attitude often encountered amongst science teachers was a tendency to emphasize laboratory experience in physical laboratories, combined with the preconception that the use of online laboratories would drive students away from real laboratory work; thus displacing an essential component of a scientific education. As long as this argument and prejudice is strong within the discourse of the faculty, promotion of online laboratories will be much more difficult.

It is ironic that one of the most important arguments for the use of remote experiments is the absence of the equipment.

In general, universities prefer to set up their own laboratory equipment instead of using the existing equipment of another institution remotely. Nevertheless, if development of in-house remote experiments is absolutely impossible, the openness towards using the equipment of another university is usually comparatively good. Hence the successful dissemination of remote experiments typically occurs not within a university, but between universities within a specific field.

Simulations are voluntarily used for the visualization of phenomena not observable in the real world (e.g. magnetic fields, phenomena on a molecular scale). This is also reflected in our online survey where "lecture demonstrations" featured as most popular scenario for the use of online labs. Simulations of this kind mostly allow the change of parameters the result of which can be viewed immediately, but no measurements. For the purpose of visualization they meet the demand exactly and are hence considered as useful.

The argument of ‘usefulness’ based on easy availability “every time, everywhere” was not prominent in discussion with lecturers.

Perceived ease of use

The most significant factor in the ‘perceived ease of use’ of online laboratories is the effort in time needed to integrate them into curricula. This does not just require new learning materials such as assignments to be developed; the whole procedure of teaching and learning has to be adapted to a more student focused and independent learning scenarios – which implicitly induces a paradigm shift in the way courses are run. This effort in time is seen as the most important obstacle to the introduction of online laboratories, even among teachers who are otherwise open and positive towards the idea. Thus, only a small proportion of those who are generally in favor of using online laboratories in their classes have actually implemented them.

While most remote labs and simulations are quite easy to use and teachers understand the principles and possibilities of an online experiment quite quickly, there are technical, organizational and political concerns about remote labs: will the client work for all students? How much support is required? Will the experiment be available when needed? Wouldn’t it be better to have our own remote experiment instead? If so, who would maintain it? Technical reliability of the experiment is also a potential issue, with apparatus such as the Cambridge Weblabs being under maintenance for as much as 25% of the year.

Simulations, especially those running on the client system, are often very easy to use, have a simple user interface, and can be used as lecture demonstrations as well as part of learning assignments without much training effort by the students. Hence they are most often used in first year undergraduate classes. Nevertheless their integration into curricula takes significant time and effort for the teacher.

The observations made during the LiLa project are not unique to the LiLa project partners’ universities; or indeed European universities in general. The recently published “National Engineering Laboratory Survey: A Review of the Delivery of Practical Laboratory Education in Australian Undergraduate Engineering Programs” (Thorsten Kostulski, Steve Murray) produced very similar results which are also reflected in a recent article of the Australian Labshare team (Steven Tuttle et al.).

3. Case Study: The Cambridge Weblabs

The Reactor Weblab at Cambridge University has been used for six successive years to teach 3rd year chemical engineering students about chemical reaction engineering, as well as exposing them to an industry-standard operator interface. The apparatus has been successfully integrated as a permanent part of the curriculum at Cambridge, but is reliant on industrial backing and synergy with other projects in order for it to be sustainable. Although many external institutions have used the Weblabs for one or two successive years, a full integration into the curriculum has not been possible at these institutions for a variety of reasons, including:

- Staff changes at the user institution, with the new staff member lacking motivation to continue using the weblab,
- Staff changes at the host institution, resulting in discontinuity in the working relationship between institutions,
- Difficulty in adapting assignments to the curriculum of the user institution,
- Failure of the Weblab instrumentation,
- Security concerns due the ActiveX plugins required to use the Weblab,
- Difficulty in managing access for a large number of external users.

It is hoped that the LiLa portal will address many of these concerns, following the first successful internal use of the Weblabs within the portal in autumn 2011. It is not immediately possible to say whether or not the services provided by the portal are sufficient to facilitate full integration into curricula for external institutions.

4. Consequences and Measures

The following table summarizes the key issues discussed in section 2 and shows what measures were taken by the LiLa consortium to promote the integration of online laboratories in curricula.

Issue	Measure	Level	Nature	Status
Scientific reputation	Make online experiments quotable in publication lists	LiLa portal	Service	Prototypically realized
Reputation for innovators	Establish teaching awards in university	University	Organisational	Suggestion; has to be realized at a local level
Learning outcome	Promote the collection of surveys on learning impact	Global	Collection of information	Started in context of the "Educational Committee" of Global Online Laboratory Consortium (GOLC)
Added value of online labs	Collect good practice examples in a structured way (LiLa case study format)	LiLa portal and global	Collection of information	Collection completed; to be published on LiLa portal Transfer to GOLC community as "GOLC narrative" in progress
Impact on student learning motivation	Collect questionnaire results about learning experience (LiLa student questionnaire)	LiLa portal and global	Collection of information	LiLa student questionnaire completed; results to be published in articles and on portal Collection also started in context of GOLC
False perception of online labs	Include learning objectives in description of good practice	LiLa portal and global	Collection of information	In progress in context of "GOLC narrative"
Time effort for creation of learning material	Support exchange of assignments and lessons	LiLa portal	Portal functionality	Realized for assignments; in preparation for lessons
Technical reliability of lab access clients	Work on technological solutions for web access to labs	Local solutions centrally published in LiLa portal as SCORM packages	Self service and Service (if time allows this)	Realized for all LiLa partners and selected partners outside the consortium

Reliable availability of remote labs	LiLa booking system	LiLa portal	Functionality	realized
Assistance for remote lab setup	Provide blueprints of remote lab setup	LiLa portal and global	Collection of information and service	Not realized

5. Literature

Everett Rogers 1983 (first published 1962), "Diffusion of Innovations".

Fred Davis 1989, "Perceived usefulness, perceived ease of use, and user acceptance of information technology", MIS Quarterly 13(3): 319–340.

Viswanath Venkatesh et al. 2003, "User acceptance of information technology: Toward a unified view", MIS Quarterly 27(3): 425–478.

Thorsten Kostulski, Steve Murray 2010, The National Engineering Laboratory Survey: A Review of the Delivery of Practical Laboratory Education in Australian Undergraduate Engineering Programs, Selected Outcomes, Labshare December 2010 (available at http://www.labshare.edu.au/media/img/labshare_report_panel_website.pdf).

Steven Tuttle et al. 2011, A Survey of Issues and Approaches to Remote Laboratory Adoption by Teacher-Academics, in: 41st ASEE/IEEE Frontiers in Education Conference, GOLC Workshop, October 12 - 15, 2011, Rapid City, SD.

Euan Lindsay and Malcom Good 2005, Effects of Laboratory Access Modes Upon Learning Outcomes, IEEE Transactions on Education, 48(4): 619-631.