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PEDAGOGICAL STRATEGIES AND MODELS FOR E-LEARNING COURSES APPLYING

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ABSTRACT

The paper describes pedagogical strategies of e-learning courses applying into a teaching process. These strategies are self-learning, e-learning courses as the main tool of a teaching process and e-courses applying as an additional tool that not obligatory. Different approaches of strategies applying are described. The subject, topic and e-learning course models are covered. An oriented acyclic weighted graph is used as the subject and topic model. The hypertext mathematical notation used to represent e-learning course model is shown. The developed and applied at RTU e-courses, their main characteristics and used pedagogical strategies are outlined.

KEYWORDS

Pedagogical strategy, e-learning courses, models

1. INTRODUCTION

The problem of increasing a quality and efficiency of a learning process is very actual because of the quantity of necessary information permanently enlarges and many new professionals of modern specialties are required, but it's not possible consequently to increase the time of education. Considering the scientific and technical progress a re-qualification of existing specialists also is continually required. Modern technologies are used successfully in teaching process almost at all educational institutions as an additional tool or as a main part of traditional education, but particularly in Distance Education, Open Education and for Life Long Learning. Different environments, platforms, learning management systems and portals, teaching and testing programs, videoconferences, electronic textbooks are created and broadly used for e-learning organization and maintenance, which allows significantly increasing quality of a teaching process. Many scientists are developing new technologies and methods of adaptive learning [3, 5, 7], universal and specialized learning systems, student models [1, 4, 6]. New methods and technologies of e-learning courses creation and usage are being studied and developed.

Unfortunately, currently problems that concern these systems usage in teaching process are not enough investigated. So, it's necessary to make a decision answering the following questions:

- how to use e-learning courses in teaching process most effectively (pedagogical strategies);
- how to represent learning material for efficiency increasing of e-learning courses.

The aim of the paper is to find answers on these questions. In the following section pedagogical strategies are described. The third chapter declares the subject, topic and e-learning course models. The last chapter shows the results of the e-courses usage that were developed considering research results at Riga Technical University (RTU) – Department of Software Engineering.

2. PEDAGOGICAL STRATEGIES OF E-LEARNING COURSES APPLYING

E-learning course is a set of learning objects implemented using modern computer technologies and consolidated into a scenario that is used for learning of a definite topic of a subject by student or students' group (Collaborative learning).

The way to use e-course is usually determined by a tutor for developed course does not include recommendations or a guide how to do it. The main factors that influence strategy choosing are as follows: (1) existing of e-learning course, its quality and its accordance to the content of the subject; (2) modes available for students in e-learning course: learning (get learning material); training (do exercises that form skills); knowledge control (perform tasks determined by a tutor), self-control. Also help (assist a student in work with the course) and references (short information on a course main concepts) are advisable; (3) types of questions and tasks offered to students (multiple choice, input word, accordance, etc.) and their difficulty levels as well as providing comments to student's answers; (4) the possibility to get the detailed information about student work results. Generally it is advisable to provide the following data: number of correct answers and given by a student, mark for a whole topic as well as for each student's answer, difficulty of the task, and time consumed.

Pedagogical strategies of e-learning courses usage in a teaching process can be divided into three groups (Fig. 1):

1. Self-learning. This strategy offers totally unassisted acquisition of a separate subject. Such approach is specific for distance education, open education and often for Life Long Learning, too.
2. The main tool of a teaching process (a part of it). This strategy means different ways of e-learning courses applying during acquisition of a subject.
3. Additional tool that is not obligatory. Such approach of e-learning courses using helps students to master a learning material better. Additional working with e-learning course is particularly useful for "weak" students.

