

PULSE Extended

Sanda Dragoş
Faculty of Mathematics and Computer Science
"Babeş-Bolyai" University
No. 1, N. Kogalniceanu Street,
400084, Cluj Napoca, Romania
Email: sanda.dragos@cs.ubbcluj.ro

Abstract—In Romanian Universities students are guided within laboratory sessions by a single tutor. This person has multiple tasks during those two hours such as presenting the new concept and showing examples so that students will be able to solve the assignments given in order to assimilate the new concept; assess the completion of past assignments; acknowledge attending students (laboratories are mandatory); answer any questions related to the laboratory and assist students in their individual work if necessary.

In this context I propose a web portal, called PULSE, to help the lab instructor as well as the students in their final goal. Students have to gain knowledge related to the new concepts and be able to solve the assignments, while the lab instructor aims to support the students obtain their goal and eventually evaluate their work in a timely and transparent manner.

I. INTRODUCTION

Most learning management systems [1], [2], [3], [4], [5], [6] come as a substitute of a human tutor being very well suited for individual study and on-line auto-evaluation based on test-quizzes. Within laboratory sessions, however, the work is more consistent and aims a complex comprehension of new concepts. The evaluation aims to quantify the level of understanding gained by a student as a result of solving the assigned problem. Thus, the evaluation cannot be done on-line but as a discussion with each student, during which the misunderstood or unacknowledged concepts can still be clarified. Thus our systems comes as a complementary tool to the tutor's work.

There is a large number (both open source and commercial) of learning management systems (LMSs). A comprehensive list of them is presented in [1].

Most open source LMSs are web-based, multi-language, cross-platform applications which support learning content management and tools for collaboration, communication, evaluation and assessment. Amongst them are OLAT (Online Learning And Training) [3] which is a Java-based component oriented application developed by the University of Zurich; Dokeos [2] which is based on per group management; Moodle [7] which is mainly aimed to help educators create online courses; and ILIAS [8] which is a complex LMS with multiple features: personal desktop, course management, cooperation (group management, file sharing), communication (internal messages, chat, forum, podcasting), test/assessment (quizzes), evaluation (survey, reporting and analysis) and administration.

Examples of commercial LMSs are Apex Learning [4], which offers courses in mathematics, science, English studies, social studies, foreign languages (e.g. French, Spanish), and Advanced Placement; Blackboard [5], which is mainly focused on academic e-learning; and CLIX [6], which offers different packages for enterprises, universities and schools.

All these LMSs are complex applications which contain many features, some of which (e.g. work sharing) do not serve our purpose.

This paper is structured as follows. Section II presents previous learning management system. Section III describes the system and the way it can be used by the students and the teacher. Section IV describes implementation details. The future work on this system along with the conclusions are provided in Section V.

II. BEFORE PULSE EXTENDED

SINE (a System with Interactive ackNOWLEDgement and Evaluation of students work during laboratory sessions) [9], [10] was my previous instrument created for acknowledging and evaluating student work during laboratory sessions. It was a Linux-based instrument that recorded all mails sent by students (using procmail) and sending back automatic notification mails and changing correspondingly a web interface. A student could send attendance or assignment mails in order to notify his/her presence and to submit his/her assignment solution respectively. All these mails had to have a specific format so they would be accepted by SINE. The web interface was a list containing all students with their assignments and corresponding colored cells if a student was marked for an assignment or just send an assignment mail. An attendance mail received would change the background color of the entire row corresponding to the student that sent that mail. After each lab-session the tutor could validate the list of students that sent attendance mails and grade students that sent assignment mails and presented that assignments during that lab-session. All these modifications were afterwards reflected on the web interface. Private information such as marks, observations and access to assignment sources were restricted by a password (the tutor's password).

This instrument was used, between 2005 and 2006, for three academic semesters during *Operating Systems* and *Computer Architecture* laboratories, at the Faculty of Mathematics and

Computer Science of “Babes-Bolyai” University, Cluj-Napoca, Romania.

PULSE (a **Php** **Utility** used in **Laboratories** for **Student** **Evaluation**) [11] was a new instrument that authenticated its users. The student interface was the main focus of this first version of PULSE, offering details such as: marks, attendances, assignments, theoretical support for new concepts and applicability examples. Tutors interface was the list of students with their marks, attendances and final marks. These lists could be sorted alphabetically, by the average of laboratory marks, by marks of practical exam or by final mark. The tutor’s web interface still lacked the administrative part of marking attendances and assignments, which were done by Linux shell scripts.

