eLearning Content Provision

R. Anane[1], S. Crowther[2], J. Beadle[2] and G. Theodoropoulos[2]
[1] *School of Mathematical and Information Sciences, Coventry University, UK*
r.anane@coventry.ac.uk
[2] *School of Computer Science, The University of Birmingham, UK*
{s.crowther, j.d.beadle, g.k.theodoropoulos}@cs.bham.ac.uk

Abstract

It is widely acknowledged that the acceptance of eLearning frameworks requires the adoption of, and compliance with standards. This requirement is especially relevant to the design and delivery of courseware. This paper is concerned with learning content provision mediated by a learning management system (LMS), which complies with Instructional Management System (IMS) standards. The requirements for the LMS, as a tool for course management, are specified through different perspectives. Issues related to content creation and delivery are identified and addressed from the perspectives of the instructor, the learner, as well as the requirements of specific learning content. The learning management system is put in context by considering ways of enhancing content mediation in eLearning. The system is part of a research programme aimed at providing a framework for agent-supported eLearning.

1. Introduction

The ubiquitous nature of the Internet and the pervasiveness of the Web have created new opportunities for generating and delivering learning information [1]. eLearning is often contrasted with the traditional learning approach because of its reliance on the networking and the computational facilities of computers. It is characterised by the asynchronous access to learning resources, the spatial distribution of these resources, as well as the increasing mediation by software in content delivery and assessment. These characteristics point to the need for the creation of specific learning content and the development of suitable schemes for organising and deploying such material.

This paper is concerned with the presentation of learning content access and delivery within an IMS-compliant learning management system (LMS). The design and implementation of an LMS for course management is part of a research programme aimed at developing a framework for agent-mediated eLearning. The framework, as outlined in [2], aims at introducing agent-based mediation at various levels of the learning process:

- Learning needs analysis: specification of learning objectives.
- Curriculum design: selection and organisation of courseware (learning content creation).
- Curriculum delivery: courseware delivery using appropriate media.
- Curriculum evaluation: conformance of curriculum design and delivery to learning objectives.

The remainder of the paper is organised as follows. Section 2 identifies the main eLearning components and their interaction. Section 3 gives a brief introduction to eLearning standards. Section 4 states the requirements for the system under consideration. Section 5 highlights some implementation issues and functionality. Section 6 presents learning content related to a specific topic. In Section 7 the system is put into perspective and pointers to further work are identified. Section 8 concludes the paper.

2. eLearning requirements

In addition to technology, which is becoming more and more transparent, the main protagonists in eLearning have their counterparts in the traditional classroom, namely the instructor, the learner and the learning content. Learning is seen as a combination of information and interaction, which can take three

forms: Learner/Instructor, Learner/Learner and Learner/Content.

2.1. Learner/Instructor

In a traditional setting the instructor is in full control of the educational process, and interacts at various levels with the learners. The instructor is responsible for organising and pacing the flow of information. More importantly, however, is the humanising aspect of the interaction. This involves stimulating and motivating students, maintaining interest by clarifying concepts, presenting personal anecdotes and examples, and initiating debate [3].

Attempts at addressing these issues and incorporating these functions into eLearning frameworks have been met with mixed success. This endeavour has been marked by a shift of focus from an instructor-centered approach to one where the instructor is seen as a study guide or facilitator [4] .

2.2. Learner/Learner

It is generally the case that the learning process can be enhanced by the interaction between learners, and that the knowledge acquired by one learner depends on what another person learns [6]. At group level, under some conditions, it was found that the group performs better that any of its members [7]. It is this group dynamics that partly motivates the introduction of virtual classrooms. Some of the goals of these virtual environments include maximising participation of students in classroom activities, demonstrating a range of behaviours by virtual classmates and creating scope for spontaneity and humour in presentations [8]. The development of the virtual classroom may require, however, the commitment of a vast amount of technological and administrative resources.

2.3. Learner/Content

Some researchers have argued that eLearning content should not be seen as a mere online replication of classroom material, with electronic version of lecture notes, tutorials or assignments. Elearning should offer value-added learning content and exploit creatively the networking as well as the computational capabilities of computers [1]. Among these, simulation and interactivity have proved extremely effective in content delivery.

