



**WP4: Final report**

**Development and Testing of New e-Learning and  
e-Teaching Practices and Technologies**

Prepared by:

Tampere University of Technology  
Ragnar Granit Institute

Asta Kybartaitė  
Juha Nousiainen

Kaunas University of Technology  
Biomedical Engineering Institute

Vaidotas Marozas  
Rytis Jurkonis

# Report

REPORT TITLE	
Development and testing of new e-learning and e-teaching practices and technologies	
WORK PACKAGE	
4. Development of new practises for e-teaching and e-learning	
RESPONSIBLE(S)	
Biomedical Engineering Institute, Kaunas University of Technology (KUT), Ragnar Granit Institute (RGI)	
ABSTRACT	
<p>The report presents e-learning and e-teaching practices and technologies that were developed, tested and evaluated by EVICAB project partners. These practices and technologies are not necessary new in absolute meaning, but nevertheless, we implemented them and have our own opinion.</p> <p>At first we present our considerations about virtual learning environment for management of e-learning courses then we describe our approach in developing and delivering of course ware: audio visual materials for presentation of learning content and “practise by doing” methods for fostering the deeper learning. Finally we describe our approach to internet based examination. Several recommendations based on obtained experience are presented at the end of the report.</p>	
KEYWORDS	
e-Teaching, e-Learning, Moodle, Courseware, Audio visual material, Practice by Doing	
AUTHOR NAME(S)	
Vaidotas Marozas, Rytis Jurkonis, Asta Kybartaitė, Juha Nousiainen	
DATE	CLASSIFICATION
Autumn, 2007	Public
EC EDUCATION AND TRAINING	
<p>Project: European Virtual Campus for Biomedical Engineering (EVICAB)</p> <p>Project no. 2005-3868 / 001-001 ELE-ELEARN, Education and training Programme</p>	

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## 1 Introduction

We live in a world where the accumulation of knowledge is exponential over time, and where the abilities to continuously learn, think creatively and solve problems are essential to survival. Development of these abilities should be among the most important learning outcomes in Biomedical engineering programs since Biomedical engineering brings together knowledge from many different sources: biology, medicine and engineering. Thus the methods of teaching and learning in the field of Biomedical engineering are equally important as the cautiously selected intrinsic body of the field's knowledge itself.

National Training Laboratories Institute for Applied Behavioural Science conducted the research study during the 1960's and developed the so called "learning pyramid" (Figure 1.):

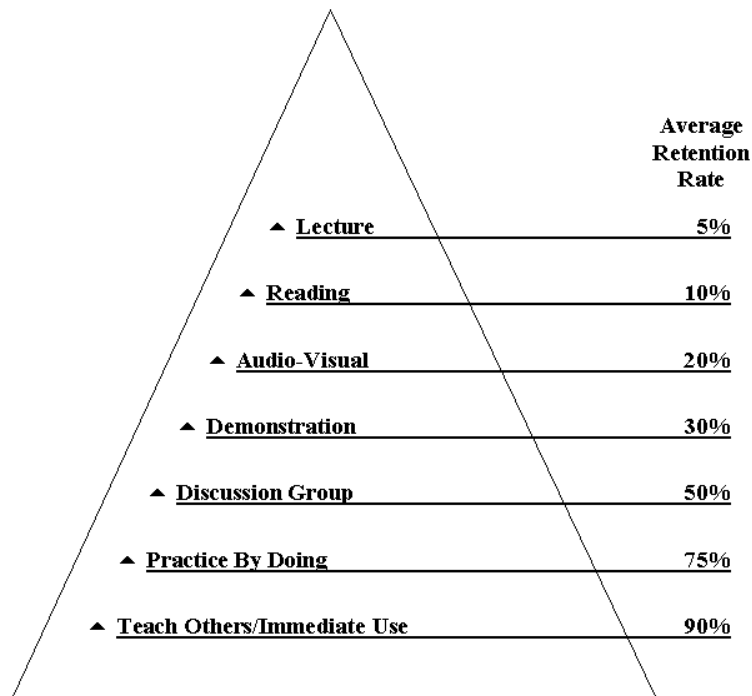


Figure 1. The learning pyramid: how much of material do the learners retain? [1]

It actually shows how important are to combine various modes of knowledge presentation in order to achieve the learning outcomes. The result in Figure 1 can be explained partially by recognition that students are different and many learning styles do exist. Thus as many modes of teaching is used as many students are reached.

Information technologies in the form of computers, computer networks and software changed the world during several decades. The success stories of projects like Wikipedia encourages us to believe if project European Virtual Campus for Biomedical Engineering (EVICAB) will collect high quality of learning materials and will use the advantage of relevant technology for e-learning and e-teaching it will achieve its goals to attract the biomedical engineering students from Europe and the world.

