

# **New Approach in Realization of Laboratory Exercises in the Subject Programmable Logic Devices in the System for Electronic Learning - Moodle**

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**Abstract:** In this work we present a new approach in teaching the subject Programmable logic devices with the use of Moodle platform. A special accent is put on implementation of a multimedia laboratory guide, the contents and conception of which facilitate realization of practical tasks related to designing, implementation and testing of hardware in the development environment Quartus II, which includes a software package and UP2 development system and is used in laboratory exercises in the third grade of basic studies at College of Electrical Engineering and Computer Science in Belgrade. Specific characteristics of the multimedia laboratory guide lie in a possibility of parallel operation of a video tutorial and real software package, with full simulation of the hardware environment for design testing.

**Keywords:** Electronic learning, programmable logic devices, multimedia laboratory guide.

## **1 Introduction**

New technologies, especially the Internet, offer various opportunities for improving the teaching process. In the past years web-based applications have been developed, i.e. E-learning platforms which can be successfully applied in a learning process, since they provide for simple adjustment of web application contents to specific characteristics of the course for which they are used. This means creation of broad opportunities for placing various electronic content forms (audio, verbal, picture or

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video), which on one side facilitate the knowledge transfer process for lecturers, while at the same time they facilitate acquiring knowledge from a field for students through an interaction with the application, which enables simulation of real and predicted events and processes, problem solving, as well as active confrontation with models of the real environment [1,2].

Development of theory and practical use of multimedia contents in web environments for learning is based on the cognitive theory which starts from existence of visual and audio channels for procession of transferred information. Under certain circumstances this enables a student to study more thoroughly if the learning material is in the form of words and pictures, and not only words [1–3]. A typical example of an open-source platform that is becoming more and more popular is Moodle [4, 5]. The many years' experience in teaching the subject Programmable logic devices, whose basic aim is learning about the architecture of high integration level programmable logic devices and possibilities of digital hardware implementation in the circuits, as well as the acquired knowledge about development of modern teaching methods, which include the possibility of distance learning, have initiated the idea of research related to formulating types of multimedia contents in Moodle that would adequately support all the teaching aspects (lectures, audio exercises, laboratory exercises and acquired knowledge checks), as well as finding most favorable ways for their practical realization.

## **2 Organization of the Teaching Content in Moodle**

On the basis of a primary research dedicated to creation of a course profile supported by multimedia tools, the methodology for teaching the subject of Programmable logic devices has been developed; the methodology can equally successfully be applied as support to the traditional way of group and individual learning, while at the same time it can be fully applied in the electronic education system, regardless of the applied software platform for e-learning.

The entire content in Moodle that refers to teaching the subject of Programmable logic devices is organized within separate integral parts, which can be divided into:

- General information (notifications, calendar of events, links for additional content, forums, etc.)
- Lectures (presentations, electronic textbook)
- Interactive tasks
- Laboratory exercises (multimedia laboratory guide)
- Knowledge check tests

One segment of general information (Figur 1) is intended for the professor and subject associates to place notifications regarding the upcoming activities within the lectures and laboratory exercises, homework terms, colloquiums and exams, to announce the colloquium and exam results. The general information may also include links and databases which will make it easier for students to acquire additional knowledge from selected fields. With a similar purpose placement of discussion topics on the forum will be initiated, which will help students obtain additional information related to the subject or solve the tasks in groups through mutual communication or communication with the lecturer and associates.

Fig. 1. A page in Moodle with basic information and contents of the electronic textbook.

The entire material intended for acquiring theoretical bases related with learning about programmable logic devices of various integration levels, principles for hardware designing and implementation in programmable logic, has been presented in the electronic textbook (segment Lectures), the contents of which is realized in

the html format (Fig. 1). Within the chapter animations are used for the purpose of more efficient explaining the operation principles of programmable logic circuits or logic networks implemented in programmable logic. Since the content of each chapter is adjusted to the teaching units presented in lectures via a Power Point presentation, at the beginning of each chapter of the textbook there is a lecture presentation in the PDF format.

The multimedia laboratory guide (Fig. 2) represents an independent application with multimedia modules for presenting video tutorials, additional information and explanations, simulation of the UP2 development system operation and work in real time in the Quartus II software development environment. The creation logic of video tutorial, algorithms for video tutorials creation and the entire visual appearance of the user interface have been designed during the preparation of this application.

