

THE CONCEPT, STRUCTURE AND PRINCIPLES OF THE DEVELOPMENT AN ELECTRONIC TEXTBOOK FUNDAMENTALS OF THE ELECTRONIC CIRCUITS THEORY

The article presents the research results based on the experience of developing an electronic textbook *Fundamentals of the Electronic Circuits Theory*. It reveals the concept, structure and principles of the development of the electronic textbook. A detailed procedure of the evaluation of knowledge is outlined. The electronic part of a book also provides a self-assessment tool online.

Keywords: electronic textbook, e-course book, distance learning, E-learning, virtual learning environment.

INTRODUCTION

Modern development of society is getting more and more informed, and the main components of it are information and knowledge. Information-oriented society perceives knowledge as the most important factor of social development. Because of this the civil demands to the education, specialist's and student's level of knowledge have remarkably changed; to a great degree it concerns Ukraine as well. Information-oriented society needs a different level of education and application of new approaches to the educational process organization. These needs involve the more active participation of specialists into the processes which require highly professional level of knowledge, thus the constantly growing requirements of in-service training are caused by the rapid development of modern technologies [10].

The self-study is a form of knowledge that is widely spread both in Ukraine and abroad. It is considered to be a self-directed individual activity with the aim to gain knowledge and experience. In the West, this form of learning functions for quite a long time and has enjoyed great popularity among students and teachers due to its economic performance and training effectiveness.

The following technologies are used for this form of learning – Moodle, Atutor, Claroline, eCollege [1, 3-6]. However, the disadvantage of the above mentioned is that they work with a "standard test" and automatic generation of input data for exercises is not allowed. The result is that after a number of clicking on the limited set of tasks students can guess the correct answer without doing an exercise itself. This type of activity does not improve students' skills. So, today there is no the appropriate software which could effectively solve the problem of self-study, namely to allow the student to learn on a limited set of tests to solve new tasks for which input data are not repeated.

The tasks presented to students in Electronic learning (E-learning) are of different types. Each type involves a student's activity during their performance and decision making. One can choose from the following:

- menu (multiple choice);
- calculation (input field, real number or several numbers);
- word (enter one or more words);
- phrase (enter a sentence);
- formula (enter a formula);
- compliance (correct answer from the menu bar for each set of sentences, pictures or photos);

- sequence (give a sequence of actions or choose it from the menu).

Another methodological aspect of monitoring is to form a set of tests. Depending on the type and aim of the test we distinguish the following approaches to completing E-learning task groups:

- the sequence of questions and tasks of varying complexity and importance that is framed in a branched or multi-level algorithm and can be used for current research and self-awareness;
- a special set of tasks of varying complexity, generated to test specific or comprehensive level of training (knowledge, skills), which is presented in a given sequence: randomly, self-selection or increasing by complexity;
- group tasks, which are formed by random sampling from the bank task considering the dynamics and complexity of the distance course discipline.

Thus it is important to create methodological and instrumental bases of simulation training systems management and control knowledge, adequate current trends in information technology and didactic principles of organizing and conducting training.

THE DISCUSSION

The concept of the textbook *Fundamentals of the Electronic Circuits Theory* jointly developed by the faculty of Lviv Polytechnic National University and Kyiv Polytechnic National University, edited by Yu. Bobalo, is based on the consideration of the following factors: complexity of the learning process, which is the integration of various forms of activities – lectures, laboratory work, and independent, under the volume of tasks allocated credits; importance of self-knowledge and effectiveness of training for laboratory work [2, 7-8].

The course book *Fundamentals of the Electronic Circuits Theory* edited by Yu.Ya. Bobalo was awarded the first place in the category *The best educational publication in engineering sciences and technology* of the First All-Ukrainian publication contest “University Book” (Fig.1.).



Fig.1. Course book cover page and diploma for the first place

E-course book presented on CD disk and supplemented with a printed book contains all theoretical material, practice tests with self-assessment tool, laboratory practice based on simulation activity.

