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## THE RESULTS OF DEPARTMENT EDUCATIONAL PROCESSES REENGINEERING IN DUAL AND DIGITAL EDUCATION CONCEPTS

*The subject matter of the article is the results of department educational processes reengineering, which was conducted at the Department of Land Administration and Geographic Information Systems of O. M. Beketov National University of Urban Economy. The current article introduces the scientific community with the results of reengineering at the department, which made it possible to implement certain conceptual and fundamental provisions of the dual, digital, and cluster approaches in the development of education. The problem, which resolves the contradiction between the standardization of learning processes by traditional methods and innovative learning processes based on the use of intelligent information technologies, is devised. Based on the analysis of the tendencies in the development of pedagogy methodology, it was concluded that today the methodological paradigms in the science of teaching and the formation of a new methodological paradigm of educology were changed. Cybernetic pedagogy, which combines methods of traditional pedagogy and cybernetics, has had a significant impact on the formation of educology. This combination of methods created a support system for the educational processes of the department. The basic theoretical decisions of the department reengineering and results of experimental research conducted based on a support system of educational processes of the department are shown in the article. The results of two full-scale experiments are presented. The purpose of the first experiment was to evaluate the possibility of independent study of science-intensive educational material in the discipline "Mathematical processing of geodetic measurements," and for the second – to evaluate the possibility of creating an intellectual property exchange of scientific-pedagogical and pedagogical workers. Besides, the results of the experimental studies allowed to creation of innovative authoring training technology "Partnership," which provides for participating students in the formation of educational material (tutorials). From the above, it is possible to conclude about the effectiveness of reengineering procedures in the concept of dual and digital education.*

**Keywords:** reengineering; dual education; digital education; university-school clustering; education; cybernetic pedagogy; knowledge modelling; digital platform of educational disciplines models.

### Introduction

The educational system of Ukraine is a fundamental state system that determines the effectiveness of all state institutions – this is an indisputable fact. Unfortunately, like the whole society, the education system and the higher education system in particular are currently in a deep crisis.

One of the reasons for such a crisis, in our opinion, is the imbalance in the development of the modern pedagogy methodology, in which humanitarian researching methods of such complex processes as training, education and upbringing are prevail. In addition, most studies do not take into account the current conditions of the information and communication singularity. Some scientists have long recognized that the methodology of the science of education and training is currently at a paradigmatic break in traditional pedagogy and innovative educology.

The pedagogy methodology is based mainly on the methods, techniques, tools of such sciences as philoso-

phy, psychology and other humanities. The educology methodology is currently based and developed on the methods of such sciences and theories as systems theory and systems analysis, cybernetics and its sections – informatics, pattern recognition, the theory of information transfer, as well as the theory of creating artificial intelligence and other methods of technical sciences.

The transformation of the traditional pedagogy methodology into cybernetic pedagogy, through programmed teaching, the creation of automated control systems for universities, expert teaching systems for universities, is described in detail in [1].

This transformation led to the idea of creating a support system for educational processes (SSEP) of the department, which became a tool for the head of the department, as well as for the scientific and pedagogical workers of the department. The main properties and functions of this system are described in [2-3]. In addition, the properties and functions of the SSEP have expanded over the 8-year period of its operation. New functions made it possible to implement elements of

dual education on its basis and create a digital platform for models of academic disciplines.

**Formulation of the problem.** The problem in this case is complex and lies in the contradiction between the requirements of educational standards that regulate and standardize the organization of the educational process in universities. At the same time, educational standards do not make requirements on the instrumental technical means of implementing the educational process.

Although the Moodle platform has great opportunities for distance training, it cannot be adapted to the specific conditions of the functioning of the department, faculty and the university as a whole. It is not intended for pedagogical experiments and is aimed only at training.

Unlike Moodle, the support system for the educational processes of the department is not limited only to training and can be used by moderators (scientific and pedagogical workers) for educational work, organizing student competitions, quizzes, ensuring communication with secondary educational institutions, as well as with employers.

## 1. Analysis of the state problem

Based on the analysis of trends in the development of the pedagogy methodology in the works [4-7], it was concluded that the current methodological paradigms are changing in the science of training and the formation of a new methodological paradigm of educology.

