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STRUCTURED DESIGN AND INTERACTIVE DEVELOPMENT OF E-LEARNING COURSES

George A. Totkov, Elena P. Somova, Kaloian Vl. Shkurtov

In this work a new approach for interactive structured design of e-learning courses on the base of structured programming is presented. The goal of using this approach is to help and ease the work of the authors of learning courses in PeU 2.0 e-learning environment. The opportunities of creation of structured learning materials are studied, the set of elementary structured constructions (elementary templates) is determined. Structured design of templates of e-learning courses is realized through the set of these elementary templates. The created interactive programming system, which is an alternative to the existing graphical editor in PeU 2.0, realizes the chosen elementary templates for generating course templates, as well as e-learning courses themself. The realization gives the opportunity to the user to create several courses with one and the same template, but with different content.

1. Introduction. A contemporary trend in education is moving on from distance learning to e-learning, realized through the so-called electronical universities. ***Electronical university*** is a Web-based environment, which modeles the process of education. Essential elements of these environments are the means, which give the authors opportunities for development and publishing of e-learning materials and courses.

For the development of the learning courses authoring languages, interactive (dialogue) systems, visual means, etc. are used. It is inconvenient to describe the learning courses through authoring language because of the difficult description and edition of the learning courses. On the other side the visual development and edition (programming) of the courses is difficult for non-specialist users. The ***interactive approach*** has more limited opportunities than the visual programming, but the interface is intuitive and easier for use by the authors of learning courses.

An e-learning environment for distance publishing of e-learning courses and learning, called ***Plovdiv Electronical University*** (***PeU***) [1, 3, 5, 6], is developed at the University of Plovdiv. This is the first attempt in Bulgaria for development of an e-learning environment, in the base of which is not the lecture, created by one author, but a set of information units. The environment PeU 2.0 is developed on the base of the so called ***Reusable Learning Objects***(RLO) [2], which suppose the use of ***common Data Base*** (DB) with materials for reusing and modification, created by different authors. RLO are small “blocks” from the course content, which can be reused in different learning courses.

Key words: e-learning, structured programming

The objects of type RLO are e-learning materials in different formats – doc, pdf, txt, html, mp3, wav, midi, mpeg, mpg, avi, gif, exe, etc. Visual means for development and update of nonlinear learning courses are given to the authors and teachers. The structure of the learning course is created with the help of a ***visual graph editor***, the nodes of which are different learning materials (respectively assignments) or groups of them, and the arcs – the relationship of type ***predecessor_of***. The grouping allows carrying out an automated learning with adaptation to each learner. In the graphical editor the following types of nodes [3] are used: *Begin* (0 input, 1 output); *End* (n inputs, 0 output); *Assignment* (n inputs, 1 output); *Learning material* (n inputs, 1 output); *Subgroup* (1 input, 1 output); *And* group (1 input, 1 output); *Or* group (1 input, 1 output); *More* group (1 input, 1 output); *Check Point* (1 input, from 1 to 5 outputs); *Choice* (M, L) (at_least/equal_to M inputs, at_least/equal_to L outputs); and *Repetition* (1 input, 1 output and 1 pointer to the beginning of the repetition section).

2. Structured course design in PeU 2.0. Structured programming [4] is scientific methodology for achieving decisions of complicated problems in a systematic way by decomposing the problem to its elements, and thus decreasing its complexity. In the structured programming nine control structures for creation of each programming logic are described. They are divided into four main classes of structures: sequence, choice, repetition and exit. Each of them can be reduced to the sum of tree elementary components: operational, conditional and collecting node.

The structured approach of the e-learning course development supposes the use of control nodes of the same type. The ***operational node*** in PeU 2.0 includes learning material – separate learning materials and assignments, or groups of them (the possible types are *And*, *Or*, *More* and *Subgroup*). The ***conditional node*** is linked with the so called *Check Point*, containing the sequence of test assignments for assessment of learner's knowledge, and the opportunity for branching of the learning course (process) in dependence of learner's success. The ***collecting node*** is modeled through the group *Choice*. The three types of elementary components can be combined in each permitted configuration in order to form the course's substructure. Each of the components has one input and one output. Such approach supposes fragmentation of a learning course content to a number of small learning parts. The following logical groups from the graphical editor of PeU 2.0 [3]: *And*, *Or*, *Check Point*, *More*, *Subgroup* and *Choice* are used for the realization of the elementary components.

