Obtaining Adaptation of Virtual Courses by Using a Collaborative Tool and Learning Design

Luisa M. Romero-Moreno, F. Javier Ortega and José A. Troyano
Escuela Técnica Superior de Ingeniería Informática, Universidad Sevilla
mariaro@lsi.us.es, troyano@lsi.us.es, javierortega@us.es

Abstract

In this work is described a collaborative tool Learning Activity Management System, LAMS (Macquarie University, Australia) which has been developed for designing, managing and delivering online collaborative learning activities. It provides teachers with a highly intuitive visual authoring environment for creating sequences of learning activities. These activities can include a range of individual tasks, small group work and whole class activities based on both content and collaboration. Then a methodology to apply this tool is described.

Keywords: Learning Design**,** Collaborative Learning, Learning Object, eLearning, Adaptation, Virtual Courses, Ontologies

1. Introduction

The main aim of this work is to review the concept of Learning design (LD) and to evaluate the tool LAMS (Learning Activity Management System). We ask ourselves what it is *new* in the virtual education and we try to identify key characteristics of *successful* online teaching and learning experiences. We point out that educational changes tend to emphasize context versus content and the group versus single learner environment. In this point of view we analyze whether and under what constraints collaborative learning is more efficient than individual learning.

Computer Supported Collaborative Learning (CSCL) is not only a frame which has positive effects on the students. Collaboration is a complex social structure in which two or more people interact with each other and where some interactions occur with interesting effects.

In the educational community, some people use collaboration and cooperation interchangeably. Cooperation is a division of the labor among participants, into activities where each person is responsible for a portion of the problem, whereas collaboration is a mutual engagement of participants in a coordinated effort to solve the problem together.

Re-usable content has been always a goal focus of *eLearning*, although the present practice of re-usable content remains limited. One cause might be that re-usable content is based on a single learning experience, whereas much of education is collaborative. A contribution comes from Learning Design (LD), which focuses on sequences of collaborative activities that can be captured, stored, adapted and re-used. Learning Designs are not only digital text documents, but rather a *set of instructions* so that software systems can instantiate supporting environments such a class forums, according to the requirements of a digital lesson plan.

From our point of view, there is absence (in present *eLearning* systems) of a pedagogic model that includes these ideas, and it is necessary to analyze new tools and to develop methodologies that are capable of taking advantages of the virtual systems of formation. In essence, *eLearning* technologies have done well at emulating the library, but have far to go in emulating the creativity of a classroom. The way teachers re-use and adapt their lesson plans has no good analogue in existing *eLearning* technologies.

The paper starts with a discussion on the uses of Computer Supported Collaborative Learning (CSCL), the concepts of interaction and participation in a learning context and the Artificial Intelligence methods applied to the construction of CSCL systems. We conclude with the need to develop new tools and methodologies.

Then we describe the tool (LAMS V 2.0), and the concepts of Learning Design and Learning Management System (LMS) integrations. These integrations make easier the selection of LAMS “sequences”. We put special emphasis on the capacity of LAMS sequences which are created in one course and can be re-used or adapted for another course, or even shared with colleagues anywhere.

Finally a formal methodology is described. Using a LMS that integrates LAMS, we describe a method by means of the definition of constraints to design a virtual course. This method integrates Learning Objects, repositories of Learning Objects and Learning Activities. A reference guide is presented in order to help the teachers to design their courses.

2. Learning Design and Learning Activity Sequences

LD is one of the most important challenges in *eLearning*. It is the subject of study and/or implementation in a growing number of academic forums. But this concept is not a new idea. In a traditional context, many teachers and lecturers may engage in the process of learning desing as part of their work or lessons.

The most important idea behind LD is that students learn more and better when they are actively involved in doing something [1]. In this way, learning activities can be sequenced in a *learning workflow* in order to provide more effective learning. Furthermore, it would be advisable that learning activities were able to record *learning designs* for sharing and re-use in the future.

In essence, LD is a name given to a new field of *eLearning* technology. It can be defined as a sequence of collaborative learning activities and it can incorporate single learner content, but also collaborative tasks such as discussion, voting, small group debate, etc. LD can be stored, re-used, customized, etc.

While learning is a process of intellectual construction that humans perform naturally, learners are not equally capable of effective and efficient learning on their own. On the contrary, more of them need several levels of guidance and support. Excellent teaching involves methods for motivating and encouraging students with well-designed materials. There are pedagogical techniques which emphasize on providing activities for learners to practice either in groups or as individuals. These techniques provide to construct deeper, agiler and efficient learning. These may be in the form of discussions, simulations, quizzes, role-plays, problem-solving exercises or meta-learning tasks such as minds-maps.