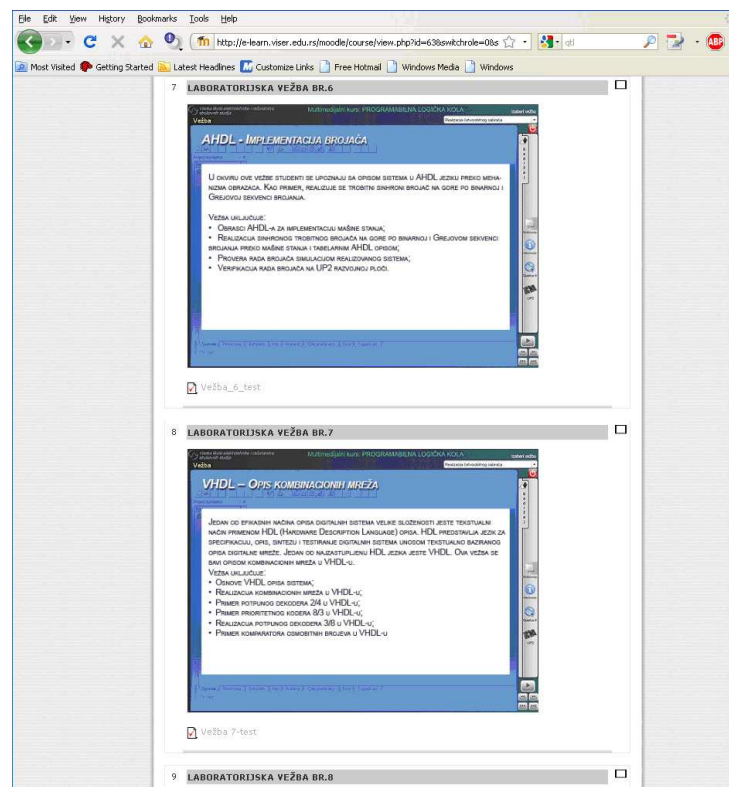


Fig. 2. Chapters of multimedia laboratory guide in Moodle.

Interactive tasks (Fig. 3) are independent applications which are thematically grouped within chapters of the electronic textbook or implemented in the multi-

dia laboratory guide. Through an adaptive approach, with visual indication of the course of performing tasks, a student is enabled to deal with procedures of solving tasks from various fields and of various complexity levels.

Na osnovu poznate sekvence promene kontrolnog signala X: 11010101 Murove mašine stanja, prikazane na slici dopuniti tabelu ako je početno stanje mreže A  
 Selektujte odgovarajuću kombinaciju.

X	t = t <sub>t</sub> Trenutno stanje	t = t <sub>t+1</sub> Naredno stanje	Izlaz
1	A	B	0
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 3. Example of an interactive task.

Tests in the Moodle platform can be divided into tests for individual knowledge check and tests for the acquired knowledge assessment. The tests for individual knowledge check are placed at the end of each chapter of the electronic textbook; the time for their solving is not limited and they can be accessed arbitrary number of times. The tests for the acquired knowledge assessment (Fig. 4) are used within laboratory exercises (before and after laboratory exercises), for passing colloquiums and the final exam. The structure of these tests, unlike the ones for individual knowledge check, is slightly more complex, and the number of accesses and time for solving the test are limited. Multimedia applications within interactive tasks significantly contribute to more successful solving of tasks in tests.

### 3 Defining the Multimedia Laboratory Guide Appearance

During the definition of the appearance of the multimedia laboratory guide [6], the main assumption was that this textbook should enable students to acquire all digital hardware development stages, from design input and testing to a realization in a programmable logic devices, through a parallel work in virtual and real software development environment on practical examples. During realization, special attention was paid to the arrangement and readability of the visual elements, as well as audio and video components [7, 8]. The multimedia textbook is realized as an application connecting the external special purpose modules

Each laboratory exercise is made of special external databases - video tutorials [9], which are activated by students using a hypertext. The main elements of the

Програмабилна логичка кола 2008/09. Пријављени сте као Стјепан Рајић (Одјави)

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Прегледaj Пробитест - 2. колоквијум

[Прими поклонак]

1. 4. На слици 1. приказан je simbol i vremenski dijagrami 4-bitnog sinhronog dekadnog brojača na čije se mogućnosti zadavaniju rubne vrednosti brojanja (load).  
 Опшени: 1

