ELECTRONIC EDUCATIONAL COMPLEX "PHYSICS OF NANOMATERIALS"

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Abstract
The subject of this paper is the concept of development of multilevel electronic educational complex "Physics of nanomaterials" ("PhNM") and its structure.
Electronic educational resource (EER) "PhNM" has been developed for support of the course "PhNM" which is offered to students of Karelian State Pedagogical University since 2003.
A work at a multilevel electronic educational complex for the course "PhNM" was begun. The multilevel structure consists in creation of additional versions of EER "PhNM" adapted for students at schools and for physics teachers.

1. Introduction
Thanks to its unique properties nanostructural materials take leading place in modern materials technology. The information stream on nanotechnologies (NT) and nanomaterials (NM) – articles in journals, materials of conferences and workshops, separate monographs – has considerably grown. In this connection creation of electronic educational resources (EER) on this theme is of high importance.
The subject of consideration of this paper is the concept of development of multilevel electronic educational complex "Physics of nanomaterials" ("PhNM") which can be used not only by university students but also by students at schools as well as physics teachers.

2. The structure of the course
Initially EER "PhNM" has been developed for the support of the course "Physics of nanomaterials". The course "PhNM" is offered to students of physics and math faculty of Karelian State Pedagogical University (KSPU). It is spent on the basis of research laboratory "Physics of nanostructured oxide films and coatings".
The course program includes lectures and practical training (Fig. 1). 17 hours are devoted to lectures and 51 hours are devoted to practical training. Besides, practical training is divided into three parts – the performance of laboratory works (36 hours), seminars (12 hours) and the final conference (3 hours).

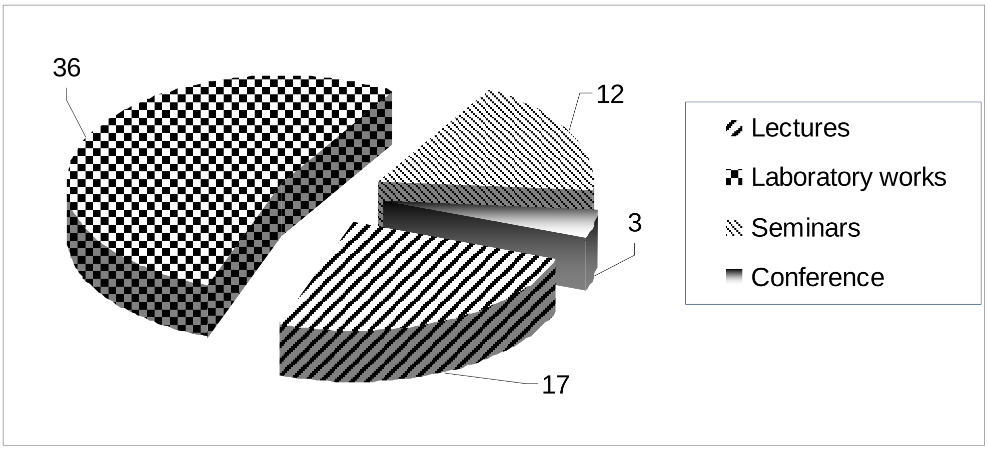

Figure 1: Types of lessons and number of lessons hours

During lectures students learn the main classes of NM (nanotubular and nanoporous nanocrystalls, nanoparticles, etc.), experimental techniques (atomic force microscopy, scanning tunnelling microscopy, infrared spectroscopy, etc.), NM properties and areas of NT applications. The part of practical training is devoted to discussion of modern NM problems and realized NT.

Laboratory practical works are important part of the course. According to table 1, both experimental works, and simulation works are offered to listeners. A number of works provides usage of special computer programs. Part of laboratory works are devoted to studying dense and nanoporous anodic oxide films: fabrication technique, technique of computer processing of electron microscopic images of objects. These items are in the field of research problems of laboratory “Physics of nanostructured oxide films and coatings”.

To get an admission to performance of laboratory work students should answer questions of tests which were developed for realization of automatic admission.

Table 1: List of offered laboratory works of the course “PhNM”

No.	Title of laboratory work
1	Kinetics of growth and electrophysical parameters of the dense anodic oxide films
2	Nanoporous anodic alumina films
3	Computer processing of electron microscopic images of nanoporous alumina
4	Studying the structure of fullerenes and carbon nanotubes and the creation of the simplest models nanodevices with the help of program NANOXPLORER
5	Application software package BASA to analyze the structure of crystalline materials
6	Determination of lattice type and cell size of polycrystalline materials
7	Introduction to fractals using FRACTAL EXPLORER
8	The study of atomic structure of materials using infrared spectroscopy
9	Determination of fractal dimensions of pores in the anodic alumina films according to the small angle X-ray scattering
10	Phase transformations of nanostructured alumina during thermal treatment

3. Electronic educational resource “Physics of nanomaterials”

The course “PhNM” is offered to students since 2003. The extensive collection of materials on the themes of the course has been collected. This collection is a basis of Library of electronic materials (LEM) which includes some students’ presentations and abstracts, as well as collection of papers of the Soros’ educational journal.

