Seven Principles of Instructional Content Design for a Remote Laboratory: A Case Study on ERRL

Nergiz Ercil Cagiltay, Elif Aydin, *Member, IEEE*, Cansu Cigdem Aydin, Ali Kara, *Member, IEEE*, and Marian Alexandru

***Abstract*—This paper discusses the results of a study of the requirements for developing a remote radio frequency (RF) laboratory for electrical engineering students. It investigates students' preferred usage of the technical content of a state-of-the-art RF laboratory. The results of this study are compared to previous findings, which dealt with other user groups (technicians in technical colleges and engineers in the RF domain). Based on the results of these analyses, seven essential principles for designing and developing such a laboratory were identified. As a case study, these principles were then implemented into a remote laboratory system. In this paper, the implementation examples are also provided and discussed. The primary aim of this study is to guide remote laboratory platform developers toward the most effective instructional design. This study also determined, from the remote laboratory system case study, what the requirements are of such a laboratory from the students' perspective.**

***Index Terms*—Adult learning, distance education, improving classroom teaching, lifelong learning, telelearning.**

I. Introduction

LABORATORY experience is an essential part of engineering education. Modern improvements in the technological arena also affect the educational environment. Today's educators and curriculum developers are able to incorporate new technologies to provide a wide range of educational alternatives for learners. Remote and virtual laboratory environments, two such alternatives, offer potential solutions for supporting current education while creating distance-learning environments [1]. Remote and virtual laboratories provide alternative approaches for solving many educational problems. However, few studies in the literature discuss the requirements of these laboratories or the instructional design issues that need to be considered when building them. As Koohang and Durante report [2], Web-based distance-learning technologies rely on interface design elements such as usability, visualization, functionality, and accessibility, all of which play an important role in learning. Accordingly, appropriate learning theories and principles as well as user interface elements need to be considered in the design of these laboratories [2]. In previous studies, the requirements for remote RF laboratory applications were discussed from the educators' [1], and from the technicians' and engineers' [3] perspectives. This paper identifies the requirements from the students' perspective, using the European Remote Radio Frequency Laboratory (ERRL) system.[1] The primary research question of the study was "How do students prefer to study in a remote laboratory environment?" The study was intended to benefit potential users of such a laboratory environment: students in higher education institutions. The scope of this study was limited to instructional content design issues for such laboratories; user interface design issues were not included.

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N. E. Cagiltay is with the Departments of Computer Engineering and Software Engineering, Atilim University, Ankara 06836, Turkey (e-mail: nergiz@atilim.edu.tr).

E. Aydin and A. Kara are with the Department of Electrical Engineering, Atilim University, Ankara 06836, Turkey (e-mail: elif_aydin@atilim.edu.tr; akara@atilim.edu.tr).

C. Cigdem Aydin is with the Department of Computer Engineering, Atilim University, Ankara 06836, Turkey (e-mail: cansu@atilim.edu.tr).

M. Alexandru is with Transilvania University of Brasov, Brasov 500036, Romania (e-mail: alexandrum@vega.unitbv.ro).

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II. Background of the Study

In remote laboratory environments, instruction can be provided in several forms, such as text, animations, images, figures, interactive content, and video and sound-based instructions. Several studies have been carried out to determine the effect of these forms of instruction on different learner groups; these studies show that the preferences of the target learner groups and their actual performance based on these different forms of instruction may differ. For instance, reading a text requires linear information processing and significant skill and effort [4], while a picture/symbol system is sensory and more efficient for representing nonlinear relationships among objects [4]. According to Mayer, visual presentation of learning material enhances learning [5]. Bele and Rugelj [6] suggest including verbal and pictorial representations for each learning page, as well as animations, thus offering learners a choice. Mayer also suggests using words and pictures in ways that promote meaningful learning: adding pictures to words, eliminating extraneous words and pictures, placing words near corresponding pictures, and using a conversational style [5]. Research shows that a combination of text and line drawings offers a clear advantage in the learning process [7]. On the other hand, Bele and Rugelj suggest interactive questions for immediate knowledge evaluation [6]. Moreover, studies [8] also show that students' preferences in Web-based instruction between linear or nonlinear ordered instructional design vary: Older students prefer direct instruction, while students who are more familiar with Windows-based computer applications tend to prefer nonlinear instructions. These studies show that the organization of the content and the design of the instructional material as well as the feedback system are all quite important for improving the performance of an instructional system. Accordingly, before an institution can offer the most effective

[1]Guest access is available at http://errlmoodle.atilim.edu.tr/ with both user name and password being "visitor."

