EFFICIENCY INCREASE OF E-LEARNING BY APPLYING ON-LINE INTELLIGENCE COMPUTER LEARNING SYSTEMS

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Abstract. Based on the analysis of existing computer learning, neural networks, information, expert and decision support systems, the following e-learning systems were developed by authors: construction, real estate, facilities management, international trade, ethics, innovation, sustainable development, building refurbishment, etc. Application of above multiple criteria computer learning systems developed by authors allows one to determine the strengths and weaknesses of analysed alternatives and its constituent parts. Calculations were made to find out by what degree one version is better than an other and the reasons disclosed why it is namely so. Landmarks are set for an increase in the efficiency of versions, etc.

Keywords: e-learning, internet, intelligence computer learning systems.

1. Introduction

Since 1999 the distance (Internet) Master degree studies "Property Management" have been introduced in Vilnius Gediminas Technical University (VGTU), and Master degree studies "Construction Economics" from 2000 as well. There are currently 176 master students from all over Lithuania studying in these two e-learning master programs. Since September 1, 2003 the e-learning Master's degree studies in "Internet Technologies and Real Estate Business" was introduced into VGTU. During three semesters master's students from 28 modules within the "Property Management" Master's degree Program and 24 modules within the "Construction Economics" Master's degree Program should optionally pass 12 examinations. During the fourth semester master students write a final thesis.

All programme materials are available as printed programme notes which are enhanced, where appropriate, to take advantage of modern teaching techniques and delivery mechanisms. In particular, the following media are used in specific modules: electronic format of the textbooks, video, computer software, computer learning systems, computer conferencing, computer networks, 'face-to-face' contact. The choice of media is often relatively easy to make because for much of the time, local constraints, questions of accessibility and of cost virtually dictate the media through which learners will have to work. Accessibility is vitally important to any learners who have to use self-instructional materials.

The module writers utilised electronic technologies in the preparation of their module material. This assisted the programming team to prepare the material in a variety of suitable formats for dissemination. Once in electronic format the material can be made available in paper format, on CD, over the Internet and by file transfer (FTP). This ensures that the learners can have the material available in the way which best suits their learning needs. Equipment, such as video-recorders and computers are utilised wherever possible. In addition, face-to-face contact, telephone, fax, surface mail, e-mail also used.

2. Development Prospects of E-learning

With the aim of correctly understanding the role of e-learning and its development prospects, it is necessary to investigate the main environmental factors influencing its existence. Various economic, legal, social, technical, technological and political factors force the traditional learning methods one way or another to transform into e-learning. Connected to different changes such as the increased qualifications of the workforce, tough competition, global economy, frequent and significant changes within the markets, the increased power of learners, accelerated moral depreciation of technologies, the increased importance of innovations and modern technologies, it has become necessary to create e-learning.

Competition within e-learning is becoming stronger and stronger and involves more and more organisations. In order to survive in such tough competition conditions, it is necessary to make every effort and aim at creating and offering something better than ones competitors. For example, development of the on-line intelligence computer learning systems, enhancement of the quality of e-learning and reduction of prices, expansion of markets, flexibility in responding to fluctuations of the demand and supply in the market, extension of the range of modules, strengthening of relations with industry, seeking for greater confidence of learners should be included. Also there are some possibilities to increase e-learning efficiency in course module design and structure, development methodology, curriculum structure and content, duration, tutoring approach, learner assessment methods, accreditation system; media and technologies to be used for the development and delivery of the course material; learner support methods and roles of teachers and tutors; information, dissemination and exploitation plans. This would allow e-learning to satisfy the needs of potential students and increase the number of the loyal and regular life long learning learners.