PULSE was successfully used, between 2007 and 2008, for two academic semesters during *Operating Systems*, *Collective Programming* and *Computer Architecture* laboratories, at the Faculty of Mathematics and Computer Science of “Babes-Bolyai” University, Cluj-Napoca, Romania.

PULSE extended comes as an “extension” to the first version of PULSE, focusing on the administrative part of it (i.e. create a web interface for marking attendances and assignments).

III. PULSE EXTENDED

The main data entity of PULSE extended is the *Subject* as it can be depicted in Figure 1. A *Subject* is a subject studied within an university during an academic semester, which has/implies laboratory sessions. There are three types of actors using PULSE:

- **Students to attend the lab:** They are the students that are assigned to attend the specific laboratory.
- **Tutors:** Persons that are related to that specific laboratory but they are not students or the lab instructor (e.g., the lecturer teaching that subject)
- **The admin:** Is the lab instructor (e.g., the person conducting the laboratory).

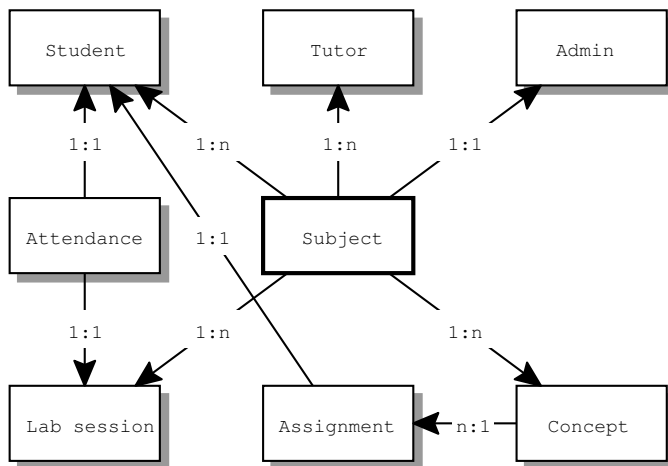


Fig. 1. Data entities and relationships.

During *Laboratory sessions* the attendance is mandatory. In each *Laboratory session* a new *Concept* can be introduced. In

order for the students to assimilate the new *Concepts*, they are given *Assignments* (generally a single one). Each *Concept* has a pool of *Assignments* from which one (or more) are randomly chosen for each student.

A. PULSE for students

The student interface as depicted in Figure 2 contains mainly the same details in the first version of PULSE (e.g. student name, group, marks for assignments, attendances, titles of the new concepts).

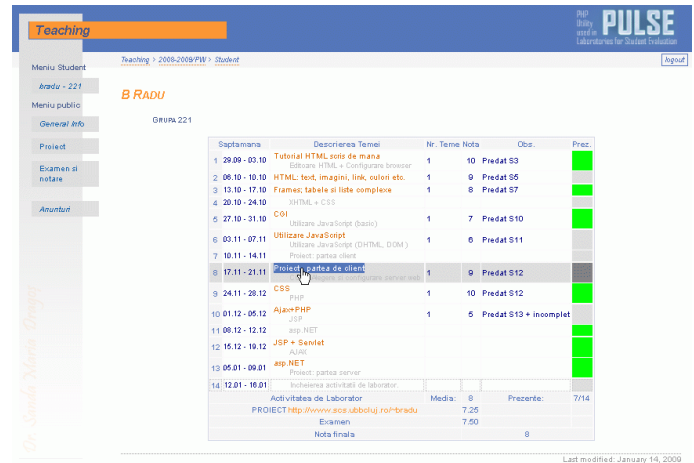


Fig. 2. Student main page.

The main new features introduced by the extended version of PULSE are:

- “bread-crumbs” allowing better navigation.
- news as *RSS 2.0* feeds (see Figure 3).



Fig. 3. RSS formatted news.

These news contain announcements posted by the admin (i.e. the lab instructor). They can be viewed within the PULSE environment, or students can subscribe to them by using any convenient RSS reader.

B. PULSE for tutors

Tutors are allowed to:

- consult the laboratory information as depicted in Figure 4;
- see the list of students as in Figure 5;
- see the details any student sees for him/her-self.