TABLE I
DISTRIBUTION OF LEARNERS BETWEEN COUNTRIES

	Male	Female	Total
France	11 (10%)	1 (1%)	12 (11%)
Germany	14 (13%)	1 (1%)	15 (14%)
Romania	37 (33%)	16 (14%)	53 (48%)
Turkey	24 (22%)	7 (6%)	31 (28%)
Total	86 (78%)	25 (22%)	111 (100%)

remote training for learners, a requirement analysis must be conducted. This study, implemented in the ERRL system, was intended to perform such an analysis from the learners' perspective.

III. RESEARCH METHODOLOGY

Remote laboratories have two primary groups of users: educators and learners. This study mainly focuses on the requirements of learners using such a system, seeking to answer the following research questions.

- How do students prefer to use a remote laboratory environment?
- Do they need guidance and help while studying?
- Do they prefer to study in a linear or nonlinear fashion?
- How do they prefer content to be displayed?
- What are students' views of computer-mediated communication?

To answer these, a questionnaire was prepared for potential student users of a remote laboratory. This questionnaire[2] was presented to 111 students from various countries, including France, Germany, Romania, and Turkey. The distribution of the subjects is shown in Table I. All students are under the age of 25.

As seen in Table I, most of the participants were male (78%), which is typical of the general gender distribution in this field of study. The ERRL content was developed to meet the requirements identified through the questionnaire analysis. This paper analyzes the target learner groups' requirements for a remote laboratory environment as a case study and describes how the ERRL content was designed to meet these requirements.

IV. ANALYSIS OF QUESTIONNAIRE RESULTS

This section analyzes the results of this study according to the research questions; the quantitative data is analyzed descriptively.

A. Study Preferences and Guidance Needs

The participants were asked about their general preferences for studying a new subject. The responses are shown by gender in Table II. The students' preference order was similar for both sexes. Most students, 55% (males: 44%, females: 11%), prefer studying with someone who knows the subject well. Their second choice would be to study alone, and lastly, they would choose to study in groups. In a previous study [3] (see Appendix, Table 5), this preference order was found to be similar for engineers: 50%, 29%, and 21%, respectively. However, the technicians' second choice was studying within a group (40%), while studying on their own fell to last place (13%). In that sense, technicians' preferences were found to be different from those of students and engineers. This difference shows that, in general, students and engineers do not choose to study within a group, and technicians do not feel as comfortable as other groups of learners in studying on their own, as they need more guidance than the other groups of learners.

[2]http://www.atilim.edu.tr/~nergiz/ERRL_Questionnaire_students.pdf

TABLE II
STUDY PREFERENCES

Q4. When learning a new subject which one do you prefer? *(Please select only one)*	**Male %**	**Female %**	**Total %**
Studying with someone who knows the subject well	44	11	55
Studying on your own	23	6	29
Studying within a group	11	5	16

TABLE III
NEED FOR GUIDANCE

Q6. Do you need to be guided when learning a new subject? *(Please select only one)*	**Male %**	**Female %**	**Total %**
Yes, I need someone to teach me	47	12	59
No, I can handle it on my own	31	10	41

TABLE IV
PERCEIVED LEARNING PREFERENCE

Q5. Which of the following best matches with your learning abilities? *(Please select only one)*	**Male %**	**Female %**	**Total %**
1-Starting from the beginning of the subject and go through the chapters by order	42	18	60
4-Searching on the keywords (by using search engine of the site or the index part of the book) and then studying on the results	14	3	17
2-Read the chapter that you want to know and leave the rest	14	0	14
3-Trying to understand the end of chapter examples & questions never read the rest	8	1	9

Most students (59%) reported that they need guidance studying a new subject (Table III). Little variation appeared between male and female responses. On the other hand, 41% of students feel comfortable studying on their own.

B. Preference Between Linear and Nonlinear Study

As shown in Table IV, most of the students (60%) prefer to study concepts in a linear order. Nonlinear learning approaches such as performing a keyword search, only reading related chapters in the textbook, and only doing exercises are less popular alternatives. Responses were similar for both female and male students. In the previous study, the situation was found to be similar for engineers and technicians [3] (see Appendix, Table 6).