3. Economic Versus Multiple Criteria Analysis

Many computer learning systems are processing and submitting only economic information for decisions and applying economic models. Alternatives under consideration have to be evaluated not only from the economic position, but take into consideration qualitative, technical and other characteristics. For exam-

ple, the analysis of a real estate is usually performed by taking into account economic, quality (architectural, aesthetic, comfort), infrastructure, technical, legal, technological, social and other factors. Therefore, applying multiple criteria (intelligence) on-line computer learning systems may increase the efficiency of e-learning.

In order to perform a complete study of the project a complex evaluation of its economic, technical, qualitative, technological, social, legislative, infrastructure and other aspects is needed. Quantitative and conceptual descriptions provide this information. The diversity of aspects being assessed should include a variety of presented data needed for decision-making. Therefore, the necessary conceptual information may be presented in numerical, textual, graphical (schemes, graphs, diagrams and drawings), equation formats, audio or as a videotape. The criteria used for conceptual descriptions, their definitions and reasons for choice of the criteria's system, their values and weights also should be analysed. Conceptual information about the possible ways of doing a multi-variant design is needed to make a more complete and accurate evaluation. Quantitative information is based on criteria systems and subsystems, units of measure, values and initial weights of the projects' alternatives. Conceptual information is a more flexible and less accurate means of expressing estimates than numbers. Quantitative information is more accurate and reliable and allows one to use multiple criteria decision-making methods.

The application of multiple criteria on-line computer learning systems developed by the authors in the teaching process creates conditions for students enabling better mastering of many disciplines and better understanding of their mutual connections. Using methods that are developed by authors can quite successfully solve this task:

- A new method of complex determination of the weight of the criteria taking into account their quantitative and qualitative characteristics was developed. This method allows calculation and co-ordination of the weights of the quantitative and qualitative criteria according to the above characteristics.
- A new method of multiple criteria complex proportional evaluation of the projects enabling the user to obtain a reduced criterion determining complex (overall) efficiency of the project was suggested. This generalized criterion is directly proportional to the relative effect of the values and weights of the criteria considered on the efficiency of the project.

- In order to find what market value will make an project being valued competitive on the market, a method of determining the utility degree and market value of projects based on the complex analysis of all their benefits and drawbacks was suggested. According to this method the projects utility degree and the market value of an project being estimated are directly proportional to the system of the criteria, adequately describing them and the values and weights of these criteria.
- A new method of multiple criteria multi-variant design of a project's life cycle enabling the user to make computer-aided design of up to 100,000 alternative project versions was developed. Any project variant obtained in this way is based on quantitative and conceptual information.
- An original model for a complex analysis of a project's life cycle enabling the user to analyse a project's life cycle and its stages, the parties involved in the project as well as its micro and macro environment as an integral whole was developed.

The methods are intended for alternatives in multivariant design, planning, multiple criteria analysis, determining the degree of utility and market value and selection of the most efficient versions.

4. Increase of Students' Study Efficiency by the Application of Multiple Criteria Computer Learning Systems Developed by Authors

Many decision making models and methods (gaming theory (Angelides and Paul, 1999), minimax theory (Vos, 1999), instructionist and constructivist model (Nussbaum et al., 2001), psychometric model, conceptual map model, linear loss model (Vos, 1995), novel model (Aleven, 2003), etc.) have been developed in the world for solving different e-learning problems.

The major players in e-learning can use AI applications (neural networks (PoseyL and Hawkes, 1996), expert (Nussbaum et al., 2001, Simic and Devedcic, 2003), decision support (Zavadskas et. al., 1996, 1998, 2000) and knowledge based (Parkinson and Hudson (2002)) systems, etc.).

Based on the analysis of above models, methods and AI applications, the following e-learning systems were developed by authors:
- Construction,
- Real Estate,
- Facilities Management,

- International Trade,
- Ethics,
- Innovation,
- Sustainable Development,
- Building Refurbishment, etc.

Application of multiple criteria computer learning systems developed by authors allows one to determine the strengths and weaknesses of analysed alternatives and its constituent parts. Calculations were made to find out by what degree one version is better than an other and the reasons disclosed why it is namely so. Landmarks are set for an increase in the efficiency of versions. All this was done argumentatively, basing oneself on indexes under investigation, on their values and weights. This saved students' time considerably by allowing them to increase both the efficiency and quality of e-learning.

