Applying Pedagogical Concepts in Online Course Development:
Experiences from the Mediterranean Virtual University

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1. Abstract

Developing countries have strong potential to shift to use e-learning as an efficient way to replace traditional ways of teaching. Designing online courses is an important step toward the success of any e-learning program. Applying pedagogical concepts and following standards at design time simplifies putting materials online. Interactivity and multimedia objects are needed in course implementation to illustrate the learning material needed to be addressed.

This paper discusses how three of the Mediterranean Virtual University (MVU) Project partners have taken the common MVU course development approach and adapted it to their own needs and context. The result being that each is producing high quality e-learning materials on a sustainable model.

2. Introduction

Traditional ways of teaching -depended on tutors teaching students in class rooms using the blackboard- were used for centuries in teaching around the world. Shifting from these will known traditional ways of teaching to the modern approach of e-learning is a challenging but yet interesting and promising step for developing countries like Egypt, turkey and Palestine. E-learning is an approach to facilitate and enhance learning based on both computer and communications technology. Advances in hardware technologies, open source software and communications made it possible to a wide range of people to own a computer system at reasonable price and get high speed Internet access. .

The availability of both computer and communications technology enabled us to explore the shift to e-learning in universities across the region as a way to provide higher education for a wide range of people at an affordable cost. For example, according to the Arab Advisors Group [1], Internet users are expected to grow from 1.94 million by end of 2003 to reach 5.6 million by end of 2008, a penetration rate of 7.4%. In some parts of the region there are barriers to accessing traditional forms of higher education, particularly in areas with a large rural hinterland, e.g. Turkey, or where mobility is restricted, e.g. Palestine. E-learning offers a mechanism to overcome these barriers of access and mobility by providing convenient and safe access to education. Student demand also cannot be ignored. Across the region students are becoming more technically savvy, and they want to get many of their course materials off the Web. Once online, they expect to be able to communicate with tutors or their peers whenever their schedules permit.

The MVU Project provided a framework for facilitating this exploration in institutions across the partnership. A programme of training events along with ongoing communities of practice and virtual support communities were the mechanism for disseminating and developing a shared model of sustainable e-learning development. All the partners engaged in this process adopted the model, but not as a strict template. The academics and developers in each partner were able to build on this common model and adapt it to their local needs and environment. This paper explores the experience of three of the nine academic partners; Ain Shams University (Egypt), Sabanci University (Turkey) and the Islamic University of Gaza

2.1. Course Overview

Each of the academic partners in the MVU Project committed to develop a selection undergraduate-level course around the discipline of Computer Science. The courses reflected the expertise and needs of the university.

At the Faculty of Compute and Information Sciences at Ain Shams University, Cairo, Egypt the aim was to develop a number of undergraduate courses to be taught initially to volunteer students in the faculty. The feedback from these students is then used to evaluate and enhance the elearning experience to be next applied in real courses. One of the developed courses is titled by “Introduction to Computer Organization”. It introduces the concept of computers and information systems by presenting the process of computation as a hierarchy of virtual machines, beginning with the hardware and moving upward through various levels of increasingly sophisticated software. This course is a beginner level targeted to first year students and has no prerequisites.

The Islamic University of Gaza has developed mainly advanced level courses. One of them is the "Distributed Systems was designed to explore various techniques and issues related to the design and implementation of distributed applications. The course focused on Java as an implementation language, and remote method invocation (RMI) and Common Object Request Broker Architecture (CORBA) as the distributed-object infrastructures. The student learn the basic building blocks of Java computing including exceptions, threads, streams, sockets, and servers. Building on these basic constructs, the course explores enterprise technology including RMI and CORBA. This course is an advanced level targeted to fifth year students and has no prerequisites.

Sabanci University developed courses at all levels. These included core computer science course, Databases and Algorithms and Data Structures, but also less traditional subjects. Relationship Management sits at the intersection between computer science and business administration and can be used to enrich the programmes developed from either field. Other partners have taken a similar approach developing courses that intersect with education, engineering and forensic science.