а) Spisanimjem brojeva (od 1 do 4, gde broj - predstavlja bit najveće težine koji odgovara ulazu Q<sub>3</sub>) na slici 2 sa odgovarajućim stanjem ulaza dopunite sliku 1. deklorom stanja trzjača koji na izlazu generiše signal S<sub>7</sub>. Ova je vrednost "1" kada je stanje na izlazu brojača 7(10). **Podrazumevani da je:**  
 1) 1) Dopunite spisanimjem vremenske dijagrame na slici 1. uzimajući se u brojač uopisuje vrednost 010(2) svaki put kada je signal LOAD=0. Brojač broji kada je signal dezerke brojanja EN=1. **Spisanimjem pečetiti od CLES.**

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Fig. 4. Example of a test for the acquired knowledge assessment.

module for showing the textbook content define appearance of the textbook page. The textbook page is divided into several graphic entities (Fig. 5). In the title field there is the school logo, the title of the multimedia textbook, the field for selection of a laboratory exercise and the name of the current activity in the laboratory exercise. The main field of the display shows the video material, which explains the course of the laboratory exercise in virtual software environment. On the right side there are buttons which provide selection of the laboratory exercise chapters, selection of the laboratory exercise modules, management of auxiliary content related to additional information and inclusion of audio content, as well as buttons for secondary navigation (stop, continue, backward, forward). Students can view sections of each exercise in two ways: 1) continuously and automatically through the entire exercise and 2) in steps, by selecting a desired part of the exercise.

Such an approach enables students to completely adjust the display dynamics of the multimedia laboratory guide content in the video tutorial to their own capabilities, i.e. to the speed of acquiring procedures and steps of the laboratory exercise realization, as well as to approach only selected parts of the laboratory exercise in an easy way, without the need of repeating the display of already acquired parts. In addition, within each exercise there are tasks for individual work, which should be realized by students in a real software development environment. Successful solving of one task enables students to proceed to solving the next one, while at

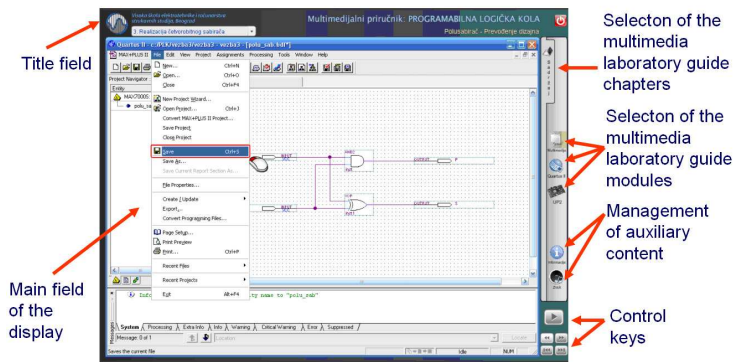


Fig. 5. Arrangement of elements on the page.

the same time an insight into the entire results is optionally allowed, in the form of filled truth tables, logic expressions or block schemes of the design to be realized.

The former experience in the work with students has shown that viewed video material is rapidly forgotten and that later attempt of repeating some steps in the software package is not successful. Therefore, students are enabled to view the video tutorial (Fig. 6) simultaneously with working in the software package Quartus II. A change from virtual to real software environment and vice versa is performed by simple selecting of a laboratory exercise module.

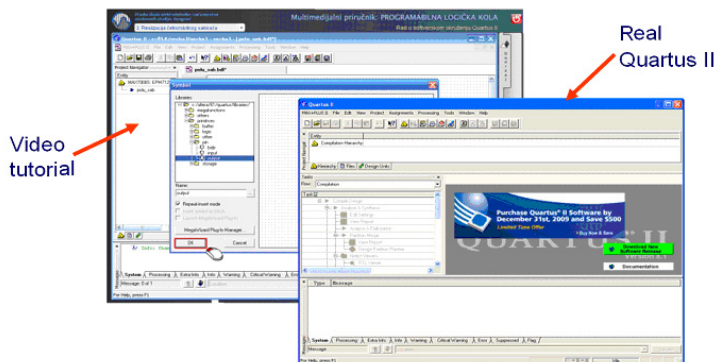


Fig. 6. Simultaneous module operation in virtual and real software environment.

The interactive simulation module provides design testing on the virtual UP2 development system in the multimedia interactive application with emphasized hardware entities and all possible conditions of switches, buttons and visual indicators that would be applied in the work with the real UP2 development system in the laboratory (Fig. 7).