Below is a list of typical problems solved by graduates in their course and diploma projects:
- Multiple criteria analysis and determination of market value of a real estate (e.g. residential houses, commercial, office, warehousing, manufacturing and agricultural buildings, etc.).
- Analysis and selection of a rational real estate version.
- Multiple criteria analysis and determination of the highest and best use of a real estate.
- Determination of efficient investment instruments.
- Determination of efficient investment projects.
- Determination of efficient financing instruments.
- Multiple criteria analysis of a property's obsolescence
- Alternative design of a project's life-time process (i.e. one-family dwelling houses, agricultural buildings, cast-in-place buildings, prefabricated panel buildings, refurbishment of buildings, etc.), its multiple criteria evaluation, determination of utility degree and the selection of the most efficient version.
- Etc.

The use of multiple criteria computer learning systems in solving various problems encountered in the course and diploma projects was also aimed at determining:
- Students' knowledge acquired at the university,
- Student's general level of education,
- Student's keenness of mind,
- Student's ability of fast and adequate response to changing situation.

In order to demonstrate the practical application of the developed systems the Construction Products Multi-

ple Criteria Computer Learning System will be considered below as examples.

5. Development of the Construction Products Multiple Criteria Computer Learning System

Technological innovation mainly through the development of Internet technology combined with computer learning systems, neural networks, experts and decision support systems have provided, by a variety of new opportunities, a new breed of e-learning. A large number of various purposes computer learning systems can be found on the Internet. Each of them is designed to solve a specific task. There are some possibilities of their integration on the module basis and their management by using a model management system.

According to the user's needs, various models may be provided by a model management system. When a certain model (i.e. search for alternatives) is used the results obtained become the initial data for some other models (i.e. a model for multiple criteria analysis and setting the priorities). The results of the latter, in turn, may be taken as the initial data for some other models (i.e. determination marker value, etc.). Following those ideas already mentioned and other ideas, the authors developed a Construction Products Multiple Criteria Computer Learning System.

At the present moment the developed System allows the performance of the following functions:

- Search of construction products. A consumer may perform a search of alternatives from catalogues from different suppliers and producers. This is possible because the forms of data submitted are standardized into specific levels. Such standardization creates conditions that can be used by special intelligent agents who perform a search for the required construction products from various catalogues and gather information about products. One or several regions may limit such a search.
- Finding alternatives and forming comparative tables. Consumers specify their requirements and constraints and the System queries the information of specific construction products from a number of online vendors and returns a price-list and other characteristics that best meets the consumer's desire/needs. The System performs the tedious, time-consuming, and repetitive tasks of searching databases, retrieving and filtering information, and delivering the information back to the user. Results of a search for specific construction products are submitted in tables, which may

include direct links to a Web page of a supplier or producer. By submission, such a display of the multiple criteria comparisons can become more effectively supported. The results of the search of a concrete construction product are often provided in one table where one can sometimes find direct links to the Web page of the supplier or manufacturer.

- Evaluation stages of alternatives (i.e. multiple criteria analysis of alternatives and selection of the most efficient alternative). While going through the purchasing decision process a customer examines a large number of alternatives. Each alternative is surrounded by a considerable amount of information (e.g. price, discounts given, thermal insulation, sound insulation, rate of harm to human health of the products, aesthetic, weight, technical specifications, physical and moral longevity). Following on from the gathered information the priority and the alternative's degree of utility is then calculated. The degree of utility is directly proportional to the relative effect of the values and weights of the criteria considered, on the efficiency of the alternative. This helps consumers to decide what product best fits their requirements.
- The after-purchase evaluation stage. A consumer evaluates the usefulness of the product in the after-purchase evaluation stage.

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