2.2. Course Curriculum

In each case the first step in development was creating the course syllabus. The Computing Curricula 2001 project (CC2001) [2] – a joint undertaking of the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) and the Association for Computing Machinery (ACM) to develop curricular guidelines for undergraduate programs in computing – outlines a set of recommendations for undergraduate programs in computer science. The CC2001 report also outlined the knowledge areas that must make up the computer science body of knowledge linking these to learning objectives to create a general framework for computer science education.

The CC2001 report provides a common framework for course development in the MVU Project thus promoting opportunities for exchange and integration. In the case of core computer science courses the syllabus and learning objects are closely specified. For advanced courses or those at the intersection with other disciplines the report provides a more general guide.

Having defined the syllabus courses were broken down into content module. These building blocks were largely self-contained allowing greater flexibility for further development of the course and for building new courses.

Following the course curriculum for “Introduction to Computer Organization”, the development team in Ain Shams divided the course into four modules: essentials of computer hardware, fundamentals of operating systems and networks, application software and computer history and ethics. Each module represents a layer of the computer organization. The first layer is hardware layer representing the essentials of computer architecture such as logic, digital circuits, assembly and so on. The second layer is the system software representing the fundamentals of operating systems, networks and so on. The third layer is the application software containing programming fundamentals and the role of human computer interaction, designing, testing and artificial intelligent. The fourth layer presented computer history and ethics. At the Islamic University of Gaza the course was divided into six modules: distributed systems, interprocesses communications, distributed file systems, synchronization, data replication, fault tolerance. Each module discusses one distributed computing technology. With the

Databases course at Sabanci University the course was broken into four topic modules that build up logically data and storage, database design, querying, and transaction processing and security

3. Learning Management System:

A Learning Management System (LMS) lies at the heart of the e-learning deployment. An LMS is a software system designed to facilitate teachers in the management of online educational courses for their students, especially by helping teachers and learners with course administration. The system can often track the learners' progress, which can be monitored by both teachers and learners. LMSs are also called Virtual Learning Environment (VLE), Managed Learning Environment (MLE), Course Management System (CMS), Learning Support System (LSS) or Learning Platform (LP).

Through a collective process Moodle was adopted as the MVU Project LMS. Moodle or Modular Object-Oriented Dynamic Learning Environment is an open source e-learning platform. It has a very large user base with over 6000 registered sites and has been translated into 61 different languages. Moodle can compete with the big commercial systems in terms of feature set and is easy to extend. However it is the pedagogical underpinning of the system that made it such an attractive choice. Moodle promotes a social constructionist pedagogy to address collaborative and social dimensions of learning. To this end it supports many interactivities such as assignments, chats, choices, forums, glossaries, lessons, quizzes, resources, individual learning journals, surveys, wikis, and workshops. Moodle also supports the inclusion of SCORM® learning objects which offer not only interoperability of content with other systems but also the opportunity to extend the range of learning experiences while remaining within the Moodle tracking and monitoring framework.

4. Course Design

As stated above a course consists of modules. Each module is divided into a number of activities. An activity fulfills some of the learning objectives of the module by presenting the student a sequence of sub-activities (Figure 1). Each subactivity represents an element of the activity that the student need to complete to finish an activity and successfully achieve its objectives. A subactivity can be any feature supported by the LMS. In the Ain Shams case this would be an assignment, a chat, a choice, a forum, a glossary, a lesson, a quiz, a resource, a SCORM object, a survey, a wiki, or a workshop. At the Islamic University of Gaza (IUG) this was enhanced with multimedia services: SMIL and voice mail. SMIL Synchronized Multimedia Integration Language provides an effective presentation of course material, power point slides (as images sequence), video lectures (video stream) for the instructor and text explanation (text stream) . Voice mail allows students to mail their questions as a voice messages in easier and more expressive way. At Sabanci the core range of LMS tools has been enhanced with simulations and game-based learning which have included role-play elements.