While using e-courses as the main tool of a teaching process (strategy 2), the following options are possible:

1) self-learning on a definite topic of a subject. Means that students acquire one topic of a subject using the e-learning system. E-courses usually are being developed exactly for this purpose. In this case there are two variations: totally self-learning or e-learning after inaugural lecture (10 – 20 minutes);
2) training courses as a part of a teaching process. This strategy means practical tasks performing and modeling of tasks that are being acquired, what helps to form skills. This option can be implemented as to solve some tasks category, which are not included for teaching on-sight as to give a possibility for students to practice in accomplishing different practical tasks;
3) self-control e-learning courses. In this case e-course is effective to solidify the knowledge obtained in a classroom and/or to gain practical skills;
4) knowledge control (testing) allows determining student knowledge and skills level. There are different control forms and methods [8]. Knowledge control can be organized on one or on several topics as well as on a whole course during classes or at any time convenient for a student.

The first option is recommended for topics that significance is not very high. The second is advisable for solving some tasks category and for student unassisted work. The third option (self-control) will be useful for students to get prepared for knowledge control. The last option always should be used in one way or another. In any case a tutor should prepare schedule of e-learning courses using and give it to a student in the beginning of a course teaching.

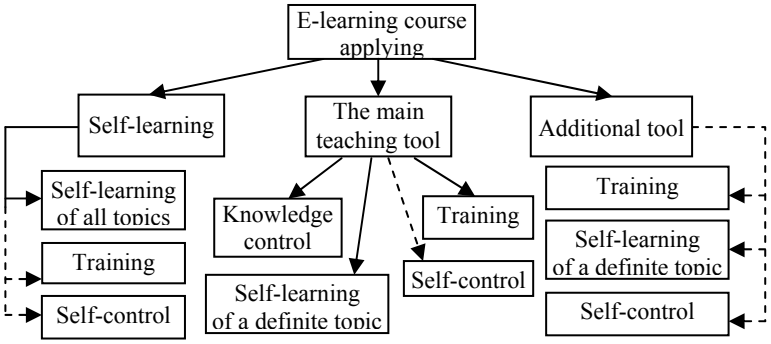

Figure 1. Pedagogical strategies of e-learning courses usage

3. SUBJECT, TOPIC AND E-LEARNING COURSES MODELS

To organize an effective teaching process it is necessary to use learning material (subject) and topic models. Therefore for computer-aided teaching systems e-learning courses and dialogue scenarios are being developed.

3.1 Subject and Topic Models

There are various models, which can be used to describe subjects and their topics. We consider that the most comprehensible subject model is an oriented acyclic weighted graph **G(V,E)**. The set **V** of the graph vertexes defines subject topics, the set **E** of edges – relationships among them. The weight of an edge w_i is one of **W = {1, 2, 3, 4}** [7]. Figure 2 shows the subject model that consists of ten topics. On the basis of the subject model it is possible to determine optimal sequence of its learning (red edges). If each vertex will be appointed by a number of hours that is needed to learn a topic then it will be easy to develop schedule for subject teaching that is essential for every form of education.

As it was mentioned above while using e-learning courses as the main teaching tool (strategy 2) several implementations are possible (chapter 2): totally self-learning on a definite topic and/or partly self-learning on various subject topics. For example, Figure 2a shows that there is totally self-learning for topic 8 (which allows extracting it from the model) and partly self-learning for topics 2 and 4, considering that topic 2 is reviewed at a lecture rather briefly, but topic 4 – more detailed.

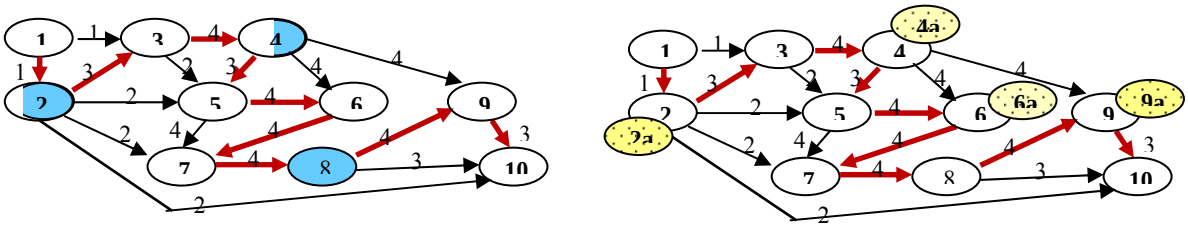

Figure 2. Subject graph model

Different knowledge control approaches can be ensured: current, border and final [8]. In Figure 2b is shown that for topics 2 and 9 (2a and 9a) the current control is used and for topics 4 and 6 – border (4a and 6a).

