

## Interactive Tasks as a Supplement to Educational Material in the Field of Programmable Logic Devices

**K. Kuk, D. Prokin, G. Dimić**

*College of Electrical Engineering and Computer Science professional studies,  
Vojvode Stepe 283, 11000 Belgrade, Serbia, tel.: +381113950010; e-mail: kristijankuk@viser.edu.rs*

**B. Stanojević**

*European University  
Carigradska 28, 11000 Belgrade, Serbia; tel.: +381113341583; e-mail: eu@eu.ac.rs*

### Introduction

Natural human capabilities, such as learning from one's own experience and the desire for playing, represent a very suitable basis for using interactivity in education. The use of interactive animations makes learning more interesting. Education in the field of programmable logic devices is based on acquiring knowledge about the architecture of programmable logic circuits of various integration levels, as well as the ways for their digital hardware implementation.

During the academic year 2008/2009, within the subject Programmable logic devices, a project with the basic aim to help students in solving practical tasks from the field of digital hardware designing was realized. Experimental interactive tasks include various examples of combination networks implementation in programmable circuits of low integration level, such as PLA and PAL, as well as examples of designing state machine, registers, counters and work analyses via time diagrams [1]. These tasks are available to students as a special teaching resource of this course in the distance learning system – Moodle.

Although there are a lot of programs for creation of interactive animations in the market, having in mind the demand for small-size files with higher resolutions, vector graphics represents an ideal format for animations on web pages. After considering the request for creation of interactive tasks, we selected the professional software Adobe Flash. Besides good visual interaction, Flash enables us to include other multimedia elements in our future activities if needed, such as voice and sound.

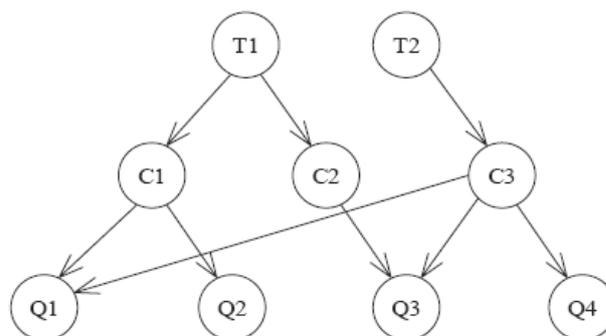
The use of multimedia in education demands from a teacher to actively use some of pedagogical software packages available on the Internet, as well as to be familiar with tools and techniques for creation and modeling of multimedia contents. The aim of modeling of all educational multimedia materials is to make possible for students to better understand and remember a specific

teaching unit. For that purpose, all the team members taking part in preparation of educational multimedia material should also be familiar with some basic rules of cognitive learning and cognitive theory process, apart from software tools.

Using this potential offered by multimedia contents, and adding interaction with participants, we have created new pedagogical techniques – interactive tasks as a supplement to educational material for preparation of exams.

### Knowledge design

For determining the level of a student's knowledge a conclusion stage is needed. Remarks can be made in the form of answers to questions, a problem solving, history of the student's behavior during problem solving, etc. The process of the remarks grouping is defined as a set of conclusion rules which translate the remarks into conclusions. There are general theories on making decisions developed especially for situations where there is uncertainty. One of them is Bayesian probability theory [2], which deals with conclusions in uncertainty.



**Fig. 1.** Graphic structure of Bayesian network

The specific knowledge base within general knowledge base consists of: a group of knowledge atoms of contents

(Atoms  $B_n$ ) on a knowledge map which describes mutual dependence among knowledge atoms [2]. Bayesian network should connect the knowledge map with knowledge atoms and integrate them with specific characteristics of a student.

Bayesian network [2] (Fig. 1) is a simple learning model in which adoption of teaching units (T1 and T2) by a student leads to acquiring various teaching items (C1...C3), which influences problem solving in tasks (Q1...Q4). Task solving can demand from a student to acquire more than one teaching item. With this Bayesian network we can make final conclusions  $P(Q1|T1=adopted)$ ; conditional conclusions  $P(T2|Q3=wrong)$ ; or their combination  $P(C3|Q1=correct, T1=not\ adopted)$ .

### Interactive tasks creation

As we mentioned above, we prepared the first experimental interactive tasks for students of the third year, for preparation of colloquiums in the subject Programmable logic devices. An example of an interactive task is given in Fig. 2.