The formation of educology was greatly influenced by cybernetic pedagogy, which combines the methods of traditional pedagogy and cybernetics.

This combination of methods led to the creation of SSEP of the department. Research in the field of dual and digital education is currently not fully developed yet.

At the same time, abroad, in particular in Germany, dual education is enshrined in legislative acts and, as indicated in the works [8, 9] has its pluses and minuses. Dual education in Germany covers only 4% of all specialties at universities. At the same time, these 4% of students have good career prospects.

As for digital education, in Ukraine the project "Action. Digital Education" [10] developed and put into operation, which is being implemented from January 21, 2020. It greatly narrows the scope of the concept under consideration. The aim of this project is computer literacy of 100% of Ukraine population, and the interpretation of the term "education" in the encyclopedic edition [11] defines education as "... purposeful cognitive activity of people to acquire knowledge, abilities and skills or to improve them ...".

Given these contradictions, we will use the definition given on the website of the Belarusian State University [12] – "digital education is a new education system that uses informatics and computer technology based on the sharing of information, open educational resources, interaction and cooperation for the formation and continuous development competencies and skills of the trainee".

In addition to the results of research in the field of education, works have appeared on the possibility of clustering educational systems, in particular, the creation of university-school clusters.

At the XIII Annual International Scientific and Practical Conference "University-School Clusters: World Experience and Prospects for its Adaptation in Ukraine", which took place in Kharkiv, a number of pressing problems related to this topic were discussed, hypotheses were put forward and directions for increasing the effectiveness of education by creating special clusters of educational systems. At the same conference, a cybernetic approach to solving problems of both dual and digital education was proposed, the essence of which is described in [13].

**The goal of the article** is to familiarize the scientific community with the results of reengineering at the Department of Land Administration and Geographic Information Systems of O. M. Beketov National University of Urban Economy, which made it possible to implement certain conceptual and fundamental provisions of the dual, digital and cluster approaches in the development of education

After formulation the goal of the article we can specify a set of tasks:

- 1) to research the theoretical foundations of the department educational processes reengineering;
- 2) to test the results of the study.

The paper is structured as follows: section 2 considers theoretical foundations of the department educational processes reengineering. Two dual systems of the first and second kind – "school – university" and "university – enterprise" will be considered. Modernization of SSEP by creating a dual system of the 1st and 2nd kind and changing the functions of the specialty guide will be shown. The experimental research methods and their results are presented in section 3.

## 2. Theoretical foundations of the department educational processes reengineering

The main theoretical foundations of reengineering at the department were the results of monographic studies presented in a series of monographs [1, 14-16]. The modernization of the processes taking place at the de-

partment is based on the synthesis of pedagogical and intelligent information technologies (IIT), which led to the creation of SSEP.

This system was developed as a tool that supports the implementation of the functional responsibilities of the department head and scientific and pedagogical workers.

In work [4], only the advertising aspect of SSEP is shown. In order to modernize this system and implement certain provisions of university-school clustering, as well as dual education, a generalized scheme of a cluster is proposed, which consists of two dual systems of the first and second kind – “school – university” and “university – enterprise”, respectively (Fig. 1).

Figure 1 shows that two dual systems are combined by SSEP. The profiling department, which includes SSEP, implements information technology for acquiring knowledge. On the one hand, it provides the preparation of schoolchildren for entering the university in the chosen specialty, on the other hand, it forms students' professional knowledge and competencies together with the enterprise where the graduates will work.

*Modernization of SSEP by creating a dual system of the 1st kind*

The dual educational system of the first kind consists of two subsystems. One subsystem includes schools and technical schools, while the other includes profiling departments, for example, as in our case, the Department of Land Administration and Geographic Information Systems of O. M. Beketov National Uni-

versity of Urban Economy. The department has created a movement of “volunteer-moderators” from among the scientific and pedagogical workers and senior students. Their responsibility is to present to schoolchildren the specialty that students master at the profiling department. Thus, the organizational connection between schools and the profiling department is carried out. In addition, with the permission of the school administration, a virtual connection is established between the websites of the schools and the SSEP of the department on the basis of the Internet. It is important not to forget about safety of data when using web resources and cybersecurity aspects of e-learning platforms are described in [17].