When a similar question was posed about Web environments, the ratio for the keyword search response increased (Table V). For instance, on the Web, only 9% of the females prefer to study linearly, whereas in classical environments, 18% of them prefer linear study (Table IV). In the case of Web-based learning, technicians, engineers, and students all behave differently than they do in traditional learning environments. Most of the technicians and engineers reported a preference for nonlinear instruction on the Web, such as seeking information by means of keywords [3] (see Appendix, Table 7), whereas in traditional study, they

TABLE V
PERCEIVED LEARNING PREFERENCE ON WEB

Q7. When you try to learn a new subject by using a web-site, how do you prefer to study? *(Please order the items below according to your preference, 1 is the most preferred one)*	**Male %**	**Female %**	**Total %**
Go through the chapters in a given order one by one	27	9	36
Reach the information by means of keywords and read only the chapter you need	31	8	39
By means of questions and answers between the system and you	20	5	25

TABLE VI
PREFERENCES FOR COMPUTER-BASED EXPERIMENTS

Q8. When performing experiments on a computer I prefer: (Please order the items below according to your preference, 1 is the most preferred one)	**Male %**	**Female %**	**Total %**
1-Interactive	13	4	17
6-Several problems and exercises	9	3	12
8-Animations on the subject	10	2	12
3-Story based	9	2	11
9-Text-based instructions	8	3	11
5-Figures on the subjects	8	2	10
7-Games related with the subject	8	2	10
2-Batch jobs	7	2	9
10-Sound-based instructions	6	2	8

mostly prefer linear methods [3] (see Appendix, Table 6). This result may indicate that when they have a chance to access information directly, they will, and advanced technologies on the Web encourage nonlinear ways of studying.

C. Display of Content

When the participants were asked to specify their preferences for the display of information, all students preferred interactive content. Female students prefer to be set several problems and exercises, while male students prefer animations. As seen in Table VI, for both female and male participants, sound-based instructions are the least favored. While engineers' first preferences are similar to the students' (interactive, animations, and problems), technicians' first preference is represented by figures on the subject, and their least preferred is running batch jobs (execution of a program on a computer without manual intervention) [3] (see Appendix, Table 8).

D. Attitudes Toward Computer-Mediated Communication

In order to identify their views on computer-mediated communication, participants were asked what they considered to be the advantages and disadvantages of such platforms. Tables VII and VIII show their responses.

As seen in Table VII, male students find geographic independence the most important advantage of computer-mediated communication. According to female students, the greatest advantage of computer-mediated communication is finding past communications quickly (this result is similar to the engineers' preferences) [3] (see Appendix, Table 3); silence and then temporal independence follow it. Geographic independence is of third-order importance for females. Table VIII summarizes what students perceive to be the disadvantages of computer-mediated communication.

TABLE VII
ADVANTAGES OF COMPUTER-MEDIATED COMMUNICATION

Q10. Please select the <u>advantages</u> you consider important for you in computer mediated communication	**Male %**	**Female %**	**Total %**
1-Geographic independence	28	3	31
5-You can find quickly elements of all past communications	17	9	26
2-Temporal independence	15	5	20
4-Silent (nobody disturb you)	11	5	16
3-You are not embarrassing for teacher's presence	7	0	7

As seen in Table VIII, the greatest disadvantage is the absence of immediate feedback in asynchronous communication (32%), followed by reading online. Students mostly feel that they have sufficient experience with the Web and Internet. However, according to 39% of the engineers and technicians, the greatest disadvantage is the difficulty in reading the computer-mediated communication on the monitor [3] (see Appendix,Table 4), whereas only 27% of students have the same difficulty. From this result, it can be concluded that the younger generation feels more comfortable reading online.

V. REMOTE LABORATORY IMPLEMENTATION

In summary, it is clear that user requirements and preferences change based on the focus groups being studied.

Differences in groups' preferences:

1) Students and engineers are in general not comfortable while studying in a group.
2) Technicians need more guidance than do other groups of learners.
3) While studying, technicians never prefer to use a keyword search or only study the end of chapter exercises.
4) The percentage of technicians preferring linear studying (73%) is higher than that of engineers (63%) or students (60%).

Common characteristics between groups:

1) The ratio for keyword search use increases for Web-based study.
2) Sound-based instructions are the least preferred.
3) Interactive content, problems, and exercises and animations and figures are the preferred forms of content.
4) Geographic independence and the rapid location of elements of past communication are advantages for computer-mediated communication.
5) Absence of immediate feedback and reading online are the greatest problems of computer-mediated communication.

