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Scientometric Research Results for Educational Trajectory Development in Electronic Educational Environment

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The higher education system keeps changing; therefore, development of new training methods is currently urgent. Control algorithm designed for the most effective individual educational trajectory is a rather important task. Results of scientometric research allow transformations of the variable part of the curriculum on the basis of modular approach taking into account demands of the most intensively-developing industries. Model formalization of information streams in development of educational trajectories is suggested to choose an optimal option of network interaction.

Key words: e-learning, scientometric research, individual educational trajectory, module of an educatio program, electronic educational environment.

The first projects of electronic (on-line) learning emerged in the world under the term "e-learning" as early as the 1990-s, but they became really popular only in the middle of the 2000-s. Nowadays, the volume of electronic learning global market is evaluated of $90 billion, its growth rate exceeding 25% per year.

The demand for a new pattern of training is conditioned by the fact that it should provide the high level of education accessibility and, at the same time, its high quality.

The possibility to master training courses regardless of student's location and simultaneous decrease in teachers' labour efforts per one student allow solving complex problems of enrolment in qualitative training over the entire territory of the country and special category of students.

To implement the mechanism of crediting curriculum modules developed by the teachers of different universities, it is necessary to perform continuous monitoring of designed training modules and select the best ones on the basis of scientometric analysis.

Selection of optimal credit mechanism for curricula modules in the course of network cooperation between professional education institutions includes solving the problem of arranging constantly updated database of such modules.

The results of scientometric research will permit building-up effective teams of university teachers to develop particular electronic educational resources (EER).

It is well known that the major problem of contemporary professional education is the low level of graduates' practical professional training.

The analysis of literature in this sphere [1] has shown that individual educational trajectories (IET) include three components: content (individual educational path), training (including interactive techniques), and management of academic process. In work [2] there is a conclusion that IET effectiveness is defined by student's intention to self-actualize in the surrounding community.

There appears a question: how to transform the training model in modern conditions? How to manage development of IET effectively?

Intensive implementation of electronic learning into academic process allows a way of solving this problem due to implementing practice-oriented training modules. However, it should be noted that such an approach can hardly be implemented without using module training.

Traditional module training is a way of arranging academic process in which instructional content is presented using block-module design. In this case the content of training is structured into autonomous organizational-methodical blocks – modules, with content and volume varying depending on didactic objectives, students' profiles and levels, students' choice of individual trajectories.

The analysis performed has shown that the most optimal module duration in learning process using distance learning techniques (DLT) is 9-hours, which was revealed from multiplicity of curriculum or professional development programmes duration to credits.

A module of educational programme is a relatively autonomous, logically concluded, structured part of the educational programme providing and evaluating the learning outcomes. 'Module' is used as a term synonymous to 'discipline' (a set of discipline parts) or 'discipline cycle' (a set of disciplines within a definite logical framework) of the curriculum.

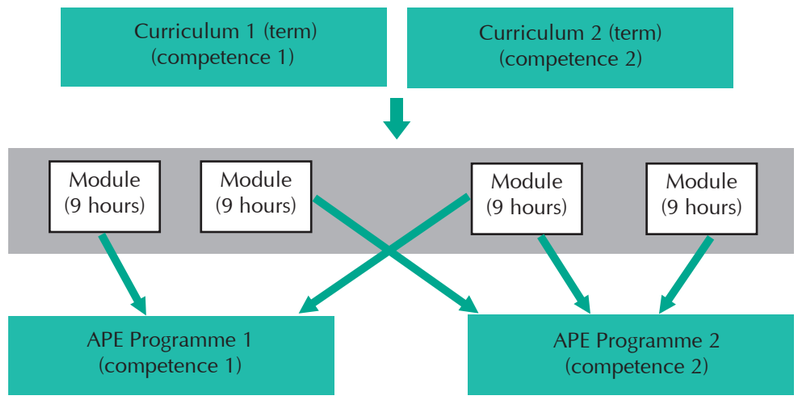
Apart from compulsory modules, curriculum may include the so-called mobility modules, i.e. "a link" of non-profile disciplines that completes student's educational trajectory and provides additional competences, for instance, of the other profile.

Every module ends in test (if necessary, it is accompanied with proctoring procedure). Proctoring is monitoring performed remotely with student's identification and control during the test. Every module is sure to contain the list of competencies (competence designators are taken in accordance with FSES requirements).

Modules can be designed in two different ways. One of them is module design based on curriculum. In this case the curriculum is broken into modules. The other way is development of independent modules, which are united into curriculum.