The characteristic features of the software used for learning the course *Fundamentals of the Electronic Circuits Theory* are the display of Greek characters in the Windows format, the answer should be given in the form of formulas, tables, and multiple test choice tasks [9].

The process of learning embraces the following components:

1) learning material M contains full or short theoretical explanation. It is organized as a tree which corresponds to the depth of nesting topics M_i and sub-topics M_{ij} . It is characterized by the number of sub-topics $|M_{ij}|$, the time t_i specified by the teacher, questions of different level of complexity Q_{ik} , and scores R_{ik} .

2) Tests T consist of the questions Qt_i , answers V_{ij} , level of complexity Sk_i and task type Tq_i .

$$E = \langle M, T \rangle, M = \langle M_i, \{M_{ij}\}, t_i, \{Q_{ik}, R_{ik}\} \rangle,$$

$$T = \langle Qt_i, \{V_{ij}\}, Sk_i, Tq_i \rangle$$

The teacher indicates the level of complexity for each topic and sets the time to do the task. If the allowed time is over and the student does not answer all questions, the test automatically stops, and the program calculates scores of the answered questions:

$$\sum_{i=1}^n t_i \geq Ts,$$

n – a number of tested sub-topics, Ts – test time limit

Students can randomly see a generated set of test questions:

- if a student scores 71-100 points, he can do the next test;
- if a student scores 40-70, he is offered to take Option 2 to clarify his level of knowledge;
- if a student has 0-39, he is recommended to revise the whole section.

The following modules are developed in the program:

1) analysis of arithmetic expression and its automatic calculation – for the implementation of issues-based problems generated by parameters;

2) the formation of special alphabet characters, their processing, redrawing the window to display the characters and the introduction of expressions from the keyboard;

3) identification of the question type and giving the answers in the form of:

- text
- formulas
- figures
- table
- mixed

4) test assessment – analysis of errors made by the teacher – specification of the number of wrong answers, non-existent type of question, etc.;

5) formation of random question bank, that consists of a number of questions according to the student's level;

6) checking of the student's answers;

7) determination of the total assessment of student;

8) setting the time of testing;

9) presenting students the list of extra resources to get them more prepared for the test.

Here is the description of the software system.

Contextual learning process diagram is shown in *Fig.1*.

Let us select the main entity of the design domain.

The slot *Student* provides information about people who study. The slot *Teacher* performs setting of educational material. The slot *Educational material* presents a graph of educational material [7].

Details of the contextual diagram are shown in Fig.2.