The report presents new e-learning and e-teaching practices and technologies that were developed, tested and evaluated by EVICAB project partners. These practices and technologies are not necessary new in absolute meaning, but nevertheless, we implemented them and we have our own opinion which is shared here in this report.

At first we present our considerations why we have chosen Moodle as the virtual learning environment for management of e-learning courses then we describe our approach in developing and delivering of learning materials: audio visual lectures for presentation of learning content and “practice by doing” methods for fostering of deeper learning and finally we describe our approach to internet based examination.

## **2 Sources providing information about EVICAB**

Two virtual sources provide information about EVICAB: 1) the official EVICAB website [2] and 2) EVICAB virtual learning environment – Moodle [3].

The purpose of the website is to communicate with and convey information to the broad audience. It is the central location for all relevant information.

Virtual learning environment – Moodle is the software system where the actual learning happens; it supplements the face-to-face classroom. It is also the management system which helps course providers to administer the educational material for the students. Evicab Moodle requires identification in order to access its content.

## **3 Management system for virtual learning environment**

Moodle as the management system for virtual learning environment was selected based on several factors [4].

- It is free, open source software package
- It is designed using sound pedagogical principles
- It can scale from a single-teacher site to a University with 200 000 students
- It has large and diverse user community all over the world (i.e., 35,143 sites and 14,920,616 users)
- It has currently a total of 75 language packs
- It supports Sharable Content Object Reference Model (SCORM) – a collection of standards and specifications for web-based e-learning.
- It provides free support, documentation and instructions for users
- It can be modified according to the needs of users
- Several of the EVICAB partners and their students have experience using it (e.g., RGI, KUT)

The technical and graphical side of EVICAB Moodle has constantly been developed and updated by the project members.

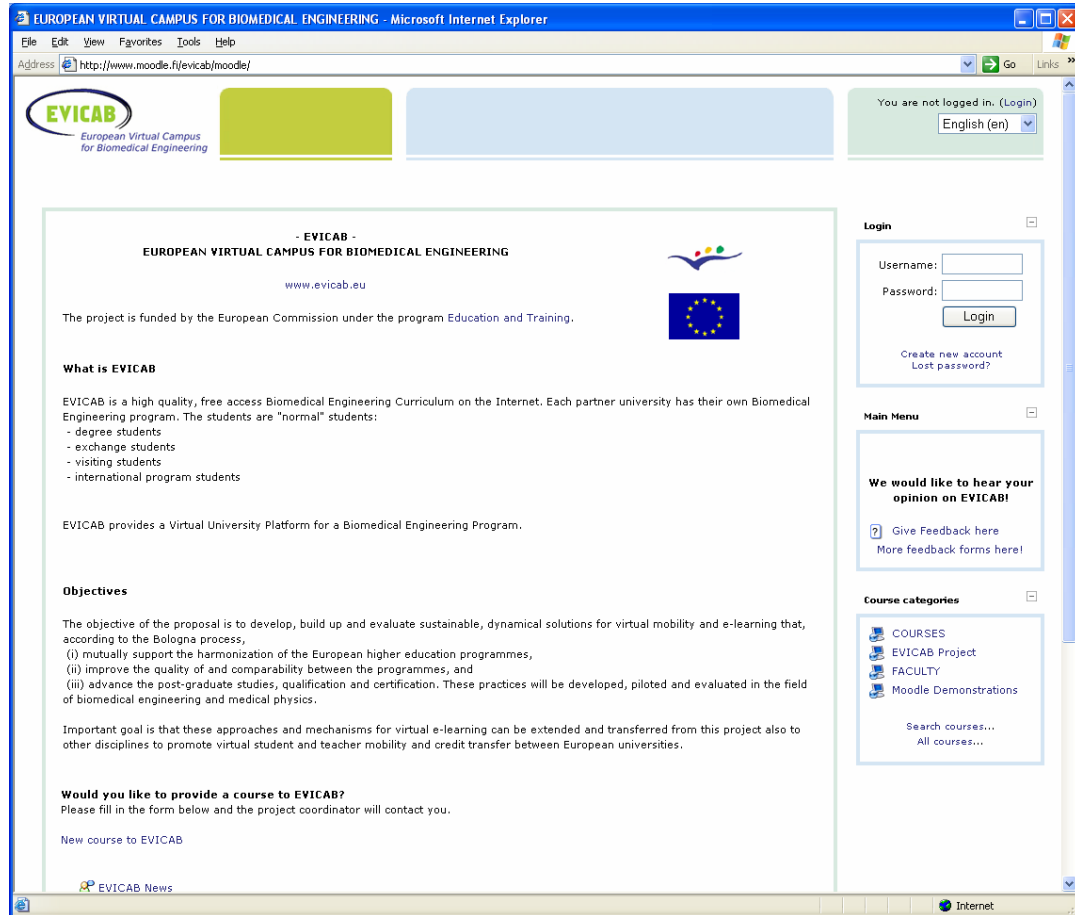


Figure 2. Learning management system – EVICAB

EVIBAC Moodle, in addition to the courses (see Figure 3), allows to suggest new course, has discussion forum, feedback forms, information about project, staff room, evaluation center and Moodle demonstrations. The information on the environment aims to be brief, easily navigated, and understandable for the new users.