The logical group with one input and one output of type *And*, *Or*, *Check Point*, *More*, *Subgroup* or *Choice* can be called ***elementary template***. Elementary template *And* is a group in the course structure, which determines learning materials, and which the learner obligatory has to examine (learn) at random order, determine by the learner him/herself. Elementary template *Or* includes materials, among which the learner chooses to learn at least one, and the rest automatically are added to the group of additional (nonobligatory) materials for the learning course. Elementary template *Check Point* is a group, containing test questions and assignments, from which the current results of the learner are formed. Passing through *Check Point* can happen only after receiving feedback from the respective teacher with a mark and comments (automatically or with intervention from the teacher). After that the process of learning (course) is automatically 'branched' in accordance with the learner's success and is orientated to the next elementary template. Elementary template *Subgroup* contains materials, the order of which is determined in advanced by the author of the learning course. Elementary template *More* is a group, that contains additional (non-obligatory) learning materials. Elementary template *Choice* is a group, from which the learner alone has to choose a respective number of elementary templates (at least or equal to m, m≥1), from which (later, in the process of learning) he/she has to finish (pass over) a certain number (at least or equal to n, m≥n≥1) determined by the author of the course.

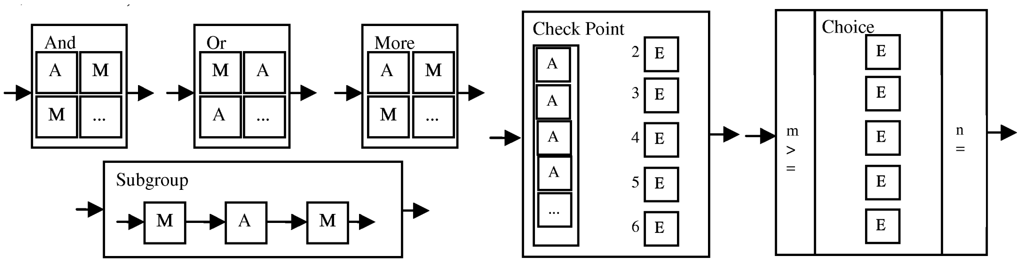

Fig. 1. Examples of elementary templates

In the *Check Point* nesting of the elementary templates from the same type is not allowed. Examples of the elementary templates from all types are presented in Fig. 1. (A – assignment, M – learning material, E – elementary template).

Course template we will call a sequence of elementary templates, starting with object *Begin* and ending with object *End*, determining respectively the beginning and the ending points of the course template. The ***node*** is an elementary template, included in the course template. ***Learning course*** is a template, each node of which contains e-learning materials and/or assignments (Fig. 2.).

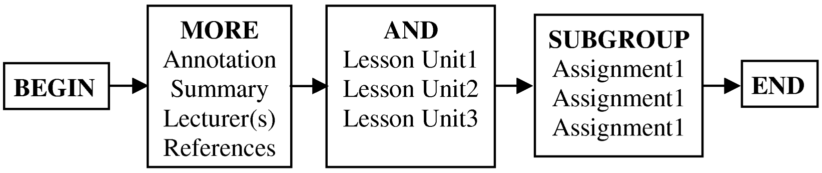

Fig. 2. Example template of the standard e-learning course

Applying structured programming allows creation of a large variety of e-learning course templates through small amount of elementary templates. Through one course template a set of courses, which have the same structure, but different learning content can be created. Because of the linearity of the developed templates and respective courses, the new approach surmounts the problem of the graphical editor of creation of the cyclic courses.

3. Interactive development of e-learning courses. The alternative of the graphical editor of PeU 2.0 for development of learning courses is presented, which is based on the ideas of structured programming. The new system supports the authors of e-learning courses, by offering the advantages, provided by the visual programming.

The system gives the opportunities to work with course templates: it supports creation of a new template, edition, saving, renaming, and deleting of the existing template. During the creation of a new template, the template nodes are determined and ordered in a sequence desired by the author. The template name and content (its composing nodes and the data in them) can be changed during the edition (Fig. 3.) of the template.

