Contributions to the Basis and Applications of the e-Learning Pedagogy in Engineering Education

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Abstract: - This article presents contributions to the introduction and efficient use of the Internet and educational platforms, Learning Content Management Systems (LCMS), in education of all levels, has been and is a primary concern of the teaching staff from higher education institutions, at the Teacher Training Departments of "Gh. Asachi" Technical University Asachi and "Al. I. Cuza" University, Iasi, Romania. Collaboration with state universities from the Republic of Moldova, and with Menoufia University, Egypt, is also mentioned. Efforts to define the notions of e-Learning Pedagogy needed by teachers using online STEM (Science, Technology, Engineering, and Mathematics) education are reviewed. The contributions in Blended Teaching and Learning (BTL) in the context of introducing Information and Communication Technologies (ICT) in the educational process are highlighted. Since STEM Education also involves conducting laboratory experiments and simulations, virtual experiments have been implemented and exemplified.

Key-Words: - e-learning Pedagogy, online educational platforms, Moodle, Significant publications, courseware, electromagnetic compatibility.

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1 Introduction

The article presents the author's contributions to the definition and use of e-pedagogy within the Technical University "Gh. Asachi" from Iasi, Romania. The Learning Content Management System (LCMS) platform, MOODLE, was used to deliver the Electrical Engineering courses.

2 Contributions to the Foundation of the e-Learning Pedagogy

Highlighted below are the most important contributions to the Foundation of the e-Learning Pedagogy:

1.PhD thesis (finished in December 2000, and sustained in January 2001) devoted to the use of Learning Technology in Science, Technology, Engineering, and Mathematics (STEM) education;

2.Online Electromagnetic Compatibility (EMC) course (in Romanian), completed in December 2000;

3."Computer-Aided Training – e-Didactics" Manual (in Romanian), Iasi, Polirom Publishing House, 2007, using the ground-breaking research results for the doctoral thesis. This manual was recommended by Romanian Ministry of Education in the Curriculum for Completion and Degree for Teachers of Technology and Economic Sciences. In the Computer-Aided Instruction (CAI) manual produced in the framework of the Rural Education (PIR) Program, information and concepts from that doctoral thesis were used.

2.1 PhD Thesis

The topic of the Ph.D. Thesis " Contributions to the improvement of the multimedia systems in the didactic process of knowledge transfer and assimilation in the subject domain of Fundamentals of Electrical Engineering (Electromagnetic Compatibility)" (in Romanian) [1] was recommended by EPF Lausanne (École Polytechnique Fédérale de Lausanne, EPFL Switzerland), [2] and [3]. The EPFL Laboratoire d'Enseignement Assisté par Ordinateur (LEAO) donated 12 computers for the realization of a Computer Aided Training Laboratory within the Faculty of Electrical Engineering in Iași (1994). Adrian A. Adăscăliței completed a training course at EPF Lausanne.

It is useful to mention words of appreciation by the doctoral supervisor, Professor Dan Gâlea, and by Academician Mircea Stelian Petrescu, member of the Doctoral Committee.

2.1.1 General considerations

"The Ph.D. thesis, having as author Adrian A. Adăscăliței, scientific researcher at the Institute of Theoretical Informatics, Romanian Academy, Iasi