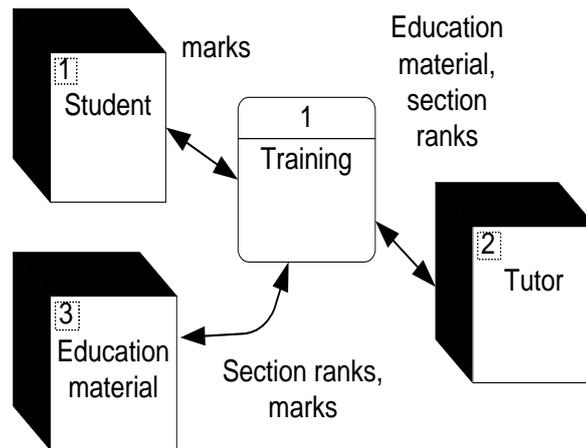


Fig. 2. Contextual learning process diagram

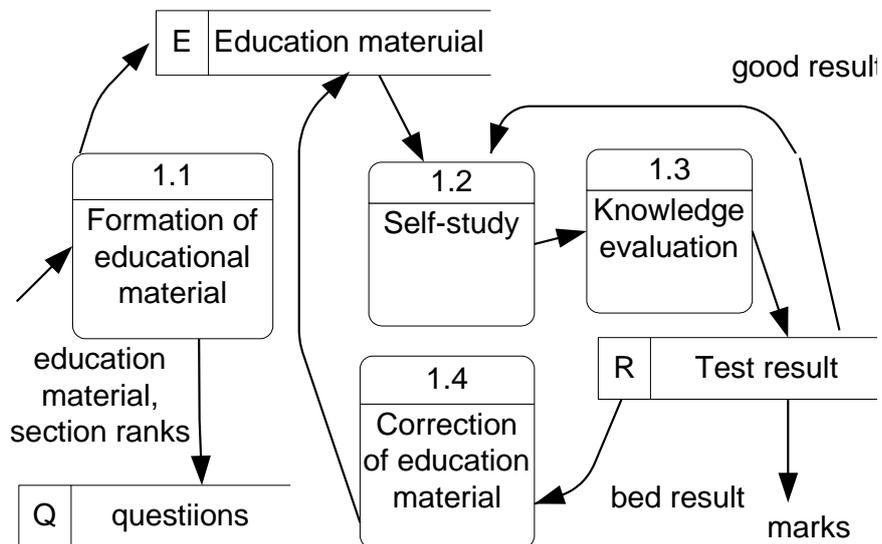


Fig. 3. Detailing the process of "Training"

Then we build the sequence of steps designed to assess student's knowledge (Fig.4).

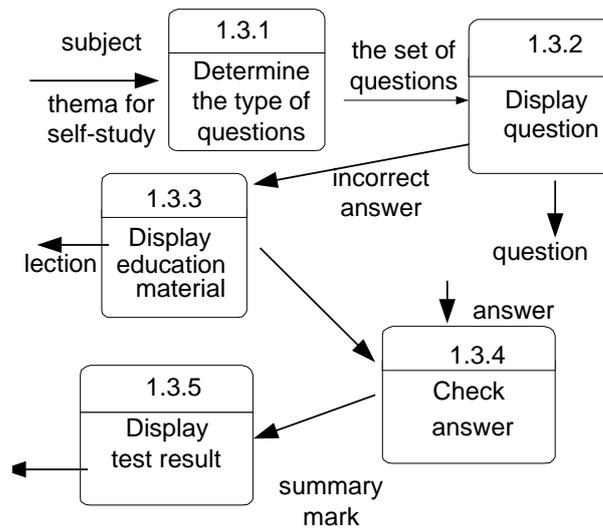


Fig. 4. Detailing the process of "Knowledge evaluation"

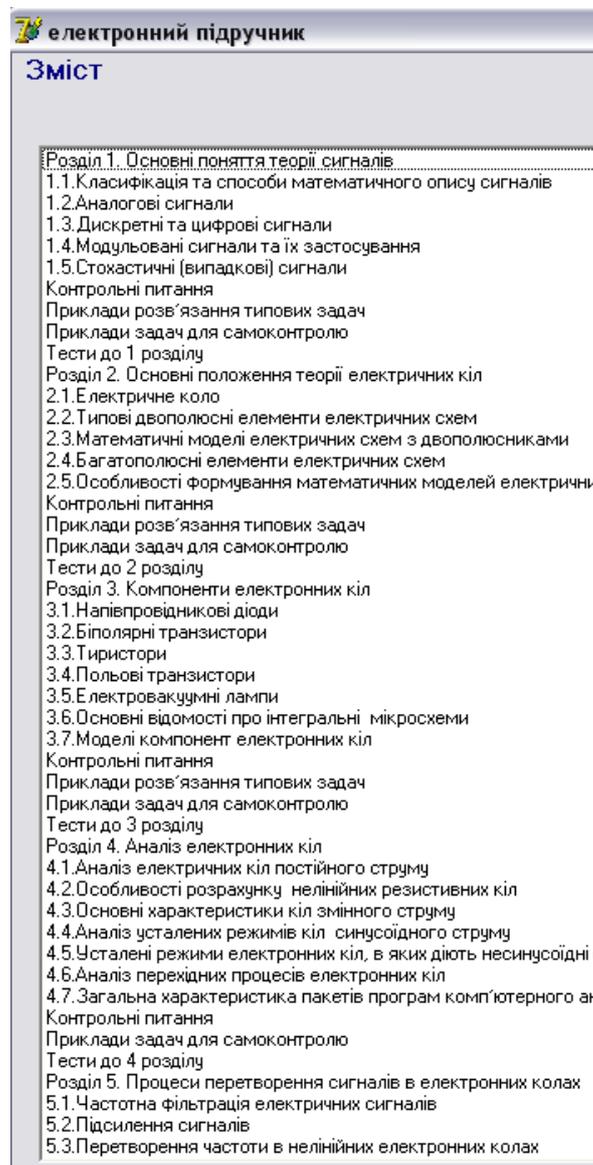


Fig. 5. The main window of program

After the beginning the user sees a window shown in Fig.5.