Careful design of on-line learning content is a requirement that will contribute to the motivation of learners. Elearning requirements dictate now that a learning session should integrate presentation, exercises and evaluation. Adequate navigation through learning content should also be provided by a well-designed and context-sensitive user interface. The Cisco programme is often given as a good example of effective learning [9]. With the introduction of an eLearning programme, the Learner/Content interaction becomes the primary focus of research, since the Learner/Instructor and Learner/Learner forms of interaction are not immediate and may even be absent. Thus, the role of an LMS is critical in mediating between learner and content. It is this aspect that defines the scope of this project.

3. eLearning standards

Conformance to eLearning standards, such as IMS (Instructional Management System) and SCORM (Sharable Content Object Reference Model) is increasingly seen as the way forward in the development and deployment of eLearning frameworks [10]. The standards use XML technology for the specification and are released by the IMS consortium. Five areas are covered [11]:

- Enterprise, for sharing data and information about learners and courses.
- Content packaging, for creating and sharing reusable content objects.
- Metadata, for describing learning resources for search and discovery.
- Question and Test Interoperability (QTI), for constructing and exchanging tests and assessment information.
- Learner, for organising learner information to satisfy different needs.

SCORM has adopted these standards, and goes further in promoting the role of learning objects. The aim of the SCORM model is to promote reusability, interoperability, accessibility and durability (RAID). Reusability is interpreted as the ability to disaggregate a course into its component learning objects (SCO's) and to incorporate them seamlessly into new courses. Accessibility refers to the ability to search and discover learning objects by inspecting metadata. Interoperability ensures horizontal consistency across different learning management systems, whereas durability is aimed at maintaining vertical compatibility across the different versions of an LMS. A learning object should run on any SCORM-compliant LMS. A SCO is therefore seen and implemented as a self-contained unit, built around one or more objectives and which is responsible for the navigation across its own content.

The LMS and, ultimately, the instructor is responsible for the navigation between SCO's.

4. System requirements

The main requirements concern the design and implementation of the LMS, as well as the development of relevant learning content. The system should support transparently a number of functions:

- navigation through system and learning content.
- creation of learning content that can be reused, aggregated and dis-aggregated.
- courses management.
- provision of formative and summative tests/assignments
- monitoring of learner performance.

The components of an eLearning framework can help in refining these requirements. More specifically, the functionality of the system is expressed in terms of four perspectives: the instructor perspective, the learner perspective, the content perspective and the system perspective:

1. The instructor should be able to manage
   - learning content by adding, removing and updating learning objects.
   - courses by creating classes and allocating students to them, and determining.
   - module components.
   - learner progression through the course.
2. The learner should be able to
   - access learning objects.
   - navigate through and revisit objects without restriction.
   - go through assessment material.
3. The learning content should
   - be IMS-compliant and interoperate across different LMS's.
   - include both learning content and assessment mechanisms.
   - incorporate visual aids.
4. The system should
   - validate and incorporate IMS-compliant learning content.
   - maintain persistent data.
   - provide navigation between learning objects.
   - support table of contents navigation.

5. Design and implementation

The software architecture of the system conforms to the client-server model, and is designed as a web-based object-oriented application with a database for storing persistent data.

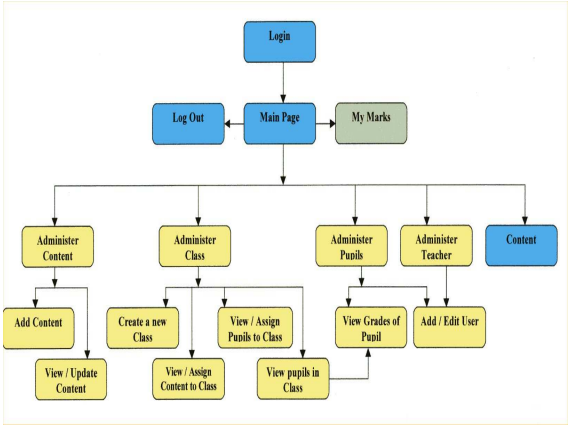

Figure 1. System Functionality.

The user interface and the functionality of the system are supported by a number of classes, implemented in Java. A combination of HTML and JSP modules are used for interacting with the database through JDBC. A presentation of the main functions and their interdependence is given in Figure 1.

The learner interface is essentially a subset of the instructor interface. The learner can only interact with the 'Login', 'Logout' , 'Main Page' 'My Marks', and 'Content' pages, as shown in Figure 1.

5.1. IMS compliance

IMS compliance, in this context, covers two aspects: Content Packaging and Question and Test Interoperability (QTI). In the implementation, each learning content object consists of two elements, a manifest file and the actual physical resources of the content. The manifest is written in XML, and contains a description of the content (metadata), the way the content is organised and the resources required by the content package.

