

MODERN TRAINING TOOLS IN NUCLEAR FIELD

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The paper presents the process of modernization, extending and development of the e-Learning platform performed by Nuclear Training Centre within “Horia Hulubei” National Institute of Physics and Nuclear Engineering – IFIN-HH. The *Learning Management System* (LMS), an important component of an e-Learning platform, is described. A course on radiation protection in medical field was developed within platform as a sample of e-Content. Several software applications that were developed are presented.

Key words: radiation protection, training, e-Learning.

1. INTRODUCTION

Nuclear Training Centre (CPSDN) department within “Horia Hulubei” National Institute of Physics and Nuclear Engineering – IFIN-HH is developing, since 1970, the post-secondary and post-graduate training for the personnel involved in practices with ionizing radiation sources or advanced physical techniques. Nuclear Training Centre offers training programs in fields as: Radiological safety in use of sealed / unsealed radiation sources, Radiation safety in mining and milling of uranium and thorium ores, Radiation protection in diagnostic and interventional radiology, Radiation protection in nuclear medicine, Radiological safety in radiotherapy, for all kind of personnel: physicists, service engineers, physicians and undergraduate personnel.

In the last time, CPSDN has started a process of modernization for using the new digital technologies in its own activities. The general aim is to maintain competitiveness and training quality both at national and european level.

At international level, there are efforts on introducing digital tools for learning both in teaching of science [1–3], and specifically in the nuclear field [4–9].

Implementation of an e-Learning system involves the development of two components: the *Learning Management System* (LMS) and the digital content (e-Content). The achievement of these components will be presented in the following sections.

2. LEARNING MANAGEMENT SYSTEM

Learning Management System (LMS) is a software application for the administration, delivery, tracking, reporting of e-Learning training programs. CPSDN has developed an information platform as a module of a complex strategy implying a coherent integration of the classical methods and the online information management systems. In the first stage, CPSDN used the open-source platform Moodle, compatible with the SCORM 1.2 standard, while the open source LMS Ilias, SCORM 2004 compliant, was tested for almost a year [10–12]. From the experience of use of both solutions the following observations have emerged:

- both solutions were difficult to use by the non-IT staff of the CPSDN, therefore an IT specialist should be permanently involved for the administration and configuration of the system,

- the frequency of publication, by the non-IT staff, of informative material on the platform was improved after updating the information platform with a more user-friendly one.

As solution, it was decided that the e-learning platform to be replaced with one more easy-to-use, which should support both the training activities of CPSDN's customers and also the integration with the information and dissemination activities. Table 1 shows the identified requirements that should be fulfilled by such a platform. As the open-source solutions do not meet the basic requirement of ease of use, it was decided to implement a solution developed by a local company.

Table 1

Requirements for the LMS solution

No.	Description
1.	The platform can run distributed on several machines
2.	Minimum SCORM 2004, 3rd edition
3.	Support for .pdf and .mp4 formats
4.	Minimum 75 concurrent users
5.	Minimum 2500 total users
6.	Support for user roles: administrator, teacher, student, manager
7.	Users can be multi-role
8.	The student-role should have access to assigned materials and be evaluated
9.	The student-role should be able to distinguish between courses monitored (SCORM) and unmonitored (pdf, mp4)

Table 1 (continued)

10.	The student has permission to access / modify personal data and password recovery
11.	The teacher-role has access to all the features of the course
12.	The teacher-role should be able to manage the assignment of courses
13.	The teacher-role should be able to view information regarding students' progress
14.	The teacher-role should be able to set the course duration (start date, due date)
15.	The teacher-role should be able to initiate audio-video conferences
16.	The administrator has full access to the platform configuration
17.	The administrator manage the users' accounts
18.	The manager-role should be able to keep track of progress and performance reports, and also keep track of the courses attendances
19.	The platform can run on at least two different operation systems

The implemented LMS has an intuitive and easy to use interface (figure 1). Each user has one or more “roles”: student, teacher, administrator, manager. Each user can see a board for sending and receiving messages from another user or from the system. Also, each user has access to My Settings section.

Figure 2 shows the workflow of the training process in order to present the usage of the platform.

Group Organizer is the place where the student can see the training materials: main course material (which must be in a special format – SCORM) and auxiliary materials (in pdf, audio or video format).

The teacher has more permissions on his own material: preview, delete, suspend, etc. In Library Section the teacher can upload courses and assign them to groups.