It contains a list of topics of *Fundamentals of the electronic circuits theory* course, check yourself questions to each unit, examples of exercises for self-control, as well as tests and tasks for self-study. To choose the necessary topic a student double clicks on its title. The short list of sub-topics, explanation on how to do tasks, and test questions are displayed in the browser [11].

The testing begins by double-clicking on a selected test required by the section. There is a window for it (Fig.6).

The main window of the program shows a number of questions and the level of its complexity. The number of scores that a student can get for the correct answer is placed in the bottom slider time. When the slider reaches the right edge of form, the test is automatically terminated. Forward and Back buttons allow you to navigate to the next question or return to the previous one. The user can see the number of points they received for the answer. The correct answer should be marked in the check box. To give an answer to some questions a student should use a keyboard.

It also provides a dimension (matrix) filled arrays (Fig. 7). Introduction to cell array is done by clicking the mouse on the appropriate cell and entering the desired value from the keyboard.

The part of the test which includes a task to do a sum includes circuits, its parameters and their values. Parameter values are generated automatically and a task is done by using a formula. Then the student gives his answer (Fig. 8).

тестування

Питання № 1. Складність - 1. К-сть балів: 5

Сигнал називають аналоговим, якщо він

неперервний в часі та дискретизований на множині значень

дискретизований в часі та на множині значень

неперервний в часі та на множині значень

дискретизований в часі та неперервний на множині значень.

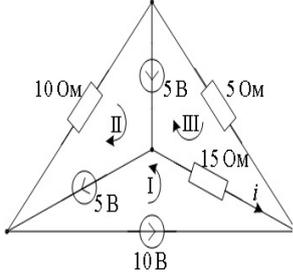
Назад

Кількість балів за питання 0

Fig.6. Test bar

Складність - 3. К-сть балів: 20

Рівняння контурних струмів заданої схеми



Кількість балів за питання

Fig. 7. Matrix-based answer

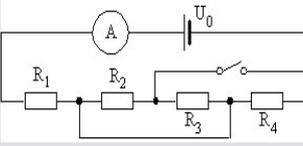
If the user answers all the questions, but still has some given time, he can look over the previous questions.

тестування

Питання № 1. Складність - 1. К-сть балів: 5

Як поменяється показ амперметра у заданій схемі після замикання ключа, якщо до замикання він дорівнював I_0

Параметри: R_1, R_2, R_3, R_4, I_0



Значення параметрів: 68; 70; 4; 87; 58

Введіть результат:

Назад

Кількість балів за питання

Fig. 8. Answering the question task

The results of a test are shown as following: (Fig. 9).

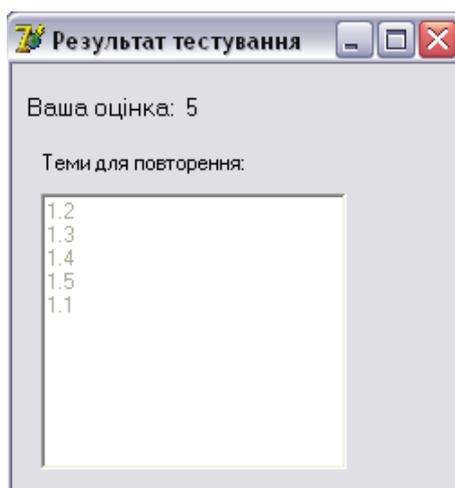


Fig. 9. Test answers

It lists the number of points obtained by students (the maximum is 100 points) and the number of topics or sub-topics that should be revised.