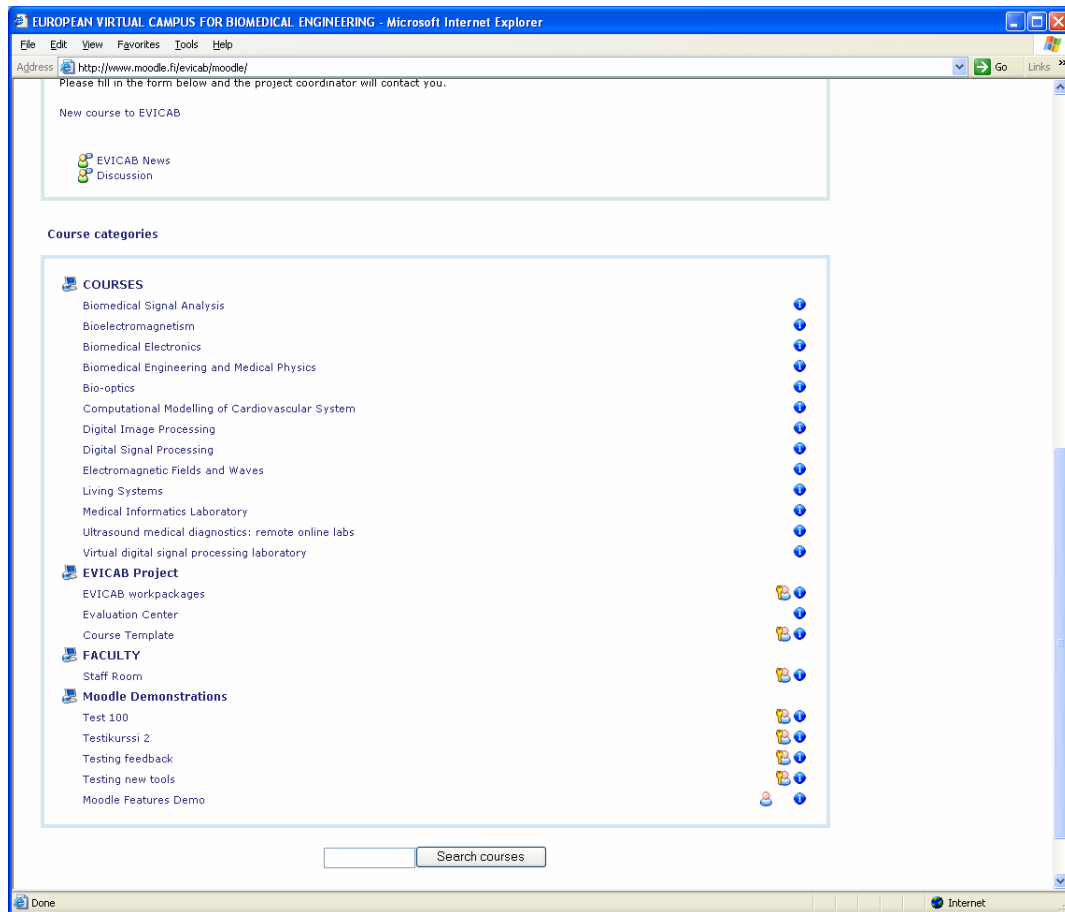


Figure 3. Links for the information that registered users can access.

#### 4 Development of audio visual e-learning methods

Course instructional materials are available in several formats.

- Text based material is delivered as HTML, PowerPoint slides or PDF documents
- Hypertext materials connect text, multimedia and exercises
- Media-rich materials – video lectures – show face-to-face classroom courses with recorded lecturers speaking and presentation slides adjusted along side, in the separate frame.

Two methods were used to produce video lectures. First, the recorded video was edited and combined with the screen captures from the PowerPoint slides by using Synchronized Multimedia Integration Language (SMIL). Hypermedia Laboratory in Tampere University of Technology provided the SMIL code. The lay-out, table of content and size of windows in the video was changed from the custom made code. These features are quite limited in commercial software [5]. Students are able to watch the video lectures by Real Player, version 10.5 (see Figure 4).

The experience showed that there is also a need to watch video lectures by other freeware or plug-ins. After analysis, commercial software [6] was selected and tested, which allows producing video lectures in Flash media files (see Figure 5).