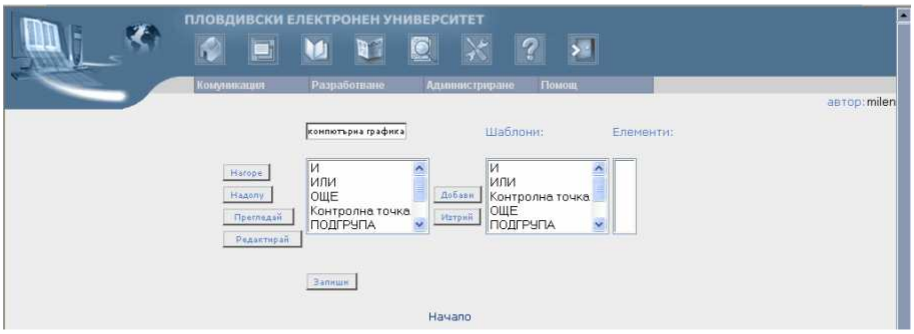

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Fig. 3. Interactive edition of a template

Created course template can be saved as a template or as a course. In the template there can be positions filled with learning materials or assignments. The template can be saved as a course, only if each of its nodes is completely filled with data (the elementary templates *And*, *Or*, *More*, and *Subgroup* have at least one filled position, the *Check Point* has exactly five filled positions, which names can be identical, and the *Choice* (m, n) has at least m filled positions with learning materials and assignments). The saved course can be visualized and edited in the graphical editor of PeU 2.0, as the changes do not reflect on the template, connected to the course. The access rights are determined during the saving of the template/course. Each compound template is owned by the author, who creates it, and only the author and the users who are authorized have access rights to the template. The authors of e-learning courses in PeU 2.0 have common access to the elementary templates. During the renaming of the template, only the name of the template is changed, but not the name of the course linked to it, if such exists.

The realization provides the following opportunities for the work with the template nodes: edition (addition and deletion) of learning materials or assignments in the node, saving and viewing of node's content. The view of the order of the whole template or course is not lost during the viewing of the node's content, unlike the graphical editor, where this view is lost. Both author means in PeU 2.0 (graphical editor and editor of templates) are compatible, which allows each learning course, created with the new system, to be edited in the graphical system. The data from the interactive system is automatically transferred through XML file for visualization in the graphical system.

The realization of the programming system is realized through using Web server Apache, script language with open code PHP and DB management system MySQL on the Windows platform.

4. Perspectives. Created interactive programming system for development of structured learning courses in PeU 2.0 can be expanded through reducing of the imposed limitations. The logical group *Repetion* from the graphical editor of PeU 2.o can be realized. Reducing the limitations of the *Check Point* through allowing the inclusion of a *Check Point* in itself, will permit more strict assessment and management of the learning process in accordance to the learner's success. Moreover, the system can be expanded by implementing the opportunity for nesting elementary template in itself, which will lead to almost equal opportunities of both – interactive and graphical editors of PeU 2.0.

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The University of Plovdiv
Dept. of Computer Science
24, Tzar Assen Str.
4000 Plovdiv, Bulgaria
e-mail: totkov@pu.acad.bg; eledel@pu.acad.bg; kaly77@mail.bg

СТРУКТУРНО ПРОЕКТИРАНЕ И ИНТЕРАКТИВНО СЪЗДАВАНЕ НА ЕЛЕКТРОННИ УЧЕБНИ КУРСОВЕ

Георги А. Тотков, Елена П. Сомова, Калоян Вл. Шкуртов

В работата се предлага нов подход за интерактивно структурно проектиране на електронни учебни курсове на базата на структурното програмиране. Целта на използване на този подход е да бъде подпомогната и улеснена работата на авторите на учебни курсове в средата за електронно обучение ПеУ 2.0. Изследвани са възможностите за създаване на структурни учебни материали, определен е набор от елементарни структурни конструкции (елементарни шаблони). Реализирано е структурно проектиране на шаблони на електронни учебни курсове чрез набор от тези елементарни шаблони. Създадената интерактивна програмна система, която е алтернатива на съществуващия в ПеУ 2.0 графичен редактор, реализира и збраните елементарни шаблони за генериране както на шаблони на курсове, така и на самите електронни учебни курсове. Реализацията дава възможност на потребителя да създава няколко курса с един и същ шаблон, но с различно съдържание.