The laboratory information are similar with that that is presented to the student (i.e. weeks, laboratory titles, links to details about new concepts). The exception is that if there are multiple languages in which the same subject is thought to different student groups, the tutor will see the laboratory information corresponding to each language. For instance, in Figure 4, there are laboratory information for two languages (i.e. Romanian and English), as our current subject, *Web Programming* is thought in both.

Week	Lab title (RO)	Lab title (EN)	Lab info
1 29.09 - 03.10	Tutorial HTML, scris de mana	HTML Editors + Browser Configuration	
2 06.10 - 10.10	Edicare HTML + Configurare browser	Edicare HTML + Configurare browser	
3 13.10 - 17.10	HTML: text, imagi, link, culori etc.	HTML: text, images, links, colors etc.	
4 20.10 - 24.10	Frames, tabele si liste complexe	Frames, tables si liste complexe	
5 27.10 - 31.10	XHTML + CSS	XHTML + CSS	
6 03.11 - 07.11	CGI	XML + CSS	
7 10.11 - 14.11	Utilizare JavaScript (basic)	Utilizare JavaScript (basic)	
8 17.11 - 21.11	Utilizare JavaScript (DOM)	Utilizare JavaScript (DOM)	
9 24.11 - 28.11	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	
10 01.12 - 05.12	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	
11 08.12 - 12.12	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	
12 15.12 - 19.12	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	
13 05.01 - 09.01	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	
14 12.01 - 16.01	Proiect - partea client	Utilizare JavaScript (DOM, DOM)	

Fig. 4. Tutor main page.

The list of students is similar with the one in SINE and in the previous version of PULSE. It contains student names, their assignment marks, attendances for each lab, the average of their marks, practical exam mark, final mark, and the ID. Student ID's are unique identifiers (they coincide in our case with their login name from the server designated for students within our department) which are links leading to the student interface.

Nume	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MEDIA	PROIECT	FINAL	EXAMEN	E-mail
Dragos Radu	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9.3	~bdr0001	0	0	~bdr0001
Tomasa Adrian Vasile	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9.3	~bdr0002	0	0	~bdr0002

Fig. 5. The list of attending students.

In the left-hand-side menu there are two buttons: one for listing all students and one for listing only the students that attended a laboratory session at least once. That is because there are cases when some students do not attend laboratory sessions (e.g. a subject may be optional), or they do not attend the first few lab sessions (e.g. for medical reasons). There are also cases when students migrate from one lab instructor to another. Therefore I allowed this flexibility which extends in the administrative part as well.

Selecting on any of the two buttons will result in displaying students per groups¹ and more buttons will appear under the button that has been selected, each new button for a student group. Within each student group, student information are displayed in tables sortable (in increasing and decreasing order) by any of its columns. This can be done by clicking the corresponding table header.

C. PULSE for the admin

The admin (i.e. the lab instructor) has all capabilities of a tutor. Additionally he/she can mark students progress (attendances and assignments solutions), add news and set final marks. Each of these events can be activated by selecting a button in the left-hand-side menu.

The interface for marking assignment solutions is presented in Figure 6. As a first step of this phase is selecting the group of students which are to be marked. That is because generally during one laboratory hour all participant students belong to the same group. There are however situations when students migrate. A rule that I apply during laboratory sessions is that no student is allowed to *hand in* more than two assignments. That because on one hand, in 100 minutes one cannot take more than 30 assignment solutions (there are usually around 15 students during a laboratory session), and on the other hand to avoid the situation when students delay their work to the end of the semester. This rule led to the configuration of the *form* for setting assignment marks as for each student there is his/her name and two sets of inputs for two different concepts. Each set contains one field for the mark and another for any remarks or reasons for setting that mark. The admin can change the concept/assignment for which to mark the students as they both have a combobox to select amongst all concepts already introduced. They are initially set to the latest two concepts. The admin can also remove any mark by setting it to '0' (zero) or any remark be setting it to '-'.¹

For changing the group a new menu button appears as long as *Mark Lab Assignments* is selected.

Marking attendances is depicted in Figure 7 and also has two steps. The first is selecting laboratory session for which the attendances are to be marked. Thus a combobox providing all the past and the current laboratory sessions is provided. Initially this is set to the current laboratory session. Within this initial step the admin also can specify if he wants to access all students or only the attending ones. The latter is

¹In our university, students from the same year of study are divided in groups.