Similarly models for each topic separately can be developed, considering e-course learning objects as vertexes.

Offered graph model can be useful as for teaching subject/topic as for implementing e-learning courses.

3.2 E-learning Courses Model

E-learning course consists of a set of learning objects (LO) that can be of two types: learning object information (LOI) and learning object task (LOT). LOs have content and metadata and usually are reusable. Content in LOI is description of a concept, and in LOT – a task or a question. Metadata is shown in the project of standard IEEE 1484.12.1-2002, which contains about 40 different parameters: LO title, description, language, platform, students age, time for learning, etc.

LOs have complex structure. Thus, LOI can store information of various types and detailing level: short information on a concept; explanatory example; detailed information on a concept; detailed explanation of an example. LOT consists of two parts: a task/question and a comment. A comment can be of several types as well: correctness; short explanation; detailed explanation.

For e-learning course modeling it is possible to use the graph model described in section 3.1. But more detailed a course structure can be represented by hypertext mathematical notation [2]:

MVT = (T, I, S, Q),

where **T** – course thesaurus that shows all the relationships among LOs; **I** – includes content of learning objects; **S** – vocabulary of all objects; **Q** – the main topics covered by LOs.

The model allows describing e-learning course mathematically and graphically. In Figure 3 the fragment of e-course thesaurus is shown, including five LOI, five LOT and providing border knowledge control (KC). The relationships used in Figure 3 are described in Table 1.

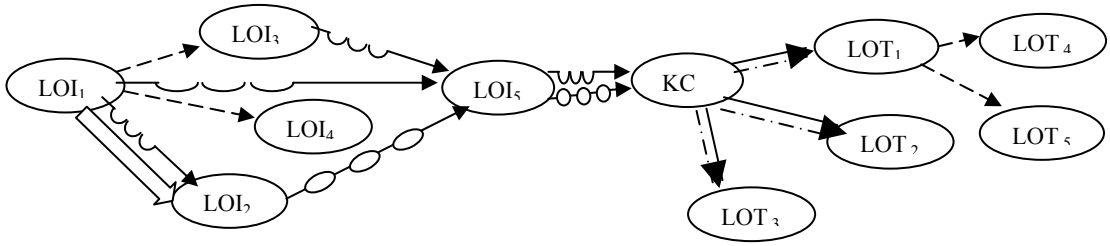

Figure 3. Fragment of e-learning course thesaurus

The thesaurus allows developing the most proper dialogue scenario for e-learning course because of it shows different types of relationships among LOs. Scenario can be implemented by using special algorithm.

Table 1. Graphical notations of relationships

Notation	Description	Notation	Description
	Kind-type (LOI-main, -example, -explanation)		Metaprocess-process (exam-test)
	Type-kind ([LOI ,LOT]-LO)		Consequence-reason (LO sequence)
	Part-whole (concept-topic, LOT-KC)		Reason-consequence
	Whole-part (KC - LOT)		Equality (LOs for the same concept with different media)
	Process-metaprocess (test-exam)		

4. E-LEARNING COURSES APPLYING

Riga Technical University (RTU) uses the joint system based on moodle that allows adding different materials, developing testing programs with various question types and managing knowledge control. During the classes on computer sciences at RTU – Department of Software Engineering the joint university system is used as well as its own development – Learning Management system (LMS), which ensures work of four user classes: students, tutors, teaching material authors and administrator, as well provides adaptive learning and knowledge control e-courses. Student can work with LMS in four modes:

- information (read learning material and watch video materials);
- learning (get learning information, fulfill tasks to master teaching material and checking its acquisition. All wrong and imprecise answers are being commented in details. Also leading questions are included);
- training (designated to master knowledge and acquire essential skill);
- knowledge control (offered to fulfill several tasks/questions. The number of questions, their sequence and students answers comments detailing level is set by tutor or students, if they use self-control option).