The first step was made by a professor who gave representative tasks for specific teaching units. In cooperation with designers and programmers, we created a model of tasks with interactive elements such as:

- Input text boxes,
- Combo-boxes,
- Check boxes.

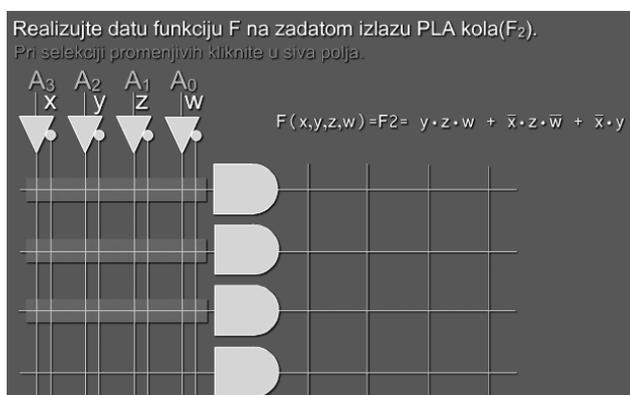


Fig. 2. PLA interactive task with check box

The given task from the field of designing combination networks and implementation in a PLA circuit demands from students to select from a combo-box one of the offered combinations of final logic products of the input signals value. In the case of guessing the right input combination, the given combination is entered into rectangular fields at the bottom of the task, as part of the final sum of the output function  $G$  product.

The example shows the way in which static educational material transforms into multimedia material through interactive elements. The very example also includes a pedagogical aspect, which is shown by the visual indicator of accurately selected combination.

### Bayesian networks

Bayesian probability theory is an instance of the normative system. The normative system is a set of rules and logical consequences of these rules [2]. Therefore, if logical concluding and behavior define the rational, the normative system can be considered a model of rational behavior. Bayesian probability theory deals with solving a problem of making conclusions in uncertainty.

Bayesian probability theory [2],[3] deals with events and probability of these events. If an event is  $X$ , the probability of  $X$  is marked as a real number  $P(X)$ . A set of all possible elementary events is called the event space. It is correct to define the event space as variable  $X$ , which is certainly in exactly one of the discrete conditions  $x_1, \dots, x_n$ . This probability is marked with  $P(X=x_i)$ :

$$P(X) = \prod_{i=1}^n P(x_i | \Pi_i). \quad (1)$$

Bayesian network represents a graphic description of probability and allows efficient probability propagation combined with strict formalism [4].

Bayesian network should connect the knowledge map with knowledge atoms and integrate them with specific characteristics of a student. Let's suppose that knowledge for solving interactive tasks has the following knowledge atoms:

- Atom A,
  - Subatom A.1,
  - Subatom A.2,
- Atom B.

Let's say that there is dependence between Atom B and Atom A.2, which means that one needs to know Atom A.2 completely in order to learn Atom B. A simplified Bayesian network is given in Figure 4. The learned nodes represent a probability level that an atom is learned. This conclusion depends on the correct answer selected (marked with T) and the recognition of visual indicators (labeled I) [4],[5].

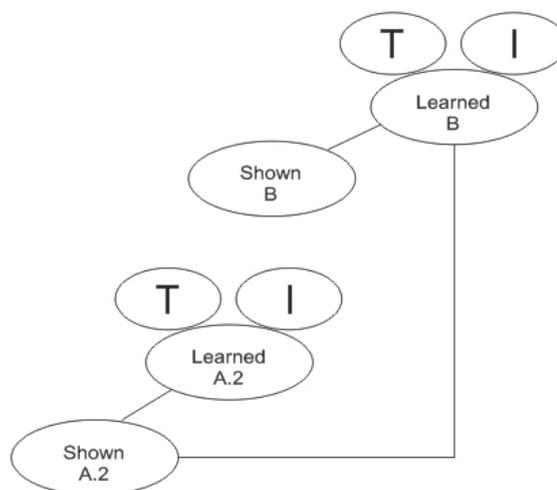


Fig. 3. Bayesian network for pedagogical actions

To illustrate the application of Bayesian network as a model that describes how to realize the principle of interactive tasks, we'll give a description of an interactive task related to the implementation of the logical expression in the PLA circuit (Fig. 3).