Another feature of successful teaching is to give more relevance to the sequential order and timing of the various activities and the presentation of the resources needed to support them. In the school sector, this *flow* is known as lesson planning; in universities it is present as the basis for tutorials and seminars. In order to instantiate this core educational requirement in an *eLearning* environment, we need to provide a metaphor of the teaching process that is akin to a flow of (often collaborative) tasks over time; rather than a webpage with links to resources.

The recent trend within *eLearning* has been to focus on a quite narrow set of learning activities that can be easily managed with a browser-based Virtual Learning Environment: “read this content”, “do this multi-choice quiz” etc. Part of the goal of LD is to help in the construction of the set of activities that are used to support a complex learning process in an *eLearning* context.

From the Learning Design arises Learning Activity Sequence by capturing the core of education process rather than simple content. We emphasize the collaborative aspect of the use of this educational technique and the powerful feature of the Learning Activity approach. In this model the content of a sequence can be modified to suit a different subject, while leaving the activity structure without changes. In addition, the didactic template itself ought to be modifiable, if a teacher desires to add, remove or modify activities from the template. Furthermore, *Learning Objects* or their *repositories* can be introduced in a *sequence of collaborative tasks*.

LD can be studied at three levels. The Table1 provides a classification of them:

LD Theory	The theoretical framework can describe both individual and group *eLearning* tasks
	The theoretical framework allows sequences of activities to be formally described, and hence captured, stored, shared, re-used and adapted
LD Standards	There are some attempts of formalizing the theory LD into a machine-readable technical standard documents
LD Software	There are a number of software tools in use or in development that are based on LD

Table 1. Three levels of LD

2.1 Learning Design and EML

A predecessor of LD is Educational Model Language (EML, 2000). It is an open learning technology specification which has been designed by the Open University of the Netherlands (OUNL). OUNL is a project supported by the Dutch national government which works on learning technologies with the goal of innovating education through the use of the computer. EML has been designed as a mean to support re-use and interoperability. The main contributions are prototypes, specifications and publications. OUNL research is academic and independent of any seller.

The language is a comprehensive notational system which has been designed to provide a method of describing the interactions in an educational context at a high level of abstraction. EML described not just the content (texts, graphs, tests, exercises) but also the roles, relations, interactions and activities of students and teachers.

EML allows to codify *units of study* in an integral way. This language and conceptual ideas behind it have evolved and have gained world-wide acceptance in the shape of the IMS-Learning Design.

EML is an XML based language, what guarantees that investment in content will last for a long time; because of the uniformity of notation and reusability that it brings. EML permits to model a variety of pedagogies for education. One may use EML to model problem based learning, self study packages, competence based pedagogy or even traditional face-to-face teaching.
EML version 1.0 was published in December 2000 as a free and open format for external use in education. After some years of internal development, companies and schools had been involved in pilot process.
The OUNL team became major contributor to the IMS Learning Design Working Group. This work led to the recent production of the first version of the IMS Specification Learning Design. The goal of this specification is to establish a digital format for encoding learning designs. But there are some differences between LD and EML. The most important thing is to understand that IMS – LD was designed in order to work with other IMS specifications such as Content Packaging Metadata.

2.2 IMS-LD Specification

From the standards/specifications point of view, IMS Global Learning Consortium has developed the IMS Learning Design based on EML, a formal language to describe meta-model of instructional design. A lot of important thing on Learning Design proceeds from a desire for adaptation and re-use.
The main reason for implementing a standard for LD is to make digital information encoding designs consistent and thus both transportable and re-usable in different software tools. Technically a *Unit of Learning* is the same as *IMS Content Package* of *IMS – LD*.
IMS – LD Specification is composed by three documents which are described in Table 2. One of them, *The Best Practice Guide*, introduces a sequence of steps that guide the development of LD for a unit of learning:

- To describe the learning objectives and activities
- To specify the course planning using UML activity diagrams
- To develop the content (resources) and, finally, to develop a content package that incorporates LD

XML Binding Document	Technical Document detailing how learning design elements are represented in XML
Information Model	This information is provided to add value to teaching and learning practice in *eLearning*
Best Practice Guide	

Table 2. Interrelated documents of IMS-LD

Besides IMS – LD, there are other standards and specifications which are important for the LD theoretical framework. These are ISO SC36 Group 2 on Collaborative Learning; the proposed extensions to SCORM to allow for inclusion of a multi-learner activity; business process and workflow efforts from result the educational sector (BPEL and WFDL); and the original design of EML V 1.0.
The core component of LD defined by IMS – LD working group, derived from the primitive concepts performed by Koper and colleagues in their work on EML is the *Unit of Learning* or *Unit of Study*. This is a unit which satisfies one or more learning objectives (a course, a lesson, an activity such as a group discussion).
Table 3 represents the elements need to be described in an IMS – LD for a unit of learning:

Roles	Learners
	Staff (Specific individual are not a component)
Activities	Learning activities
	Support activities
Learning Objectives	One or more Learning Objectives
Activity-structures	Activity-structures permit to aggregate activities
Environment	Learning Objects (URL, etc.)
	Services (Discussion Forums, etc.)
Resources	Web content
	IMS – LD content
	Person
	Service facility
	Dossier
Method	- Play which contains a Sequence of Acts - Each act contains Role-Parts - Each Role-Part associates a Role with a Activity or Activity - Structure

Table 3. Morphology of Learning Design

In order to systematically evaluate software tools in a framework for LD we compile in the Table 4 a set of evaluation points. These points are organized into three aspects:

- Points about the purpose of software
- Points about the design features of software
- Points about technical aspects of the software tools

3. Our Election: LAMS

In this section we describe the tool we have chosen, an implementation of a Learning Design (Macquarie University). We justify the didactic benefits of LAMS [3, 4, 5, 6]. The tool is not a Learning Management System (LMS) in the sense of covering the whole eLearning process. Instead of this, LAMS only deals with the collaborative aspects of *eLearning*.

Purpose of the software	Description
	Scope
	Integration
	Does the software implement IMS-LD?
	Perspective of the designer
	Who is the system for?
	Who is involved?
Design Features	Main concepts
	Model of Activity
	Model of Workflow
	Run-time environments
	User Interface features
Technical Features	Technical requirements to run the software
	Form of the software

Table 4. Evaluation framework for LD software tools

LAMS is an online web-based system for creating, managing and delivering sequences of collaborative learning activities. It is designed for use by teachers or professors and students of any level. It is an open source system that is inspired by LD approach. The designer of LAMS –James Dalziel- has been part of the Learning Designer Working Group. LAMS allows giving the steps that permit to create sequences of learning activities which involve groups of learners interacting within a *structured set of collaborative environments*. The current collaborative options in LAMS are voting (with total responses *shared* with the group), asynchronous discussion forum, question and answer (with student answers either anonymously or identified), synchronous chat, MCQ (questions and answers databases), tests, notebook/journal, and various combinations of tools, including chat and scribe. In addition, sequences designed in LAMS can be used among teachers by email or through the LAMS repository [2].
LAMS represents the most comprehensive implementation of the concept of Learning Design available to date. Although sequences can not be created or adapted easily on the fly it introduces innovative design features that locate it at the vanguard of current tools for activity management.
According the Table 4 we analyze the characteristics of LAMS in the following sections.

3.1. Purpose of the software

- **Description**: it is an online web-based system for creating, managing and delivering sequences of collaborative learning activities. The visual authoring environment is designed to be easily used by non-technical staff and the run-time features allow real-time monitoring of the performance of learners.
- **Scope**: LAMS constitutes both an authoring environment and a run-time management and delivery environment.
- **Integration**: It runs online via a web-server. LAMS sequences can only be run within the LAMS environments.
- **Does the software implement IMS-LD?**: No.
- **Perspective of the designer**: The designers of LAMS, James Dalziel and his colleagues, are interested in making *eLearning* work with a range of pedagogical approaches. The aim to create innovative software tools that support a variety of pedagogies. J. Dalziel has been part of the Learning Design Working Group and so is well acquainted with the aim of the LD and the technical difficulties of achieving those aims in a shareable and re-usable form. For this reason LAMS has implemented the concept of LD but not the specification.
- **Who is the system for?** : It is designed for be used by teachers and students.
- **Who is involved?** : People of any level of technical expertise.

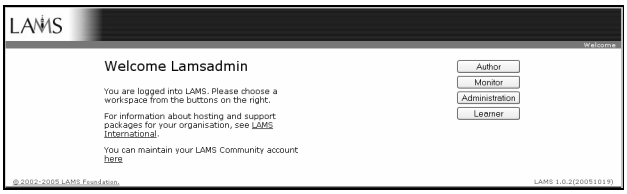

Figure 1. LAMS Welcome page

3.2. Design Features

- **Main concepts**: The *Activities* are both individual and collaborative, the *Sequences* are Sequential Workflow Design and the *Groups* are formed by students who can be aggregated into

groups and sub-groups for the performance of activities.

