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INNOVATIVE APPROACHES TO EDUCATION ARE NOT AN END IN THEMSELVES, BUT THIS IS A NECESSARY CONDITION FOR THE SUCCESSFUL DEVELOPMENT OF NATIONAL ECONOMIES

Shpak Ivan Ilyich

Candidate of Technical Sciences, Associate Professor

ORCID ID: 0009-0007-7008-9388

Paramonov Anton Ivanovich

Candidate of Technical Sciences, Associate Professor, Head of Department

ORCID ID: 0000-0001-6616-2481

Belarusian State University of Informatics and Radioelectronics, Minsk, Republic of Belarus

Abstract. *The research aims to investigate the impact of innovative initiatives in the field of education on the effectiveness and quality of professional training of specialists for all areas of human activity, starting with economic, social, household and ending with socio-political, and spiritual spheres. The issues of indirect impact of educational outcomes on the successful development of national economies are considered. An analysis of the conditions for the application of innovative approaches leading to a significant increase in the efficiency of the modern process of vocational education was carried out. The modern ways of development and improvement of the educational process are explored.*

This made it possible to achieve the set goals and prove the formulated hypotheses. The results of research have shown that to achieve the set goals it's advisable to use adaptive educational technologies, combined with the use of modern ICT capabilities, AI and modular learning technologies based on the MLC-ILO concept. The results indicate the need for targeted improvement and development of educational technologies, considering the needs of the labor market. The conclusions presented are confirmed by the results of many years' professional, scientific and pedagogical activity of the authors' team. The research contributes to the understanding that the economic development of both – individual countries and the global economic community as a whole – is possible only based on innovative development of vocational education systems and strict adherence to the Sustainable Development Goals.

Keywords: *Innovations in Education, Adaptive Educational Technologies, MLC–ILO concept, Competency-Based Approach, ICT.*

1 Introduction

1.1 Problem Area

The level of the national economy's development for all countries is directly dependent not only, and not so much, on the main production assets and financial resources available to the country, but no less on the level of professional training and competencies of the country's human resources.

The provision of highly qualified personnel not only for all industrial enterprises, but also for other sectors of the national economy: healthcare, social sphere, science, education and culture, directly depend on the state of the education system development at all levels: starting with general school, technical, special; and especially on the effectiveness of pedagogical, medical, academic and professional education.

In order to determine the directions and ways of developing and improving vocational education, it is necessary, first of all, to proceed from the needs of specialists to be trained. To ensure the successful operation of the vocational education system and the relevance of the results of this activity, it is necessary to clearly navigate and adapt to the requirements of a dynamically developing labor market. Here, according to the author, we can talk about the need to adapt the directions and content of the entire education system activities to the needs of the labor market (i.e. to talk about the systematic adaptation of educational activities to the requirements of the labor market).

For the practical implementation of such adaptation, or the mutual alignment of education with the labor market needs, it is possible to successfully use the results of the activities of the Organization for Economic Cooperation and Development (OECD). The annual OECD reports contain data, obtained by analyzing changes in labor market conditions over the past period, and forecasts for the future [1]. It is significant that the OECD Report on the state and Prospects of Employment in 2023 focused on the fact that the rapid development and spread of Artificial Intelligence (AI) can significantly change jobs, and therefore affect vocational education. The OECD Employment Survey for 2024 [2] focuses on the transition to zero emissions into the environment, which by 2050 will have a serious impact on the Labor Market and the jobs of millions of workers.

Based on the data contained in the reports, it is possible to determine the training needs of specialists in these specialties and skill levels who will be in demand and, thanks to this, will be able to find a job soon.

Along with the need noted here for a holistic or systematic adaptation of vocational education to the needs of the labor market, the educational process itself, to be effective and of high quality, must be adaptive in nature.

1.2 Research Objectives

Education should be adaptive. The very idea of adaptability of the learning process, according to A. V. Khutorsky, a corresponding member of the RAO, was gradually formed as learning developed in ancient times [3]. Already in the treatises of the first century BC [4] there is information about attempts to adapt the process of formation by ancient man of knowledge about the world around him, both – to the capabilities of the students themselves, and to the needs for this knowledge.

Having skillfully processed what had been accumulated over the centuries, the great teacher of the Middle Ages, Jan Amos Komensky [5], creatively developed the elements of didactics, that had come down to him and formulated the pedagogical principles of a classroom-based learning system, which, in fact, is the basis of adaptive learning systems.

