

Challenges in the wider adoption of EML/LD: two exploratory case studies

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Dai Griffiths, Josep Blat, Rocío García, Sergio Sayago, Francisco Casado, Juanjo Martínez

Introduction

This case study presents the conclusions drawn from the creation and evaluation of three Units of Learning by the Interactive Technologies Group of Universitat Pompeu Fabra (UoLs). They were developed using Education Modeling Language (EML), and trialed in both distance and blended learning. The focus of the work reported was on evaluation of EML as a possible solution for two contexts: a distance education course, and online support for face to face education. While our conclusions address the suitability of EML for this purpose, we are very much aware that this is determined to a substantial degree by the tools used to create and deliver the Units of Learning. Consequently we report extensively on this aspect of our evaluation.

We provide a brief description of the purpose of the UoLs, and the development process, and then focus on our reflections on the outcomes, drawing on usability studies and feedback from learners. In particular we discuss the constraints which limited the adoption of the solutions, principally the difficulty of the authoring process. We conclude with reflections on the need for tools which can support users in making use of the wide range of opportunities opened up by the EML/LD specifications.

The Units of Learning Developed

The Units of following UoLs were developed:

a) The two *SCOPE UoLs*. These constituted the prototype for a distance learning continuous education training course for medical specialists, created within the SCOPE project and funded by the eContent program of the EC. We acknowledge the essential contribution made by our partners, particularly the publisher DOYMA, and the Hospital Clínic Barcelona, and the technical support generously provided by Perot Systems, Netherlands. The SCOPE project took content from a medical journal and repurposed it for web delivery, establishing the G&H Continua-da service.

The *aim* of the SCOPE UoLs was to add further value by re-using these resources in educational activities, and they constituted the prototype for an on-line continuing education course for medical specialists.

The *objective* was to demonstrate reuse of resources in different contexts by separating educational resources from pedagogic structure, assess the effort involved, and carry out a small-scale evaluation of the end-users responses.

The *work carried out* included the creation of two parallel UoLs with two pedagogic approaches: the traditional "read and test", and "problem based learning" (PBL). This chapter assumes a basic understanding of PBL in the sense used by (Barrows, 1980) in a medical setting, and by (Waters and McCracken, 1996) in a computer science environment. Both UoLs used the same learning resources, to demonstrate that the UoLs could function as pedagogic templates

for use with learning resources. The development process was evaluated, and small scale trials were carried out with users.

b) The *Interface Design UoL* was designed for a contrasting environment: an on-line complement to a face to face second year degree course in Interface Design at Universitat Pompeu Fabra. Many teachers have questioned the added value of LMSs as a support to presential learning, over and above that provided by the Web. This trial UoL was prompted by the perception that EML and LD might have value in this respect, as they are fundamentally oriented towards pedagogy. It constitutes an initial cost / benefit analysis of the advantages and effort involved in using LD for supporting face to face classes. The authors are aware that the EML specification was not developed for this purpose, but we wanted to explore its potential contribution, in line with Raymond's aphorism "Any tool should be useful in the expected way, but a truly great tool lends itself to uses you never expected" (Raymond, 2000, p.16).

The *aim* of the Interface Design UoL was to test the quality and usability of existing tools, and the cost required for learning and using them compared to the benefits for teachers and learners.

The *objective* was to blend a small portion of a typical subject with an on-line UoL, assess the effort involved, and carry out a small-scale evaluation of the end-users responses.

The *work carried out* included creation of an EML UoL to support face to face teaching of a topic in a face to face course in interface design for undergraduates. This was used with a cohort of students, and a questionnaire administered.

Developing the UoLs

All three UoLs were created using the LD Editor and delivered using Edubox, and we thank Perot Systems Netherlands for providing us with free access to these tools, and technical support. The UoLs were created using EML, because the LD specification had not been published when development started (November 2002). The pedagogic framework for the SCOPE UoLs was established following discussions with experts in the field from the Hospital Clinic. The UoLs were designed taking into account our target users, final year students and professionals in hepatology and gastroenterology. The UoLs offered two learning paths: problem-based learning (PBL), and a traditional "read and test" approach. Both paths were designed for single learner interaction.

