PROF. M. LÁNSKY VISION FULFILLMENT: E-RESEARCH AS A MISSING LINK IN THE INTERDISCIPLINARY CYBERNETISATION OF THE TEACHING PROCESS

NAPLNĚNÍ VIZE PROF. M. LÁNSKÉHO: E-VÝZKUM JAKO CHYBĚJÍCÍ ČLÁNEK V INTERDISCIPLINÁRNÍ KYBERNETIZACI VÝUKOVÉHO PROCESU

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Abstract

The paper introduces Integrated E-Learning utilizing the strategy of the education applied in the scientific work and thus fulfilling the basic idea of prof. Dr. Miloš Lánský who considered research and experiment as a indispensable link in the cybernetisation of the teaching process. Here, we present remote experiments across the Internet with the general principle Server-Client and software ISES WEB Control package. Examples of implementation on real-world quantitative experiments, Electromagnetic induction, Oscillator and Photovoltaic element are presented and experience gained in a pedagogical experiment discussed.

Abstrakt

V příspěvku je zaveden Integrovaný E-Learning jako vyučovací metoda založená na metodice známé z vědecké práce a tak naplňující základní ideu prof. Dr. Miloše Lánského, který považoval výzkumné metody práce a experiment jako chybějící článek v kybernetizaci vyučovacího procesu.V této práci představujeme vzdálený experiment na internetu na základě obecného schématu Server-Klient a software ISES WEB Control. Jsou podány příklady experimentů pro kvantitativní studium jevů reálného světa, Elektromagnetická indukce, Vynucené kmity oscilátoru a Fotovoltaický prvek a je pojednáno o zkušenostech při jejich využití v pedagogickém experimentu.

Key words

E-Learning, Integrated e-Learning, remote experiment, web services, data transfer across Internet

Klíčová slova

E- Learning, Integrovaný e-Learning, vzdálený experiment, webovské služby, přenos dat po Internetu

1. Introduction

In his pioneering works in the 70[th] on Educational Cybernetics [Lansky] prof. M. Lánský described the educational process by means of six didactic state variables and using the exact optimisation procedures he tried to find the optimal value of them. Subsequently, in his general model of Educational Cybernetics, later labelled as of the Austrian-Czech origin, compared to the not so general German model [Bung, Lansky], he included and modelled not only teaching process itself, but also other relations and components of the educational process. Specifically, he foresaw the importance and the role of computer-oriented and remote experiments in this respect [Lansky and Capek].

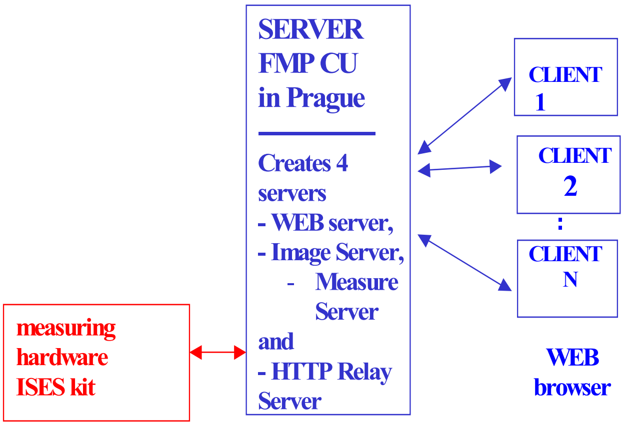
Thirty years later the Nobel price winner Carl Wieman calls in a series of papers [Wieman and Perkins] for the necessity of the transformation of physics education and as a solution he sees the introduction of the methods that worked well for advancing scientific research – i.e. biasing the teaching practice on research and problem solving of the phenomena of the real world. He stresses the importance of new technologies, especially interactive simulations [Colodardo]. Similar approach was taken by the project oriented teaching methods by McDermott [McDermott and Redish]. Recently, the educators realised that new phenomenon starts to come into existence: Real, on line remote experiments across the Internet, examining the real objects and phenomena of the real world, filling the existing gap in e-Learning. The possibility to start a new era in e-Learning, based on the methods known from research and introducing the more complex term of combined e- LTR (e- Learning, e- Teaching and e- Research) was presented by Thomsen group [Thomsen et al].

