Modeling of Control in Educational Process
by LMS

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Abstract
The final function of the learning management system (LMS) is routing the communication depending on the student’s knowledge and abilities and according to that changing the quantity and ambitiousness of the material offered to the student. Interaction between student and LMS in the process of teaching and learning is a composite process. The aim of the system for the teaching control is to regulate the communication according to the student’s knowledge and ability and thus modify the amount and sophistication of submitted materials for the student. In the concept of control theory, the transition from combinatorial procedure to sequential series and optimized processes is obvious. One of the assets of modelling the teaching processes by means of Petri nets is their formal description, which is complemented by a visual graphic representation. A precise and accurate specification of the process is thus allowed, which enables us to remove ambiguities, uncertainties and dubiousness and contradictions. For the description of teaching processes, such as browsing in the study material in e-learning education, it is appropriate to use mathematic and graphic methods, where mainly serial machines are successfully used, which, however, have certain limitations. These issues could be solved more effectively using Petri nets for their precise and exact specification.

Keywords

Introduction

Static structure of information on the web, the task of which is to provide information, has long been overcome. More and more web software systems originate which are more complex than ever before. From the point of view of the system’s application, there is a more and more frequent necessity to enrich the information space of heterogeneous sources, managed by the mentioned systems, with elements of adaptation to the user and/or the environment, in which the user operates. The aim is to present the user personalized information, if possible only those that are relevant for the user, and in such a way, which suits the given user most (Bieliková and Návrat, 2006).

With the rapid advance of the Internet, e-learning systems have become more and more popular (Gomez-Albarran, 2005), (Jun-Ming et al., 2006). An e-learning system provides the following functions: (1) delivery of learning content for students via the Internet; (2) record of learning
progress and portfolio; (3) management of learning content, assessment and course; and so on (Scorm 4th Edition Version).

E-learning has become an increasingly popular learning approach in universities due to the rapid growth of web-based technologies. E-learning implementation at universities is a long-lasting and complicated process. This process has to overcome a wide range of internal and external factors influencing e-learning effectiveness and content quality resulting in stakeholders satisfaction and acceptance of web-based learning (Drlík and Skalka, 2011).

The Internet and related web technologies do offer great solutions for presenting, publishing and sharing learning content and information, as is the case in many other areas. Special software called Learning Management System (LMS) (Figure 1) is generally used in most institutions providing web-based learning (Cavus, 2008). Most universities combine a form of learning using one of a number of commercial or free LMS. They decided to use products such as Claroline, Fle3, ILIAS, MS Class Server, WebCT, Eden, Enterprise Knowledge Platform, LearningSpace, eAmos, eDoceo, Uniforms, uLern, Aspen, Oracle iLearnin, NETOPIL School and Moodle (Cápay and Tomanová, 2010)

![Figure 1: Structure of the Learning Management System (LMS) (Cavus, 2008).](image)

Now that the Internet is recognized as the main platform for education, web-based applications are preferred when it comes to educational activities, channels for communications and systems to access knowledge. LMS are often viewed as the starting point of any web-based learning program (Cavus and Uzunboylu, 2007). Many pedagogues were introducing their models of electronic education in the early 20th century, but they had no sufficient tools to their effective implementation at that time (Skalka and Drlík, 2009). Nowadays electronic learning systems provide the possibility of saving all information about student’s activities in one place. Teacher could monitor the student’s activities after his login into system. Systems offer submission of the file, testing the control of the communication and cooperation too. LMSs facilitates teacher to keep his methodical portfolio dynamic and offer electronic students’ portfolio in every moment (Cápay and Tomanová, 2010). An LMS provides the platform for the web-based learning environment.

The aim of the system for the teaching control is to regulate the communication according to the student’s knowledge and ability and thus modify the amount and sophistication of submitted materials for the student. In the concept of control theory, the transition from combinatorial procedure to sequential series and optimized processes is obvious (the strategy of continuous assessment of the student instruction reflection, and based on that, adaptation of the following instruction, is comparable with the dual principle of identification and adaptive management). There
is an advantageous use of Petri nets for description and consequential control of this kind of teaching form. (Klimeš and Balogh, 2012)

**Possibilities of transition with e-course**

We differentiate two main types of teaching programmes according to how binding the individual steps sequences are for the student. Those are linear and branch ones.