In addition, the connection between schools and the department is strengthened by the interdisciplinary educational and journalistic student magazine “Gravitation”, which is distributed by volunteer moderators in schools. The authors of this journal are not only students and teachers, but also schoolchildren (see the article by Yu. V. Voronena in No. 5 of the journal [18]). In order to strengthen vocational guidance in the SSEP, a page has been developed, which was called “Geography Cabinet”, where students are invited to deepen their school knowledge of geography, for example, at stand No. 1 “Geography as the basis of all earth sciences”, “Teachings of V. I. Vernadsky about the noosphere”, “Evolution of the concept of the size and shape of the Earth”, “Sci-fi, real-virtual and romantic journey of Marco Polo along the Silk Road” (quiz) [19]. It should be noted that the quiz is currently under development.

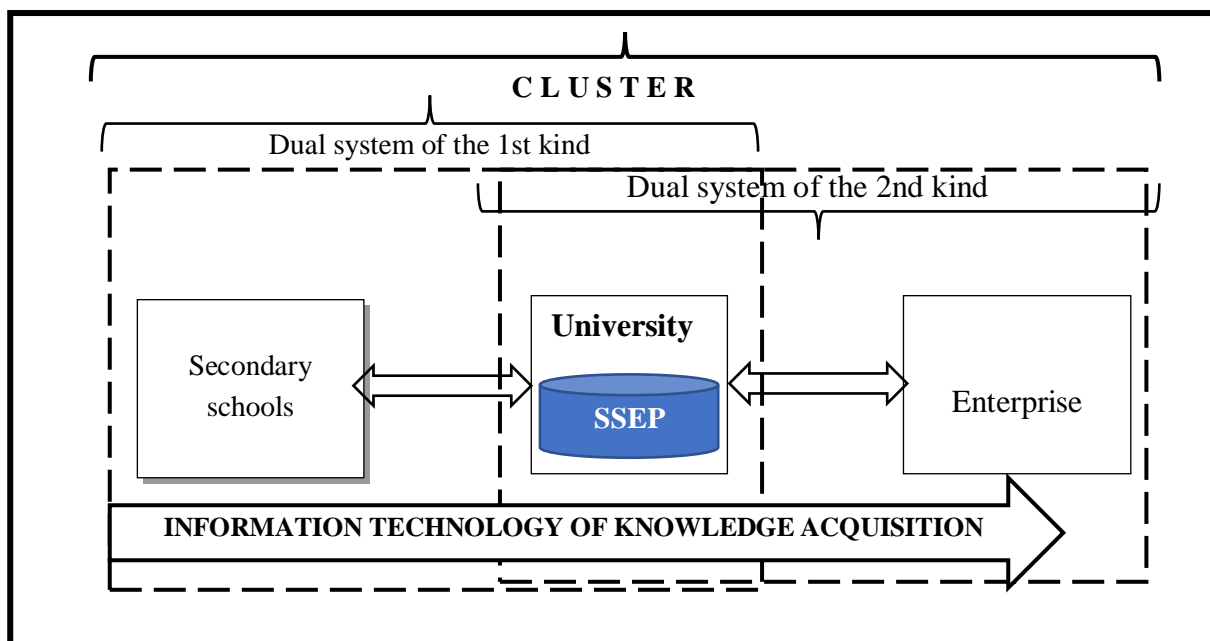


Fig. 1. Generalized diagram of an educational cluster consisting of two dual systems

*Modernization of SSEP by changing the functions of the specialty guide*

Trends in paradigmatic changes in pedagogy and digitalization in education have led to the realization that radical changes are needed in SSEP. If only annotations of academic disciplines and their characteristics were presented in the guide to the specialty, then as its modernization, it was decided to transform it into a digital platform of academic disciplines models. In other words, build a training model in accordance with the curriculum, and provide each discipline annotation with the academic discipline model. In addition, create and establish in SSEP a discipline model that would unite all other disciplines. For this, an innovative training manual has been written, which sets out the training technology “Systematization”, which is based on the modeling of educational knowledge of both teachers and students [20].