As the QTI specification deals with many types of questions that were not directly relevant to the project, it was decided to support only questions that conform to QTILite, a subset of QTI. A QTI file is specified in XML and describes the presentation of a question, the probable answers, the way the user is

required to answer, the method for evaluating the answer, the possible solutions and the feedback.

Once created, both learning content and QTI objects need to be parsed to ensure conformance to IMS standards. Content deployment involves a number of steps:

- parsing the manifest file of the object.
- uploading the content.
- deploying the content into the LMS.
- navigating the content.
- delivering/accessing the content.

5.2. Learner/Content interaction

The interaction between learner and content requires the allocation of the learner to a class, which is associated with specific learning objects. A learning content object is deployed and made available to the learner through the LMS. The learner is initially presented with a list of contents from where he/she able to select a topic through content navigation. This facility is well illustrated by the interface for the Pythagoras Theorem learning object. The learning content object is implemented as an applet, as shown below (Figure 2), and is associated with a test learning object. This example is an instance of a combination of content packaging and QTILite. Pythagoras Theorem offers also a good example where visualisation can help in understanding fundamental concepts.

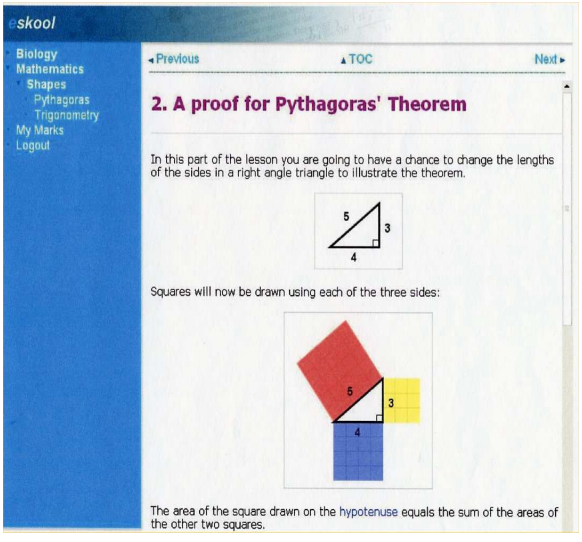

Figure 2. Pythagoras Theorem

The theorem is introduced with the help of a square for each side, which can be resized by the learner. The visualisation is designed to show the effect that the resizing of the triangle has on the sides of the squares. The computational aspect of this learning content is also supported by an on-line calculator. The learner can validate and solve related equations and thus acquire a deeper understanding of the subject matter. Furthermore, a glossary is made available in order to facilitate the consolidation and the acquisition of new concepts.

The learner is given the opportunity to take a test on the theorem and the results are stored in a read-only file. The grades can be checked and the test taken again if authorised by the instructor.

6. Learning content for Networks

By far the most important function of the LMS is to facilitate the interaction between learner and content. The LMS was applied successfully to the mediation of learning content for a High School mathematical course. It is, however, a general-purpose system that can accommodate various subjects.

An application where interactivity can provide significant added value to the teaching process is a Computer Networks course [12]. As a discipline, Computer Networks courses tend to attract a large number of students and, as such, can make laboratory sessions prohibitive and unmanageable. Computer simulations of specific topics offer a viable alternative to laboratory set-ups. They allow unrestricted experimentation anywhere, anytime. In addition, they have the advantage of providing a visualisation of the dynamic behaviour of the components in network technology

From a pedagogical point of view, a Computer Networks course can be organised and presented through a protocol perspective. The OSI model and more distinctly the TCP/IP protocol suite delineate layers of abstraction with specific concerns. With a few exceptions such as the ARP protocol which works across two layers, most protocols are associated with a specific layer. This feature is extremely important for the determination of the scope of the learning content.

As part of a blended learning programme for Computer Networks, various simulation tools were designed and developed. They deal with well-defined topics and conform to most of the design principles of learning objects [13]. In particular, they are:

- independent and self-contained since each object deals with a specific topic.
- pedagogically complete since they provide useful instruction.

- manageable thanks to their relatively fine granularity.

The common thread to the simulation tools that were developed is their relevance to the TCP/IP protocol stack. As an example of instructional object, Figure 3 presents a snapshot of the behaviour of a data link protocol. Learners are able to control the behaviour of the protocol by setting various parameters. They can replay the simulation as often as required and thus refine their understanding of specific issues.