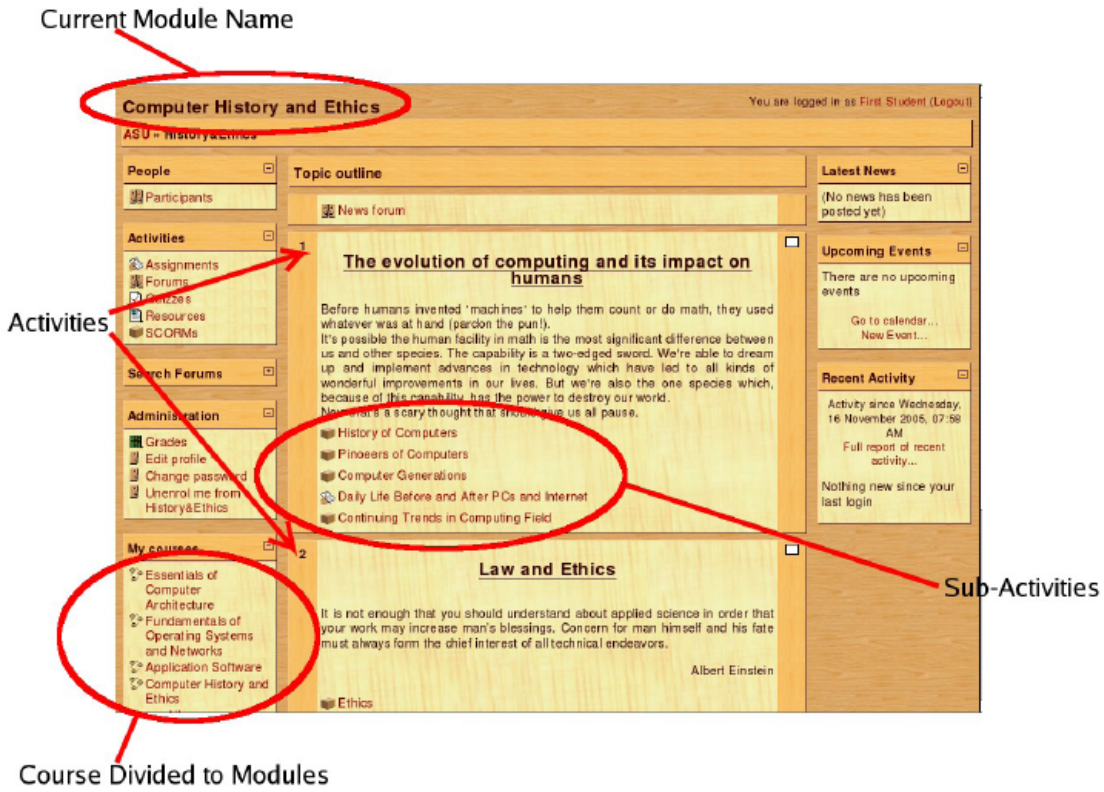

Figure 1a: Activities divided into sub-activities, Ain Shams

Figure 1b: Activities divided into sub-activities, Islamic University of Gaza

Although the tools deployed may have varied all the development teams tried to follow sound pedagogical guidelines while designing the course material. These guidelines where Bloom's taxonomy, Gagne's Nine Events of Instruction, and the Guerra scale. These concepts and their relation to the course are presented below.

4.1. Bloom's Taxonomy

The Bloom's taxonomy [4][5] classifies the forms and levels of learning. The taxonomy divides the objectives of learning to six levels as shown in Figure 2. It starts from the lowest level of learning "Knowledge" up to the highest form of learning "Evaluation". Bloom suggested that one cannot effectively address higher levels until those below them have been covered.

