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A Laboratory Assistance Module

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***Abstract*—** We propose that Virtual Learning Environments (VLEs) should be designed by taking into account the characteristics, the special needs and the specific operating rules of the academic institutions in which they are employed. In this context, we describe a VLE module that extends the support of the organization and delivery of course material by including administration activities related to the various stages of teaching. These include the co-ordination, collaboration and monitoring of the course material development process and institution-specific course material delivery modes. Our specialized module, which enhances VLE capabilities by Helping Educators and Learners through a Laboratory Assistance System, is willing to assist the Greek tertiary technological sector, which includes Technological Educational Institutes (T.E.I.).

***Keywords*—**Virtual learning environments, Teaching coordination, Laboratorial education, Technological institutes.

I. Introduction

THE ever increasing processing capacity of personal computers and the development of fast interfaces between the computer and other digital devices reduced significantly the effort and cost required for the creation and manipulation of multimedia files. As a result, existing technology provides the means for the development of electronic course material in a variety of forms [4]. On the other hand, the wide acceptance of Internet, with its open technological standards and widely available browsers [2], caused the 1990's re-evaluation of adapted practices in a wide range of disciplines including teaching [5]. New course delivery methods exploit information and communication technologies and allow academics to deliver live lectures to geographically dispersed audiences (synchronous teaching) [12] or to provide anytime-anyplace access to their course material (asynchronous teaching) [11]. Both approaches require the preparation of rich electronic course material, and in the case of synchronous teaching the instructor is responsible for "on-the-fly" organization and presentation, while in asynchronous teaching the material is organized through a Virtual Learning Environment (VLE).

In general, it could be stated that current VLEs offer user-friendly facilities for the organization and delivery of electronic course material, providing more power to students in order to control their learning [1]. Current VLEs provide a set of teaching tools, which typically include the following: organization of curriculum into elements, tracking of student activity and achievement in relation to these elements, access to learning resources, online tutor support, peer group support, general communication facilities such as e-mail and group discussion. VLEs, being general-purpose content-organization and delivery platforms, implicitly claim to address the needs of all academic institutions adopting any mode of teaching (face-to-face, distance).

This paper argues that VLEs should be able to take into account the characteristics, the special needs and the specific operating rules of the academic institutions in which they are employed. VLEs that have been enhanced to serve a specific institutional environment may extend their support not only in the organization and delivery of the course material but also in administration activities related to various teaching stages.

Academic institutes that adopt face-to-face teaching often supplement their lecture courses with laboratorial classes, so that students gain a hands-on-experience. Usually these laboratorial classes involve a number of instructors teaching small groups of students. The resulting large number of classes and the substantial number of academic staff members teaching the same course to different classes raise various problems. The institution has to monitor the pace of teaching in each class in order to assure course delivery to all classes as scheduled. Corrective actions have to be taken as soon as classes appear to divert from the predefined schedule. A VLE should be extended to monitor such progress. Moreover, the number of staff members influences course material itself. Therefore, the VLE should also provide mechanisms and procedures that establish the wide acceptance of the developed course material prior to its delivery. A way to achieve this is through the provision of a special user group of reviewers.

In an attempt to face the above-mentioned issues, we present the design and implementation of an institution-specific add-in VLE module. Such systems are expected to serve institutes with similar needs and demands. Focusing in the Greek tertiary educational sector (Technological and Educational Institutes T.E.I.) we propose the HELLAS module (Helping Educators and Learners through a Laboratory Assistance System).

II. Technological Education Institutes Presentation

T.E.I.s are public academic self-administrated institutes and

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constitute the technological sector of the tertiary educational system of Greece. As a natural consequence of their technological nature, T.E.I. offer a large number of computer-based laboratory courses that support the lecture classes. All the classes (lecture and computer-based laboratories) are delivered in the traditional face-to-face mode. The departments are made up of Sectors and are administered by elected full-time academic staff members: the head of the department and the sector supervisors who collectively form the departmental committee, while the full-time staff together with student representatives constitute the departmental aggregation. The administrative activities, supervised by the departmental committee, as well as other important activities related to course preparation and delivery are briefly discussed next.