TABLE VIII
DISADVANTAGES OF COMPUTER-MEDIATED COMMUNICATION

Q11. Please select the disadvantages you consider important for you in computer mediated Communication	**Male %**	**Female %**	**Total %**
1-Absence of immediate feedback for	26	6	32
asynchronous communication			
4-Reading online especially if the amount of information to be read online is significant	21	6	27
2-Imperfect technology	14	3	17
5-You may not be certain whether other participants have received your message	13	3	16
3-Not yet sufficient experience with the web and the Internet	4	4	8

TABLE IX
EQF LEVEL STANDARDS AND ERRL CONTENT

	RF / MW level 4 (Basic)	**RF / MW level 6 (Intermediate)**	**RF / MW level 7 (Advanced)**
Knowledge	- knowledge about the basic physical phenomenon of RF/MW and electrical quantities (wavelength, electrical length, MW power, impedance, attenuation), awareness of theoretical concepts about line sections, coupling elements, filters, and other simple components; -knowledge about basic RF/MW measurement devices and principles	- fundamental knowledge in electromagnetic wave propagation - awareness of measurement technology used in MW, including the Vector Network Analyzer - knowledge about the analytical and graphical methods used in deduction of formulas used in micro-waves	- the ability to employ high-level mathematics (mathematical vector analysis, statistics, mathematical distribution theory employed in field density study) - knowledge about asymmetric line applications and degenerative guides - knowledge about limit conditions in interpreting microwave phenomena (boundaries conditions, boundaries problems, electric charge conservation)
Skill	- ability to conduct basic RF/MW experiments - ability to handle a power meter, oscilloscope, signal generator, modulation generator, spectrum analyzer slot line, and reflectometer	- ability to make correlations between physical phenomena (what is happening and what are the causes) - ability to design simple and medium complexity microwave systems - ability to handle high complexity measurement devices (e.g. VNA)	- ability to apply theoretical notions for realizing medium and complex experiments - capacity to design high complexity microwave systems - ability to test microwave systems
Competence	- ability to read and interpret data provided by an RF/MW measurement system	- ability to explore the possibilities of a particular RF/MW system - ability to apply and transmit specific RF/MW knowledge - ability to develop and improve an RF/MW communications system	- ability to develop RF/MW communications systems - ability to coordinate RF/MW field specific tasks - ability to demonstrate scientific synthesis aptitude in order to accomplish optimal compared analysis between RF/MW communications systems

6) The younger generation feels more comfortable reading online.
7) The learners' habits are changing because of nonlinear ways of studying made common with the introduction of advanced technologies on the Web.

The Seven Principles for ERRL: For a remote laboratory implementation according to the ERRL system, the following seven principles were used as design guidelines.

1) Tailor instructions to be appropriate for the user group. The requirements study proved that the different potential study groups' had different requirements and expectations from the ERRL system. In order to satisfy their unique needs, the course contents were described according to skill level, in the following manner.

After studying the needs analysis reports and consulting teachers from six European countries, three skill levels were identified, based on the available European Qualifications Framework (EQF) level standards [9]. These three skill levels adopted by project members are equivalent to levels 4 (vocational education and training or VET), 6 (Bachelor's degree), and 7 (Master's degree and continuous learning). Course contents were developed for each of these levels. Table IX shows

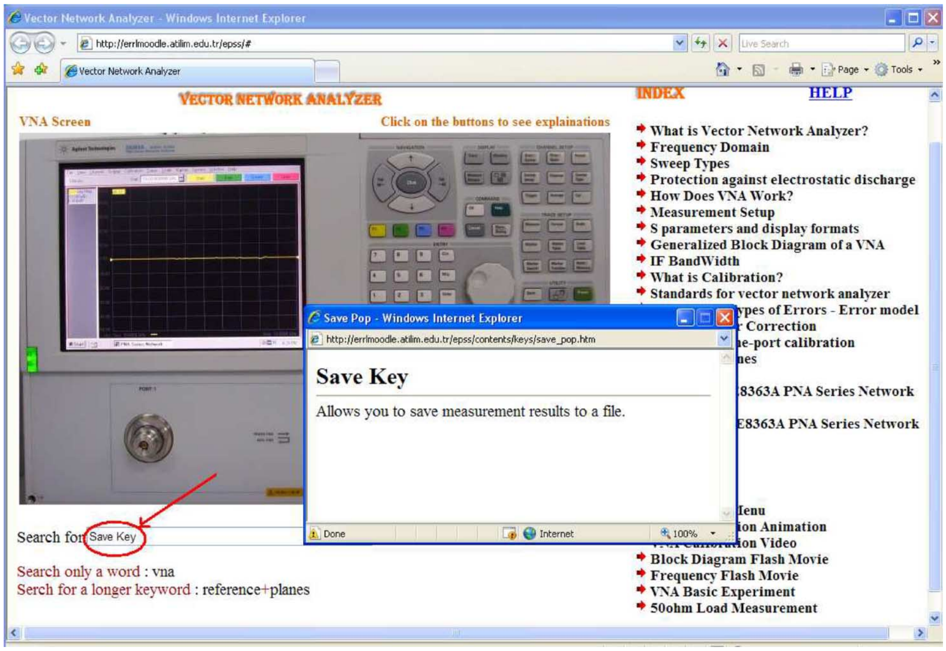

Fig. 1. Searching with keywords.