*Modernization of SSEP by creating a dual system of the 2nd kind*

The concept of dual education assumes that students acquire theoretical knowledge at universities, and they acquire practical skills at an enterprise. Practice shows that many students get a job after the 3rd year. Some find work in their specialty, others in order to earn money and pay for education – work that is not related to their future profession. This fact prompted the SSEP moderators to organize a special page, where the dynamics of student training was illustrated for employers.

After completing the next course, all students were classified into groups. The excellent students were highlighted in red, the good ones in blue, and the rest in green. Constant filling of tables and accompanying the “color” rating of students gives employers the opportunity to choose students based on the dynamics of improvement or deterioration in their academic performance. It should be noted that creating such a connection with employers (see Fig. 1) stimulates students to study.

### **3. Experimental research methods and their results**

One of the significant results of reengineering at the department is the creation of a special page in SSEP, on which various kinds of experiments would be organized.

The most ambitious are two experiments – a pedagogical experiment, which was named “Along the paths of the snow leopard” and the “Exchange” experiment. The purpose of the first experiment was to assess the possibility of students' independent study of a science-intensive discipline in extreme conditions. The pedagogical experiment had a number of peculiarities, first-

ly, it was carried out in a playful manner, the plot of which was the ascent of Everest, and secondly, the experiment was carried out in the summer-autumn time, i.e. the period of summer practice and vacations for students, thirdly, the discipline “Mathematical processing of geodetic measurements” was independently studied, fourthly, in the process of the experimental game, all actions of the participants in the experiment were controlled and evaluated, fifthly, the educational process of the experimental group was visualized and commented on by the leaders of the experiment.

Based on the results of the experiment, a visual study guide was published for scientific and pedagogical workers [21], and the methodology and results of the experimental game in electronic form are placed in the SSEP on the page “Experiment”.

The second full-scale experiment – “Exchange” was developed on the basis of an article published by the rector of O. M. Beketov National University of Urban Economy [22], which outlines the idea of creating an intellectual exchange. In order to implement the processes and phenomena of the exchange functioning, a methodology for conducting an experimental game has been developed [23]. The composition of the “Labor and Intellectual Property Exchange” has been developed, which consists of six sections, and presented in Figure 2. To provide the exchange personnel with complete information on purchase and sale operations, a geographic information system has been developed that provides visualization of the location of sellers and buyers of intellectual property, the interface of which is shown in Figure 3.

During the experiment, buyers from the USA, Canada, Saudi Arabia, Israel, Belarus and Bulgaria turned to the exchange via the Internet. In addition to experiments related to SSEP at the department, a pedagogical experiment was conducted, the purpose of which was to test the possibility of teaching students on the basis of a free choice of information within a specific academic discipline, namely “Fundamentals of Systems Theory”. As part of this experiment, students were lectured using the traditional method, and at seminars they had to make proposals for improving the educational material or increasing the semantic load of the educational material by:

- changes in the text of the lecture;
- introduction of additional definitions into the text;
- supplementing the text with illustrative material;
- supplementing the text with examples;
- presentation of educational material in graphic form;
- supplementing the text with quotes from prominent scientists, etc.