The course was designed in such a way that the first action of the user was to select one of the learning paths. The traditional approach consisted of the completion of questionnaires and consult scientific articles. The PBL path consisted of the completion of several stages, each of which presented the user with a specific problem and a number of possible solutions. Both, diagnostic and therapeutic competencies, were tested in the PBL path.

Metadata was added for each piece of information inside the EML, in order to support the definition of reusable learning objects in a range of granularity, as described by Duncan (Duncan 2003). This was done for the whole course, the different learning paths, the scientific articles and every individual question and questionnaire. Each of these items was considered potentially reusable for eLearning in the context of a medical publishing company. The scientific articles were reused from the electronic medical journal service provided by the publisher. As first step towards promoting reusability these articles were disaggregated from the journal, and each in turn disaggregated in three types of resources: the article itself, the bibliographic references and key related issues, as discussed by Koper (Koper 2003). The UoLs were duplicated in HTML, which provided the opportunity for early user feedback, on the interface and look and feel, before access to the player was available.

Reflections on the development process

The editing environment

The three UoLs were implemented by technical staff using a Beta version of the Perot LD-Editor² which was kindly made available by Perot Systems Netherlands. This tool presents the structure of an EML document to the author, who can edit the various elements directly, facilitating navigation through the document, and helping to produce valid EML. Two usability evaluations of this tool were carried out: a semi structured interview with two EML editor users and a heuristic evaluation, following the method established by Nielsen (Nielsen 1992, 1994; Mack and Nielsen 1994). The conclusions coincided in indicating that the chief determinant of the usability of the application is the way in which it closely reflects the specification itself. The interface is designed using the same terminology as the standard and the relationships between EML elements are directly mapped in the interface. This makes the interface demanding to use for two reasons³:

- the user must have a deep knowledge of the specification, in terminology and structure, before starting,
- there is no way of conceptualizing a course or UoL design independently of the specification.

While these issues may not be a problem for the LD-Editor's target users, who are technical experts, they mean that a tool of this type is not appropriate for the content experts and authors, such as those who in the preferred workflow for the SCOPE course would have authored the UoLs which we produced. If such users are to be able to use authoring tools, then the terminology used in the application should not depend on that used in the standard. At the same time the underlying structure of the concepts should be maintained, so that the system is effective for both novices and experts (who will recognize the concepts underlying the day-to-day vocabulary).

These design principals were applied within SCOPE in the development of QAed⁴, an Open Source tool for the authoring of tests and questionnaires using IMS QTI-lite (IMS 2001). This tool is centered on the practice of creating tests rather than on the structure of the specification. It provides support for the usual workflow of the teachers when performing this type of tasks; the specification details, and how the support to the standards is performed is hidden from the user by means of offering a comprehensible terminology, which is closer to the users, and mapping into the user interface the structure of the specification. The QTI specification is much less complex than LD, but the application provides a simple case which shows the approach which we recommend for the development of IMS-LD tooling addressed to non technical users. Our experience in developing QAed indicates that developers should consider if the focus of an editing tool is a specification or rather the teachers and learners workflow. This might involve a combination of different specifications, but the author need not be aware of the fact. The IMS QTI and IMS LD specifications are not designed for teacher and learner centered approaches to course development, and so their suitability for this purpose is not a criteria for their success. Nevertheless, we believe that this context is important for authoring tools working with these specifications. Even in content publishing contexts, such approaches could be useful for promoting participatory design jointly with teachers and learners while content authors are developing learning scenarios.

² The Perot editor generates EML code, but is called “LD Editor” because it is planned to provide the capability to convert EML to IMS-LD.

³ It should be stressed that a Beta version of the LD-Editor was used

⁴ QAed is available for download at <http://www.tecn.upf.es/gti/leteos/newnavs/qaed.html>.

The expert users of the LD-Editor identified some additional features which would have assisted them in their task, which may be generalizable to other editors which work close to the specification.