After finishing the work in the last three modes the number of correct answers, time spent at every task and mark is shown. Student can see the list of offered questions, given and correct answers.

Tutor defines the working mode, forms a test (determines number of questions, their significance and difficulty, time to fulfill the test or each task, etc.) and gets results of definite student or a group.

Teaching material author develops LOIs and LOTs [7], subject model and possible dialogue scenarios, as well checks the correctness of an e-course performance. For LOTs the following metadata is defined: id of corresponding LOI; type of a task [8]; significance and difficulty [7]; number of tries; mark.

Currently, there are developed and successfully used in the teaching process 13 e-learning courses. Each of them includes 15-74 LOs and consists of tasks of different types [8], which have various didactical characteristics [7]. The e-courses designated for learning (L) contain two types of LO – LOI and LOT. There are three level difficulty tasks in each e-course. The e-courses include comments – explanation on each answer. The knowledge control (KC) or training (T) e-courses are testing courses with teaching elements [7]. These e-courses don't include LOIs. The main objective of the teaching e-courses is to provide students with knowledge and/or to test background knowledge, while the others – to enhance skills.

Starting with 2004 e-learning courses are successfully applied in RTU, implementing different pedagogical strategies. First, the 3rd strategy (section 2) was chosen. Students could optionally use the e-courses for self-control and training. Then some e-courses were used for knowledge control, too. Since 2008 the e-courses on the subject "Software engineering" are offered for self-learning (strategy 2). Before the course the inaugural lecture is given to students.

To evaluate the applying of e-courses considering the quality (effectiveness) enhancing the experiment was held. The participants were 373 students of study program "Computer systems". The results were processed with two mathematical statistics methods – Student t-criteria and Laplas function and they proved that e-courses enhance learning effectiveness (significance level is α=0.05). The results show that students' marks for performed tasks averagely increase for about 41% (exams – 26%, practical works – for 56%).

As well students' satisfaction was assessed offering them questionnaires. The answers show that some of the students (about 10%) don't use e-courses, assuming that it wouldn't be any help to them and they know enough; about 20% take e-courses as obligatory requirement and do it once; others – use several times. The last group (used e-learning courses several times) also defined the reasons of that – to increase the mark or to get more detailed knowledge and improve skills. Also there was defined positive tendency for including e-courses into a teaching process – before an exam students repeatedly used the e-courses and thanks to that their marks were much better.

5. CONCLUSION

According to the made research results on pedagogical strategies and models there were developed and being successfully used 13 different e-learning courses for the students of study program "Computer systems" at RTU. During the experiment that was held from 2005 till 2008 two strategies were used – e-course as optional tool and later on it was changed to self-learning. The outcome of using the e-learning courses shows the learning improvement. The LMS e-courses indicate better results for they use the adaptive algorithm. The joint university systems tests don't ensure this feature and many students were complaining that the tests were difficult for them, but others thought them as too simple. So, the adaptation helps to fit students for them to be interested in working with a system.

The adaptation in the developed e-courses (included in LMS) is provided based on the subject model, which can be represented by acyclic oriented weighted graph or using hypertext mathematical notation. The hypertext mathematical notation allows defining different types of relationships among learning objects and that ensures easier implementation.

As further work we plan to create new adaptive e-courses that consider various strategies and different models of necessary information about learning process and materials used in e-learning to cover all topics of the subject and research their applying influence on subject acquisition effectiveness in comparison with the courses used till now.

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