In this paper, we pay tribute to the life-long work of Prof. Lánský, presenting the Remote experiment across the Internet as a new educational technology and opening the real possibility to Integrated e-Learning as a new approach for the study of Physics and Natural sciences. The accompanying paper gives, in the form of an example, the application of the Integrated e-Learning in the teaching of the oscillations [Ozvoldova, Schauer and Lustig 2006a].

2. E- Research -philosophy and technical implementation

Integrated e-Learning is based on the methods of cognition used in the scientific work based on the observations of the real world, tracing, ordering and storing information, explanation of the observations and the data and results presentations, where the active role of the observer is vital. For the teaching process based on the cognition the new technologies are coming into existence as prerequisites: the dynamic simulations [Colorado] and remote experiment across the Internet, both as the building blocks of the e-Research. This paper deals with our approaches in the letter one and its implementation for real remote experiments.

Let us briefly describe our solution of remote experiments. Our general scheme for the remote experiment across the Internet is based on the Server-Client approach and WEB Internet services (Fig. 1). For the transfer of information WEB HTML language and ready for use modular Java applets are used. On the client computer (remote experiment user) a standard browser (Internet Explorer, NetScape, Mozila, etc.) with implicit Java support is used. The measuring hardware implemented in remote experiments is ISES (Intelligent School Experimental System) [Lustig] on the server side. The software kit, developed and produced in the Faculty Mathematics and Physics, Charles University in Prague – CD - ISES WEB Control kit [Lustig2004] - consists of WEB server, Image Server for the support of WEB cameras, Measure Server for the control of the hardware (in our case ISES) and HTTP Relay Server. On the server side the WEB pages are generated using Java applets, which create control keys and bars for the control of outputs, applets for measuring and digital displaying of input values, applets for graphic displaying of input values, applets for the transmission of measured values into the client computer, applets for the image transmission from a WEB camera, etc. In Fig. 2 are several examples of modular Java applets from ISES WEB Control ®kit as building tools and blocks for remote experiments construction: display (a), control slide (b) and graph for data presentation (c). The kit consists up to now of 15 applets, which feature a lot of input parameters and great flexibility.



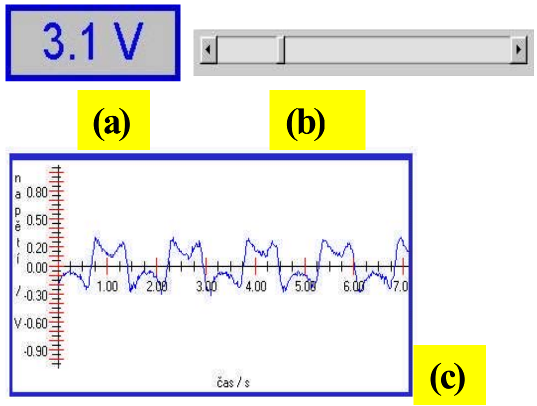


Fig.1. Schematical representation of the remote experiment with ISES measuring hardware, server and several clients.

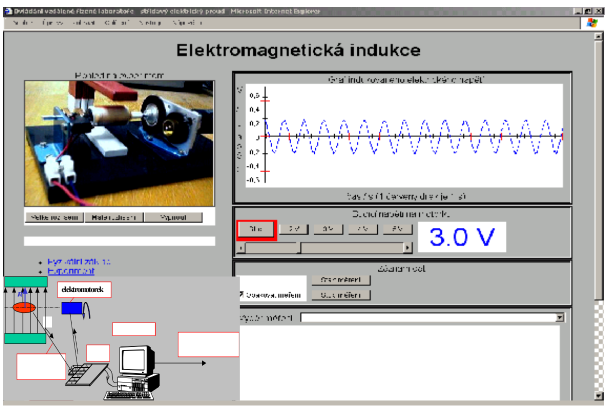
Fig. 2. Examples of modular Java applets from ISES WEB Control ® kit [Lustig 2004] as building tools and blocks for remote experiments construction depicting: (a) display, (b) control slide,

(c) graph for data presentation.