Study program approval: The departmental program of study is revised every two years by the departmental aggregation. The courses of the study program and their classification to the departmental sections, the course content and course-teaching methods (weekly hours of lectures and laboratory classes) are determined in the study program.

Staff assignment to courses: T.E.I.s employ a small number of full-time academic staff. As a result, a large number of courses is taught by part time staff, who are selected among a list of applicants. The assignment of staff takes place before the commencement of the academic year and typically its duration is for one academic year. Quite frequently, members of the part-time staff are assigned to teach different courses in subsequent years, or not assigned to teach a course at all.

Student enrolment: Regulated at national level.

Weekly schedule: The courses are delivered according to the face-to-face model. The schedule is announced before the commencement of the academic year.

Group formation: The computer-based laboratory courses are taught to small student groups (around 20) in appropriately equipped computer laboratories. The majority of the computer-based laboratory modules are delivered by part-time staff, who are employed as laboratory associates. Sometimes, one part-time staff acts as the module leader.

Initial co-ordination of the staff members: When one course is taught by a number of people, the assigned teaching staff agree on the depth at which each topic will be taught.

Material preparation: Laboratory associates are responsible for preparing the appropriate course material they will use. Since part-time associates may not be reassigned to the same course, this results to effort multiplication and uncommon course material. Furthermore, there is often a need for the re-development of course material.

Laboratory course delivery: Laboratory associates present concepts, software tools, examples and tasks to the students. A number of problems are raised due to the lack of common course material. Detailed printed documentation to overcome these problems may be used, but the result is a time-consuming, difficult to manage, and expensive solution [7].

Regulations: According to the regulations, each student registered to a laboratory module has to attend a pre-determined minimum number of laboratory sessions.

Special needs (co-ordination & collaboration, staff-supporting course material, delivery mode, attendance): The large number of computer-based laboratory courses delivered by a large number of laboratory associates necessitates the coordination and collaboration of the involved staff. The face-to-face delivery mode of the laboratorial courses requires the delivery of the material to a large number of student groups, according to the specific schedule of each group. The fact that part-time staff is often assigned to teach a course for the first time, brings up the need for a teacher-friendly course material. Regulations require the tracking of student attendance according to the schedule of the group in which they belong.

The proposed system (VLE-module) includes two subsystems, namely the *Administrative Infrastructure Subsystem* and the *Course-related Subsystem*, which are described next.

III. HELLAS' Design

A. Administrative Infrastructure Subsystem

The following data areas sourcing from the existing departmental administrative infrastructure provide related data to VLE. These are identified and modeled in the Administrative Infrastructure Subsystem:

--Curriculum data area
--Educational staff data area
--Student data area
--Semester schedule data area

Curriculum provides information concerning the scientific sections, which represent the various sections of the department. This structure is directly reflected to a Classification of Courses in the Relevant Sections of the department. In addition, the curriculum data area provides a course outline along with the general thematic areas covered in the provided Laboratorial Sessions of each Course.

The curriculum data area is related to the educational staff data area, according to decisions taken by the department's committee. As stated previously, this committee is responsible for various assignments, with the most significant being the election of Section Leaders Heading Department's Sections. Successively the Courses Belonging to Section Leaders' Responsibility are automatically defined. The next periodical activity occurring on an annual basis is simulated inside the educational staff data area and provides Assignments of Courses along with the Related Laboratorial Modules to Permanent and Part-time Staff.

The student data area is wholly processed by permanent administrative staff and provides a huge amount of VLE related information. Beyond General Student Data, the student data environment provides any information related to Registration to Semester Courses and Registration to Laboratory Groups. Historical Student Data may also feed the VLE, especially in cases of statistical processes aiming to analyze student performance or course difficulty, for strategic decision-making purposes.

Demand of laboratorial courses specifies the necessary Laboratorial Groups for the Delivery of Sessions to be formed for a specific semester. Students satisfying the requirements set by the regulations of the department become Registered Students to Laboratorial Group they apply. At this stage current semester's weekly schedule is formed for the Laboratorial Groups Assigned to the Related Educational Staff. A Syllabus of Laboratorial Courses containing the content of education along with the weekly schedule is determined and incorporated in the simulation process.