Branch, is devoted to a current, exciting topic, at the confluence of several fields, namely: a distinct chapter on Artificial Intelligence – Computer Assisted Education, Information and Communication Technology and Pedagogy of the Teaching of Engineering Sciences.
The emergence and development of the Internet communication network, as well as of the Web technologies, made possible the materialization of an idea that seemed utopian, until that moment, that of continuous and distance education. Complementary to the classical training solution, the open, continuous and distance education method widens the learning space from both the educator's and the student's point of view. Practically all the major universities, professional companies, and commercial firms have reacted promptly to the challenge offered by Internet technology. Numerous government strategies have been developed that support research programs in this direction. The European Society for Engineering Education (SEFI, Brussels, Belgium), the International Society of Engineering Pedagogy (IGIP, Klagenfurt, Austria), UNESCO CEPES (European Centre for Higher Education), IEEE (Institution of Electrical and Electronics Engineers), the UNESCO International Centre for Engineering Education (USICEE, Melbourne, Australia), IACEE (International Association for Continuing Engineering Education), the General Association of Engineers in Romania (AGIR) are just a few professional organizations which coordinate programs for the introduction of Information Technology in Education. The author of this thesis has kept permanent contact and exchanged information with specialists from the above-mentioned institutions. He launched his ground-breaking research program developed through the Institute of Theoretical Informatics in Iasi of the Romanian Academy, having as initial partner the EPFL Laboratory of Computer-Aided Training (LEAO). Subsequently, in the framework of a Leonardo pilot program, carried out by the "Gh. Asachi" Technical University Iasi, information exchanges were conducted with other partner universities in the European Union, to mention just a few: the Technical University of Lisbon, Portugal, the Technical University of Darmstadt, Germany, and the University of Warwick, United Kingdom.
The result of the doctoral research is a combination of the oldest field of electrical engineering, electromagnetic field theory, engineering pedagogy, and the newest information processing tool, web technology. The Ph.D. thesis retains attention by its scale - 182 pages representing the actual work and 78 pages representing 3 annexes; a rigorous, clear, and neat presentation; a large number of charts, graphs, organizational charts, figures, summary tables; a wide range of bibliographic references cited - 120, 20 of which are the author's papers published in the country and abroad.".

2.1.2 On the content of the thesis

The doctoral thesis is structured into five chapters preceded by an introduction, three annexes containing the web locations of the virtual campus and of the EMC course, the list of citations of the Web course, as well as the list with the HTML code of some representative applications.
Chapter 1, "The current situation of the field (history, informatics pedagogy)", is an overview of the issues of the training process and the fundamental theories regarding the planning of training. The study finally provides a classification of computer-assisted instruction programs (CAI). The author introduces the specific terms of the interdisciplinary field of research, that of learning technology (e-Pedagogy), analyses the stages of the training process, and proposes the classical structure of the interactive lesson (tutorial) and the practical exercise (to be performed by the learner). The author synthesizes each type of didactic activity used later in structuring online training.
Chapter 2, "Information system for training (hardware tools, network, multimedia)", presents the multimedia teaching tools used by the teacher. Compared to the classical method, the author proposes the structure of the computer-aided training model realized and implemented through Client-Server applications. The author also proposes the minimal hardware and software configuration necessary to carry out the training process with the involvement of multimedia tools. The structure of such a hypermedia system includes the components of a hypertext eBook and allows the circulation of Web documents, search, location, and uploading of these documents, ensures compatibility with e-mail, and allows connection to the server mailbox.
The author proposes that multimedia documents be considered discrete documents, if temporal relationships between components (text, graphics, static images) are not defined, and documents for which synchronization information is required (for which temporal relationships between components are essential). The author concludes that the structure of the multimedia documents requires more hardware resources for the system because, besides the logical structure of the data representing the didactic material, a temporal component emerges, increasing the risk of the impossibility of

covering these requirements with the available hardware resources.

In the author's opinion, for the network to be able to ensure the transfer of any type of document, it should comply with certain standards for format specification, content, the network's presentation, and sequencing. It follows that the networks currently used for classical e-mail cannot be used for multimedia document transfer.

Chapter 3, "Synthesis and Research," discusses the author's original vision of computer-based pedagogy of engineering teaching and learning (structuring a course) with the help of information technology. The main application areas of Learning Technology are presented, as well as the open research directions to be continued in the future. This chapter analyses all the necessary steps for the implementation of a computer-assisted education (CAE) project are also analyzed.

In conclusion, starting from the theoretical substantiation, offered by the communication sciences, of the human-computer interaction, the hierarchy of the distribution of the information presented in the form of HTML pages is proposed. Noteworthy is the facility offered by the system so that the selection in each situation of a sequence of documents accessible in the network can be carried out based on predefined structures of knowledge trees. Also, the user orientation in the training space can be done in parallel with the supervision by the system of how each topic reacts to the interaction with the informative material.

In the 4th chapter, are exposed the two applications that are the subject of the thesis: the online EMC course and the Informatics Structure called Virtual Campus (VIR TU i S, id est Virtual Campus of "Gh. Asachi" Technical University Iași).