- Linear teaching programmes dictate a strict and binding sequence of steps for all students in a single line. Contents of education are studied in small amounts of information; however, the best is to study one of the information in each step only. The designed notion is practiced as to the need, until the student masters it. Adding one notion to another, the student gets acquainted with the whole theme and its issues. Opponents of linear programmes state that very small steps interrupt the trains of thought of the student in an undesirable way. As to the practical experience, linear programming is suitable for teaching basics and principles of the problem and also for the formation of the word-stock and new concepts. (Klimeš and Balogh, 2006).

- Branch teaching programmes are susceptible of varied procedures when solving problems. Alternatives of „branches“of the programme finally lead to the successful coping with the problem; however, each student takes the line, while its length corresponds to his personality, knowledge and gift. When teaching facts, a certain main line is visible in the programme, out of which various formed side lines evert and reintegrate. The main line usually allows for proceeding in wider and more demanding steps, which can be mastered only by a gifted student, answering adequately to the inserted control questions. Shorter and easier steps for less gifted individuals and slowly working students take place in secondary lines. There are examples for successful revise of a particular lecture, tasks and instructions referring the student e.g. to solve an experience, use graphic tools or sequence which completes the lecture so that the opinion or fact would be confirmed. Branch programmes are especially suitable for the provision and manipulation with new concepts. Their basic benefit is that they allow the student to choose, upon studying the study material, the individual line, which corresponds to his intellect and previous knowledge. (Klimeš and Balogh, 2006).

**E-course modeling with Petri nets**

When modelling the educational process, it is necessary to draw from interaction understanding, from mutual social interactions of participants of the educational process. A „general model of educational process“, was thus created which includes wider environs, input factors, the process itself and its products (immediate results and long-term effects) (Balogh and Turčáni, 2009).

The aim is to create a functional communication control model in LMS system by means of the created model in Petri nets. It is necessary to create a universal e-course model in LMS by which the pedagogue’s and student’s activity would represented in the course and in arbitrary subjects, e-courses would be created according to similar models. The model has been created so that it would reflect the pedagogue’s and the student’s requirements. It would be enough modular, intelligible and clear and would not be too complicated.

The benefit of educational process modelling using Petri nets is its formal description, which is complemented by a visual graphic depiction. This allows for a precise and exact specification of the
process, which facilitates elimination of ambiguity, vagueness and contradictions. Petri nets besides the visual graphic expression have also square defined mathematical fundamentals which can suitably be used in various software tools for the specification and analysis of computer-solved company processes. For the description of educational processes, such as passing through the study material in e-learning education, it is appropriate to use mathematic and graphic methods where mostly serial machines are profitably used. However, they have certain limitations. The issue can be solved by means of Petri nets, thanks to their precise and exact specification. (Balogh, Turčáni, and Burianová, 2010), (Magdin, Cápay and Mesarošová, 2011)

For the description of the communication of a man with a computer it is suitable to use graphic tools (Markl, 2003), allowing to adequately describe and express the interaction. The teaching interaction between a student and an information system managing the instruction is a complex process, for which Petri nets should be applied.

Edge superimposition is one of the problems with interpretation of the model in Petri nets but in many cases it is necessary. This problem can be solved by marking each of the edges by means of various colours. This colour dissimilarity helps the identification of various process flows and also to understand the functionality of the model. Then it is possible to divide the model into each sector and thus name their components what helps identify each component’s function, i.e. place appellation and transitions.

E-course model production with exam

There are markings (tokens) in two places in the initial model state: Pedagogue (P800) and Student (P0). Tokens symbolises the pedagogue’s and the student’s process while using LMS.