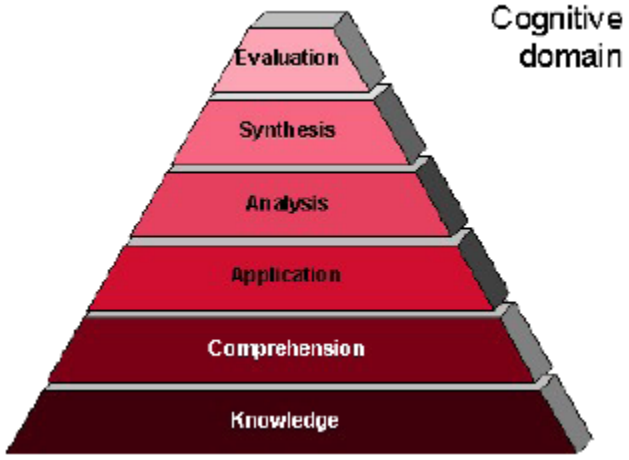

Figure 2: Bloom's Taxonomy

It is important to classify the activities while designing them according to Bloom's taxonomy to ensure that the sub-activities will gradually evolve to achieve the desired level. Bloom's taxonomy is also important to guide the material designers to satisfy the learning objectives by reaching the desired level. For example, if an activity's goal is to reach "Application" level then this means that its sub levels must first start at "Knowledge" and passing through "Comprehension" and finally reaching the "Application". This helps the designers of an activity to correctly specify sub-activities and achieve objectives. In a subject area where application is a very common and important learning objective simulations and practice environments provide a basis for practical projects.

4.2. Gagne's Nine Events of Instruction

Gagne's book, *The Conditions of Learning*, first published in 1965, identified the mental conditions for learning. These were based on the information processing model of the mental events that occur when adults are presented with various stimuli. Gagne created a nine-step process called the events of instruction, which correlate to and address the conditions of learning. Table 1 shows these instructional events in the left column and the associated mental processes in the right column. These nine events activates the processes needed for effective learning. Gagne believes all lessons should include the sequence of these events.

Instructional Event	**Internal Mental Process**
1. Gain attention	Stimuli activates receptors
2. Inform learners of objectives	Creates level of expectation for learning
3. Stimulate recall of prior learning	Retrieval and activation of short-term memory
4. Present the content	Selective perception of content
5. Provide "learning guidance"	Semantic encoding for storage long-term memory
6. Elicit performance (practice)	Responds to questions to enhance encoding and verification
7. Provide feedback	Reinforcement and assessment of correct performance
8. Assess performance	Retrieval and reinforcement of content as final evaluation

9. Enhance retention and transfer to the job	Retrieval and generalization of learned skill to new situation

Table 1: Gagne's Nine Events of Instruction.

Applying Gagne's nine-step model to any training program is the single best way to ensure an effective learning program. In the course development model this is applied to activities by designing its sub-activities to match the Gagne's nine events of instruction; starting from sub-activities that gain attention and define objectives up to sub-activities that provide feedback and assessments.

4.3. Guerra Scale

The Guerra scale [6], shown in Figure 2, outlines the range of online content that can be used. It describes an increasingly interactive user experience using a one-to-ten scale, in which "one" involves the common experience of simply reading text on a screen and "ten" represents a virtual reality scenario. In addition to a more interactive user experience, each step up on the scale represents an increase in complexity, functionality, development time, demands for programming skill, demands for instructional design versatility, and demands for more patience and attention from subject matter experts.

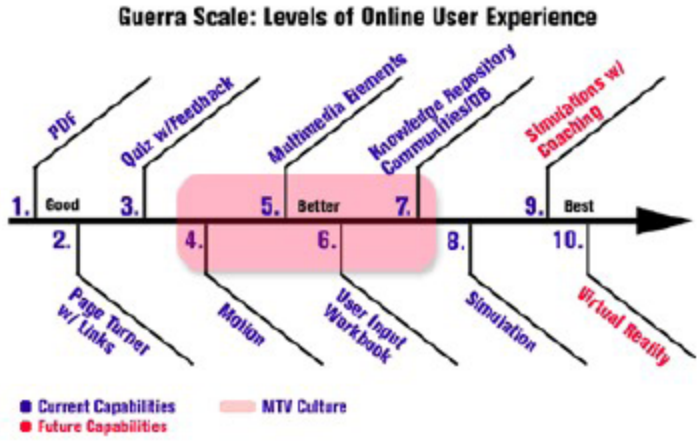

Figure 2: Guerra Scale

Guerra scale is important in designing subactivities to measure levels of online user experiences and also to estimate the development time and complexity. The level of interactivity in our course ranged from GS1 to GS8 according to what is appropriate to best present the material to students.