In addition to the tools of E-learning software the tutor as the expert of this subject must design and present the optimal algorithms and methods for assessing students' knowledge.

CONCLUSION

The developed e-course book demonstrates a new approach to training and methodological support in teaching basic disciplines. The authors have successfully presented all types of lessons of *Fundamentals of the Electronic Circuits Theory* course and similar courses which are taught at Lviv Polytechnic National University in a one 330 page coursebook along with a CD. It provides the better results in teaching process as a new theory is learnt with the application of new methods to information access, acquisition of practical skills with the help of both traditional and computer methods, and doing laboratory tasks based on simulation activities. The electronic part of a book also provides a self-assessment tool online.

1. ATutorLearning Management Tools. – [Електронний ресурс]. - [Режим доступу]: <http://atutor.ca/atutor/docs/index.php> 2. Bobalo Yuriy. Software implementation of electronic textbooks "Fundamentals of the theory of electronic circuits" / Yuriy Bobalo, Petro Stakhiv, Bohdan Mandziy, Natalia Shakhovska, Roman Holoshchuk // Матеріали XII міжнародного симпозіуму "Обчислювальні проблеми електротехніки", 5–7 вересня 2011 року / Відп. за вип. С. Рендзіняк. – Львів : Видавництво Львівської політехніки, 2011. – С. 17–18. 3. Claroline. – [Електронний ресурс]. - [Режим доступу]: <http://demo.claroline.net/index.php> 4. E-college. – [Електронний ресурс]. - [Режим доступу]: www.e-college.ru/education/speciality/manager.html 5. Elsom-Cook M. Student modelling in intelligent tutoring systems // Artificial Intelligence Reviw. - 1993, vol.7, n.3-4. - p.227-237. 6. Moodle. – [Електронний ресурс]. - [Режим доступу]: <http://moodle.org/mod/forum/discuss.php?d=133543> 7. Yuriy Bobalo, Petro Stakhiv, Bogdan Mandziy, Natalya Shakhovska, Roman Holoschuk: The concept of electronic textbook "Fundamentals of theory of electronic circuits" [Електронний ресурс] // PRZEGLĄD ELEKTROTECHNICZNY (Electrical Review), ISSN 0033-2097, R. 88 NR 3a/2012. – P. 16-18 <http://pe.org.pl/articles/2012/3a/6.pdf>. – Заголовок з титул. екрана. Przeglad Elektrotechniczny is indexed by Thomson Scientific Web of Science Philadelphia (Philadelphia list). Impact Factor: 0.242. 8. Голощук Р. О. Веб-спільноти в дистанційній освіті / Р. О. Голощук, Н. О. Думанський, Ю. О. Серов // Науковий вісник Національного лісотехнічного університету України.– Львів, 2008.– Вип.18.10.–

С.286-292. 9. Голощук Р. О. Структура та програмна реалізація електронного підручника «Основи теорії електронних кіл» / Р. О. Голощук, Ю.О. Серов // Інноваційні комп'ютерні технології у вищій школі: Матеріали 3-ї науково-практичної конференції. м. Львів, 18–20 жовтня 2011 року / Відп. за випуск Л.Д. Озірковський – Львів : Видавництво Львівської політехніки, 2011. – С. 57–61. 10. Голощук Р. О. Характерні моделі, структура та технології електронного навчання / Р. О. Голощук // Інноваційні комп'ютерні технології у вищій школі: Матеріали 4-ї науково-практичної конференції. м. Львів, 20–22 листопада 2012 року / Відп. за випуск Л.Д. Озірковський – Львів : Видавництво Львівської політехніки, 2012. – С. 16–20. 11. Голощук Р.О. Використання програмно забезпечення Moodle та Adobe для організації електронного навчання / Р.О. Голощук, О.О. Довбуш // Інформаційні системи та мережі : [збірник наукових праць] / відповідальний редактор В. В. Пасічник. - Львів. : Видавництво Національного університету "Львівська політехніка", 2010. - 396 с. : іл. - (Вісник / Національний університет "Львівська політехніка" ; № 673). - С. 249-258.