The EMC course presents, by using multimedia teaching tools discussed in Chapter 2, and considering the structures presented in Chapter 3, the coupling mechanisms through electromagnetic fields that cause undesirable phenomena of electromagnetic interference. Elements of equipment design and operation are described, so that the electrical equipment becomes immune to these interferences and the field dispersed by the equipment itself remains within the limits imposed by the standards. In this chapter, all the necessary steps for the realization of a computer-assisted education (CAE) project are analyzed.

The basic notions specific to EMC, namely: the fundamentals of electromagnetic theory, the theory of antennas, filters, electrostatic discharges, and shielding are structured into several modules so that the traditional student-teacher communication can be replaced with a communication mediated by the information system.

The virtual campus integrates the network equipment and the software system based on the constructivist educational model, having as an objective the notification of all the participants involved in the education and training activity. A discipline holder can call on the online course designer by providing him with at least the following elements: structured information material including demonstrations and simulations, connection trees, and how to test knowledge.

The closing chapter presents the author's conclusions regarding the obtained results and lays down possible directions for future research. The material presented in the annexes allows navigation in the VIRTUiS space, being able to follow in detail the functionality of the EMC online course."

2.1.3 On the original contributions

" The author's main contributions are the following:

1. Systematization of the problem of informatics pedagogy, the conclusions drawn allowing the proposal of original solutions for the design of student-computer interfaces
2. Systematization of the information material of the EMC course and structuring of the educational components: the lesson, the dynamic exemplification of the phenomena, the simulation, the testing, the virtual laboratory work, the design elements, and the interactive exercise.
3. Creation of a virtual library for the EMC course by highlighting the connections to bibliographic sources offered by various sites around the world.
4. Conceiving and designing the Virtual Campus as a distributed software system accessible to the Web, making it easier to perform operations corresponding to teaching activities.
5. Integration of the EMC course components into the structure of the Virtual Campus allowing for the implementation of the designed teaching process.
6. Optimization of the functioning of the distributed software structure mainly through: the organization of video sequences in the form of optimal structures to obtain high performance in terms of high transfer rate and resolution; adaptation of the way documents are represented according to their complexity and; available network hardware resources necessary to achieve high transfer performance."

2.1.4 Conclusions

"The theme approached by the author is ambitious and complex. In solving the formulated research problem, the author demonstrates that he masters the knowledge of modern pedagogical principles and their application in engineering education. The author is also an exceptionally good connoisseur of Web technology, which has allowed him to implement the structure of the educational model conceived through a VIRTUiS functional software product.

This software was installed on the server of the Faculty of Electrical Engineering and has been tested by many users. The author considered the suggestions formulated by the students as well as by the partners within the research program. The EMC course, accessible on the Virtual Campus, VIRTUiS, is quoted by prestigious universities such as the University of Warwick, Great Britain, the Technical University of Darmstadt, Germany, and the Technical University of Lisbon, Portugal, receiving words of appreciation. The research initiated by the author allows for the opening of a direction that may prove its usefulness in the modernization of the didactic process in Romania."

2.2 Web-Supported Course Website

The online EMC course is an application and illustration of the concepts developed in the doctoral thesis, [4].

2.2.1 Planning the Components of a Web-Supported Course Website

There are two major uses to enhance a face-to-face course by using the Web: to make the course content available to students and to conduct online activities. As in all courses, the quality of the instructional planning maximizes the learning for all students. In the Web environment, the components of a course website, which enhance teaching and learning and save time by being posted for students' online access, are especially valuable.

At the most basic level, instructors can post content and announcements to a course website. However, course planning usually begins with a course map – an outline of topics, weeks, objectives, activities, assignments, and assessments to show alignment of course components with each other in a weekly calendar format. Planning also includes the purposeful design of activities to create a student learning community – collaborative student groups in a course that develops with the students' active access, pursuit, generation, and evaluation of information and learning in their discussion, chats, and e-mail communications.

2.2.2 Course Website Components

Course content (Fig. 1) is aligned with curriculum standards, objectives, assignments, and assessments.