- Feedback indicating what information will appear in the player would be valuable, for example by distinguishing visually between elements which will appear in the rendered UoL, and those which will not be rendered, but which are required to enable the system to work. Similarly the user interface should distinguish between mandatory and non-mandatory elements.
- The authors requested access to an HTML editor during the design process, so as to avoid entering HTML by hand, and so creating the possibility for errors. In the Valkenburg Group architecture a separate materials editor is foreseen, so the solution would appear to be an integration of the materials editor and the IMS-LD editor.
- Even for expert users, if all the navigation related to the creation of activities, environment, roles, etc. is located in the same menu, then the learning curve may be steep. A modular approach is an alternative possibility.
- As a general principal for such applications, all authoring actions which can be carried out automatically, such as keywords or identifiers, should be automatic, so as to reduce the cognitive load on the user. Similarly the UI should indicate to users how to fill in the fields, for example by offering default values.
- The UoL authors found that there was a lack of support in Edubox for the representation of the specialized symbols required by mathematics and scientific subjects. This was resolved by the use of images inserted in the text, but a better solution would be the use of a widely recognized specification, such as the W3C recommendation MathML⁵. Developers of players should be aware of the need to incorporate such functionality.

Delivery and evaluation of the UoLs

All three UoLs were delivered using Edubox⁶, which is described in Chapter 16 of this Volume⁷. Support for Spanish was added to the Edubox system through the creation of an XSLT stylesheet, demonstrating its extensibility.

Evaluation of the SCOPE UoLs consisted of four sessions with individual physicians, some of them post-graduate students, who had extensive knowledge of the subject matter covered by the UoLs. As the UoLs were intended for continuing education for medical professionals, these users were a close match to the intended learners. The focus of the evaluation was on the usability of the course user interface and the UoL designs. Questionnaires were designed and administered to users before and after the trials, gathering information on the background of the users (pre-test) and their impressions after using EDUBOX and the UoLs (post-test).

In addition to the questionnaires a “talk through” evaluation was also carried out. A list of tasks to be carried out by trial users was prepared, which were typical of learner actions when using the UoLs. The users were asked to “think aloud” while following the requests of the evaluation monitor, and were video recorded for subsequent analysis. For example, the protocol for one task was:

- The first step is to select one of the two learning paths. Could you tell me if you understand what these two learning paths are about?
- Please try to complete the first level of the problem-based learning.

⁵ For more details about MathML, see <http://www.w3.org/Math/>

⁶ Again provided by kind permission of Perot Systems Netherlands. The SCOPE UoLs are currently available at: ouserv3.perot.nl/edutool/EduToolController (Edubox version), www.tecn.upf.es/gh/ (HTML version)

- Do you understand the relationship between the “tools and resources” and the “to do” panel?
- Are the icons comprehensible? To what extent?

The Interface Design UoL was used with a class of students who all attended a face to face class which covered the same material as that in the UoL. During the labs they used the UoL for half an hour, and were then asked to fill in a questionnaire. The responses of the teacher and the UoL editor were also evaluated. The following sections discuss the outcomes of the evaluations.