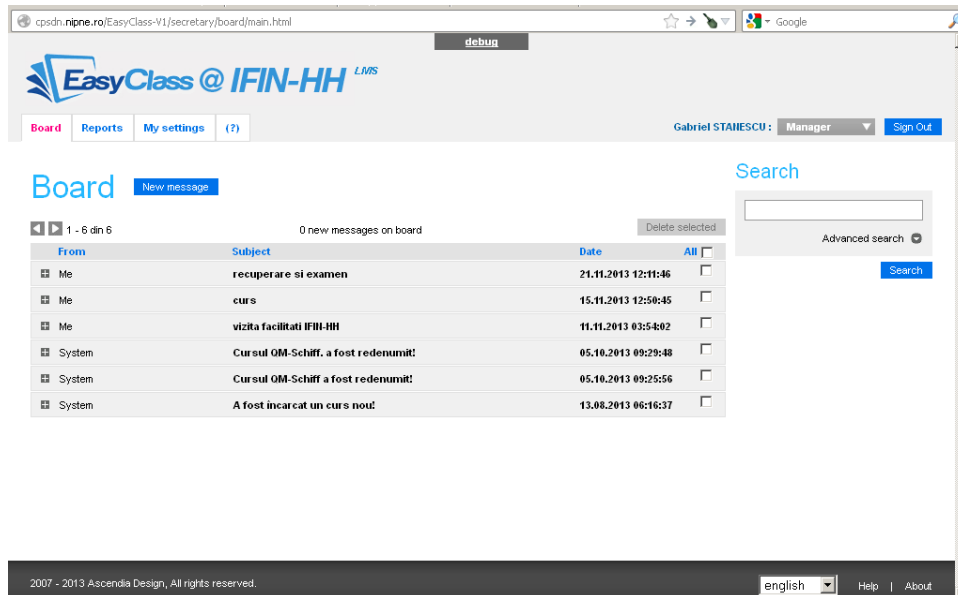


Fig. 1 – Board page of the LMS.

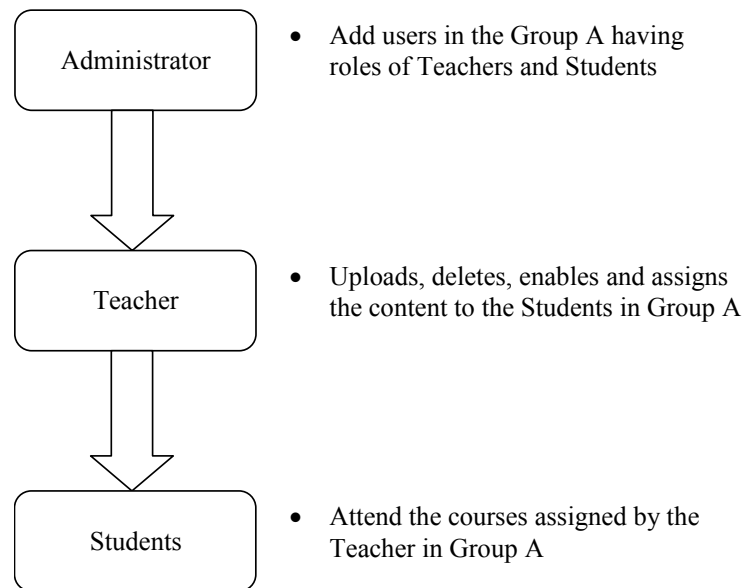


Fig. 2 – The workflow of the training process.

3. DEVELOPMENT OF AN INTERACTIVE ONLINE COURSE

As it could be noticed from the concerns of the international bodies in the field, also underlined in the informative section of the platform, one of the major issue consists in the exposure increase due to the medical applications of the ionizing radiations [13, 14]. Many people are exposed to ionizing radiation during diagnostic and interventional medical procedures. According to the present evaluations, doses due to medical exposure are among the highest doses of the human activities.

In countries with high health-care level the annual average number of diagnostic procedures using ionizing radiation exceeds 1 per capita. More than that, patients' doses during diagnostic examinations with X-ray are significant different in various laboratories, fact that suggests that optimization is necessary.

New high-dose X-ray imagistic technologies (especially computed tomography) represent the cause of the fast increase of the procedures number in many countries and thus a significant increase of the collective dose.

In some countries this determines, for the first time in history, that the annual collective dose and per capita average dose due to the diagnostic radiology exceed dose due to the natural background radiation.

Moreover, workers from the medical field represent the main part (75%) of the occupationally exposed workers from artificial sources.

Optimization of the radiological protection within the diagnostic and interventional medical procedures requires high qualification of the involved medical and nonmedical personnel.