In following we show three remote experiments that reached considerable level of sophistication, operated at CU in Prague, i.e Faraday's law, Forced oscillations and an example of a Material Science experiment Photovoltaic cell characterization [Schauer, Ozvoldova and Lustig 2006b].

2.1. Remote experiment - Faraday's law (http://kdt-20.karlov.mff.cuni.cz)

As the first example of the remote experiment across the Internet is the experiment to verify the electromagnetic theory of Faraday (Fig. 3 and Fig. 4). The coil is rotating in the homogeneous magnetic field at the constant but variable frequency and the resulting electromotive force is collected The students have to prove the validity of the Faraday's law of electromagnetic induction**.**



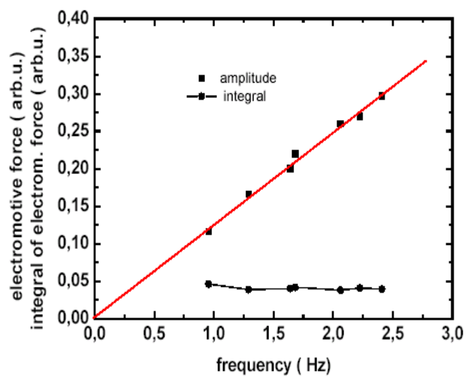
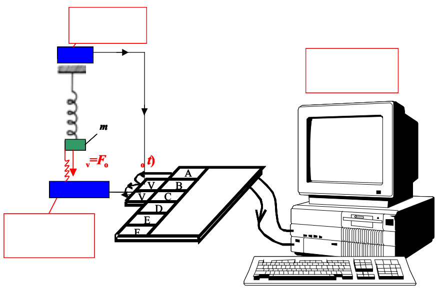


Fig.3 Web page of the remote experiment Faraday's law with controls, graph of the output voltage, life web camera picture and schematics of the experiment.

Fig. 4 The remote experiments evaluation - dependence of the amplitude of the output voltage on the frequency of the rotation of the coil, and the integral $\int_0^{T/2} |\varepsilon| dt = \int_0^{T/2} NBS\,\omega \sin(\omega t) dt = 2NBS = konst$.

2.2. Remote experiment – Oscillations (http://kdt-17.karlov.mff.cuni.cz)

As the second example of the remote experiment across the Internet is the experiment dealing with oscillations, Fig. 5 and Fig. 6. There can be studied both damped and forced oscillations and such phenomena as the resonance. The transferred data give information about frequency and instantaneous value of the driving force and the instantaneous deflection giving both amplitude of the forced oscillations and their corresponding phase. The usage of the experiment is manifold, determining the own frequency of the oscillator, its damping, the resonance, the amplitude and phase transfer functions and e.g. the energy transfer from the source of the driving force to the oscillator.