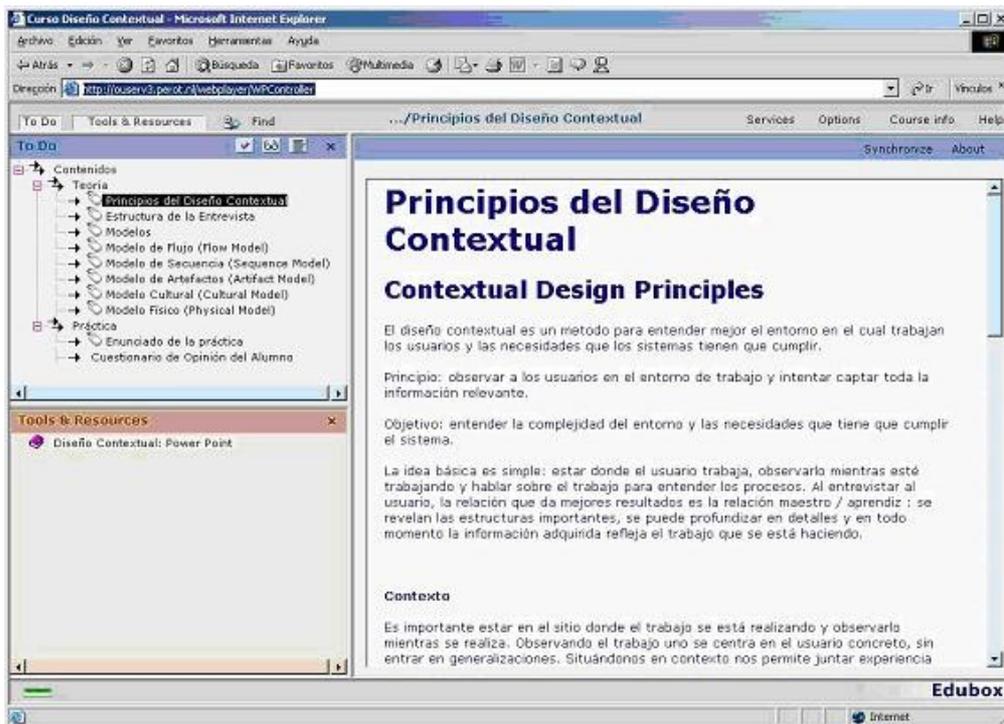


Fig. 1. The Interface Design UoL opening screen in Edubox.

Reflections on UoL delivery

In both the SCOPE and Interface Design UoLs the interface of Edubox was usable, in that it did not constitute a barrier to use of the application, but certain issues were, however, identified.

Terminology and choice of learning routes. The response to the organization of the two learning routes in the SCOPE UoLs was positive (suggesting that pedagogic flexibility is valued by the users). They chose the traditional read and test methodology learning itinerary, rather than the problem based learning itinerary for skills development. The reason for this was a salutary reminder for course authors: the learners reported that they not really understand what “modelo para el desarrollo de competencias” (skills development) was, and so they stayed with the more familiar sounding “modelo instruccional tradicional” (traditional instructional model).

This underlines at the level of the user the need to avoid technical language and terminology which we also identify at the authoring level. This is an especially difficult issue at the European level, as, for example, the concepts of competencies and skills would be more familiar to learners in some other countries⁸. It also reminds the author that the adoption of more sophisti-

⁸ This may in part be a problem of translation, and in later versions of the UoL the Spanish equivalent for Skills Development was changed to “actualización / revision de conocimientos”. Nevertheless it

cated eLearning pedagogies is not simply a technological issue, but also one of culture and practice.

Reflections on the use of EML for supporting assessment as part of the learning process.

EML proved to be sufficiently flexible to model assessment as well as learning processes. In the medical case study, for instance, the corresponding assessment scenarios were implemented using EML as well as the IMS QTI Lite specification, and both specifications were satisfactory. In the other implemented UoLs, however, our conclusions identify shortcomings in the IMS QTI Lite and ASI (IMS 2001) specifications when trying to describe some common assessment scenarios such as the Question Item Bank (QIB). Question Item Banks are considered in the sense used by (Bull and Dalziel, 2003), i.e. as collection of items which can be used to construct assessments through the selection of questions based on various predefined criteria according to the appropriate assessment scenarios envisaged. While QIB is supported by IMS QTI ASI specification, important features for its practical use, such as the overlap exclusion requirement, are not supported, as described by Garcia Robles (Garcia Robles et.al 2004). Overlap exclusion means, in simple terms, enabling some questions to force the removal of other questions. As stated in the Assessment Chapter, there are also other advanced assessment scenarios such as peer to peer, self-assessment or group-work are not supported by IMS QTI ASI and Lite specifications, but IMS Learning Design can be used if the assessment is to be integrated into the overall learning process.

Representing activities and resources. One open question identified by users was the best way to represent activities and resources. In the SCOPE UoLs there were many scientific articles associated for each learning activity. Edubox showed these articles as a list, and uses icons to distinguish between the different states which they are in at any time (such as "consulted", "passed", "pending", etc.). User comments suggested that they would prefer to see the activities which they need, at any moment, and not the whole set of activities. For example, at the beginning of the course only the main activities could be shown (activity structure, choice activities,...) and subsequently, only the activities related to the main activity selected, etc. It seems that in this case the more information which they were shown, the less useful it was.