For example, Additional Professional Educational (APE) curricula (APEC) with required competences are composed of different modules (Fig. 1). Each module is described with definite parameters. APE programme is also described with a definite number of parameters. To design

Fig. 1. Module design and APE curricula



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the programme effectively, the algorithm of module selection is schematically shown in Fig. 2.

In the suggested project the innovative development of electronic learning environment resulted from using database of discipline modules in learning process.

Modulus approach allows transferring to individual learning process. Individual educational trajectory includes student's individual syllabus consisting of compulsory (invariant) modules (disciplines) and modules (disciplines) chosen by student from proposed disciplines, and individual timetable. Due to student individual syllabuses it is possible to take into account different levels of students' preparation from the first term and make necessary adjustments in their individual syllabuses. Students showing insufficient preparation in the placement test may choose modules, for example, on physics, mathematics of "zero level" (in terms of curricula of the school programme), whereas advanced students may exclude from the syllabus modules that they have mastered at school or studied at colleges.

Individual planning permits including disciplines by choice, mobility modules not only from the individual syllabus, but also from the syllabuses of the related profiles, as well as other university programmes. Using modules in the form of on-line courses these, modules may be recommended to study in the local document.

On the whole, the educational trajectory consists of modules united in a steady set formed by the programme and completely mastered by the students to achieve general learning outcomes corresponding to the particular type, sphere, and professional activity.

To manage the formation of students' individual educational trajectories, a mathematical model was developed. It includes: determination of managed and unmanaged variables of the model, determination of optimization function shape; establishment of the model content and structure; calculation of its parts dependence.

The developed model can use functional, information, resource, and managerial elements. The project is focused on information (learning and research aspects) and managerial elements (interaction in university hierarchical structure).

The innovative development of electronic learning environment is more effective under the condition of managing all its elements online by means of different automated control systems. These systems suggest revealing intersection nodes (points) of information flows followed by management of the information flows just in those points. To control the information flows, the points' location should be adjusted to the university organization structure. It has to be underlined that targeted management control of the information intersection points changes their parameters.

Formalization of information flow model includes conceptual model production followed by mathematical modelling. Let us put:

S – information flows of "university – Ministry of Education" system;

$x_i \in X$, i =1, 2, ..., n_x – a set of input flows;

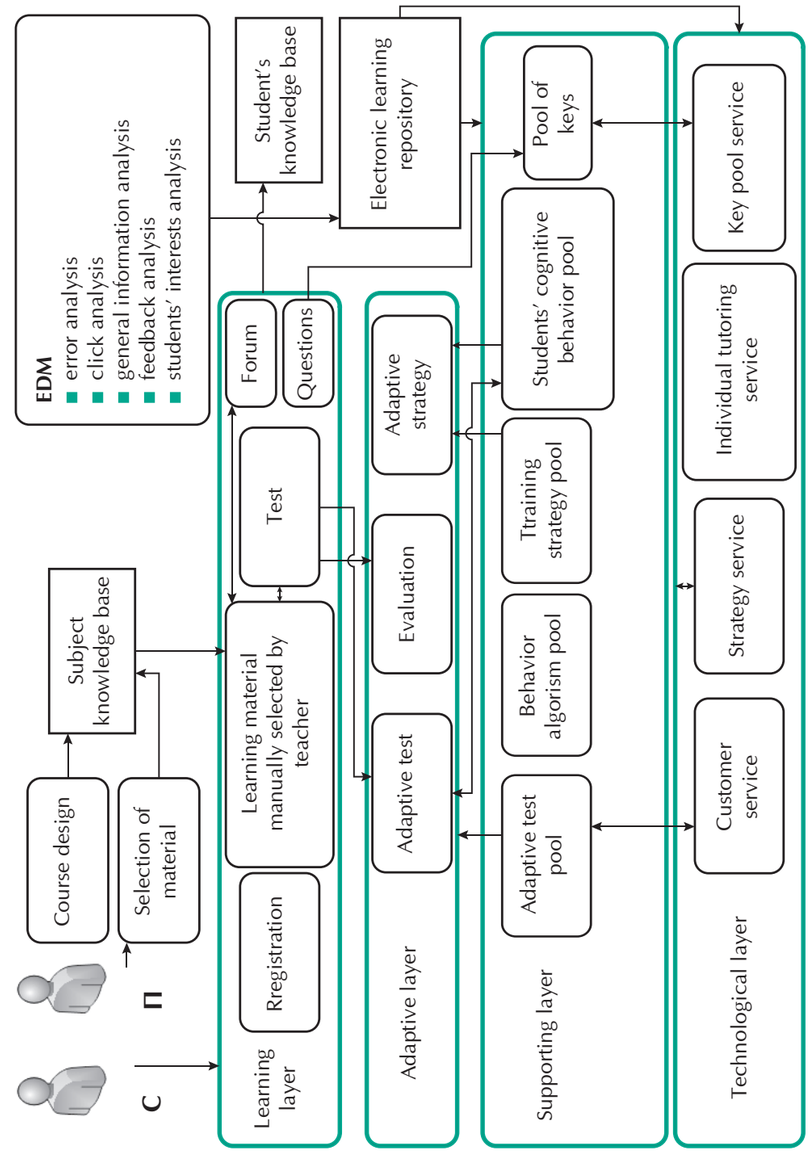
$h_l \in H$, l = 1, 2, ..., n_h – a set of internal actions;