To be able to accurately fill the fields that are marked with visual indicator, students need to know the logical functions of logical gates with multiple inputs.

Another condition for successful solving of the given interactive task is to be familiar with the structure of programmable array in the PLA circuit, on the basis of which we define the electric junction between signal lines by which values of input signals are distributed through the programmable AND array, and input of proper AND gate by selecting appropriate intersection junctions within overshadowed rectangular fields (Fig. 5). Selection of accurate intersection junctions creates a possibility for executing the first level of the task, i.e. creation of logic products at outputs of the AND gates [6]. An overshadowed rectangle will appear along the output of the selected AND gate, as an indication of properly implemented logic product (Fig. 4).

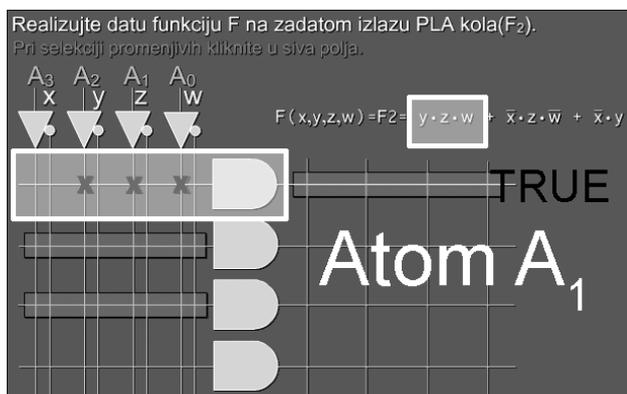


Fig. 4. Topic A<sub>1</sub> - correct selection

In the case of making a mistake on selection of the intersection junction, i.e. if the logic product is not properly implemented (Fig.5), it won't be possible to continue solving the task until creation of a proper logic product in the programmable AND array, i.e. until visual indication appears in the form of an overshadowed rectangular along the output of the selected AND gate.

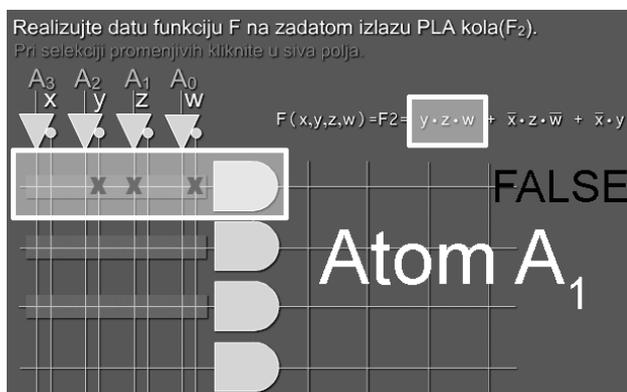


Fig. 5. Topic A<sub>1</sub> - incorrect selection

The second stage of the interactive task, which is completed on assumption that all logic products from the given logic expression are successfully created, is at the same time the last stage and represents creation of the sum of logic products in the programmable OR array.

Table 1 shows conditional probability of events for a rule with two parents, a teaching unit and a proposition.

Table 1. Conditional probability of Atom B

Atom X <sub>m</sub> .N	Atom X <sub>m+1</sub> .N+1	Proposition X <sub>m</sub>	Probability
T	T	T	0.9
T	T	F	0
T	F	T	0.3
T	F	F	0
F	T	T	0.3
F	T	F	0
F	F	T	0
F	F	F	0

If both rules are adopted (T in the first and second column) and the proposition in operating memory is present (T in the third column), the probability of completing the task is 0.9. If the proposition is not present (F in the third column), or both rules are missing, the probability of completing the task is zero [7][8]. There is a small probability – 0.3 that the task will not be completed, although one parent is true and the proposition is present.

## Conclusion

Summarizing the results and taking into consideration a very good result in passing exams during the academic year 2009, we can conclude that interactive tasks produced very positive reactions of students.

We used Bayesian network for modeling the relation between students' activities and the results. With the efficient concluding mechanism via a graphic outline, Bayesian network helped us in modeling the interaction which we added to interactive tasks. The pedagogical aspect of solving parts of a problem before reaching the final solution gave a very good response.

Interactive tasks in which knowledge is checked or acquired by guessing the correct answer with the help of visual indicators turned out to be a good teaching material. However, they are not sufficient for exam preparation, but they represent additional material modeled in a specific way.