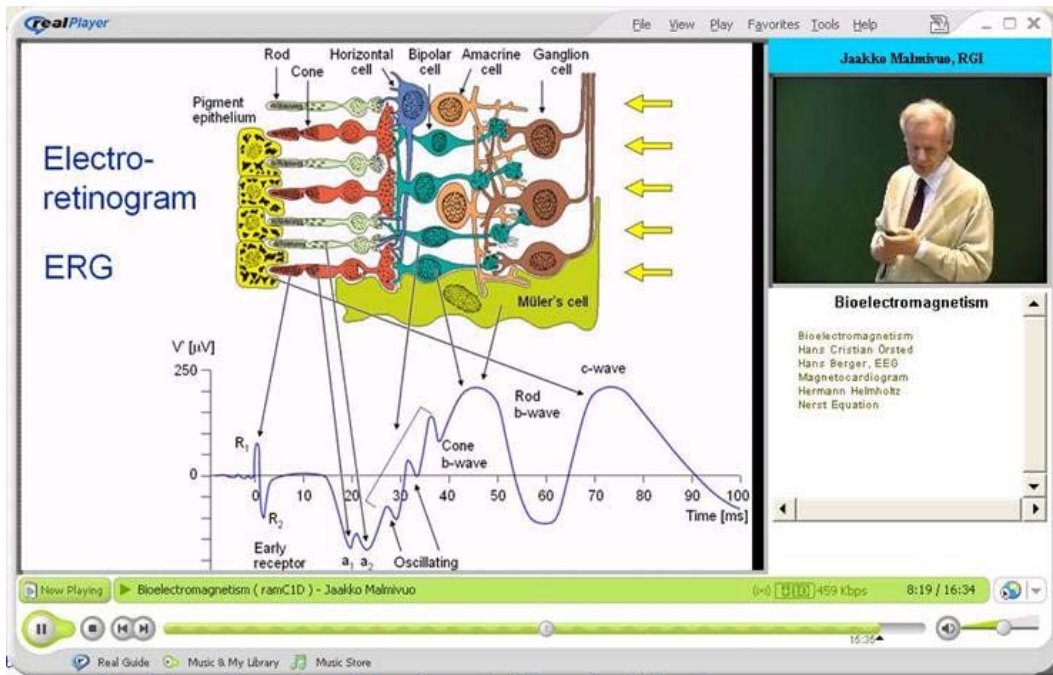


Figure 4. Example of video lecture which can be seen with Real Player 10.5

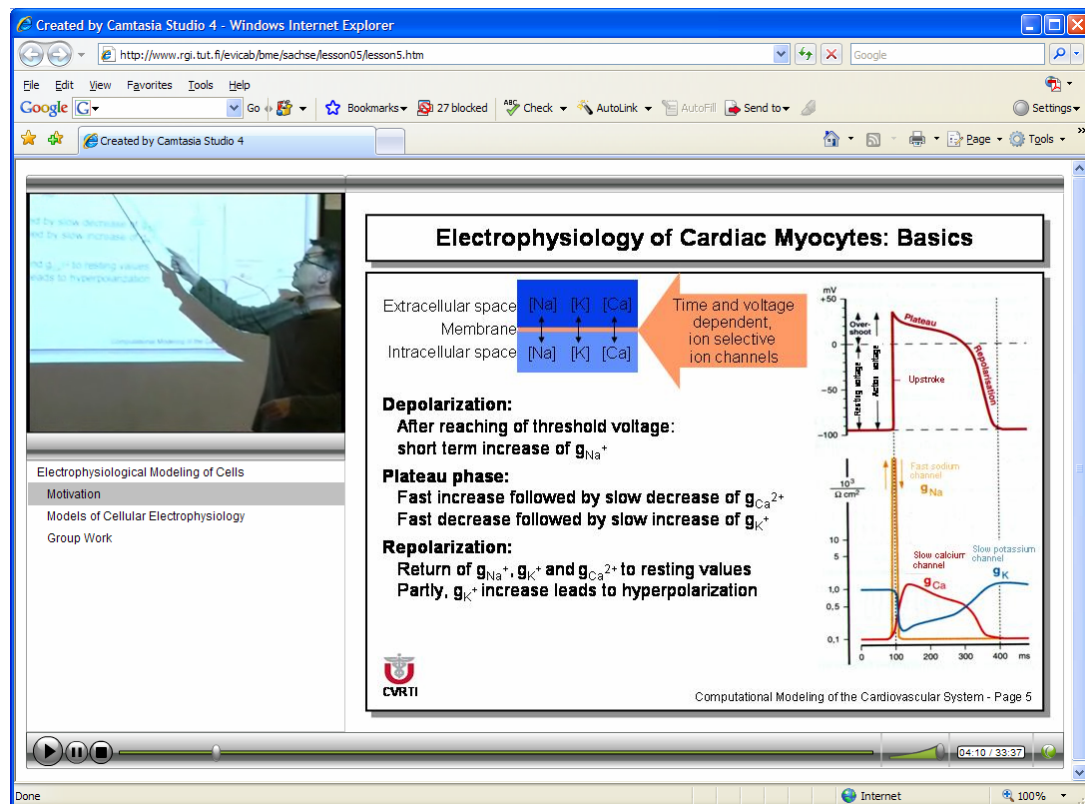


Figure 5. Example of video lecture prepared with Camtasia Studio



Another application which was tried for development of combined video - audio - slide lectures was Microsoft Producer 2003. The Microsoft Producer 2003 is one of a few Microsoft's software applications that are free and can be downloaded from Microsoft's web site. It is well integrated with other Microsoft applications: PowerPoint, Internet Explorer, Internet Information server, Windows Media streaming server. Those accustomed to working with video editing application such as Adobe Premiere will find quite easy to transform PowerPoint presentation with all slide transitions and custom animations into video - audio - slide lectures. Figure 6 shows the example of video lecture authoring using MS Producer 2003. Several of MS Producer 2003 features that make life easier for content developer can be pointed out: time tracks in the timeline help to produce rather complex presentations involving precise in and out points, the presentation menu (left hand side in Figure 6) is constructed automatically from imported headers of slides. From the user point of view, good feature is that there is no need to install anything if MS Internet Explorer is used. Of course, the dependence on Microsoft products could potentially create problems especially to those who are working with the Macintosh platform as there were bugs noticed [7]. Thus we haven't proceeded to this direction.



Figure 6. Example of video lecture authoring using MS Producer 2003

## 5 Development of “practice by doing” e-learning methods

### 5.1 “Hands on” simulation experiments

Deeper learning and longer retain of what was learnt can be supported by “hands on” exercises, simulated experiments and real experiments. The interactive experiments in software help students to grasp difficult theoretical concepts or develop specific skills.