Additional administrative activities occur inside the HELLAS VLE-module and are related to regulations for and relationships between the users involved in a laboratorial course development. This data area is termed Regulatory Data Area and may be defined as the data area where collaboration and coordination of human resources is supported through the activation of the major laboratorial entities, and constitute the basis of the Course-related Subsystem.

The Technical System Administrator imports any data already existing inside the Administrative Infrastructure Subsystem. Some of the Imported Educational Staff is primarily Classified as Moderators who assign laboratorial courses to course leaders. These are usually the Section Leaders. Data related to Moderators may exist and be inherited by the VLE database environment or may be initially provided by HELLAS Technical System Administrator.

So far, the two major laboratorial entities (the educational staff and the laboratorial courses) populate HELLAS data environment. Interaction between these two principal components is modeled through the relationship Laboratorial Course Assignment, which refers to the assignment of a laboratorial course to a Laboratorial Course Leader, who is responsible for coordinating the development of the specific course material. This activity initializes the Course-related Subsystem through the generation of the course components.

B. Course-related Subsystem

Inside the Course-related Subsystem the represented administrative activities focus in the development and delivery of Laboratorial Courses. The laboratorial course initiation and its assignment to the respective Laboratorial Course Leader grand the privilege for the Laboratorial Course Components Initiation. By this activity the major components (thematic areas) covered in a Laboratorial Course are initiated.

Given that a course may be subdivided into several thematic areas, the next step is the assignment of these components it consists of, to laboratory associates defining certain rules and privileges for them. This activity is the Laboratorial Course Components Assignment, which is carried out by the Course Leader. As a result one Laboratorial Course Component Developer, possessing development rights, is specified for each Laboratorial Course Component and is responsible for the Laboratorial Course Components Development.

During a Laboratorial Course Component development a number of associates assist the leader and the developers by reviewing and evaluating the course material under development (formative evaluation) [3]. These users are the Laboratorial Course Component Commentators who provide Laboratorial Course Components Evaluation during Development. Responsible for this kind of assignments is the respective Laboratorial Course Leader.

Course evaluation is a repetitive process occurring also after the development (partial summative evaluation). Users involved in the delivery of the course material and monitoring of student performance provide Laboratorial Course Components Evaluation during Delivery. The factors enforcing this type of evaluation may be related to technological evolution, to possible deficiencies identified on the course material or to inappropriate order or size of the course material components. Special methods are followed in order to remove influence of the above factors and refine the course material [9]. However, applied modifications may cause new undesirable effects to the rest course material or may generate other type of deficiencies, not identifiable a priori. Thus, evaluation process is assisted by Keeping Back-up Versions of the Revised Material. Students are also involved in the evaluation process. Course Components Evaluation by Students is performed whenever a new version of the course material is initiated.

Finally, the delivery of the developed course material is differentiated depending on the user. Thus, Laboratorial Course Instructors who are responsible for teaching the course material have access to more detailed information related to the course (e.g. to exercise solutions, detailed explanations) while Students may not access such information. Laboratorial Course Instructors are assigned by the Laboratory Course Leader and may be staff that has also participated in the course material development, while Students have already been imported through the administrative infrastructure subsystem.

Based on this detailed textual analysis, a set of requirements were captured and analyzed. Nouns or noun phrases, relevant to the problem domain, are pointing out the candidate classes simulating the System. After identifying enough candidate classes, we developed a data dictionary for these classes, which contains descriptions as well as the scope for each class (Table I). The identified candidate classes are expressed as a Class Diagram (Fig. 1), using the UML notation [10].

IV. Implementation Issues and Concluding Remarks

The way of developing, incorporating and integrating this individual special purpose module to a VLE is proved to be the challenge at hand. A set of technical statements indicates critical issues to be followed during the implementation phase.

HELLAS aims to serve as an add-in Module of an existing VLE: It is rather introduced to provide additional capabilities related to laboratorial education applicable into technological section, than substitute proved VLE functionalities.