If UoLs are to be reusable, they should be created independently of how the player will represent the course. However, if these suggestions were to be implemented, and a variety of possible player renderings of the same UoLs were available, it would raise the issue of how the UoL author could predict the interface on different systems. This is why a reference runtime player will be of significant importance to the implementation of Learning Design. Working within EduBox, the author of a UoL has the responsibility of modeling the learning process in such a way that this overload is avoided.

Similarly users suggested that the resources associated with each activity could be classified using folders which were related to one question (which is the meaning of... according to the study of X and Y), questionnaire, or activity, It was also requested that content which had become available as the learner progressed should be flagged. One possible approach to this request would be to use nested environments.

There is probably no single best way to represent activities and resources, but we note this issue as one which should be borne in mind in authoring and rendering UoLs. To provide flexibility in this respect it might be advantageous to provide preferences which could be set by the learner, or by the course administrator.

highlights the problem of translating some educational concepts, which can hinder the reuse of UoLs across cultures. The issue of multilingual educational terminology is being addressed by CEN ISS. This is valuable, but does not resolve the differences in practice and concepts which underlie the differences in terminology.

The meaning of icons and menu items. In the Interface Design UoL about half the students who answered the questionnaire stated that the EduBox icons were understandable, if not at first glance, then with the help of the contextual help (text which appears when the cursor is placed above the icon), but the majority of the users felt that the meaning of the icons could be clearer. Similar results were obtained from the four “talk-through” trials of the SCOPE UoLs.

The students in trials of all UoLs were generally in agreement that the functionality of the modules was clear, but they again drew attention to the terminology used was not always immediately clear, and could be improved. In the “talk-through” sessions for the SCOPE UoLs one interface feature relating to this issue was identified: in the menus "Actividades" (Activities) and “Herramientas y recursos” (Tools and resources) the items shown in the latter depend on the activity selected in the former, and this was not immediately apparent to users. Once the evaluation monitor had helped them grasp this idea the use of the menus presented no problems.

It should be added that the responsiveness of the UoLs in all trials was rather low, which was a function of the performance and connectivity of the server, rather than the software used. This may have caused doubt in the mind of the user as to whether they have chosen the correct action.

General reflections. These results suggest that both the software used, and the particular UoLs which we developed could be improved in various respects. We conclude, however, that the questions identified in the evaluation of delivery of the UoL all reflect the same underlying issue: it is hard to represent Learning Design structures to learners in a way which is immediately comprehensible. There is no reason to suppose that this is the result of a structural problem in EML or LD. Rather it is a function of a lack of an established body of practice and feedback from users. LD has been developed to encode the essential elements of a pedagogic approach in an iterative process lasting a number of years, and we believe that a similar iterative process will be required to develop the best approaches to representing this encoded model both to learners and to teachers, and the applications which make this possible.

The HTML version of the SCOPE UoLs closely followed the look and feel of the G&H *Continuada* journal which provided the learning resources used. It did not prove possible to reproduce exactly the HTML version exactly in the Edubox version. A particular limitation was that the frames are not resizable and do not have a scroll bar. This would not be a problem for many implementations, but in the context of SCOPE this was significant, because the publishing partner wanted to extend the look and feel of the journal to the continuing education course which is based on it.

The effectiveness of the solutions developed

The conclusions regarding the effectiveness of these two prototype applications were essentially the same: the effort involved in creating the UoLs in this context, and with the current tool set, is too great to justify the benefits which come from the use of EML. This similarity, however, masks substantial difference between the two contexts, both of which make use of different subsets of the functionality offered by EML.

In the SCOPE UoLs, the learner interactions required by the system are relatively straightforward. There is a single learner, completing a series of learning tasks, and being evaluated with a multiple choice test. There are no services being called, and there is no collaborative learning. In these circumstances something similar could be created using a simpler standard for which more mature authoring tools available. In this context the added value of EML is limited, main-

⁹ Screen shots from the two applications are available at www.tecn.upf.es/scope/showcase/training_course.htm.

ly being the ability to adapt to a more flexible pedagogic structure if that should be required. In practice, however, changes are likely infrequent, because pedagogic decisions are not taken by teachers, but for the entire program. Similarly, the business model for resource sharing is primarily envisaged as taking place within a single publishing company.