Training courses are essential for ensuring the radiation protection of patients and workers [15, 16]. In this way one of our objectives consisted in the development, as a sample of e-content, of an interactive online course in this field, under the platform, which allows specialists access to a qualitative, friendly and accessible training.

Training curriculum was developed taking into account years of CPSDN experience in this type of training and international standards in the field. The course structure is shown in Table 2.

Table 2

Syllabus of the course

No.	Topic
1.	Introduction
2.	Production of X-ray and interaction of radiation with matter
3.	Dosimetric quantities
4.	Biological effects
5.	Radiation protection principles
6.	X-ray generator. Radiological equipment
7.	Image receptors
8.	Exposure optimization. Practical aspects
9.	Quality Management System. Acceptability criteria
10.	Specific regulations

During the course there are approached subjects necessary for the development of radiological safety culture, from basic physics in radiology and biological effects of the ionizing radiation to the presentation of the legislative and regulatory framework in the field.

Online presentation of this course required the development of a SCORM 2004 package published under the above-mentioned LMS learning platform.

For each of the course chapters there have been developed interactive applications, simulations, 3D modelling, animations to assist the student to fix knowledge presented during the course.

Additionally to the interactive resources having different degrees of complexity, the course offers text type and images resources, as well as quiz type questions.

Taking into account the newest technological progresses in hardware, a required development was that the interactive applications should run on touch screens (touch/multi touch, interactive table, mobile devices).

We brief present in the following, for example, some of the interactive applications developed under the course.

Filtration of X-ray beam

It was developed an application used to explain the concept of filtration of the X-ray beam in order to improve the beam quality (figure 3).

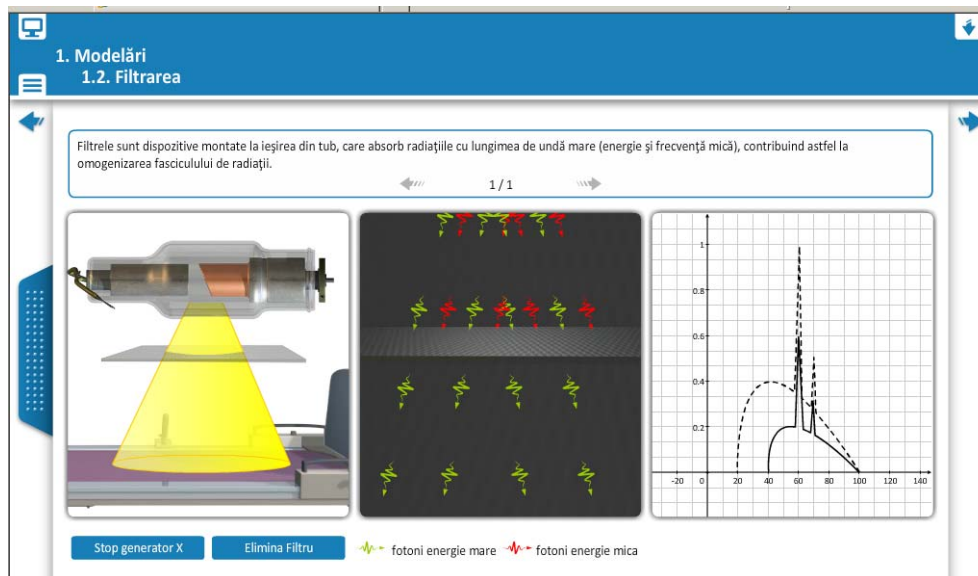


Fig. 3 – Screenshot of 'X-ray filtration' application.

Under this application the student could correlate filters utilization with the beam quality. It is presented in a dynamic way the spectrum modification through the elimination, by filters, of low energy photons which do not contribute to the image formation, but they useless increase patient dose.

Biological effects

Effects of ionizing radiation on health are presented through an interactive application under which the student could discover step by step the main types of biological effects produced by radiation (figure 4).

Collimation of X-rays beam. Effects on patient dose

Through this application (figure 5) it could be simulated patient exposures with different beam collimations. There are estimated doses on the exposed organs based on exposure parameters and DAP (Dose-Area-Product Meter) measurement. User could collimate the interest zone and modify different parameters of exposure. In this way are revealed the important dose modifications on organs adjacent to the interest zone.