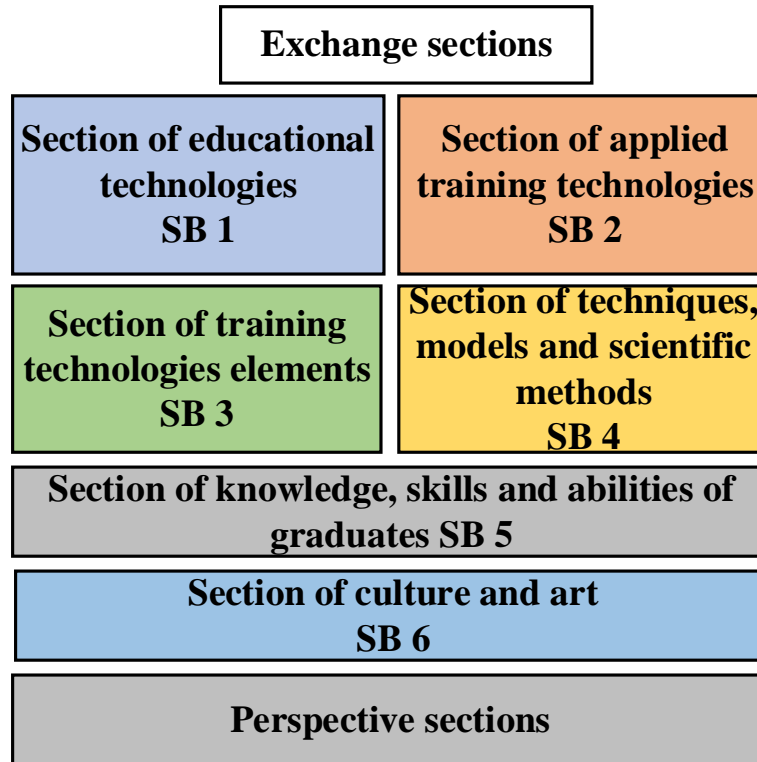


Fig. 2. Composition of the labor exchange and intellectual property



Fig. 3. GIS interface for purchases and sales

Such educational work was motivated by the fact that the most active students who provided successful additions to the educational material can become co-authors of the textbook. As a result, the textbook “Fundamentals of systems theory: innovative author’s technology of teaching “Partnership” was published in co-authorship with eight students. This experience made it

possible to invite one of eight students as a co-author for writing a new textbook on the discipline “Fundamentals of Scientific Research”, who had already written fifteen scientific papers in the third year of study.

The textbook on this discipline was named “From student to professor” [24]. Experimental results, from the first experiment to the writing of the student to pro-

fessor textbook, led to the idea of evaluating students by their research work.

For this purpose, a special page “Territory of student science” has been created in SSEP, where the pages “Outstanding Students of the World” and “Results of Scientific Activity” are highlighted to motivate students to conduct researches.

For each student participating in olympiads, competitions, experiments and other studies, a “Memorable record of scientific activity” was formed.

And in the conclusion of the results presentation of experimental research, we note the results of students' modeling of their knowledge.

In order to create the teaching technology “Systematization” a number of experiments were carried out to create models of their professional knowledge by students of different courses. The experiment involved groups of 1st, 2nd and 4th year students. The first-year students studied the discipline “Introduction to the specialty”, the second-year students studied the discipline “Fundamentals of systems theory”, and the fourth-year students – the discipline “Fundamentals of scientific activity”. Students were asked to create a model of these disciplines by the end of the semester. Totally 68 models were built and a competition was announced for the most interesting from the point of view of the teacher (20 models). These models are shown for evaluation on the page “Olympiads, competitions” of SSEP [25].

From the results of experimental research conducted to determine the possibility of students creating models of their professional knowledge, it follows that 30% of 2nd and 4th year students are able to create models of their professional knowledge that can be taken as a basis for formation of a generalized model of presentation of educational knowledge, which is the main element of SSEP.

### Conclusions and prospects for further researches

Thus, the SSEP developed at the department has shown itself to be a flexible, multifunctional, open and reliable system that provides support for the training, scientific and educational activities of the scientific and pedagogical workers of the department. The creation of such systems does not contradict the conceptual and fundamental provisions of dual and digital education, but on the contrary is a tool that ensures the implementation of their main functions. As for the clustering of educational systems, the unification of schools and universities into special clusters, in our opinion, is a counterproductive idea. It is another matter if it unite schoolchildren from different schools with a specific professional orientation in their education with the corresponding profiling departments of universities. Then, in

our opinion, two dual systems can be called a cluster, the core of which is a profiling department equipped with SSEP.

The prospects for further researches, in our opinion, are the continuation of the improvement of SSEP based on the methods of creating artificial collective intelligence [26, 27].