For EML / LD to be a viable solution within this context, tools would be required which simplified the task of producing pedagogic templates for a relatively unchanging set of UoLs, and, more importantly, for editing those templates to include new learning resources, etc. A tool for editing the smallest possible effective subset of metadata descriptors would also be necessary¹⁰. At present such tools are not available off the shelf, and although producing the templates would be possible using present tooling (as the SCOPE UoLs showed), the maintenance tools would have to be created specifically for this purpose at considerable cost, or a technical expert would be required to carry out this function on a regular basis.

The limitations mentioned above on the presentation of the course in EduBox (the only player available) were also a significant factor for the publisher. This could no doubt be adjusted in the EduBox application, but again would cost money which cannot be justified by the benefits of using EML / LD. In the current state of tooling, therefore, EML / LD was not a cost effective solution for the SCOPE prototype, given that the project did not need to use many of the more sophisticated features of the specification.

The teacher involved in the trial of the User Interface Design UoL was enthusiastic about the technology when it was first explained to him. However this enthusiasm turned to skepticism when the effort involved in creating the UoL became clear, requiring lengthy work by a team of experts. In particular the features which offer a clear advantage over the (such as learner tracking, and communication tools) are those which are most time consuming (and hence expensive) to implement, and which can be substituted in a face to face environment by direct contact with learners. Moreover the aspects of reuse, and interoperability of content, are also expensive both in terms of planning and implementation, and are outside the traditional role of the teacher in the face to face university environment. We conclude that at present work with EML and LD has to be carried out with support of specialized centers, which cushion users from the difficulties. The high cost of such a service could be balanced against other strategic factors to make the use of EML/LD in a blended environment an attractive option.

The existing traditional teaching context constrains the use of the technology just as much as the technology constrains teaching practice. In our case this was fundamentally a lecture and practical work with on-line documentation, and for this purpose the learners noticed little change with the introduction of a UoL. To explore the wider potential of Learning Design teaching practice would have to change, along with the role of the technology within it, and this is not an easy task. The evolution of mixed presential and on-line learning programs might well enhance the cost effectiveness of EML/LD within traditional education, as would tools which are easier to use by an order of magnitude. In this case the valuable focus on flexible pedagogy, and the ability to support multiple users, would become convincing features.

Conclusions

The SCOPE UoLs achieved their objective of demonstrating reuse of resources in different contexts, with the educational resources separated from the pedagogic structure, confirming the suitability of EML (and by extension IMS-LD) for this purpose. The UoLs constituted a template for the creation of the continuing education course, which facilitated the aim of reusing

¹⁰ The increasing demand for tools for editing the smallest possible effective subset of metadata descriptors was one of the conclusions of the POOL project (www.edusplash.net/) in Canada.

published resources in educational activities. This was not developed and tested in a full scale implementation because of the lack of suitable tooling. The essential tool required for the specific needs of SCOPE was a specialized editor, enabling teachers to adapt UoLs within the pre-defined pedagogic framework without the assistance of technical experts. A desirable tool for this publishing context is a specialized player, which preserves the look and feel of the G&H Continuada service, and meets the needs and preferences of a specific learner group.

The objectives of the Interface Design UoL were also met, and the UoL was used successfully with a cohort of learners as a support for a face to face course. In our particular case the added value provided by the use of EML as opposed to HTML was not significant but the result may not be generalizable to other pedagogies. The effort involved in developing the trial UoL was considerable, and prohibitively expensive for providing support for courses developed by individual teachers. This is no doubt why EML in the past, and now IMS-LD, have not been used beyond the context for which they were designed: distance learning institutions which have a clear need to exploit its ability to model a wide range of pedagogic approaches, or to use its capability to coordinate multiple learners. Our small scale study suggests that the use of IMS-LD in blended learning will not be possible unless, firstly, new tools are provided which teachers can use without the help of technical experts, and secondly the pedagogic context adapts in order make use of the capabilities of the new technology. Now that more flexible and varied tooling for IMS-LD is becoming available the first of these conditions may soon be met. The second condition may be more intractable and is likely to be the subject of extensive future debate and research.

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