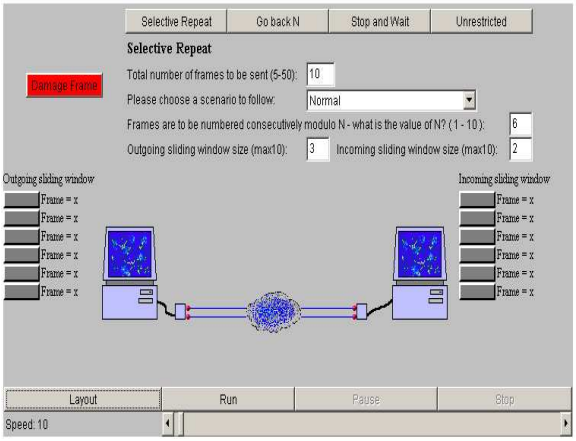

Figure 3. Data Link Protocol Simulation

An initial evaluation of the impact of the learning objects has produced satisfactory results. We intend to carry out a more comprehensive evaluation in the near future.

7. The system in perspective

Although the LMS provides a subset of the functionality of WebCT [14] or Moodle [15], it was decided to develop a system from scratch in order to achieve a better understanding of the technology involved, gain experience in implementing standards, and have full control over the software product. The LMS is a research project with more focus and with different objectives than WebCT. This orientation will hopefully ease the enhancement of the system by providing more functionality and finer customisation.

As part of a large framework the LMS offers an extremely useful base on which to build. The relevant perspectives have been considered in the design and the implementation of the system. The LMS fulfils its role and provides useful functions required for course management. It offers an additional benefit in being IMS-compliant, thus making it easier to search for, discover and retrieve learning content. As such, the LMS supports full interoperability with courseware developed by the IMS consortium and ensures conformance to Content Packaging and QTI.

On the practical side, the LMS plays a critical role in mediating between learner and content, by facilitating access and navigation through contents and objects, and by supporting customisation. The instructor can assign a learner to a class and determine the subjects for that class and therefore the learning content. By monitoring the performance of learners the instructor can tailor the course according to their needs, by adding, updating or removing learning material.

On a wider perspective, the availability of a variety of learning content in an LMS enhances the learning process. The learner enjoys greater flexibility because the resources are available anytime, anywhere. Learners are also driven towards more autonomy by improving their cognitive skills. They develop abilities to adapt to various learning situations and also learn how to learn [16]. Content navigation is fully transparent. Both instructor and learner are unaware of the implementation details. Pedagogically, the learning content is designed for completeness and autonomy, by incorporating information, tests and evaluation. The learner is able to take advantage of the computational abilities of the computer and the mediation provided by the software. With respect to course creation it is worth noting that although small units of content are more manageable and flexible than larger ones, they may distort or over-simplify reality because of a lack of context [6].

More specifically, software mediation acts as surrogate for interaction with the instructor. The learner is able to see the affect of various parameters over which they have full control. The changes are immediate, visible and animated. Simulation is extremely important in engaging learners with the content. The tasks are also repeatable. Learners are able to experiment with programs or simulation without being penalised for their mistakes. Learners can work at their own pace, interact with the learning object, until they understand its behaviour.

Under the current implementation, feedback is limited to monitoring performance. Further work would aim at providing support for historical records and their manipulation and display. As it stands the system would require interaction between learner and instructor either through direct contact, email or telephone.

As the focus of this work is on the Learner/Content interaction, the immediate task is to expand the mediation between learner and content, by incorporating agent technology in the monitoring process. A more meaningful mediation between learner and content would require some form of user modelling. For example, a user model can be related to the tasks and activities performed by a learner, and the information searched for [17]. Although a fully independent eLearning framework is desirable, in many situations, however, such as in engineering education, the contribution of the instructor is crucial to the learning process

8. Conclusion

The deployment of eLearning frameworks depends on the adoption of standards, and the acquisition of relevant learning content is facilitated by adequate annotation and description. Central to this requirement is the development of standard-compliant learning management systems.

The provision of learning content requires careful design in order to make it as self-contained as possible, with clearly stated objectives. It implies a clear separation of concerns that will ensure that learners do not suffer from cognitive overload. Well-crafted learning content is crucial in motivating learners and in maintaining their interest, especially in situation where both Learner/Instructor and Learner/Learner interactions are limited, if not totally absent. The computational power of the hardware systems can be used to great effect in creating value-added components in eLearning.

Ultimately, the challenge facing the eLearning research community is the development of systems that can provide a credible and viable alternative to human mediation.

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