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## РЕЗУЛЬТАТИ РЕІНЖІНІРИНГУ ОСВІТНІХ ПРОЦЕСІВ КАФЕДРИ В КОНЦЕПЦІЯХ ДУАЛЬНОЇ Й ЦИФРОВОЇ ОСВІТИ

*К. О. Метешкін, О. І. Морозова, О. Є. Поморцева*

Предметом вивчення в статті є результати реінжинірингу освітніх процесів кафедри, який було проведено на кафедрі Земельного адміністрування та геоінформаційних систем Харківського національного університету міського господарства імені О. М. Бекетова. Метою статті є ознайомлення наукової громадськості з результатами реінжинірингу на кафедрі, який дозволив реалізувати окремі концептуальні та принципові положення дуального, цифрового і кластерного підходів в розвитку освіти. Сформульовано проблему, яка полягає у вирішенні протиріччя між стандартизацією процесів навчання традиційними методами й інноваційними процесами навчання на основі використання інтелектуальних інформаційних технологій. На основі аналізу тенденцій розвитку методології педагогіки було зроблено висновки про зміну сьгодні методологічних парадигм у науці про навчання й формування нової методологічної парадигми едукології. На формування едукології мала значний вплив кібернетична педагогіка, яка об'єднує методи традиційної педагогіки й кібернетики. Таке об'єднання методів призвело до створення системи підтримки освітніх процесів кафедри. У статті показані основні теоретичні рішення реінжинірингу кафедри й результати експериментальних досліджень, проведених на основі системи підтримки освітніх процесів кафедри. Наведено результати двох повномасштабних експериментів. Метою першого експерименту була оцінювання можливості самостійного вивчення наукоємного навчального матеріалу з дисципліни «Математична обробка геодезичних вимірю-



вань», а другого – оцінювання можливості створення біржі інтелектуальної власності науково-педагогічних і педагогічних працівників. Крім того, результати експериментальних досліджень дозволили створити інноваційну авторську технологію навчання «Партнерство», яка передбачає при формуванні навчального матеріалу (навчальних посібників) участь студентів. З наведеного вище можливо зробити висновок про ефективність процедур реінжинірингу в концепції дуальної й цифрової освіти.

**Ключові слова:** реінжиніринг; дуальна освіта; цифрова освіта; університетська-шкільна кластеризація; едукологія; кібернетична педагогіка; моделювання знань; цифрова платформа моделей навчальних дисциплін.

## РЕЗУЛЬТАТЫ РЕИНЖИНИРИНГА ОБРАЗОВАТЕЛЬНЫХ ПРОЦЕССОВ КАФЕДРЫ В КОНЦЕПЦИЯХ ДУАЛЬНОГО И ЦИФРОВОГО ОБРАЗОВАНИЯ

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Предметом изучения в статье являются результаты реинжиниринга образовательных процессов кафедры, проведенного на кафедре земельного администрирования и геоинформационных систем Харьковского национального университета городского хозяйства имени А. Н. Бекетова. Целью статьи является ознакомление научной общественности с результатами реинжиниринга на кафедре, который позволил реализовать отдельные концептуальные и принципиальные положения дуального, цифрового и кластерного подходов в развитии образования. Сформулирована проблема, которая заключается в разрешении противоречий между стандартизацией процессов обучения традиционными методами и инновационных процессов обучения на основе использования интеллектуальных информационных технологий. На основе анализа тенденций развития методологии педагогики делается вывод о смене в настоящее время методологических парадигм в науке об обучении и формировании новой методологической парадигмы эдукологии. На формирование эдукологии оказала большое влияние кибернетическая педагогика, которая объединяет методы традиционной педагогики и кибернетики. Такое объединение методов привело к созданию системы поддержки образовательных процессов кафедры. В статье показаны основные теоретические решения реинжиниринга кафедры и результаты экспериментальных исследований, проведенных на основе системы поддержки образовательных процессов кафедры. Приведены результаты двух полномасштабных экспериментов. Целью первого являлась оценка возможности самостоятельного изучения наукоёмкого учебного материала по дисциплине «Математическая обработка геодезических измерений», а второго, оценка возможности создания биржи интеллектуальной собственности научно-педагогических и педагогических работников. Кроме того, результаты экспериментальных исследований позволили создать инновационную авторскую технологию обучения «Партнерство», которая предполагает при формировании учебного материала (учебных пособий) участие студентов. Делается вывод об эффективности процедур реинжиниринга в концепции дуального и цифрового образования.

**Ключевые слова:** реинжиниринг; дуальное образование; цифровое образование; университетско-школьная кластеризация; эдукология; кибернетическая педагогика; моделирование знаний; цифровая платформа моделей учебных дисциплин.

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