EER “PhNM” contains the selected lectures, guides for laboratory works, LEM and a block with automated admission to performance of laboratory works (Fig. 2). Students and other users do not need additional software to use EER, it is available online in KSPU Intranet.

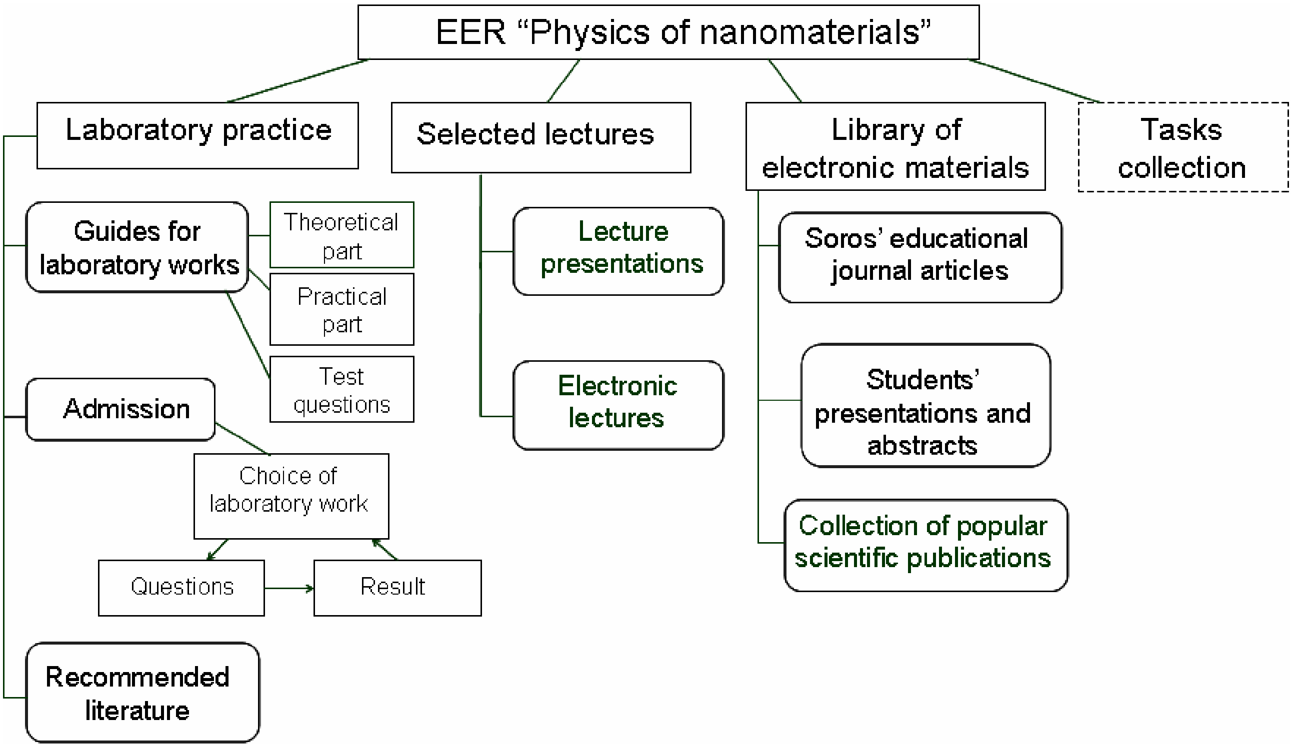

Figure 2: Scheme of EER "Physics of nanomaterials"

Basic parts with which users can work are presented on the main page of resource (1, Fig. 3). Transition to guides of laboratory works and to tests for the admission to performance of works is carried out under the reference "Laboratory practice". To learn a lecture material it is possible having followed the link "Selected lectures". The Soros' educational journal articles and students' presentations are accessible in "Library of electronic materials". As EER "PhNM" is in a stage of development and is constantly updated, soon students will have a possibility to study NM and NT solving problems which will be placed in the block "Tasks collection" (2, Fig. 3).