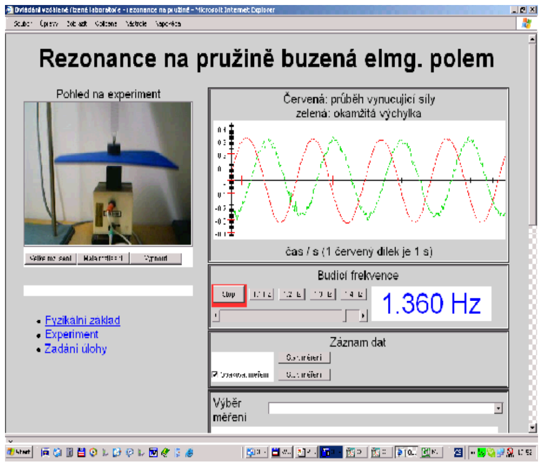
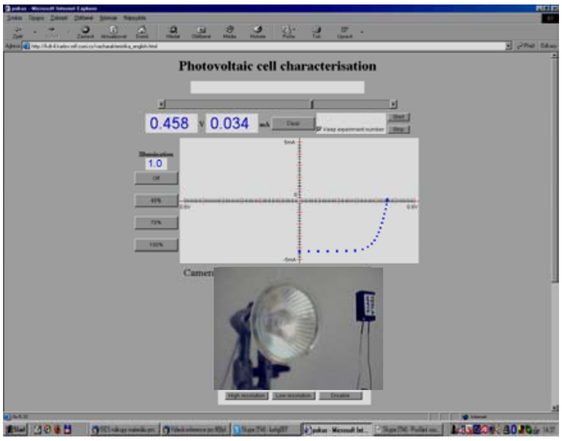


Fig. 5 The schematical representation of the remote experiment Oscillations with ISES hardware.

Fig. 6 The Web page of the remote experiment Oscillations with controls, life web camera picture and graph of the transfer characteristics (red – driving force, green instantaneus deflection).

2.3. Remote experiment – Photovoltaic cell http://kdt-4.karlov.mff.cuni.cz/fotodioda.html

As the third example of the remote experiment we present the remote experiment Photovoltaic (PV) element characterization in Fig 7 and Fig. 8. This is a popular real world experiment interesting both from the physical and environmental views. We have recently devised the more sophisticated version of this experiment as an example of the possibility to use remote experiments in Material Science [Schauer, Ozvoldova and Lustig 2006b]. The students were encouraged to study the quality factor of the dark current ***I-U*** characteristic of the diode and fill factor of the illuminated device that is decisive for the efficiency of the radiation to electrical energy transformation. The measurements are straightforward; the focus is then laid on the data evaluation. The extra variable parameter may be the intensity of light and temperature of the PV element. The students faced no problems with data transfer, but had to cope with some problems as to the physical phenomena involved and data evaluation.



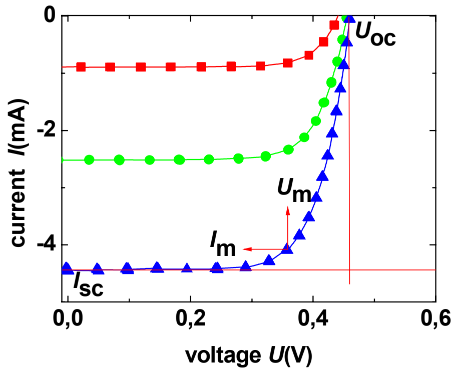


Fig 7. Web page of the remote experiment Photovoltaic cell characterization with controls, life web camera picture and graph of the *I-U* characteristics.

Fig. 8 *I-U* characteristics of the cell for illumination with three relative light intensities:

L (triangles), 0,7 *L* (circles) and 0,4 *L* (squares).

3. Pedagogical experiment

With the presented experiments the pedagogical experiment with the students was organized. Students were provided with instruction manuals for each experiment explaining the remote experiment basics, brief theory of the phenomena in question and tentative notes on protocol compiling. Their quality proved to be one of the most important circumstances for the good outcome of the experiment. Students were then allowed to measure on any suitable for them WEB station (PC Faculty laboratory, student hostel, at home, etc.) and asked to submit the written protocol with the theory, data, achieved results, and conclusions. On top of this, the students were asked to evaluate the technical, pedagogical and other aspects of remote experiments and suitability for their future carriers. In all phases of the process the instructors and teachers constituted the necessary informational feedback. The important factor was the extremely good motivation of the students.

4. Conclusions

This paper is a tribute to the vision fulfilment of prof. Lánský in Educational cybernetics, presenting the remote experiment across the Internet as a new educational technology opening the real possibility for Integrated e Learning as a new approach for the study of Physics and Natural sciences.

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