Applying WWW in Teaching of Course "Environmental Issues of Electric and Electronics Industry"

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Abstract— **As information techniques are improving they give a chance to developed new tools for teaching. Web-based education material has been developed in the Laboratory of Electrical Engineering and Health at the Tampere University of Technology for a few years now. The aim of this paper is to present the course "Environmental Issues of Electric and Electronics Industry" and ideas for applying WWW in the teaching as well as a virtual laboratory exercise for the course. The course was carried out as a traditional and also as a virtual course on the Internet. The course consisted of lectures, calculation exercises, interactive exercises and supplementary study material in paper. The course was operated in a learning environment developed at the Laboratory of Electrical Engineering and Health.**

Index Terms–**WWW-education, Virtual laboratory, Distance learning, Laboratory exercise, Java applet**

I. Introduction

Recent development in the area of information technique, especially the fast expanding of the use of the Internet, has created possibilities for new forms of education. The use of the WWW makes it possible, e.g., to distribute teaching material efficiently as well as to form new learning communities. The Laboratory of Electrical Engineering and Health (LEEH) at the Tampere University of Technology (TUT) has been involved in developing web based teaching environments for a few years now [1],[2]. One of the forms of this development has been the constructing of a learning environment for the web, which was used in the course "Environmental Issues of Electric and Electronics Industry". For teachers this environment provides, e.g., a way to produce web based material. For students the learning environment provides a chance for easy navigation.

The aim of this paper is to present the course "Environmental Issues of Electric and Electronics Industry" and ideas for applying WWW techniques as well as a virtual laboratory exercise being developed for the course.

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II. The Realization of the Course

The course "Environmental Issues of Electric and Electronics Industry" was arranged both as a traditional course and as a virtual web based course. The traditional course was attended by 31 students and the virtual course by 17 students during the autumn term 2001.

The basic idea in using the WWW is that it should provide some additional value compared to traditional teaching and learning and not just be applied for its own sake.

A. The traditional course

The traditional way of teaching the course included 14 hours of lectures, 3 calculation exercises and a laboratory exercise. The lectures lasted two hours each. The exercises were carried out in a classroom under a teacher's instruction, and they consisted of calculation exercises related to the topic of previous lectures. In addition, laboratory exercise was carried out in groups of five students. The laboratory exercise was carried out in a university laboratory, and the topic was "Studying of Exposure to Magnetic Fields". The actual laboratory exercise consisted of magnetic field measurements. Figure 1 presents the schedule of the traditional course.

Week	36	37	38	39	40	41	42
Chapter	1	2	3	4	5	6	7
Calculation exercises			X		X		X
Laboratory exercise				X	X	X	

Fig. 1. The course schedule of the traditional course.

To complete the course, the students also needed to pass the final examination of the course.

The material used in the traditional course consisted of a textbook and additional material for the calculation and laboratory exercises. The calculation exercise material was also distributed on the Internet, and the signing up for the laboratory exercise was made on the Internet.

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B. The Virtual Course

The virtual course consisted of lectures on the web, three meetings and a virtual term paper. Figure 2 presents the virtual course schedule.

Week	37	38	39	40	41	42
Chapter	1	2	3	4	5 and 6	7
Meetings	X		X		X	
Feedback form		X		X		X
Group 1		Term paper		Opponent		
Group 2			Term paper		Opponent	
Group 3				Term paper		Opponent
Group 4			Opponent		Term paper	

Fig. 2. The course schedule of the virtual course.

The course material consisted of a traditional textbook and the virtual lectures on the web. For pedagogical reasons the lectures of the virtual course were kept more compact than in the traditional teaching. The web based lectures were divided into short paragraphs, consisting of about three screen layouts each, because it was assumed that the students do not want to read longer texts from the screen.

The virtual course lecture topics were: Introduction, Environmental Effects of the Production of Electricity, Environmental Effects of the Electrical System, Electromagnetic Radiation in Environment, Environmental Hazards and Dangers Related to Electricity, Life Cycle Analysis (LCA) for Electrical Apparatus and Electronic Device, and Evaluation of Environmental Health Effects.