The positive results stimulated us to continue improving the existing tasks and to give a basic concept of their creation and usage in other fields as well.

## Reference

1. **Prokin D.** Online presentation of Programmable logic devices / College of Electrical Engineering and Computer Science professional studies. – Belgrade. – 2009.
2. **Bayes T.** An essay toward solving a problem in the doctrine of chances // Philosophical Transactions of London. – Vol. 53.

3. **Conati C., Gertner A., VanLehn K., Druzdzel M.** Online student modeling for coached problem solving using Bayesian networks. – In Jameson A., Paris C., Tasso C. (Eds.), *User Modeling: Proceedings of the Sixth International Conference, UM97*. – Vienna, New York: Springer.
4. **Conati C., Gertner A., VanLehn K.** Using Bayesian Networks to Manage Uncertainty in Student Modeling // *Journal of User Modeling and User-Adaped Interaction*.
5. **Gamboa H., Fred A.** Designing Intelligent Tutoring Systems: A Bayesian Approach // *Proceedings of the Third International Conference on Enterprise Information Systems*. – Setubal, Portugal. – 2001. – Vol. 1. – P. 452–458.
6. **Lubica S., Michal G., Otto C.**, Interactive animations in Microelectronics education // *EWME 2008 – 7th European Workshop on Microelectronics Education*. – Budapest. – 2008.
7. **Mayo M.** Bayesian Student Modelling and Decision-Theoretic Selection of Tutorial Actions in Intelligent Tutoring Systems / Ph.D. Thesis. – University of Canterbury, Christchurch, New Zealand.
8. **Hugo G., Ana F.** Designing intelligent tutoring systems: A Bayesian approach.

Received 2009 11 01

**K. Kuk, D. Prokin, G. Dimić, B. Stanojević. Interactive Tasks as a Supplement to Educational Material in the Field of Programmable Logic Devices // *Electronics and Electrical Engineering*. – Kaunas: Technologija, 2010. – No. 2(98). – P. 63–66.**

The model and architecture of a multimedia environment for the realization of interactive tasks by Bayesian approach is described. Interactive tasks are developed with the basic aim to make it easier for students to acquire practical knowledge in the field of digital design and implementation of complex programmable logic circuits. Exploring the impact of interactive tasks on students' success in acquiring the knowledge about complex logic devices operating principles and their implementation, at the end of the course we conducted a survey. Survey included all students who had classes in subject Programmable logic devices in the academic year 2009. III. 5, bibl. 8 (in English; summaries in English, Russian and Lithuanian).

**К. Кук, Д. Прокин, Г. Димич, Б. Станоевич. Интерактивные задачи как дополнение к учебным материалам в области программируемых логических устройств // *Электроника и электротехника*. – Каунас: Технология, 2010. – № 2(98). – С. 63–66.**

Описывается модель и архитектура мультимедийной среды для реализации интерактивных задач по байесовскому подходу. Интерактивные задачи разработаны с целью облегчения студентам освоения практических знаний в области проектирования цифрового оборудования и осуществления сложных программируемых логических схем. В конце курса проведен опрос студентов по изучению интерактивных задач и их воздействию на успехи учащихся в приобретении знаний о сложных логических устройствах и принципах их работы. Обследование включало всех студентов, изучающих программируемые логические устройства в 2009 учебном году. Ил. 5, библи. 8 (на английском языке; рефераты на английском, русском и литовском яз.).

**K. Kuk, D. Prokin, G. Dimić, B. Stanojević. Interaktyviosios užduotys kaip priedas prie mokomosios programuojamųjų loginių įtaisų medžiagos // *Elektronika ir elektrotechnika*. – Kaunas: Technologija, 2010. – No. 2(98). – P. 63–66.**

Aprašomas daugialypės terpės, skirtos interaktyvioms užduotims sukurti Bajeso metodu, modelis ir architektūra. Interaktyviosios užduotys kuriamos siekiant palengvinti studentams įsisavinti praktines žinias apie skaitmeninį projektavimą ir sudėtingų loginių įtaisų kūrimą. Studentų pažanga buvo analizuojama dalyko studijų pabaigoje. Į apklausą buvo įtraukti visi 2009 metais šį dalyką studijavę studentai. Il. 5, bibl. 8 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).