- **Model of Activity**: The activities are one of the *main* innovative characteristics of LAMS. These activities are more oriented to teaching and learning than generic collaborative tools such as chat and conferencing.
- **Run-time environments**: LAMS has a high-level of interactivity. It includes rich real-time monitoring. Because the sequences produced in LAMS are designed to run in LAMS, many of the technical problems that face IMS - LD designs about peculiarities of external run-time environments are avoided.
- **Model of Workflow**: The workflow model is based on sequences of activities with stop points to allow control of run-time behaviour.
- **User Interface features**: The visual interface for sequencing of activities is a great improvement over tabular "field-editing" in terms of ease of use for non-technical users.

3.3. Technical Features

- **The technical requirements to run the software**: The browser must support Flash.
- **Form of the Software**: LAMS is a web application that runs through a standard browser.

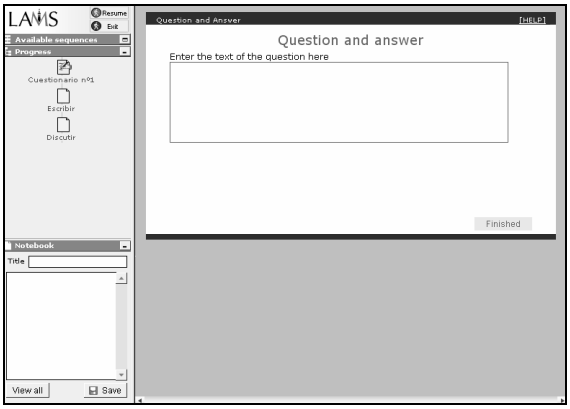

Figure 2. Screen of execution of a sequence

It is possible to obtain LAMS and LMS integration, especially with Moodle. Moodle is a Course Management System for managing flexible communities of learners through a dynamic website. There are three possible ways of integration:

- LAMS as a Moodle Activity: this means a LAMS sequence can be added as an individual activity within a Moodle course.
- LAMS as a Moodle Course Format: this involves a new Moodle Course Format that is centred in one or more LAMS sequences.
- Linking to a Moodle activity from within a LAMS sequence: the URL for an existing Moodle activity can be included in a LAMS sequence through Share Resources allowing LAMS to launch a Moodle activity at a specific point in a LAMS sequence.

4. A Methodology for Virtual Courses Adaptation

From our point of view, the major advances in *eLearning* in general, and especially in educational standards, have been related to the interoperability of the systems and the re-utilization of the didactic materials. But there are many things to do in fields like the adaptation of the courses to the special needs of the students [7]. There have been several contributions related to adaptation, but most of them are focused on personalization of courses for concrete students.

Nevertheless, the adaptation has not been so treated, from a point of view of group pupils, especially in what concerns to the presentation of the courses, and not only to the contents. That is to say, we do not have a system that allows the selection and ordering of course contents and their adaptation to the special characteristics of a group of students that work together in a collaborative way. One of the reasons for this, is the absence of collaborative features in most of the existing LMS. In this section we present two specifications in order to achieve the content adaptation and the course presentation adaptation.

4.1 Content Adaptation

The specification that we propose is based on IMS, and consists of adapting automatically the contents of a course to the changeable attributes of a group that learns in a collaborative way [8, 9, 10]. The key idea is to specify the contents, and then to generate the learning activities depending on the initial cognitive conditions of the group of pupils. From the perspective of the group we propose to open dynamically the suitable content according to the previous knowledge and experience of the group. From the perspective of the designers of the contents we pursue to create courses allowing the re-use of educational existing material.

The central concept is the learning object, which can be considered as the unit of content together with the metadata that describe it. Then a course adapted for every group is designed, by combining the above mentioned learning objects. The proposed sequence is:

- To divide the courses in units or learning objects.
- To model the cognitive context of the group, using the didactic methodology that better suits the features and knowledge of the group. We propose as the best way, the creation of an Ontology of representing the cognitive context of the group.
- To annotate the learning objects with the tag of the ontology.
- To employ user modelling techniques to obtain different profiles of adaptation.
- To adapt the learning content to the cognitive context of the group using the model of the group and the metadata associated to the learning objects.

We can use RDF as the notation for the annotation of the resources, according to LOM (Learning Object Metadata), and as language to define ontologies. We could use other languages like OIL or OWL, but they are not so used in the context of the *eLearning*.

4.1.1. Elements of the model to adapt the contents. In order to obtain an ordered list of learning objects we need the following elements:

- User model of the group of students, obtained by means of LAMS and its integration with the LMS (Moodle). This will give us the type of previous knowledge of the group and the didactic style in function also of the learning matter.
- Didactic ontology to be used depending of the user model.
- Ontology of the knowledge domain that will be chosen depending on the previous didactic ontology.
- A repository of learning objects recovered thanks to their metadata, by means of the utilization of recovery heuristics based on ontologies.