TABLE X
DIFFERENT FORMS OF ERRL CONTENT

	Basic	Intermediate	Advanced	Total
Text+Picture	40 (40%)	51 (46%)	35(45%)	126(44%)
Text	35(34%)	34(30%)	38(49%)	107(37%)
Animation	13(13%)	13(12%)	2(3%)	28(10%)
Picture+Animation+Text	11(11%)	11(10%)	1(3%)	23(8%)
Animation+Text	2(2%)	2(2%)	0(0%)	4(1%)
Total	101	111	76	288

the corresponding ERRL courses, according to the EQF level standards, in the RF/Microwave (MW) area.

The content was divided into three levels: basic, intermediate, and advanced. Theoretical texts and experiments were arranged according to the needs of each study group. Therefore, although the title of the subject is the same, the content for each level is organized and prepared differently. For instance, the theory of Experiment 1.1, "Measurement of Scattering Parameters of Open, Short, Matched Load," includes the subject "Voltage Standing Wave Ratio (VSWR)" in each level. However, the number and type of formulas and the types of graphs and examples are as appropriate for each level—basic,[3] intermediate,[4] and advanced.[5] Additionally, since the learning content was designed to satisfy the requirements of different study groups, the instruction for beginners is highly guided.[6] Parallel to this, the same instructions are organized as an experimental manual to help instructors start experiments quickly for intermediate or advanced users.[7] Also, the ERRL platform is flexible enough to change the lectures from one semester to the next and to add new experiments. In the future, the project team intends to provide an opportunity for the teachers to create accounts on the ERRL Web site where they can upload specific lectures and experiments.

2) Support both linear and nonlinear presentation of content. From the requirements study, learners' preferences for nonlinear instructions in Web-based environments became clear. However, they still prefer the linear study of traditional materials. Accordingly, the ERRL system has been designed to provide both methods of instruction. Learners do not have to follow each instruction in a linear order; they have the option to search for only the information necessary for each step. For instance, Fig. 1 shows the design of the instructional instrument that explains how to use each piece of equipment and is supported by a search feature and a question and answer tool.

Search results were in the form of links to text documents, videos, audios, or forms from the Learning Management Systems' (LMS) database. Furthermore, experiments and theoretical parts of the ERRL system included many hyperlinks providing direct access to and information about equipment and content.

3) Limit the number of sound-based instructions. Table X shows the distribution of different forms of ERRL content in each skill level. There are no movie- or sound-based instructions in the ERRL system.

Similarly, the amount of text-based instruction was higher for the advanced level (49%) than for the basic (34%) or intermediate (30%) levels. Most of the instruction in all levels was a

[3]http://errlmoodle.atilim.edu.tr/file.php/30/moddata/scorm/38/index.htm

[4]http://errlmoodle.atilim.edu.tr/file.php/29/moddata/scorm/44/index.htm

[5]http://errlmoodle.atilim.edu.tr/file.php/7/moddata/scorm/1/index.htm

[6]http://errlmoodle.atilim.edu.tr/file.php/29/EX_2_2/manual_form/Extraction.htm

[7]http://errlmoodle.atilim.edu.tr/file.php/29/EX_2_2/manual/PilotExperiment_12_11_2007.htm

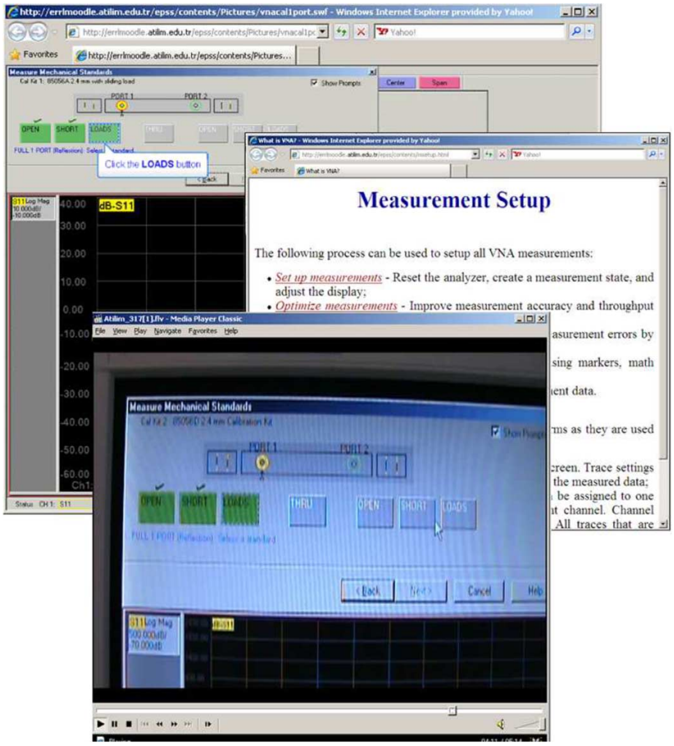

Fig. 2. Learning content in different formats.