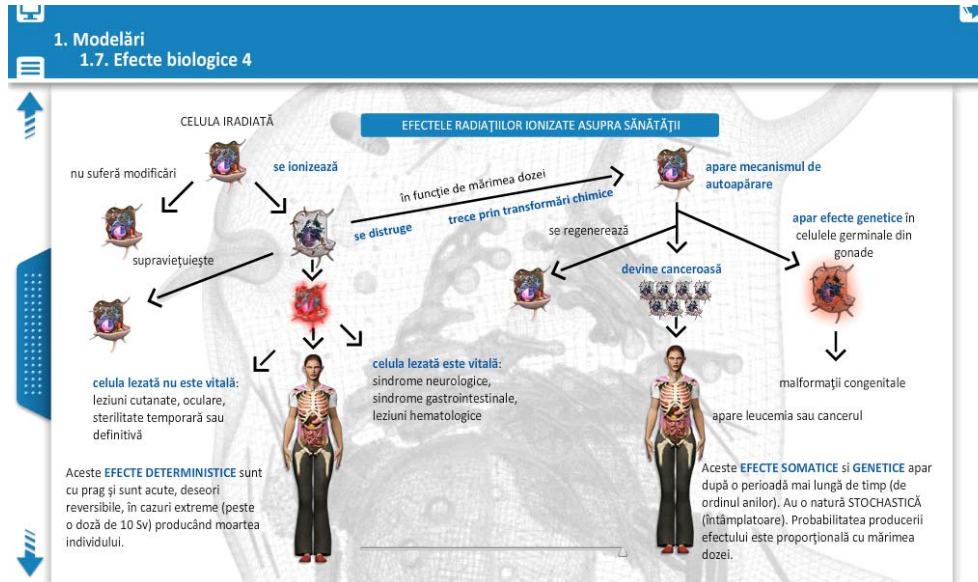


Fig. 4 – Biological effects.

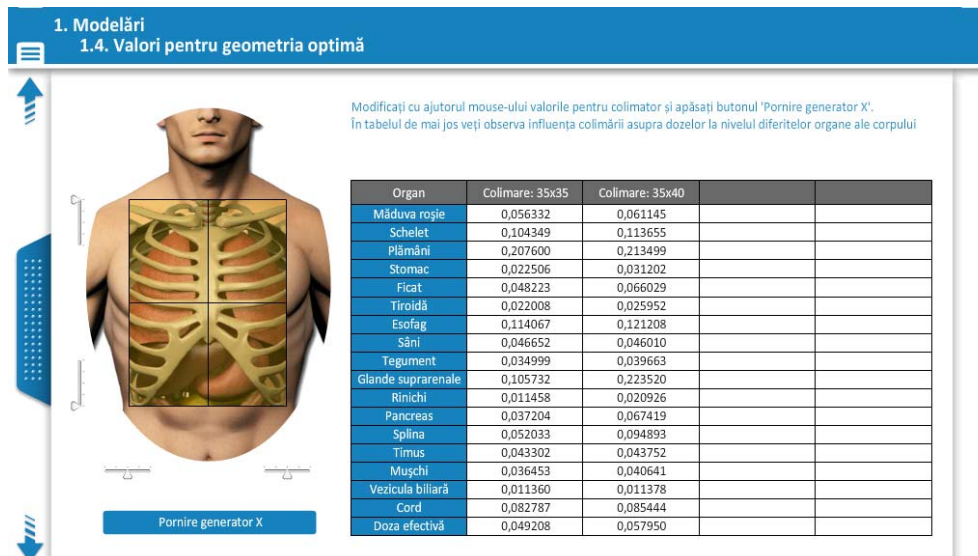


Fig. 5 – Software used to calculate the radiation doses on organs as a function of X-ray beam collimation.

Characteristics of digital images – grey levels

One of the major changes in diagnostic radiology during the last years is represented by the large use of digital imaging. Besides its numerous advantages there is the justified concern of the international community from the radiation protection field regarding potential useless increase of patient dose due to the incorrect use of digital equipment. Knowledge of the digital imaging characteristics by practitioners represents an essential point in the optimization process. This application (figure 6) allows the students to understand the grey level concept of a digital image.