One example of such software experiment is presented in Figure 7. The interactive environment helps the student to develop intuitive understanding of relationships among various controlling parameters in one complicated tool of digital signal processing- the joint time - frequency analysis using spectrogram. It is known in theory that increasing resolution in time decreases resolution in frequency and vice versa (the Heisenberg uncertainty principle). The student can see this by himself/ herself. The resolution in time and frequency

is controlled by the length of the analysis window (“Window length” slider). The resolution in frequency also is changed by the size of fast Fourier transform (“FFT size” slider). In order to smooth the results, time windows can be overlapped (“Overlap” slider), however this significantly increases the analysis time (“Processing time” indicator). In addition, time - frequency resolution depends on the shape of analysis window. All the parameters must be adjusted in order to get the optimal time – frequency representation of the signal. But different signal means different parameters. Thus several signals: oscillatory, pulse, chirps can be tried and evaluated.

The simulated experiments software was developed using Labview 8.2 software package (National Instruments Inc.) and can be accessed in EVICAB campus within Virtual signal processing laboratory, lab work “Time - frequency analysis of non stationary signals”[3].

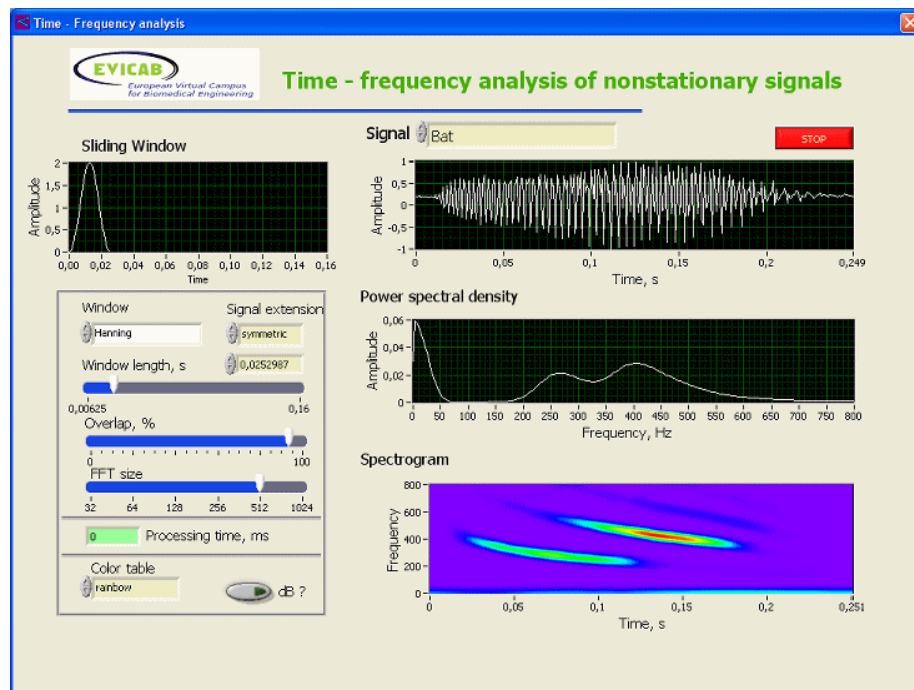


Figure 7. Example of simulation based lab work for developing of understanding of relationships between the time - frequency resolution and analysis parameters

Previous example shows, that it is possible to program complicated equations, give the student interactive sliders to control the parameters in the equation and present the results online in the graph. However, software of simulated experiments can integrate and do even more. It can in some sense replace the teacher and become „e-teacher“. According to the model of learning and teaching proposed by Mayes&Fowler [8] the learning with technology can involve a cycle of conceptualization, construction and dialogue.