combination of text and pictures. Animations additionally supported the learning system. The amount of animation for the basic-level users (13%) was higher than that for intermediate- (12%) and advanced-level users (3%). In general, the instruction was primarily a combination of text and picture representations of information (44%).

4) Display content in various forms, such as figures, animation, and video. When the program content was particularly complicated to teach over a distance, it was presented in a variety of different formats, such as animation, text, and video. Fig. 2 shows a sample of content on the calibration of specific equipment that uses text, video, and animation formats.

In this way, learners can select the content presentation that is best for them and are free to study the concepts repetitively across different formats. Additionally, animations and simulations provide a better visualization of each physical phenomenon under study.

5) Include interactive content such as exercises and experiments. As shown in the literature, experiments and exercises are essential in engineering education [10]. Accordingly, the ERRL system was designed to provide many exercises for the learner to practice upon.

As seen in Fig. 3, the learner can set experimental parameters and repeat the experiment as many times as s/he wishes. This activity also offers a trial-and-error learning approach for ERRL learners. They are able to analyze results in different graphical formats, such as a Smith Chart or Log Magnitude, to compare and choose the most accurate one (Fig. 4). This feature of the system is critical because it demonstrates interactive learning with real equipment.

6) Limit text-based content and the need for extensive reading. The findings of the requirements study indicated that learners expect the content to be explained through text

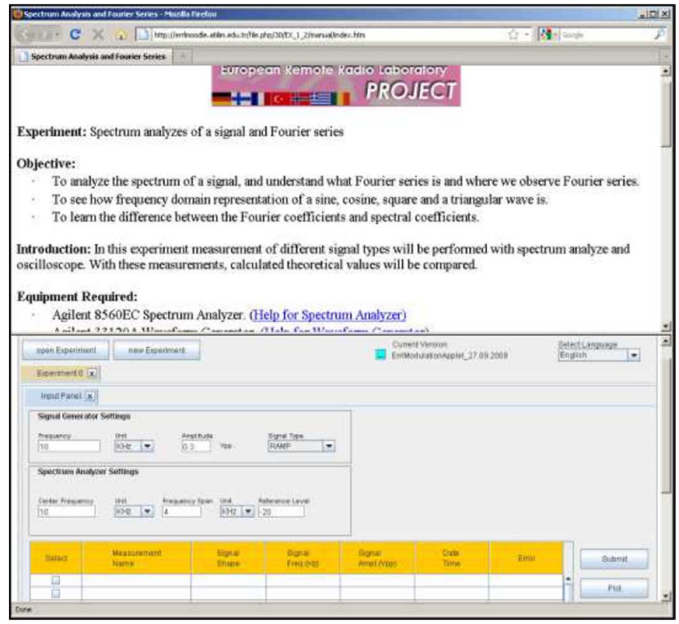

Fig. 3. ERRL experiment.