• Course Syllabus. The course contains a syllabus and supporting documents. The course includes items such as course title; correct course semester; course description; course contact and credit hours; course prerequisites; course objectives; course assignment; course test schedule; required course materials; grading criteria; testing information; library resources; any on-campus requirements; work ethics information.

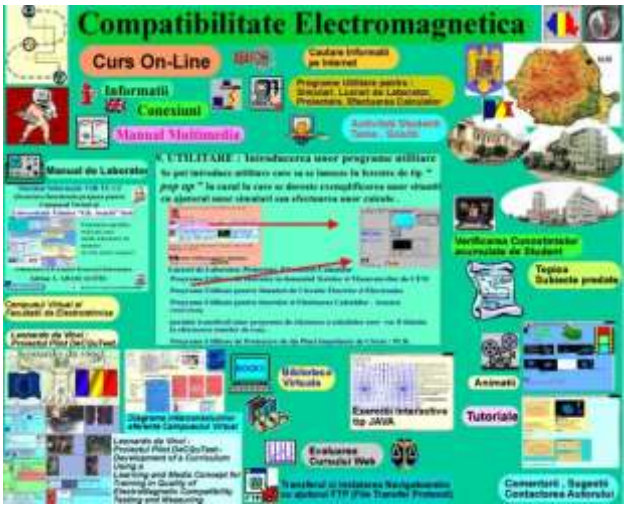

Fig. 1: Electromagnetic Compatibility On-Line Course (in Romanian)

• Staff Information. The course contains staff information: instructor name; appropriate picture (optional); e-mail address; telephone and fax numbers; office hours • Student Information. The course contains a student orientation and explains: how to get started; technical equipment requirements; technology competency requirements; browser recommendations; drop deadlines; format for assignments; requirements for chat room and/or e-mail; instructor response time; and troubleshooting advice.

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• Course Calendar – Scheduled dates for readings, activities, assignments, quizzes, and exams
• Assignments and Activities, including directions and scheduled dates. Course assignments are designed: to be interactive, with students being required to interact with each other and their instructor via e-mail, chat room, and/or discussion board; and to address a variety of learning styles through: written assignments; reading activities; discussions; simulations; case studies; and allow students to engage in critical and abstract thinking. Students are challenged to complete one or more of the following: solve problems; apply concepts in context; and complete practical applications.
• Course Documents – Additional documents for reference or study or answers to frequently asked questions. The course document section includes a variety of learning media. Course content is delivered through media such as PowerPoint presentations; Short lectures in audio or video format; links to resources on websites; and CD-ROM materials.
• Lectures – Notes and audio to highlight key concepts of course content. A word of caution: for face-to-face classes with web enhancement, faculty may wish to include required assignments, even if minor, for extra points to be turned in at the scheduled class times or other incentives to maintain class attendance.
• Communication Tools – Areas for sending and receiving e-mail, participating in group or class discussions about particular issues, keeping electronic journals, completing "dry or simulated lab" exercises to prepare for "wet or real lab" experiences, or engaging in chat sessions. Many students are able and willing to participate more fully online than in face-to-face classes, especially when discussion assignments require each student to post a comment or the results of a brief assignment and to reply to a comment or question from other students.
• Student Tools – Areas for using a digital drop box to send and receive completed papers, homepages, or personal profiles of students, and access to grades.
• Assessment Tools– Areas for quizzes, exams, and surveys; online grade books; and assessment statistics. Course assignments are designed to be interactive and require students to interact with: each other and their instructor via e-mail, chat room, and/or discussion board. The course structure includes adequate and appropriate methods and procedures to measure student mastery of course competencies. Assessments include a variety of the following: online or proctored testing; standardized tests; projects; demonstrations; presentations; and case studies.

2.3. Computer-Aided Training – e-Didactics Manual

In 2007, Computer-aided training. e-Learning Pedagogy was published (in Romanian: Instruire asistată de calculator. Didactica informatică) by Polirom Publishing House, used for blended teaching and learning courses (Fig. 2) is a Manual developed within DPPD, UAIC, and TUIasi for Computer Assisted Training (CAT) and associated disciplines. CAL Manual is a development of the doctoral thesis completed in December 2000 and defended in January 2001.