During the course, the students were to familiarize themselves with the textbook and the seven virtual lectures, and also to become acquainted with the calculation examples at the end of the lectures. In addition, interactive multiple choice control questions were found at the end of each lecture. By answering these questions, the students could test their skills after studying the lecture. These answers were immediately checked by the computer software. An example of a multiple choice control question is presented in figure 3.

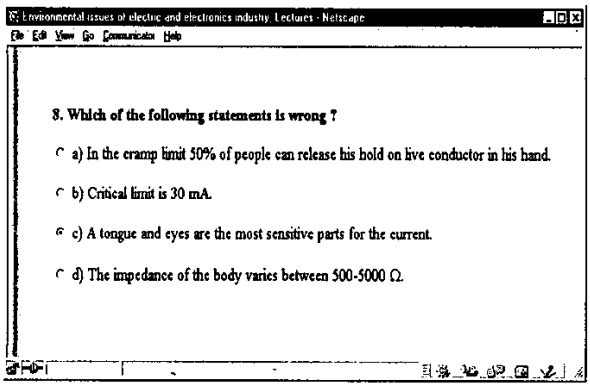

Fig. 3. Multiple choice control question

During the course, the students also had to participate in three meetings. In these meetings, the students could ask questions on the topics they had found difficult to learn. Since there was not a laboratory exercise in the virtual course, the students were to do a virtual term paper in small groups instead. The term papers were published weekly on the web in order to be reviewed by other groups acting as opponents. By doing this term paper well, students could get better marks for the course. The students also had an opportunity to participate in the lessons of the traditional course.

The virtual course did not include a laboratory exercise, but a virtual laboratory exercise is being developed and will be introduced in the future.

To complete the virtual course, the students needed to pass a final examination.

III. DESCRIPTION OF THE VIRTUAL LEARNING ENVIRONMENT

The Laboratory of Electrical Engineering and Health developed a web based learning environment that was used in the virtual course "Environmental Issues of Electric and Electronics Industry". Only the participants of the virtual course were allowed to access the course's web pages. Each attending student was given a user name and a password to login to the starting page. The virtual course included curriculum, announcements, students, lectures, seminar, links, personal page, help and logout that could all be found on the starting page. The starting page of the course in this learning environment is presented in figure 4. (The original course was only available in Finnish but the figure has been translated into English.)

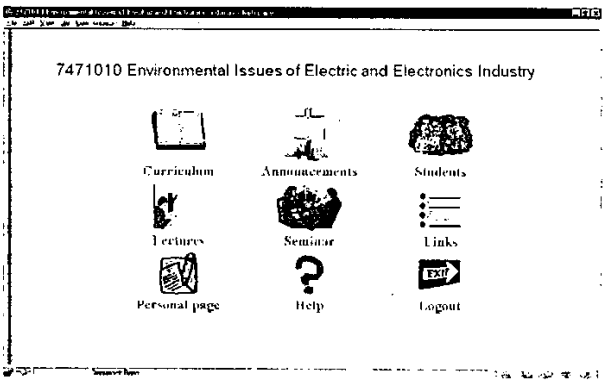

Fig. 4. The starting page of the virtual course.

The *Curriculum* contains basic information about the course. The *Announcements* includes information on topical issues, such as meeting schedule, results of term exams and laboratory exercises schedule. The *Students* page includes the students' contact information, e.g., their e-mail addresses. The *Lectures* page contains the actual self-study material. The term papers made by the students are available in the *Seminar* page. The *Links* page includes several references and web sites that the students can use in acquiring further information on the subjects of the course. The *Personal* page is reserved for the students' own notes and for submitting the feedback form.

The *Help* page contains information about the use of this WWW -course.

IV. Feedback of the Virtual Course

The students were asked to give comments of their learning process every three weeks on an electronic feedback form. The students were allowed to fill in the feedback form even more frequently if they wanted to. Altogether, 43 answers to the feedback form were received. The feedback form could be filled in either groups or individually. Figure 5 presents the feedback form.