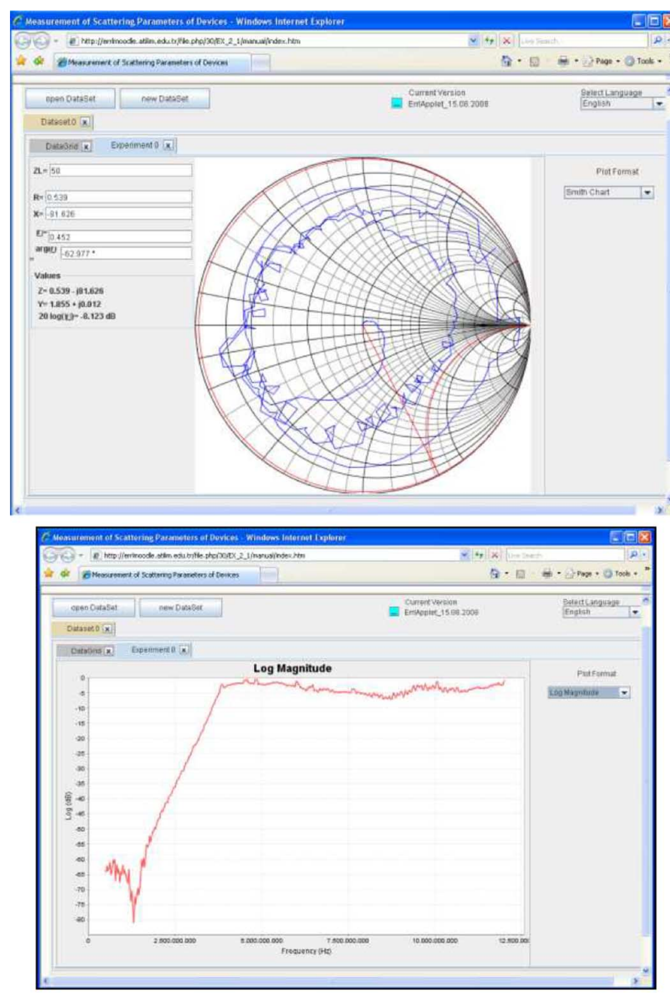

Fig. 4. The same experimental result shown in different graphical formats. (Top) Smith chart. (Bottom) Log plot.

materials while they are studying. However, expectations for the same content vary between learner groups. Accordingly, in

TABLE XI
EXAMPLE OF COURSE OBJECTIVES AND SKILL LEVELS

Goal: Acquire knowledge of transmission lines		
Beginner	**Intermediate**	**Advanced**
To understand types of transmission lines and practical transmission lines	To understand how E and H fields can propagate	To understand types of transmission lines and practical transmission lines
To be able to make comparisons between different transmission lines and know where they are used in practical systems	To understand types of transmission lines and practical transmission lines	To analyze lossless and lossy transmission lines
To understand transmission line parameters, namely characteristic impedance and dielectric constant	To analyze the transmission line using high level mathematical concepts	To understand power propagation concepts
To understand terminated transmission lines, reflection	To understand terminated transmission	To understand terminated transmission lines, reflection
coefficient, standing wave ratio, and matching concepts	lines, reflection coefficient, standing wave ratio, return loss, and matching concepts	coefficient, standing wave ratio, return loss, and matching concepts
		To study the transmission lines using the Maxwell equations

order to limit the amount of text to be read for different learner groups, the content of the ERRL system was organized into small learning objects, or LOs [11], referenced by the objectives and goals determined based on skill levels (Table IX). Each LO was designed to contain the smallest unit of learning content. Then, the content was arranged using LOs in forms and designs appropriate for each group. As an example, for the experiment to measure scattering parameters, while the goal of the experiment was the same for all learner groups, the objectives were set differently to address the needs of each skill level. Additionally, the learning objects for each course were organized specifically by skill level and designed according to the requirements of each group. Table XI shows the relationship between the objectives of the experiment's second goal for each of the three learner groups.

7) Provide a useful feedback system. In the ERRL system, in order to provide feedback on learning performance for both learners and instructors, the assessment system was organized in the form of skill level, experiment, and equipment tests. The skill level test was advised to be taken immediately after registration in the system, and could be taken as often as the learner wished. The main purpose of this test was to link the prior skill level and progress of each learner. Precourse assessments that identify areas where relevant background knowledge is missing or prone to misconceptions can aid instructors in revising and improving the curriculum, encouraging collaboration within and across departments.

Experiment tests were applied immediately after the implementation of each experiment. Tests were generally short, and as they were multiple-choice, they were useful for immediate quantitative assessment of student understanding. The experiment-user interface covered both the theoretical background for the experiment as well as the experiment itself. The ERRL online tutorials had built-in assessments or interactive components that combined instruction and assessment. Another assessment (experiment test) can be taken immediately after studying each experiment. These experiment test items cover both theoretical and experiment specific issues to be tested based on the objectives of each experiment. There were at least three test items for each experimental objective. Each learner's current skill level was calculated using the experiment test results. At the request of the learner, a summative evaluation report could be prepared to show their progress from their starting point to their current level. More detailed progress reports for each test were also offered to the learners to help their learning.

Another test implemented in the ERRL system was the equipment test. The main purpose of this test was to assess learners' knowledge of each piece of equipment. Learners were asked to pass this test before starting any experiment that required specific equipment. The equipment test content was specific to each piece of equipment; however, the testing system strategy remained the same as that for the experiment tests.

VI. DISCUSSIONS AND CONCLUSION

In this study, learner requirements specific to this case study were collected and analyzed. Accordingly, the following seven principles for designing the ERRL application were put forward.

1) Tailor instructions to be appropriate for the user group.
2) Support both linear and nonlinear presentation of content.
3) Limit the number of sound-based instructions.
4) Display content in various forms, such as figures, animation, and video.
5) Include interactive content such as exercises and experiments.
6) Limit text-based content and the need for extensive reading.
7) Provide a useful feedback system.