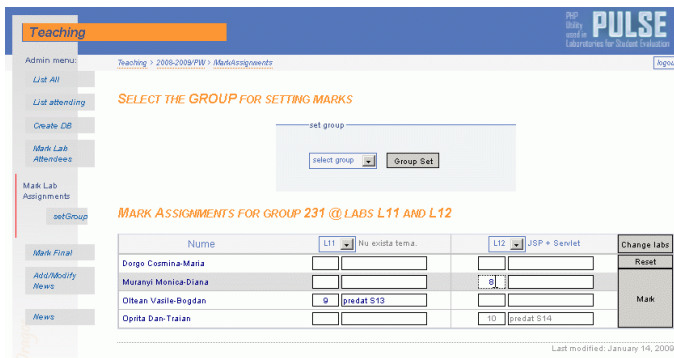


Fig. 6. Marking assignment solutions.

the implicit value. After this, there are presented two lists. One containing students from all groups that were not marked as attendees for the selected laboratory session and another one containing students which attended the selected laboratory session. Adding or deleting attendees is done by moving students between the two lists (by double-click if only one student is selected at a time or using the bottom buttons if more students are to be moved). If only students from one group are to be marked (or deleted) the group/groups can be specified by un-selecting the “ALL” checkbox-button and selecting the ones corresponding to the preferred group(s).

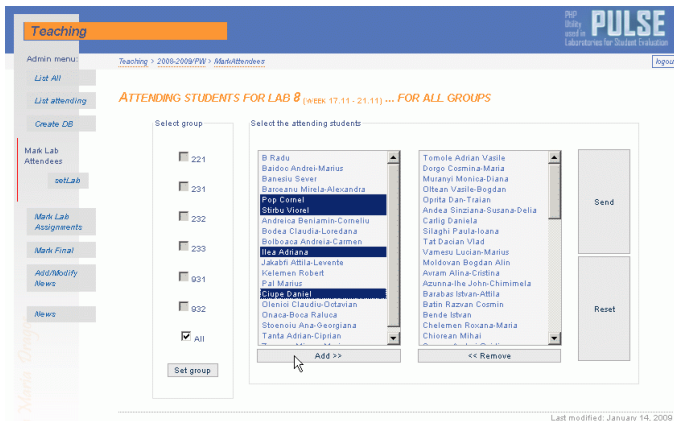


Fig. 7. Marking attendances.

Adding news can be done in English and/or in Romanian as presented in Figure 8.

If the checkbox corresponding to the preferred language the fields corresponding to it will become editable. Any RSS entry has three required fields (i.e. title of the news, description and link). There is a field for each of these in the *Adding News* form.

All news that are already introduced can be modified. When the *Modify* checkbox is selected, the *Adding News* form expands to one more combobox that contains all timestamps (viewed as day:month:year Hour:minute:second) at which the news were introduced. Selecting one of them will result in all other fields being filled in with the corresponding values. By submitting this form (after processing the required mod-

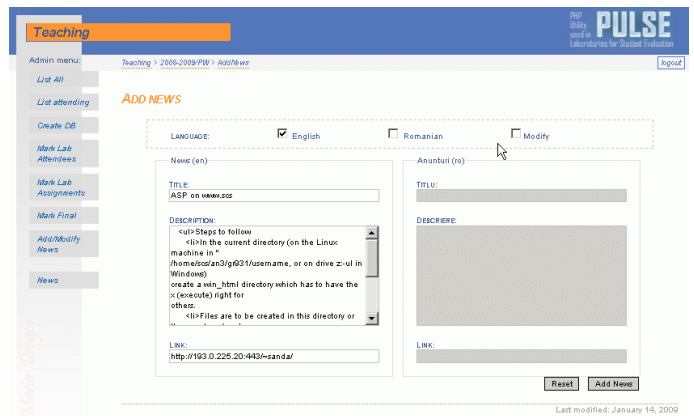


Fig. 8. Adding news.

ification), the MySQL entry that corresponds to the selected timestamp will be updated.

Final marks can be set as depicted in Figure 9.