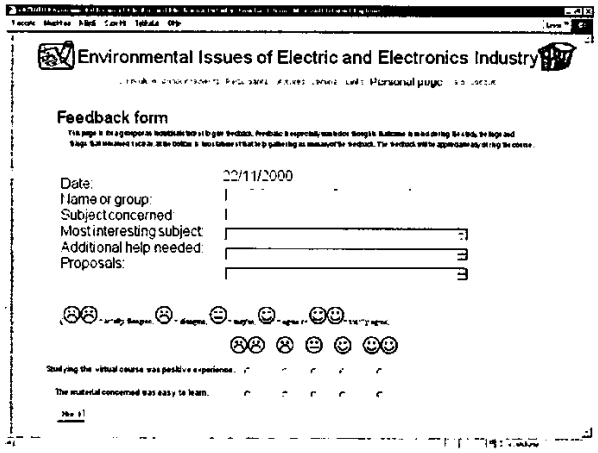

Fig. 5. The feedback form used in the course.

The students were asked to evaluate the following two statements:

1) Studying in the virtual course was a positive experience.
2) The course material was easy to learn.

The results are presented in figure 6. Statement 1 is shown with lighter color and statement 2 with darker color.

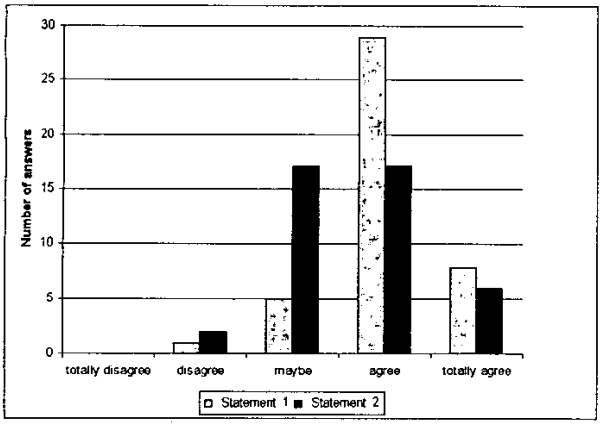

Fig.6. Feedback from the students [n=43].

The results of the feedback form, together with other feedback received by the teachers, shows that the students participating in the virtual course were still not prepared to study by themselves without any guidance. However, they were clearly intrigued by the idea. Also, the course seemed to be rather liked.

V. Developing the Laboratory Exercise for the Virtual Course

A part of developing the course further is the virtual laboratory exercise. The topic of the exercise is electrical safety, which is considered to be a very important matter. The virtual laboratory exercise is developed based on a traditional laboratory exercise used earlier in the teaching of electrical safety. The exercise presents different methods for human protection against electrical failures in regular low voltage devices. These methods concern the use of neutral and protective earth conductors as well as fuse based protection.

Like in the traditional laboratory exercise of the course "Environmental Issues of Electric and Electronics Industry", also in this virtual exercise the students will need to write a preliminary report. This report includes a few basic questions about electrical safety. The preliminary report is stored in a cookie, after which, the student is allowed to proceed with the exercise. They will use the virtual network device shown in the upper part of figure 7 to perform a couple of tasks concerning the protection methods mentioned above.

In the upper part of the figure 7, boxes with letter V and A are voltage and current meters that indicate virtually measured values. On the rightmost, *Device* stands for a high power electrical device connected to the low voltage network. One can generate a failure to this device by pressing a button, in which case the device's shell will become live and thus current is able to flow through it. There is also a light on the device that indicates whether the device is working in the different situations or not. In the middle of the network device, there is a switch S_0, which uses resistance to simulate other low-power electrical devices in the network. Resistance can be added to the network with this switch and thereby alter the power consumption of the low power devices. Switches R_P and R_N are the resistances of the phase conductor and the neutral conductor. The switch F is a fuse panel used in the task concerning fuse sizing in the low voltage network. In the upper left hand corner, there is a box, which illustrates the main switch of the low voltage network. This switch activates the complete network device.

All the parts of the virtual network device described above are functional buttons. By using these buttons, the students can create the network situations needed to perform all the necessary measurements and to understand how people are protected against failure voltages and currents. While performing the tasks, the students will also fill in a measurement report shown in the lower part of the figure 7.