Particular attention was paid to maintaining the learners' engagement with the materials in the zone identified by Guerra and Heffernan as characterising the "MTV Culture" of many of the more technically aware students. Engagement was maintained through self-paced interactions, e.g. quizzes and simulations, but also through group and communication-based activities, e.g. forums and projects.

4.4. Course Proforma

The purpose of the course proforma and the storyboard is to organise the design and build process. All the MVU Project developments have used a common template for this design tool

The course proforma can be considered as a detailed syllabus. It presents the syllabus, course objectives, course modules, and most importantly a detailed description of all the activities in the course. It also explicitly links activities to learning objectives and provides a useful check that all the course learning objectives are adequately addressed through the course design.

An activity is described by a table similar to Table 2. The table specifies the activity title and a brief description, its parent module and its sequence in the module, who will perform the activity and the type of activity, the time required to complete the activity, how and when the activity is assessed, the learning objectives that should be achieved after finishing the activity, and the level of this activity according to Bloom's taxonomy. The course proforma captures the general design of the course and is

independent of the LMS used. It simplifies the course creation process and it is a necessary step in developing any e-course.

Parent Module	4 - Computer History and Ethics
Activity Title	Discussing the evolution of computing and its impact on humans
Sequence in Module	#1
Who will perform the activity	The whole class and the tutor
Type of activity	Reading and discussion
Brief description	To prepare for the discussion, the students are encouraged to read about: · Pioneers in the computing fields · Daily life before and after PCs and Internet · Continuing trends in computing field
Nominal time required	3 Hours
Status	Mandatory
How assessed	Tutor evaluates the student performance through out the discussion
When assessed	At the end of the activity. By itself
Learning Objectives	SP 1.1 - List the contributions of several pioneers in the computing field. SP 1.2 - Compare daily life before and after the advent of personal computers and the Internet. SP 1.3 - Identify significant continuing trends in the history of the computing field.
Bloom's Taxonomy	Comprehension

Table 2: Example from a course proforma showing an activity.

4.5. Storyboard

The storyboard goes one step further by giving detailed description about what is exactly happening inside the activity. An example of the storyboard for an activity is shown in Table 3. The storyboard consists of a sequence of steps that the student must go through to successfully complete the activity. These steps should follow the Gagne's events of instruction. The storyboard also encapsulates a structured approach. In the case of Sabanci University the development of simulations and scenario-based learning materials required activities to maintain a clear narrative thread or storyline.

The range and type of interactivity at each step should be specified by the designers. The designers should also specify what feature of Moodle should be used in each step. Most partners have taken a flexible approach here so that different activities have different structures according to the needs of the learning, however in practice most adopt a fairly regular pattern. For example IUG's activities typical follow a regular structure. Each activity begins with a presentation in Flash™ format and a reading material and a FAQ. Also each module have some assignment and simulation all supported with forums and chats to encourage interaction between students and to have feedback from the students.

The storyboard is ultimately constrained by the LMS used and the facilities available. For example, the Moodle configuration in Ain Shams does not come with a support for video conferencing capabilities so the storyboard can not use them but should rather workaround it whereas the installation in IUG includes added support for voicemail.

Step	**Description**	**Assets, Interactions, Feedback employed**	**Gagne's Events**	**Guerra**	**Moodle**
1	Introduction	none	G1	GS2	Topic Description
2	Objectives	none	G2	GS2	Topic Description
3	Life before computers	MCQ	G3	GS3	SCORM
4	Pioneers of computers	Knowledgebase	G4	GS7	Glossary & SCORM
5	Continuing	Knowledgebase	G4	GS7	Glossary &

	Development				SCORM
6	Select top ten events in computer history	Article	G5	GS7	Wiki
7	Discussion with tutor	Discussion	G6	GS6	Forums
8	Assessment	Feedback	G7&G8	GS3	Tutor

Table 3: Example of the storyboard for an activity.