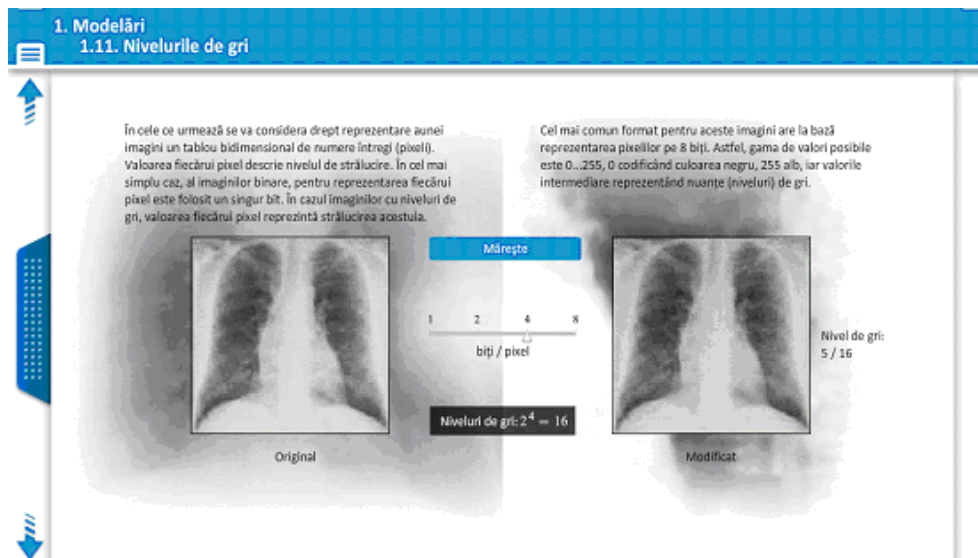


Fig. 6 – Understanding the concept of gray levels.

Dosimetric quantities. Emulation of using a radiation detection device

It was emulated the operation of an area dosimeter by virtual replication of its menus and functions. Dosimeter operation is illustrated through a virtual experiment which involves measuring the dose rate of a radiation source and allows the user to verify the law of dose variation with distance.

The developed e-learning content can be used in blended learning way, internet based delivery or computer based training. The next steps could be: the assessment of the course implementation and development of new online courses for other practices (non-destructive testing, radiological emergency, etc.)

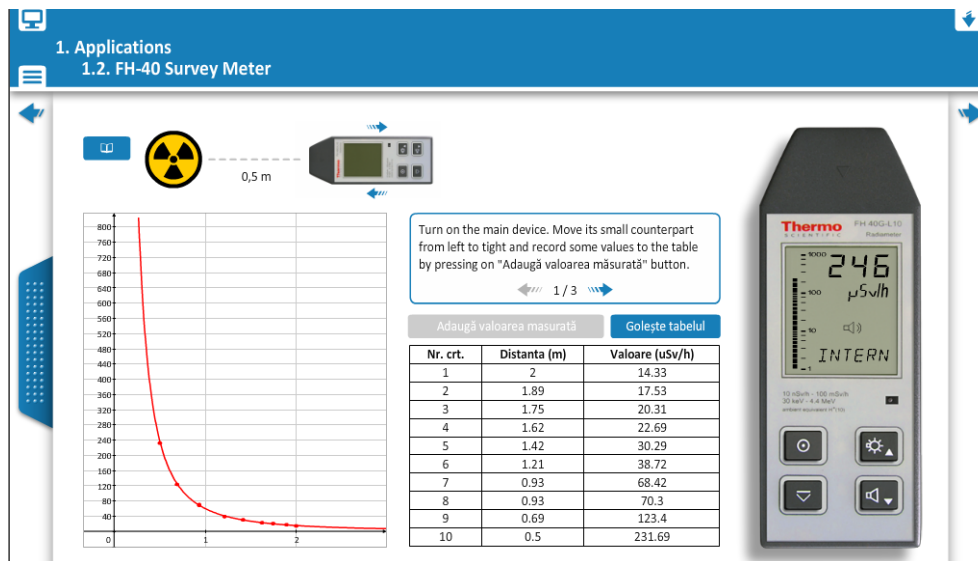


Fig. 7 – A full simulation of functions of a radiation detection device.

4. CONCLUSIONS

Implementation of a modern system of informing, training and dissemination represents a complex activity which assumes the existence of important material, human and financial resources, as well as the necessary competences for the development of the interactive electronic contents. Through the implementation of an information and dissemination platform doubled by a functional e-Learning component, CPSDN made important steps towards the alignment to the actual standards on presentation, representation and distribution of information.

Modernization of the e-Learning component of the platform allows IFIN-HH to organize both formative activities (distance training, computer assisted training) and informative activities under the dissemination process.

E-Learning has certain benefits over traditional methods. Distance learning allows students to learn at a distance away from source of expertise. Web based training has lower training development cost, eliminates travel cost and it is time saving. It allows trainees to have training anytime, anywhere and at the amount they need [17]. There are a lot of advantages in physics in general, because it eliminates the need for equipment, and in atomic and nuclear physics in special, because phenomena at the microscopic level can be modeled and intuitive illustrated.

Implementation of the *Learning Management System* (LMS) and the development of a pilot course with an increased interactive component necessary for CPSDN training activities, as well as illustration of digital presentation

possibilities of scientific knowledge would allow future development of a quality e-Content within the platform.

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