The place and transition numeration is specified. Places, where are the pedagogue’s positions, begin with the number 8 what is the pedagogue’s identification number. The second number identifies the sector (part of the model) where is a place. And there is the last number what is the pedagogue’s place type:

- 0 entrance place – conditions to open a new lesson
- 1 entrance place - conditions for lesson availableness
- 2 entrance place – conditions to peruse the task
- 3 entrance place – conditions for lesson availableness

Student gets into the first sector (introductory part) by registration into the course. This sector contains various information about the course e.g. subject information sheet, recommended literature, course requirement to successfully pass the course, links of web pages referring to the themes, etc. These choices are represented by places P101 to P106. After the token (student) perused the selected information, he gets to the place P109 (Figure 2) from where he will be able to advance to the first lesson, if the pedagogue allows it.
The pedagogue’s task

On the created process model we can see that the information (articles, themes, textbook, and publications) is available for the student only if the pedagogue allows it. In this case the pedagogue is the administrator of the course; he creates and modifies the course, uploads, adds or removes links and materials for study, checks students’ activities, prepares, corrects, replies to tasks and many other functions that the system allows. The created model represents the student’s perspective; therefore, the model does not contain the pedagogue’s activity options and the important elements concerned about the student have been left. The pedagogue’s task has thus simplified. He opens new lessons in the course, then assigns some tasks to it and finally, declassifies the exam so that the student would fulfil the requirements.

We can monitor the transition realization on Figure 3 where the first numbers interpret the previous sector on the transitions T121 and T122. The second number interprets the next sector and the third is a type of transition where 1 is the transition for opening a new lesson and 2 is a transition from the previous lesson to the next.
Courses in LMS are divided into individual lessons according to the course of study of a particular subject. It contains study materials, interactive animation, pictures, tasks, autotests, tests, exercises, etc. Lessons can be divided according to various criteria e.g. theme, content, time, etc. And according to settings, students can set linear or ramified education. It is always the pedagogue who sets these parameters and who determines the style and the rate of the educational process. The number and the content of the lessons are not limited, i.e. PX01 – PX06, where X ∈ N = {1, 2, 3...}. The number of lessons does not affect the function of the model.

After the student passed the task or perused the lesson, he is able to return to the previous lessons which he had already passed successfully (Figure 6) or is able to shift to another new lesson. He can choose from the previous lessons to which he wants to return and chooses from the transitions T440, T430, T410, (TXX0). The marking logic of these transitions is:

- 1. number identifies the current sector (in this case 4)
- 2. number is the number of sector (lesson) where the student wants to get (3,2,1)
- 3. number (0), is a intersectional transition
Inhibitive and test edges were used in the model, then also deterministically types of transitions, places with a given capacity and various IF-THEN rules. Procedural e-course model designed in LMS contains other important parts e.g. scoring, the student’s continuous assessment and the student’s exam results.

Discussion

The importance of advanced information and communication technologies, such to education has increased significantly during the past few years. In order for electronic learning systems making use of these technologies to be successful, effective and of a quality comparable to some of the traditional educational learning systems, the electronic learning systems must be designed and constructed with care, using a scientific approach embracing well designed procedures and techniques (Drlik and Skalka, 2011).

E-learning has become an increasingly popular learning approach in universities due to the rapid growth of web based technologies. E-learning implementation at traditional universities as well as creating of any kind of virtual universities is a long-lasting and complicated process. It is necessary to see the e-learning implementation as a continuous and iterative process. The points of the entry into this process will vary depending on the institutional context and personal skills of the teacher. It is becoming increasingly clear that there are many reservations, worries, objections and questions about e-learning from the pedagogical, professional, and sociological point of view that must be taken seriously (Barajas and Gannaway, 2000).

Conclusion

The target function of LMS managing the instruction is the direction of communication as to the student’s knowledge and abilities, thus changing the amount and demandingness of the materials submitted to the student. In the theory of management there is an obvious transition from combination procedures to sequence chains and optimized processes (the strategy of continuous assessment of the student instruction reflection, and based on that, adaptation of the following instruction, is comparable with the dual principle of identification and adaptive management). For the description of the communication of a man with a computer it is suitable to use graphic tools (Markl, 2003), allowing for suitably describing and expressing the interaction. The teaching interaction between a student and an information system managing the instruction is a complex process, for which Petri nets should be applied. Another attitude to the description of true and real teaching procedures is an application of fuzzy modelling (Novák, 2000). Most frequently, the personalization of e-learning courses is realized on the bases of extracted knowledge of usage data by means of the web log mining techniques (Munk, Kapusta and Švec, 2010), (Munk, Vrábelová and...
Kapusta, 2011) (Munk, Kapusta and Švec, 2010); however, we focus on the personalization using Petri nets.

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