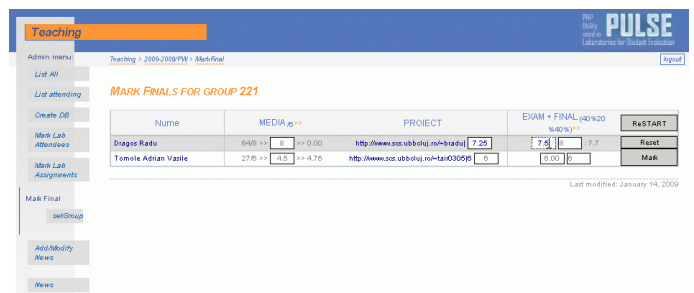


Fig. 9. Setting final marks.

The average of laboratory marks are automatically computed, while the final mark is computed as the other two fields are filled. In our case these fields are the final project or practical exam and the written exam. The final mark is computed by using different weights (e.g., in this case we have 40%, 20%, 40%) that can be set beforehand.

IV. IMPLEMENTATION DETAILS

As its name suggests, this application was developed using PHP version 5.2.6, XHTML 1.0 Transitional and CSS level 2.1. The PULSE logo and the menus for each *actor*² are loaded dynamically using *jQuery* 1.2.6. The “bread-crums” and the drop-down sub-menus (e.g. groups submenus to the List menu) are also created dynamically by using PHP and *jQuery*.

A. Authentication

All PULSE users are members of our department and therefore they have an account in the department’s informational system. Thus, I am using the department’s authentication server³. This simplifies the access to PULSE by eliminating the need to remember yet another username and password.

²Student, tutor or the admin.

³In this case I use the FTP server.

B. Subject selection

The subject on which a user wants to log-on to PULSE has to be specified in the URL as a query string (e.g. <http://cs.ubbcluj.ro/~sanda/teaching/PULSE.php?2008-2009/PW>) as an academic year “2008-2009” and a subject code “PW”. Each subject has a “year/code” directory in which it holds its files such as student information database, tutors file and details about the new concepts to be introduced.

C. Session management

The first access on the PULSE webpage results in initiating a PHP session. This allows using `$_SESSION` variables. Upon a successful login a `$_SESSION['student']`, `$_SESSION['tutor']`, or `$_SESSION['admin']` is set to the login name of a student, tutor, or the admin respectively. The next action of PULSE depends upon the existence and value of one of these variables. For instance the information displayed for a student contain only data related to the login name used in the login process and thus contained in the `$_SESSION['student']` variable.

Other useful values are also kept in `$_SESSION` variables:

- **The current week**, which is used to:
 - highlight the current laboratory in the first student/tutor/admin page.
 - determine the most probable laboratory on which attendances are to be marked for admin’s *Mark Lab Attendances* phase.
 - determine the most probable laboratories for which students hand in assignment solutions for admin’s *Mark Lab Assignments* phase.
- **The processed laboratory**, which is set during admin’s *Mark Lab Attendances* phase and is maintained during the current session until its value is changed.
- **The processed group**, which is set during admin’s phases *Mark Lab Assignments* or *Mark Finals* and is maintained during the current session until its value is changed.

The PHP session functionality cannot guarantee that the information you store in a session are only viewed by the user who created the session upon the login phase. Additional measures need to be taken in order to actively protect the integrity of the session. Thus, PULSE implementation uses PHP’s include functionality and encapsulation by using PHP objects and classes. This means that one cannot directly access any PULSE page by skipping the login phase.

Ending a PULSE session can be done by either *logout* from PULSE or ending the HTTP session (e.g. ending all instances of the browser used for accessing PULSE or 20-30 minutes of inactivity). The logout code is depicted in Figure 9.

Here `session_unset()` frees all session variables currently registered. However, the session is still on the users computer and the variable still exists. Thus `session_destroy()` is used to destroy the session variables, both in the script and where the session data are stored on disk. Using `session_unset` in tandem with `session_destroy` is much more effective means of actually clearing out data. However, there might be an amount of time

```
session_unset();
session_destroy();
$_SESSION = array();
```

Fig. 10. Logout code.

while a session object can remain active before the garbage collection process sees it as garbage. Thus, `$_SESSION = array();` clears all session data.

D. Data Management

PULSE distinguishes between its actors after they pass the authentication phase. The admin is the person having the PULSE script into his/her web account. Tutors are specified into text files within the subject directory. Thus, any subject may have different tutors. The students have to have an entry into the student database kept for a subject.