$z_k \in Z$, k = 1, 2, ..., n_z – a set of environment impacts;

$y_j \in Y$, j = 1, 2, ..., n_y – a set of output flows.

The term "scientometry" was coined by V.V. Nalimov [3] in 1969, and scientometric indicators are used to solve (not always unambiguously) the problem of measuring some quantitative characteristics of scientific information. The goal of scientometric studies is to provide a true picture of scientific trend development and their estimation. The results obtained will allow predicting the demands for the staff with higher education and high research competencies. Every scientific trend can be characterized by a set of scientometric parameters, on the basis of which the idea development graph is built [4] making possible to track the progress of trend. Hence, the extremum of target function in network cooperation

Fig. 2. The algorism of module selection



will be calculated for the condition of trend progress limitations. The modular technique is based on individual educational trajectory if a large resource of modules is available. It provides the possibility to transform curricula quickly, in this way reducing information uncertainties in labour market management.

Let us enumerate the university benefits expected from implementation of the project: minimization of graduates' adaptation period for the labour market requirements; transformation of curriculum variable part taking into account the professional requirements (internships in the industry); implementation of most effective ELR.

It should be noted that cost-reduction of new ELR development (that do not give any new information to students) increases the effectiveness of university financial and operational activity saving its resources . It makes possible to choose the best option in network cooperation based on target function:

$$Q = \sum_{m=1}^{n_Q} q_m \rightarrow \min \qquad (1)$$

The optimal option is that with the least value of the target function:

$$Q^* = \min(q_1, q_2, ..., q_{n_Q}) \qquad (2)$$

Management of students' individual educational trajectory development based on scientometric research in the course of university network cooperation will contribute to competitiveness of:

- universities on the global market of education services (development of graduates', post-graduates', doctoral students' research competences);
- industrial enterprises in the market of import-substituting products (more effective staff training);
- areas by means of extending universities' activities in the market of educational resources.

Conclusion: Management of students' individual educational trajectories using credits of discipline modules developed in different universities based on the results of scientometric research is an important factor of innovative development for all interested parties to set clear priorities and build effective corporate teams.

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Training of Specialists Using Network Forms of Educational Programmes

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The article discusses the features of implementing the network forms of educational programme. A functional model of interaction using the network forms of learning, the basic characteristics of the training network forms, their components and tasks are presented. The sequence of training process on the basis of the network of educational programmes and the possibilities of their implementation at the profile departments are considered.

Key words: professional training, network forms of educational programs, network forms of learning.

At the present stage of social and economic development of the country new strategic tasks are set for the higher educational system. The decree of the President of Russia No. 599 and the Resolution of the Government of Russia No. 211 are directed to inclusion of not less than five Russian universities in the first hundred leading world universities list according to the world rating of universities by 2020 [1, 2]. According to the Federal law on education [3], the network form of educational programmes implementation provides an access of a student to the resources of several organizations including foreign ones which carry out educational activity, and also, if necessary, to the resources of other organizations.

There is no unambiguous determination of «the network form of education» today, however, the specialists of the Center of information and innovations of The Open University Business School consider that network education is based around educational communities and interaction of educational and other organizations that expands access out of limits of educational space and promotes an increase in training efficiency.

In case of the network forms of education, a number of the researchers [4] consider information and communication technologies determining; by means of these technologies not only pupils, but also their works on joint creation of educational resources interact in the educational community with sharing responsibility among them.

According to the education law, the following organizations can participate in the network form of educational programmes implementation:

- the educational organizations, i.e. the organizations carrying out educational activities as the primary task with the license and according to the purposes and tasks for achievement of which such organization was founded;
- the organizations carrying out educational activities and the organizations carrying out educational activities as the secondary task with the license including the foreign educational organizations;
- the other (resource) organizations, such as: the scientific and medical organizations, organizations of culture, sports, etc., i.e. possessing necessary resources for education, training, etc.

Network interaction is a steady, organizationally arranged interaction of educational organizations and other organizations to increase efficiency of

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