Figure 8 shows an example of such software. By using this labwork the student is able to develop the skills required to efficiently control oscilloscope in order to measure different parameters of pulse signals. At the conceptualization stage the student is introduced with the concepts of 11 different parameters which describe the shape of the pulse signal. This information is available for the student from “Info” tab in the user interface.

At the construction stage, the student applies the developed signal parameterization and oscilloscope control concepts in real task– during the limited time, e.g. 10 min, he has to measure parameters of the pulse signal and write these parameters in the table (upper part of Figure 8.). The pulse signal is generated internally in the program with the randomly selected

parameters, thus it is impossible to memorize the signals. The student, in order to accomplish the task, uses virtual oscilloscope with all the relevant and working knobs and switches.

The dialogue stage happens at the same time as the secondary stage i.e. the student gets the feedback online in the form of the grade. If the grade increases by “1”, this means the error of the just “measured” parameter is less than 10% and it is accepted as “right” answer. This stage serves also as an automatic student assessment. The system stops and remembers the grade after the time is elapsed.

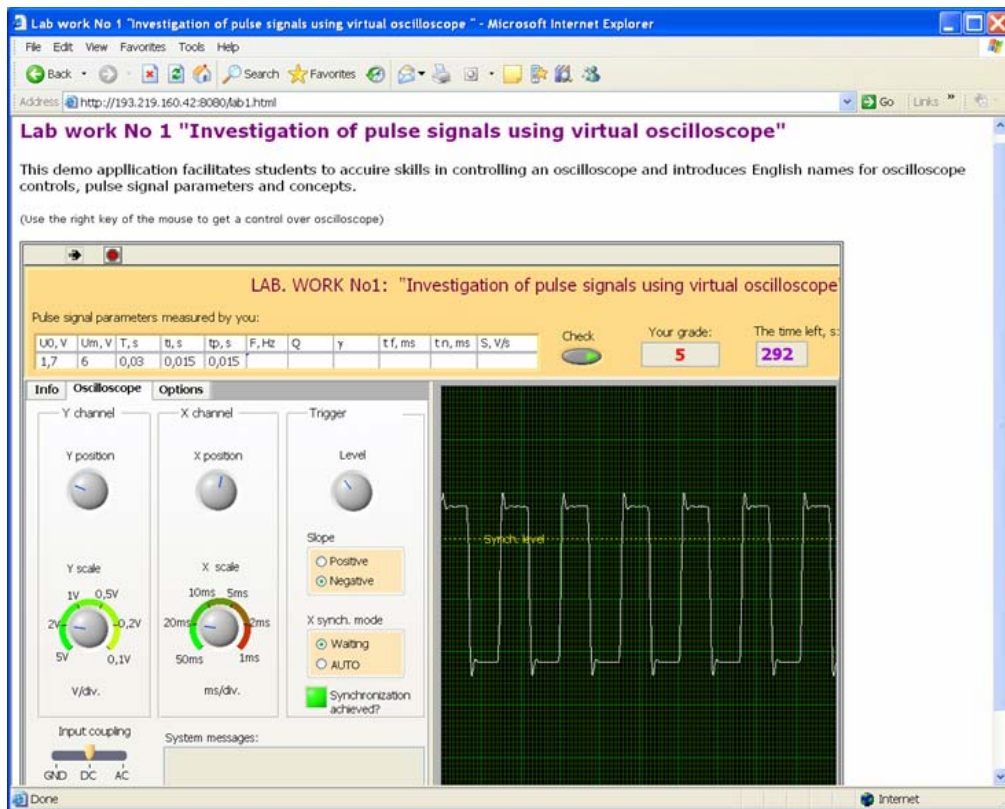


Figure 8. The WEB based lab work which integrates three functional blocks: signal generator, oscilloscope and automatic “assessment”

## 5.2 Remote laboratory

In spite of usefulness of simulated experiments, it is noticed that real experiments are more attractive to students than simulations. In order to be even more attractive they have to include some explicit and clearly stated challenge.