Student information are kept within XML files for portability and practicality reasons. That is because an XML file can be easily moved or translated into a database if necessary and after the semester passes that information became read-only (i.e., it will only be consulted and not modified). There is one such file for each subject which contains all student information as depicted in Figure 10. One XML file may contain more student groups, within each student group there are more students, each being distinguished by his/her unique ID (given as a student attribute). A student has a name, more lab-entities, an average mark for all labs, a project⁴, and the final mark. Each lab-entity has as attributes:

- **no** represents the number of the laboratory session or the week;
- **attended** is set to YES is the student attended that lab session and NO otherwise;
- **assign** is the number (code) of the assignment given to the student for the new concept introduced in that laboratory session. This number will be used to identify the assignment details from the XML file containing the pool of assignments for that concept.
- **mark** is the mark for the solution provided by the student for the assignment.

The text inside the XML “lab” tag is the remarks or reasons for evaluating that student with that mark.

Student, tutors and the admin can access information from this XML file during but even after the semester in which the subject is taught. When the admin wants to perform modifications on the student information (e.g. setting marks or attendances) MySQL database server version 5.0 is used. All the information from the XML student file will be automatically transferred into a MySQL database by selecting the *CreateDB* button on the left-hand-side admin menu. All the modifications are done on this MySQL database, after which the XML student file is updated by running a shell script.

⁴For this subject there is a complex project that student has to develop along the entire semester, for other subject there is the practical exam.

```

<WP>
  <group nr="931">
    <student id="snie1234">
      <NAME>Sample Name</NAME>
      <lab no="1" attended="YES" assign="3" mark="10">well done</lab>
      <lab no="2" attended="NO" assign="12" mark=""></lab>
      ... <AVGLab>0</AVGLab>
      <PROJECT>http://www.scs.ubbcluj.ro/~snie1234| </PROJECT>
      <FINAL>0</FINAL>
    </student>
    ...
  </group>
  ...
</WP>

```

Fig. 11. Sample of XML file containing student information.

All labs that introduce new concepts will have a directory called “labX” where X is the number of the laboratory session they are to be introduced in. An *index.php* file with the first line containing the title of the new concept will be detected by PULSE and introduced as a link in the first page⁵. These directories contain documentation for the new concept, applicability examples and the XML files with the pool of assignments. A sample of an XML file containing the pool of assignments for the *JavaScript* concept is presented in Figure 11.

```

<JS>
  <assignment no="1">
    <requirements>Write a JavaScript function which validates a string
    representation of a date. The function receives a second parameter
    that represents the date format.
    The function should have at least the following formats:
      zz/ll/aaaa
      ll/zz/aaaa
      zz/ll/aa
    </requirements>
    <example>
      validate(31/01/2006, zz/ll/aaaa) - valid date
      validate(02/29/1997, ll/zz/aaaa) - invalid date
    </example>
  </assignment>
  ...
</JS>

```

Fig. 12. Sample of XML file containing the pool of assignments for the *JavaScript* concept.

The news contain data that are constantly changing. Therefore, such information are also kept in MySQL databases. All news are to be recorded into the same table regardless of the language or subject. For that I introduced a new field called “YearSubjLang” which contains fields like “2008-2009/PW/en”, where 2008-2009 is the academic year, *PW* is the subject code and *en* is the language. The details for every separate RSS feed are also kept in an MySQL table with the same additional field. The information from the two MySQL tables are processed by using PHP to list the news for a subject in XHTML 1.0 Transitional format or as a RSS 2.0 feed format.

⁵All the three types of fist pages (of a student, tutor or the admin) contain the laboratory information.

V. CONCLUSION AND FUTURE WORK

PULSE extended as well as its predecessors are created with the aim to support any professor that uses them to provide high quality education for a large number of students⁶ in a field of rapid changes and practical aspects. Therefore these instruments were successfully used but constantly monitored and adapted to the needs of their users.

The future work on PULSE consists in extending its capabilities to a learning content management system (LCMS) by implementing a editor for new concepts and editing and running test-quizzes.

ACKNOWLEDGMENT

This material is partially supported by the Romanian National University Research Council under award PN-II IDEI 2412/2009.

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⁶“Babes-Bolyai” University (BBU) is offering more that hundred majors and has a student population of over 50 000.