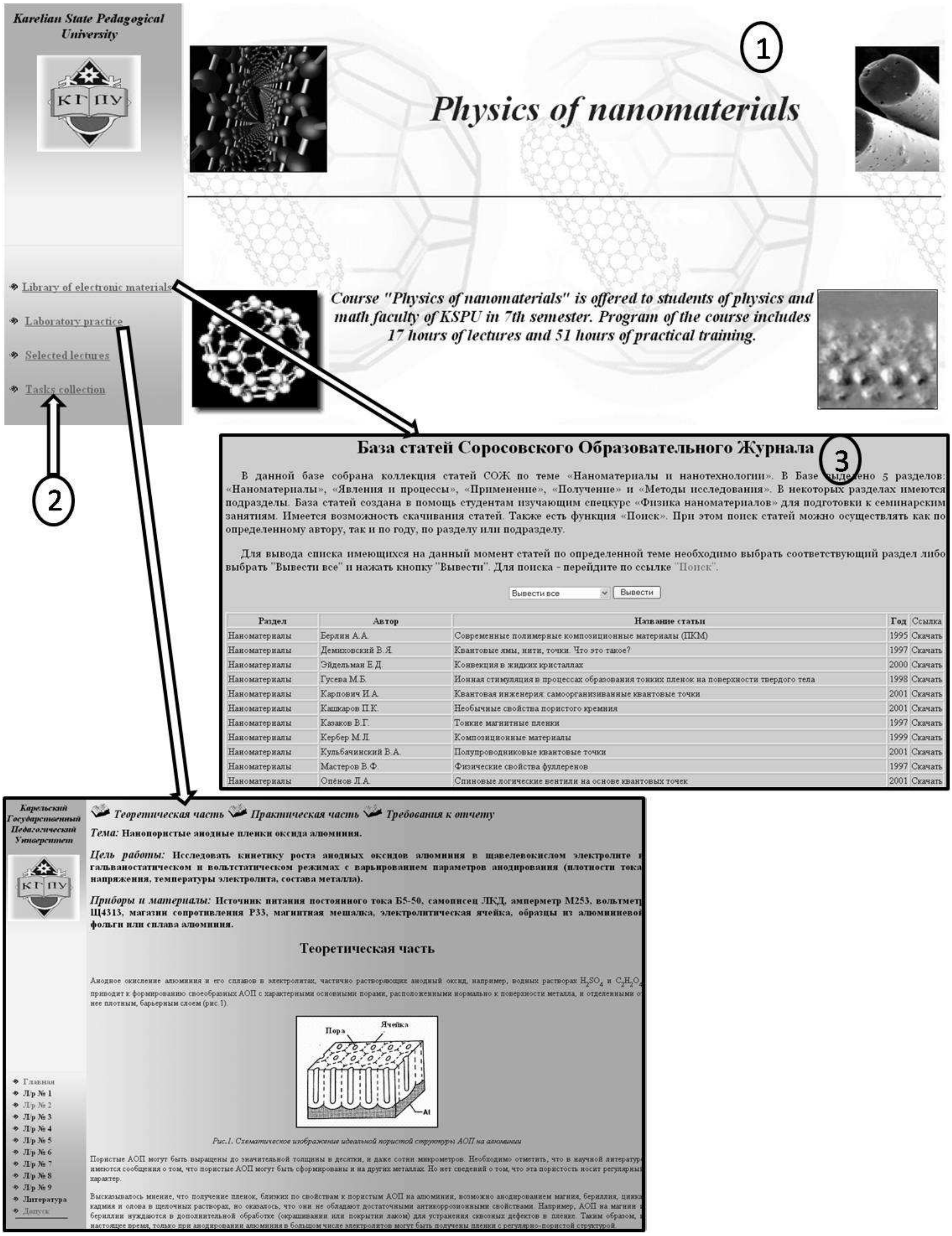

Figure 3: Interface of EER "Physics of nanomaterials"

Lecture component is presented by the block of lecture presentations and the selected electronic lectures. Electronic guides were developed for methodical maintenance to laboratory works united in the module "Special practice on the physics of nanomaterials".

The library contains three components: data base of scientific and popular scientific publications; archive of students' works; data base of articles of Soros' educational journal (3, Fig. 3).

In Data bases of articles and publications function "Search" is organized, it can be carried out both on the certain author, and on a year or on the title of section. When the user found the necessary article, he can "download" it.
The archive of student's works contains the best abstracts and the presentations prepared by students and presented on seminars of a course.

4. Conclusions

EER “PhNM” is in development stage and accordingly is often updated. As studying NT and NM is of high actuality, therefore a work at a multilevel electronic educational complex for the course “PhNM” was begun. The multilevel structure consists in creation of additional specialized versions of EER “PhNM” adapted for students at schools and for retraining of physics teachers. Now EER “PhNM” contains some elements which can be used by students at schools in their research activity. These elements are: collection of papers of the Soros’ educational journal, part of students’ presentations and abstracts. A number of electronic lectures and presentations can be used by school teachers.
On the basis of a course “PhNM” it is supposed to create the program of additional education for improvement of professional skills of physics teachers. It is planned to make lecture component distance. The laboratory of distance learning "Moodle" which allows tracing level of mastering of a course will be involved for this purpose. The laboratory practical work and seminars will pass full-time with support of adapted variant of EER "PhNM". Thus, final version of EER will represent a multilevel electronic educational complex.

References

Suomolaynen K., Yakovleva N., Glazneva N., Pakhomova A. (2009) Electroinc educational resource “Physics of nanomaterials”, Selected Contribution of Materials of 10th International Conference “Physics in the system of modern education”, Volume 1, Saint-Petersburg, 437-439.