4.6. SCORM®

SCORM stands for Shareable Content Object Reference Model [7]. It is a standard for web-based e-learning. It allows us to create Self Paced Learning Objects (SPLOs) that is a reusable unit of instruction for e-learning. SCORM also allows us to share and reuse material and it is independent of the LMS used.

The SCORM package provides a wrapper that can contain a wide range of learning material including definitions, theories and methods needed to be acquired. As e-learning lacks the role of the teacher in illustrating the learning material, SCORM packages can also encapsulate multimedia objects, controlled movies or simulators using Flash to help students to be more active in the learning process. We also added simple small quizzes within the individual lesson. The aim of such quizzes to gain attention of the student, ensuring that the student had enrolled the lesson, and even to direct the student to recall some parts of the lesson according to his answers. In courses developed at Sabanci extended simulations and immersive scenario-based presentations have been captured inside SCORM objects, including audio, animation and interactivity (Figure 3). At IUG SMIL has allowed the inclusion of synchronised video and text (Figure 4). Despite this diversity all the SCORM packages operate in a similar manner within Moodle and all record feedback and tracking information back into LMS.

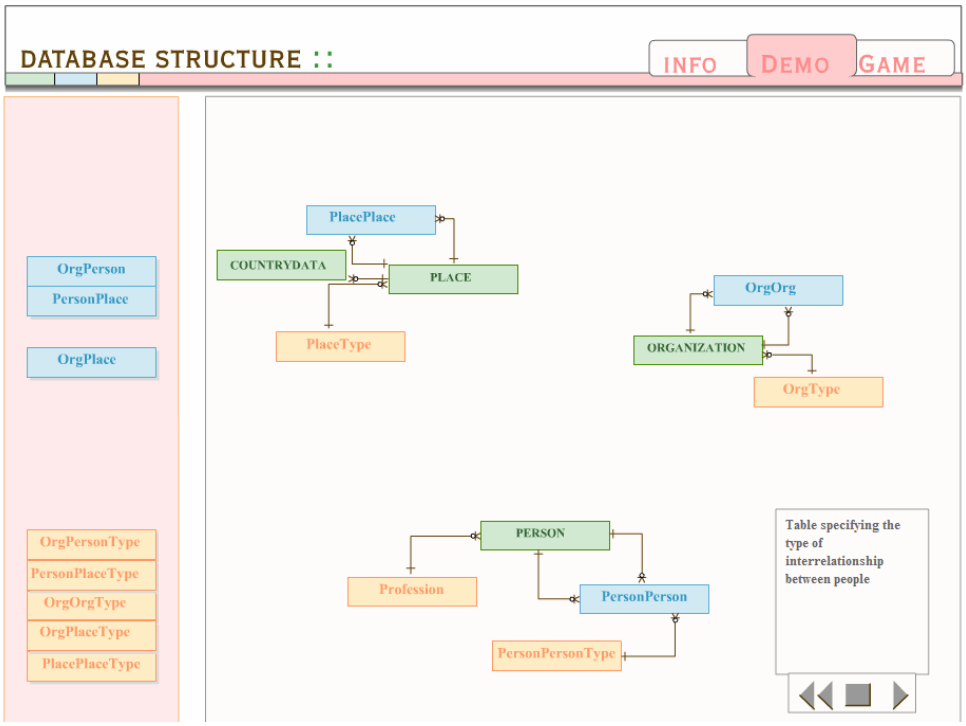

Figure 3: SCORM package delivering Flash™ animation and game

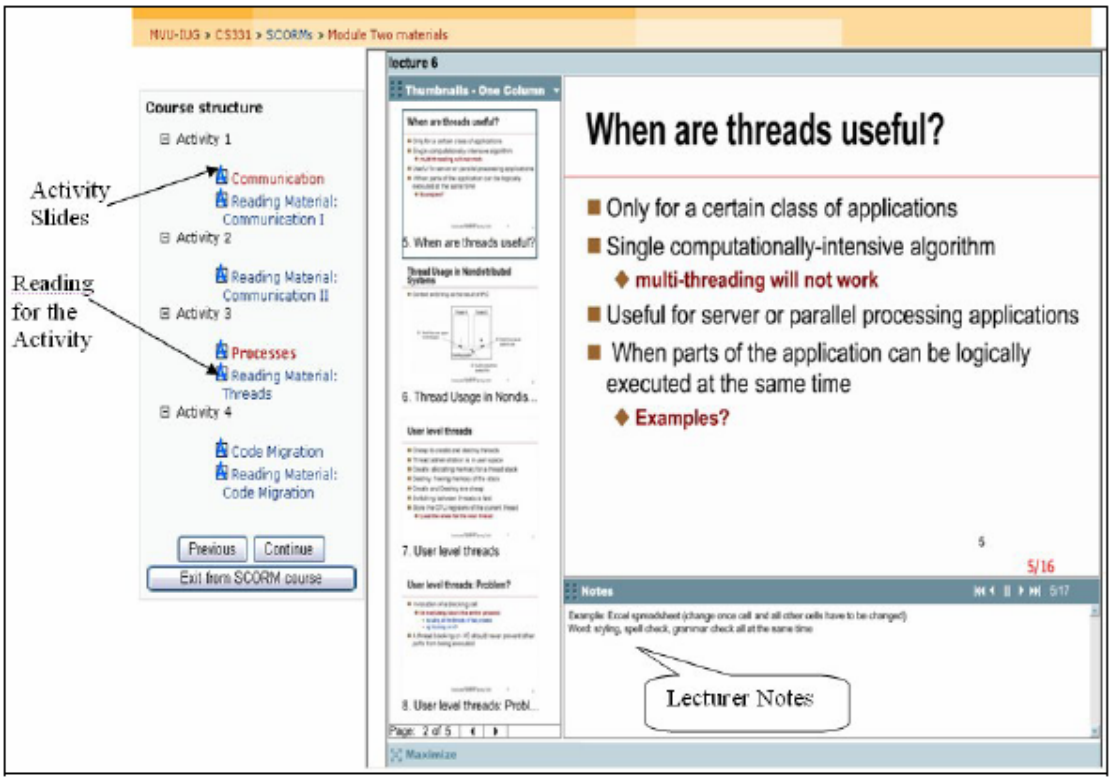

Figure 4: SCORM package delivering SMIL content

5. Course Material

A good design for the course following the pedagogical concepts presented in the previous section simplify putting the course material online by following the guidelines in the course proforma and the storyboard.

The essentially didactic elements of course material were encapsulated into SCORM objects. Other interactive elements such as chats, forums, glossaries, journals, workshops and so on, were implemented using Moodle capabilities. While SCORM packages are essentially individual activities, these Moodle-based activities brought learners back into a social context providing the support and motivation that only responsive feedback from tutors and peers can deliver. These social tools also provided opportunities for organising group activities that are often difficult to achieve in e-learning environments.

Assessments were also implemented using Moodle features by providing one or more assignments, between lessons or at the end of the activity. Different types of assignments were employed including practical assignments, e.g. designing of logic circuits, group presentations, reports, and group publishing through wikis. Traditional assessment methods such as solving problems were supported along with computer marked quizzes, however these approaches were primarily used for formative assessment.

6. Conclusion

The growing number of Internet users in developing countries has encouraged the shifting to e-learning instead of traditional learning. Through the MVU Project partners have joined in developing a sustainable model of course development, figure 5. The model is grounded in core pedagogical concepts that are captured in the common frameworks of the course proforma and storyboard: an approach that assures high quality e-course implementation. The model is also flexible enough, as these three examples show, to allow partners to develop their own emphases and approaches, allowing all to build on their strengths and accommodate to their own institutional and educational environments.