Architecture of a browser-based Client served by a Web/Database server will be adopted: Client-Server applications are written in scripting languages for Web development and web servers cooperate with DBMSs to serve

TABLE I
DATA DICTIONARY FOR THE IDENTIFIED CLASSES OF HELLAS

Class	Description
SYSADMIN	Responsible for interfacing HELLAS module with the rest VLE components as well as with other external data sources. May be charged with the execution of activities related to the population of the System with data.
MODERATOR	Assigns an electronic course to a specific user granting the tile of Laboratorial Course Leader. This establishes the framework for the development of the highest hierarchy laboratorial course entity, called Module.
MODULE LEADER	Responsible for coordinating the development of a Module (Session initialization). Activates Sessions development by assigning them to other laboratory associates.
SESSION DEVELOPER	Develops Sessions. During this development other associates (Session Commentators) may assist. May also participate as a Session Commentator to other Sessions.
SESSION COMMENTATOR	Participates in the Evaluation of a Module by making comments to one or more Sessions of it.
INSTRUCTOR	Charged with the face-to-face delivery of a laboratorial Module. Teaches to one or more Groups of Students.
STUDENT	Attend a Module, provided that they fulfill certain requirements. To satisfy Students demand for a specific course the necessary Groups are formed.
STUDENT COMMENTATOR	Subset of Student who participates in the partial summative Evaluation process.
MODULE	Consists of a number of Sessions.
SESSION	Represents a general thematic area of a Module and consists of a number of Items.
ITEM	Can be (a) Task that has to be carried out by a student, (b) Useful information (Info) provided to the student, or (c) Hint, in case it helps the student to solve a task.
GROUP	Set of Students and is formed during a specific semester for the Delivery of a specific Module.
FORMATIVE EVALUATION	Associates Sessions Commentators that evaluate Sessions during development stages.
SUMMATIVE EVALUATION	Associates Sessions Commentators that evaluate Sessions during delivery stages.
STUDENT EVALUATION	Associates Students that evaluate Sessions whenever a new version of the course material is initiated.

clients' requests [8].

HELLAS will be under the General Public License (GPL) agreement: Most VLEs serving educational institutes come as open source software, under respective license agreements [6].

Modification of existing Database schema serving existing VLE should be avoided: The Database schema of the existing VLE should rather be enhanced to satisfy HELLAS data processing and manipulation than modified.

Interfacing to external data sources: Interfacing to external data areas has already been stated as a critical set of operations. However, interfacing cannot be standardized since the way data are processed inside the institutional administrative environment is also not standardized.

We strongly believe that web-based administration and learning can be assisted through appropriate modifications and enhancements in existing proven VLEs. The HELLAS module aims directly to this purpose and is willing to compensate the above-mentioned problems and needs. We wish to provide a system that will be open enough to serve similar needs of other educational institutes with slight modifications. Current VLEs are too general to directly reflect the institutional

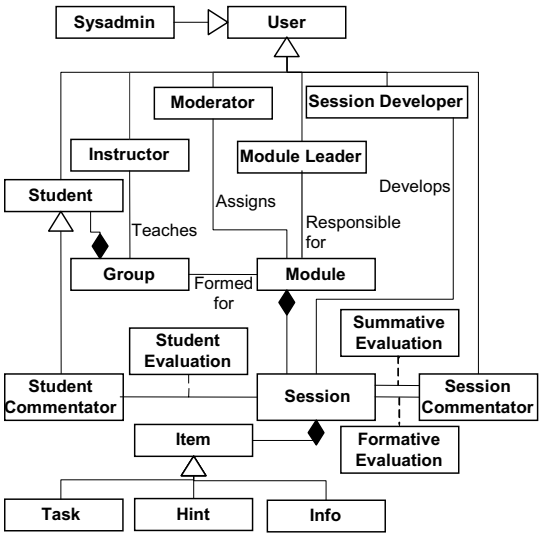

Figure 1: UML Class Diagram

framework of each and every academic environment. As a result, we hope HELLAS will serve, if not only as an automated module, at least as a guidance towards similar efforts.

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