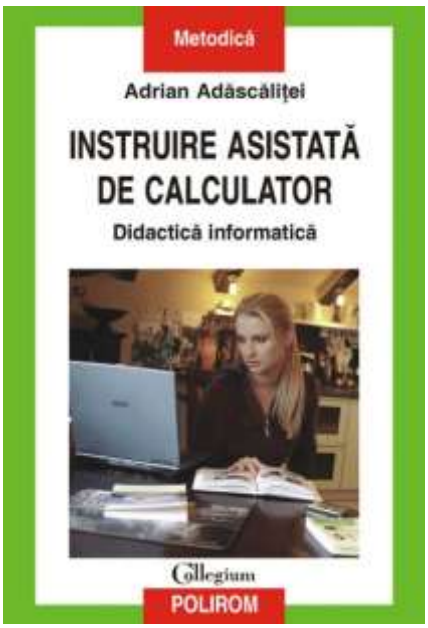

Fig. 2: CAI Polirom manual cover (in Romanian)

Computer-assisted training (CAT) is a didactic method that capitalizes on the principles of modeling and cybernetic analysis of training activity in the context of new information and communication technologies. The synthesis between the pedagogical resources of the programmed training and the technological availability of the computer (information processing system) gives this educational method important qualities regarding computerization of the teaching-learning-evaluation activity; improving training through management-documentation-interrogation actions and interactive automated simulation of knowledge and skills engaged in the educational process, according to official education planning documents.
Table of Contents (TOC): CAI (Computer-Aided Instruction), e-learning, and instructional technology
• Fundamental theories of training design •

Classification of computer-aided training programs • Scenarios for conducting computer-aided training • Role and functions of the tutor in CAI • Development of study materials for CAI • Methodology for designing and implementing computer-aided training programs • Interactions. Computer-mediated communications (CMC) • Model of a CAI education center (online, e-learning) • Elements of design and standardization of resources for e-learning.

3 Activities and achievements that complement the use of Learning Technologies in STEM Education

1. BTL (CAI) courses at DPPD from UAIC and TU Iași on Moodle platforms: moodle.ee.tuiasi.ro and elearning.utm.md (at Technical University of Moldova, Chișinău, Republic of Moldova);
2. Active participation as a trainer in the project ”acquire skills in the field of interactive teaching and learning techniques and ICT”, i.e. DIDATEC project [5]. I produced an Online course located on moodle.ee.tuiasi.ro platform;
3. Participation in ”the Création d’un Réseau d’Universités Numériques Thématiques en sciences appliquées et sciences économiques en Moldavie” (CRUNT) Program [6]. I created an Online course on the network platform in the Moldova Technical University, Chișinău, Republic of Moldova. The papers published in collaboration with universities from the Republic of Moldova can be viewed and downloaded at Adrian A. Adăscăliței, National Bibliometric Instrument, https://ibn.idsi.md/ro/author_articles/47281.
4. Participation as a member of Scientific Committee and reviewer in National and International Conferences devoted to Learning Technology in Education [7], such as the International Conference on Virtual Learning (ICVL) [8]; National Conference on Virtual Education (CNIV) [9]; International Scientific Conference on e-Learning and Software for Education (eLSE) [10]; |a.s.o.
In 2009 the CNIV and ICVL Conferences were organized in Iasi, by the Faculty of Electrical Engineering, Technical University "Gh. Asachi", with the support of AGIR Iasi Branch.
5. Collaboration with Menoufia University, Faculty of Engineering, Egypt. in the BTL field also using virtual laboratory experiments and simulations, in online courses distributed on an LCMS platform (moodle, for example).

4 Conclusion

In the attached selective bibliography, I have mentioned some of the significant works illustrating the content of the article.
Information about articles in English published by the author, Adrian A. Adăscăliței, detailing the results mentioned in the current article, are indexed in well-known databases such as Scopus, Web of Science, etc. and are available to the public.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The author contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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Conflict of Interest

The author has no conflict of interest to declare that is relevant to the content of this article.