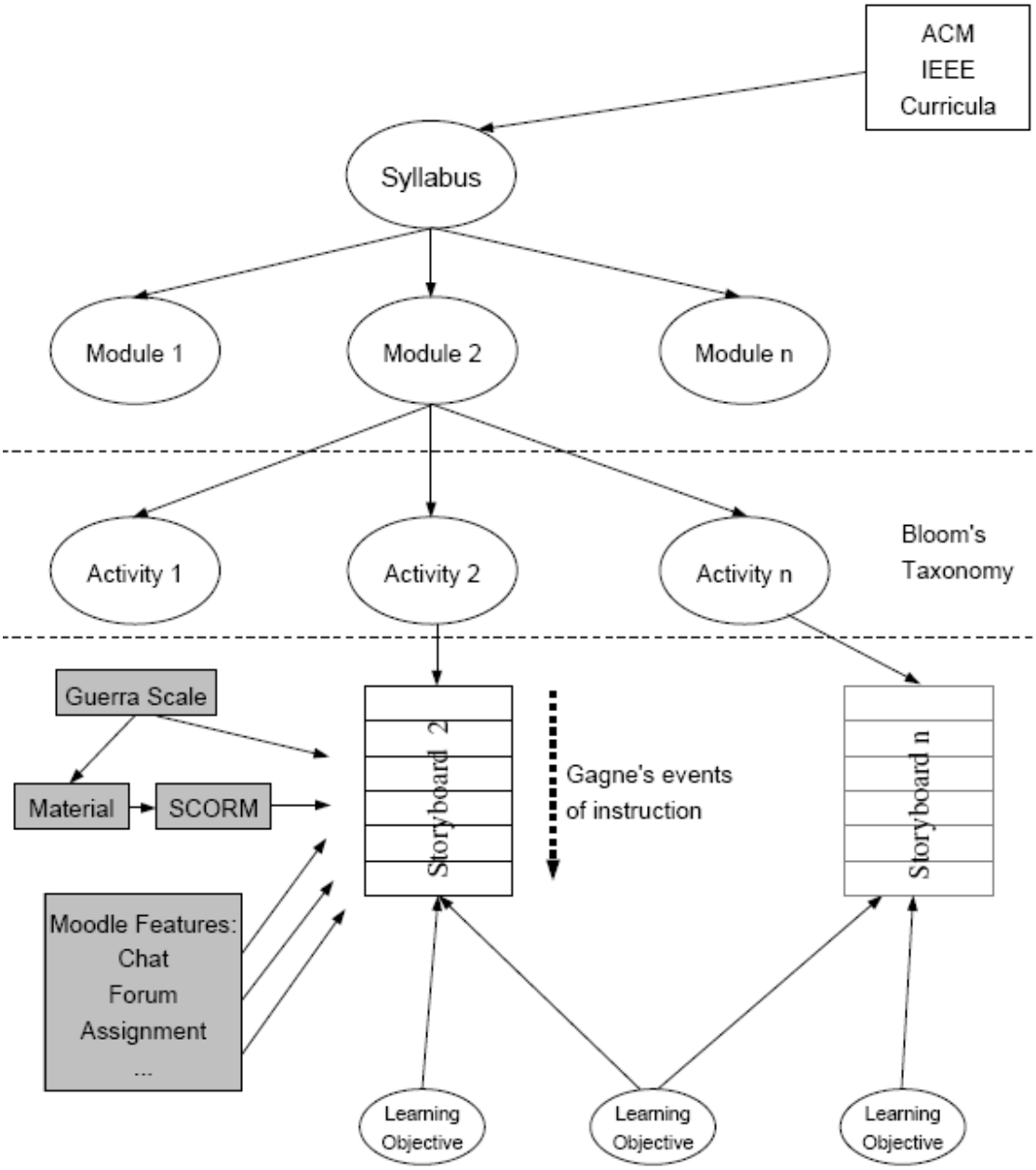

Figure 5: MVU course development model

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