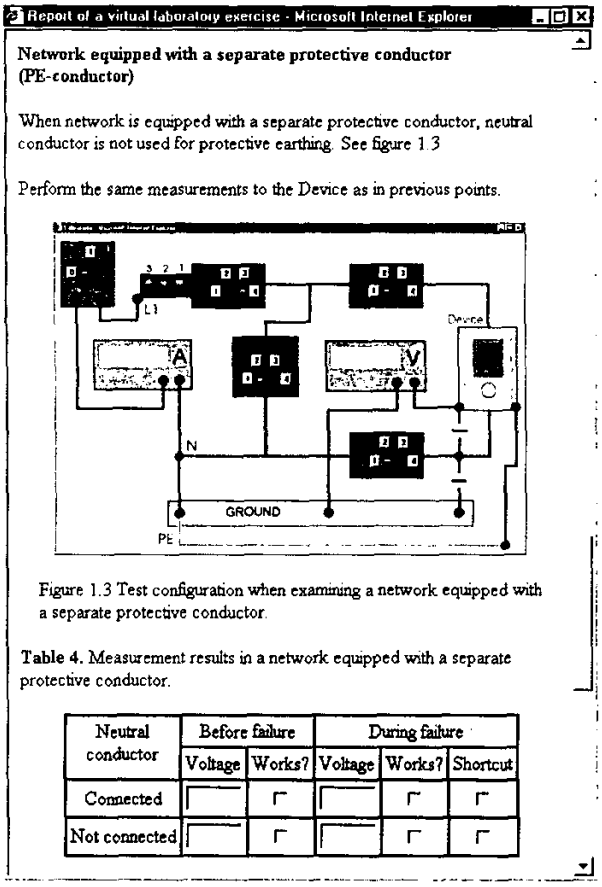

Fig. 7. An example view of the virtual laboratory exercise page.

The measurement results obtained in the exercise are automatically controlled. After doing all the measurements, the student will push a *submit* button and the system will give instant feedback whether the answers were correct or not. Students will also be given a certain number of tries to answer the questions, which represents the fact that in regular laboratory exercise there is an assistant helping with the measurements.

In the developing of the virtual laboratory both Java and Perl programming languages were used.

VI. DISCUSSION

The use of the WWW applications is considered to be a good addition to the traditional teaching methods, but can not replace conventional techniques completely, at least not at the moment.

The students' experiences from the course "Environmental Issues of Electric and Electronics Industry" were altogether positive. However, they were still not prepared to study all by themselves, but felt the need for the teachers' guidance.

Both the students' and the teachers' opinions of the course have increased the motivation of developing the course, and especially the WWW-applications further. The virtual course will be improved with the implementation of a virtual laboratory exercise in the future. As the students have not yet been able to test the virtual laboratory exercise, it is not known what kind of reception it will get and how it will affect learning.

Nevertheless, it can be said that the realization of the virtual laboratory exercise itself has worked out as expected. The created virtual network device corresponds to the real network device that was used as its model. It is possible that we may see more virtual laboratory exercises in the future.

VII. REFERENCES

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VIII. BIOGRAPHIES

Pekka Laitinen was born in Uusikaupunki, Finland, April 1976. He is studying control engineering at the Tampere University of Technology (TUT) and is working as a research assistant in the Laboratory of Electrical Engineering and Health at TUT.

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Tuija Mannila was born in Kuusankoski, Finland, in 1968. She graduated from the Tampere University of Technology in March 2000. After receiving her M.Sc. degree, she worked as a research engineer at the Tampere University of Technology (TUT), Electric Power Engineering. Now she works as an assistant in the Laboratory of Electrical Engineering and Health at TUT. Her main areas of interest consist of electricity economics and environmental issues related to electric and electronics industry.

Leena Korpinen was born in Turku, Finland, in 1963. She received her M.Sc. degree in electrical engineering at the Tampere University of Technology (TUT) in 1986, M.D., Ph.D. at the Tampere University in 1993, and Dr.Tech. degree at the Lappeenranta University of Technology in1996. From 1993 to 1994 she was an acting associate professor, from 1995 to 1998 she was associate professor, and since 1998 she has been a professor. From 1997 to 2001 she was also the head of electric power engineering at TUT, and since 2001 she has been the head of the Laboratory of Electrical Engineering and Health at TUT. Since 1996 she has also been a docent in medical technology at Tampere University. Her research areas include the health and environmental issues related to electric and electronic industry and also WWW in teaching and studying (electrical engineering and medical technology).