Internet made feasible new kind of laboratories - remote laboratories with real interactive experiments by using internet connected laboratory equipment: measurement devices and devices under investigation. In order to test such kind of “hands on” experiment, we developed and implemented remote lab work “Ultrasonic characterization of tissue like material” which can be accessed in EVICAB campus within “Laboratory of Ultrasound medical diagnostics” [3]. The approach with details was presented in the conference CISSE’2007 [9].

The challenge presented to the student is: “based on remote measurements and analysis identify the material from which the phantom is made”. The motivation behind this theme of

experiment is the importance to maintain the adequate competence of medicine doctors and biomedical engineers in principles of ultrasound medical diagnostics and sonography.

Laboratory experiment includes four main stages: self-sustained preparation and preliminary test before experiments; hands-on experiment, results documentation and report preparation, interpretation of results, conclusions and after labs testing quiz.

At first students use e-learning materials available in EVICAB project's e-Learning platform Moodle (see Figure 9.) to get acquainted with the methodology description and derivation of equation how to characterize material from features of echo pulses. The equation includes data derived from echogram. The calculations of relevant parameters are programmed in the virtual instrument, but students should get an idea of these "hidden" calculations after reading the method development chapter. The given challenge: identification of the phantom material, is accomplished by examination and comparison of estimated parameters with the parameters in the materials catalogue.

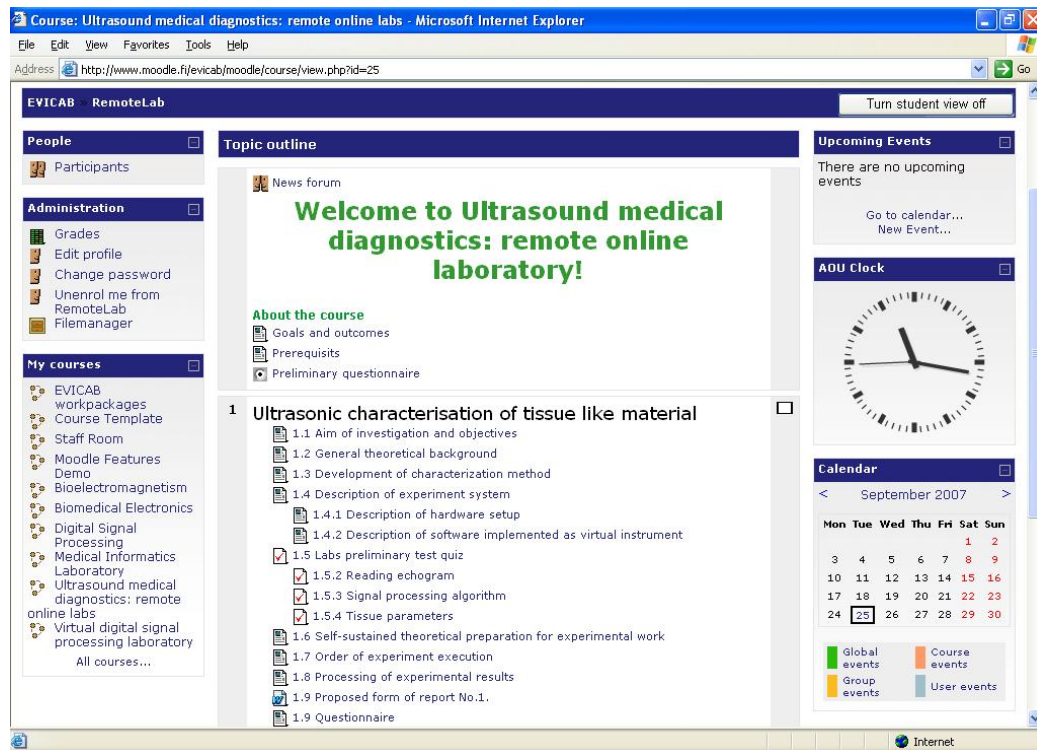


Figure 9. The screenshot of Ultrasound Medical Diagnostics web page in Moodle.

The technology behind the remote lab includes hardware and software. The experimental system is based on high speed (100MHz), high resolution (12bits) digitizer Picoscope ADC 212/100 (Pico Technology Ltd., Cambridgeshire, UK), function generator Hameg HM8131-2 (Hameg Instruments GmbH, Mainhausen, Germany), ultrasound transducer (central frequency 2,25 MHz, aperture 13 mm in diameter) and matching circuit. All the hardware can be controlled by the student remotely using the virtual instrument built with Labview (see Figure 10).