Once we have the ordered list of learning objects, it is possible to obtain an adapted course to the group by offering to the students the learning objects in this order. By applying the rules of the didactic ontology, the learning content can be adapted to the necessities of the group.

With these elements we can define a method for constructing adaptation of the contents to group of pupils who learn and collaborate together in a LMS. The central idea is to annotate semantically learning objects, together with the use of the tool LAMS integrated with a LMS.

4.2 Presentation Adaptation

We base also this aspect of the methodology on IMS. Our aim is to automatically adapt the presentation of a course to the changeable attributes of a group that learns in a collaborative way. We can take advantage of the methods and technologies used in other contexts of adaptation [11]. In order to determine the type of adaptation that has to take place we use a definition of the user model based on a knowledge structure called stereotype, that is composed by:

- A system which contains certain information in users to whom the *stereotype* is applied.
- A sequence of shooters that are values obtained of certain attributes. The shooters can be values of the previous system, or values of entry that do not belong (concern) necessarily to the above mentioned system.
- Relations between every stereotype and the rest of other stereotypes of the system. The above mentioned relations are optional in every concrete stereotype. The most common of these relations is the one that describes a hierarchy of generalizations.

The use of stereotypes provides us a heuristics to predict the attributes values of the system from the shooters. Since the acquired knowledge comes from a heuristic method it must be supervised by an expert.

To be able to realize the adaptation to the user is necessary to know information of the user model. We propose a preliminary work session with LAMS (previous to the course presentation), in order to capture the features that will configure the user model. The attributes of the system of stereotypes can be related to the device in which the presentation is realized. Our choice is to use the specification Learner Information Package IMS's (LIP), also followed by LAMS. This specification allows a format of interchange of information among the students, from several systems of formation that follow IMS specifications.

The characteristics that can be established by means of a user profile are, for example, size of sources, formats, colours, shadings, or the type of access for connecting (institution, particular house, company, university etc.). This technology can be used as a supervision mechanism for the results obtained with the stereotypes heuristic, by manually re-writing the characteristics defined by the stereotype.

4.2.1. Elements of the model to adapt the presentation. To carry out the adaptation of the presentation of the courses, the design must fulfil one interface, taking into account the *stereotype* user model.

- To extract the attributes of the stereotypes from the first student connection to the LMS (integrated with LAMS).
- To rewrite, if it proceeds, of some attributes established in the system of stereotypes.
- We can apply XSLT transformations to include the specific features of the user model.

With this method we can, starting from standards, construct an adaptation of the presentation of a virtual course for a group of students who learn and collaborate together in a LMS which integrate a collaborative tool.

5. Conclusions

The main conclusion of our work is that software development in this field is still at a preliminary stadium, although there is important development in progress.

At the moment LAMS is one of the most interesting tools, because is the first one in validating the concept of LD in practice. In consequence further work should be conducted by examining the benefits and limitations of the LAMS software.

Most of the tools implement the IMS-LD specification at some level. LAMS, however, has been developed to implement the concept of collaborative *eLearning*, and it does not follow the standard in its usual form. So we still can not experiment how the IMS-LD specification works in a practical way. It is necessary to develop collaborative tools that follow IMS-LD specification. In this sense, two of the main challenges of the *eLearning* community are to demand didactic and useful collaborative tools, and to be involved in their development.

These points of view evidence the influence of both top-down and bottom-up approaches to software development in LD. The IMS-LD specifications (and its predecessor EML) are examples of top-down attempts to specify all the information about learning and teaching situation. Some software designers think that to write tools completely tied to the specification may hamper the creativity of the software designer. In this sense, the bottom-up influence of creative software development should continue to help shaping and refining the specifications.

Our future work is to continue advancing in the establishment of the ontologies needed for the adaptation of contents of courses, and also to extend the construction of the interface described for the adaptation of presentations of courses.

The methods and techniques from the Semantic Web can be both incorporated into the analysis of the interactions and added to the design of the collaborative web-based learning systems

We conclude with the need to *establish* a pedagogic model that allows the incorporation of methodologies and the development of new tools, which help to give a quality education from the *eLearning* techniques.

In addition this work points out the need for software tools to be designer in order for the majority of teachers to engage with the process. Even if teachers were used to developing environments in narrative form, very few could analyze turning these into UML diagrams and then XML in IMS - LD form. Software tools are needed to support the authoring of learning designs and tools to play learning designs in run-time environment.

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