Based on these principles, the ERRL system was developed and will be improved continuously. The feedback from the sample groups from different countries demonstrated that the principles provided a good approach for Web-based learning, which provided encouragement to continue this work.

The results of this study show that the absence of immediate feedback and reading online are the greatest disadvantages of computer-mediated communication. They also show that the younger generation feels more comfortable reading online. However it seems that when learners have a chance to access information directly, they will, and with the introduction of advanced technologies on the Web, their habits are shifting to nonlinear methods of studying. As concluded by Feisel and Rosa, laboratory instruction has not received a great deal of attention in the last few years [12]. This study addresses the importance of instructional content design issues for developing remote laboratories. For future work, this system is planned to be integrated into the curricula, and its success will be evaluated didactically by addressing these principles. Although these principles were developed for the purposes of this specific case study, they can be improved and implemented for any Web-based instructional system. In that context, this study can guide the instructional designers of future remote laboratory systems.

APPENDIX
SURVEYS OF TECHNICIANS AND ENGINEERS [3]

- Table 3: Advantages in Computer Mediated Communication, p. 85.
- Table 4: Disadvantages in Computer Mediated Communication, p 86.
- Table 5: Preferred Way of Studying (in groups or individually), p. 86.
- Table 6: Preferred Way of Studying (in linear or nonlinear order), p. 87.
- Table 7: Preferred Way of Studying on the Web (linear or nonlinear order), p. 87.
- Table 8: Participants' Preferences While Performing an Experiment on Computer, p. 88.

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Nergiz Ercil Cagiltay received the B.S. degree in mathematics, the M.S. degree in computer engineering, and the Ph.D. degree in instructional technology from the Middle East Technical University, Ankara, Turkey, in 1988, 1991, and 2003, respectively.

She worked for commercial and government organizations as a Project Manager for more than eight years in Turkey. She also worked for Indiana University Digital Library Program, Bloomington, as a System Analyst and Programmer for four years. She has been with the Computer Engineering and Software Engineering departments of Atilim University, Ankara, Turkey, since 2003, as an Assistant Professor. Her main research interests are in educational technology, distance education, e-learning, information systems, and engineering education.

Elif Aydin (M'09) received the B.Sc., M.Sc., and Ph.D. degrees in electrical engineering from Gazi University, Ankara, Turkey, in 1992, 1996, and 2001, respectively.

She was a Visiting Scholar with the Electromagnetic Communication Laboratory, Pennsylvania State University, State College, from 1999 to 2000. Since 2001, she has been an Associate Professor with the Electrical Engineering Department, Atilim University, Ankara, Turkey. Her research interests include high-frequency techniques, genetic algorithms in electromagnetics, antenna and radio systems, and remote lab applications.

Cansu Cigdem Aydin received the B.Sc. degree in electronic and communication engineering from Suleyman Demirel University, Isparta, Turkey, in 2004, and the Master's degree in computer engineering from Atilim University, Ankara, Turkey, in 2008.

She is an Instructor with Atilim University. Her research interests include distance learning, learning management systems, e-learning, and genetic algorithms.

Ali Kara (M'02) received the B.Sc. degree from Erciyes University, Kayseri, Turkey, in 1992; the M.Sc. degree from Cukurova University, Balcali, Turkey, in 1996; and the Ph.D. degree from Hacettepe University, Ankara, Turkey, in 2002, all in electrical engineering.

He was a Visiting Scholar with Polytechnic University, Brooklyn, NY, from 1999 to 2000. Since 2000, he has been an Associate Professor with the Electrical Engineering Department, Atilim University, Ankara, Turkey, where he has been Head of the department since 2003. He was the coordinator of the LdV-ERRL project. His research interests include radiocommunications, radio aspects of wireless and mobile communication systems, short-range radio systems and its ultrawideband (UWB) applications, radar systems, e-learning, and remote laboratory applications.

Marian Alexandru received the B.Eng. degree in radio electronics and radars from the Military Technical Academy, Bucharest, Romania, in 1990, and the Ph.D. degree from Transilvania University of Brasov, Brasov, Romania, in 2005.

Since 2002, he has worked for the Romanian Air Force, first as a Research Engineer and subsequently as an Instructor in the Air Force Academy from Brasov. Currently, he is a Senior Lecturer in telecommunications engineering with Transilvania University. He has written over 25 published papers, authored a book in the telecommunications field, and is coauthor of two radar books and a patent. His research interests include applications of digital communications, wireless networks, indoor location, domotics, and distance learning.