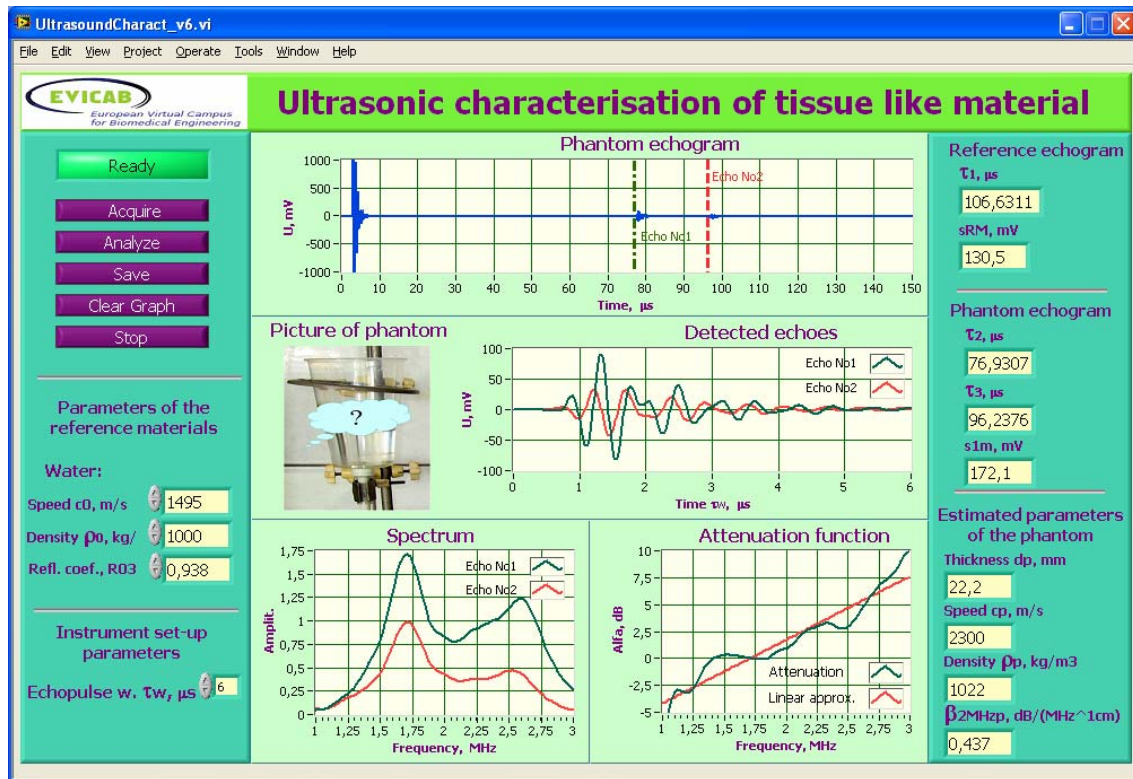


Figure 10. Example of remote lab work interface

The first aspect which needs attention when planning such experiments is the amount of interactivity needed to perform the experiment. There is danger of too much automatic experiment when students will lack the interaction. On the other hand, if students are left with manual processing of the acquired data, the path to the results could be too complicated and nobody will succeed. Thus the goal, for example, to show the power of ultrasonic tissue characterization method, could be not reached.

The digital domain signal processing algorithms are rapidly developing and have the increasing importance in ultrasound diagnostics. Virtual implementation of instruments will enable us easily to modernize the lab by the simple change of software algorithms. Therefore students will get the most up-to-date system to work with. This is important aspect of virtual experiments systems development taking into account constrains of capital and time resources.

## 6 Development of e-assessment methods

Internet examination is a new dimension in e-learning which was taken into use at the RGI. Internet examination is realized in the following way: The students attend the examination at the computer class and their identity is checked. When the examination begins, the examination questions may be opened on the computer. The computers are connected to the Internet and the students may use all material available, including the textbook and all other teaching material of the course. Thus, the examination primarily tests the students' understanding on the course material and ability to make conclusions on it. The Internet examination also makes it possible for the teacher/assistant to monitor the progress of the examination independently of the location where they are.

## 7 Conclusions

- Our personal experience and feelings support the NTL's "learning pyramid" as being true, though the pointed out percentages can be argued. Nevertheless, it has to be taken into account in all types of courses including face-to-face classrooms, on line and of off line e- learning modes.
- Virtual learning environments such as Moodle are becoming mature technology and really help the teacher to develop the courses which could serve students with different learning styles. However, the teacher must be aware that it will take some time to learn the new tool and it is normal as it was when learning how to drive a car.
- Students belonging to "digital" generation do not afraid experimenting with technology; actually, they like it and try it willingly. Teachers can exploit this "weakness" in order to attract the attention of students.
- Proper caution must be observed when designing the simulation experiments - students some times try to use "trial and error" method when approaching the problem. They should be warned against that, as no real learning happens in that case.
- The really advanced, multimedia technology rich courses will be designed and developed by teams of experts from different fields: pedagogy, art, software and hardware technology.
- In our opinion, the assessment plays very important role in learning process and it will gradually drift from testing the students' memory or ability to recall the material. The alternative is a formative assessment which will take place during the whole course and will asses the students' ability to consolidate the new knowledge with what was known and to solve the problems relevant to the field of study.

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