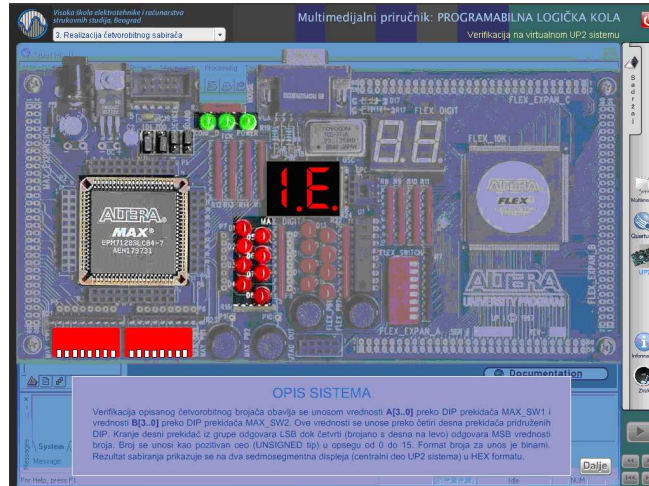


Fig. 7. The module for simulation of the UP2 board operation.

The content of this module enables a student to learn about the expected functional behavior of the hardware implemented in the programmable logic circuit, in compliance with the task or laboratory exercise. At the same time, this module completely encircles the conception of the virtual laboratory realization in Moodle platform.

#### 4 Techniques of Multimedia Application Creation

The software tool Adobe Flash CS3 Professional, made by the company Adobe, was used for the creation of the multimedia textbook. The software tool HyperSnap 6, which provides recording the activity on the screen, was used for the preparation of static pictures.

Although Flash works with vector pictures, in order to obtain the real appearance of the screen of the software being explained, bitmap pictures have been used as a background part of the animation. The time line axis used for the animation control has been made of separate pictures shown at the speed of 25 Hz.

Both animation creation techniques from Flash were used in creation of each exercise sections:

- The frame-by-frame technique provided for arranging of static pictures into a whole, as well as for control of their play each second.
- Creation of tweens between the initial and end picture (key frames) provided for simulation of movements of the animated pointer, which represents position of the mouse in the screen.



The bitmap pictures have been compressed to about 10 times smaller dimension in Photoshop CS3, in order to maintain their quality and appearance which corresponds to the original.

## **5 Conclusion**

During the creation of a multimedia content in Moodle platform, which has been used in teaching the subject Programmable logic devices since the school year 2008/2009, the cognitive theory was used intensively, with special emphasis on the audio-visual way of education. At the same time, much better success in acquiring knowledge by students has been achieved.

Practical usage of multimedia laboratory guide, during students' preparation for laboratory exercises has shown that main advantages of the online availability of the laboratory guide material are the following:

- Individual working dynamics (the beginning, pace, the end) selected by a student or laboratory assistant,
- The availability of the teaching content 24 hours a day, 7 days in a week,
- The availability of the teaching content on any computer connected to the Internet,
- The availability of the auxiliary (supplemental and additional) teaching content,
- Networking of students and laboratory assistants aimed at assistance, support in work, exchange of opinions and finding solutions.

As a direct result of the said advantages, better preparedness of students for practical work in laboratory exercises was noticed, as well as their better efficiency in individual realization of tasks from the multimedia laboratory guide, better understanding of the laboratory exercise content, and more successful use of the knowledge acquired in laboratory exercises in solving tasks on the final exam. The another analysis has been made showing that most students accessed electronic tests and interactive tasks during preparations for colloquiums, as well as that, the number of students who passed the exam increased more than 10% when compared to the previous school year, when Moodle platform was not used in the teaching process of the subject Programmable logic devices, which resulted from the use of modern methods in teaching.

Also, during the semester in which the subject Programmable logic devices was taught, a poll was made in which students assessed usefulness and quality of the offered electronic material in Moodle platform. On the basis of the poll results

Table 1. The marks of students for teaching material.

Electronic material in Moodle platform	Grade (1-5)
Electronic textbook	4.48
Multimedia laboratory guide	4.14
Tests for individual knowledge check	4.05
Test for the acquired knowledge assessment	4.21
Interactive tasks	4.02

(Table 1), it can be seen that most students gave high marks to the content of all teaching material.

The obtained results give a stimulus to intensive work on improving the existing and development of a new teaching content in Moodle in the upcoming period.

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