The main program document, which defines the strategy and tactics of the development of the national education system of the Republic of Belarus [6], declares: “One of the main trends in the development of education in the world can be attributed to the orientation towards the personality of the student in order to fully reveal his abilities and meet his educational needs.” The implementation of this is possible only with the use of adaptive learning.

In our century, the rapid development of informatization, digitalization and artificial intelligence (AI), actively penetrating all spheres of human activity, significantly facilitates the possibilities of implementing an adaptive educational process at all levels of education: preschool, general secondary, secondary special, as well as higher education.

Algorithmization of the adaptive learning process. The realization of a modern system of adaptive learning at any of the previously mentioned levels: whether it is preschool education or higher education, involves the primary solution of a three-pronged task – determining: – what, – to what, – and how to adapt. The modern approach to solving this very difficult, multi-stage task of implementing an adaptive learning system, involves the following three stages: creating a model of an adaptive learning system; development on the base of this created model – the algorithm of the system functioning; and then, the development of a hardware and software complex, using which, adaptive learning process will be implemented [4].

It is necessary to draw attention here to the fact that any professional training, both traditional and adaptive, ultimately comes down to the following:

- to prepare the volume of educational material, which is necessary for studying, or to formation of the content for professional training;
- to the full assimilation of educational material by students, further consolidation of the acquired knowledge, and the formation of skills and competencies, which are necessary for future professional activity.

In the modern infocommunication language, the task of creating an adaptive learning system, at the first two stages is – to create a model of the system, then an algorithm, that implements this model, and then – the using and optimal interaction of two data sources: training content (models of the professional field); data about the opportunities and needs of the trainee (trainee model).

From what has been said, an unambiguous conclusion follows:

- high-quality professional training is *Impossible* without the necessary completeness and quality of the training content,
- for modern adaptive learning, it sounds like – without a highly effective model of the professional field.

2 Materials and methods

2.1 Creating a Professional Field Model

The model of the professional field, or the content of vocational training, should be uniquely determined by labor market demand. The vocational education system should provide training for specialists of all skill levels and competencies in professions that are in demand on the labor market at a given time. The OECD conducts a constant analysis of changes in the labor market situation.

The most important factors influencing the development of the world economy, the global labor market, and therefore the need for specialists, before the COVID-19 pandemic were [7]:

- *regionalization*, or the unification of a few countries in different parts of the world and the creation of regional economic unions;
- *globalization*, i.e. using the opportunities of the global labor market and production facilities to increase the efficiency and profitability of the creation and sale of goods and services;
- *digitalization* due to explosive progress in the field of information and communication technologies and artificial intelligence and the transition from an industrial to a digital economy.

These factors, being interrelated and interdependent, have a direct or indirect impact on all areas of human activity, including vocational education.

Unfortunately, the pandemic has not simply “abolished” regionalization and globalization as such. It was able to cause significant differences between countries and entire regions. This can be confirmed by the numerous problems that still arise in highly developed EU member states and in the USA due to violations of legislation in the vaccination process [8].

The creation of the professional field model (the formation of the content of vocational training) can be carried out by using two alternative ways: traditional way and activity-based way [9].

The traditional way of forming the content of educational material involves the use of a subject-specific (lecture-seminar) approach. The educational material

obtained in this way is a set of academic subjects (or disciplines). However, it is known from pedagogical practice, that even a sufficiently deep and complete assimilation and mastery of the material of individual academic disciplines does not always lead the student to formation of the required competencies and to effectively use his knowledge in practice.

The activity-based approach [10], based on the analysis of the activity, that the trained specialist should be engaged in, is much more effective in shaping the content of educational material for vocational training. This approach is also called functional.

The essence of the approach is as follows. A group of experts conducts a predictive analysis of the content of the future specialist's work. All labor functions are identified, as well as the sequence of their performance in the labor process. The means of labor and objects of labor are considered and identified. As a result, an exhaustive description of the future activity of a specialist is obtained, including a list of all the tasks that he will have to solve in his professional practice.

Based on the description of these tasks, the following are determined:

- the necessary content of educational material sufficient for the professional training of a future specialist;
- the appropriate structure of educational material and sequence of learning is also determined.

In most institutions of higher education, the traditional approach is widespread in various implementations [9], although it is inferior to the activity-based approach in terms of effectiveness.

2.2 MLC–ILO Concept as the basis for the Professional Field Model

A highly effective model of the professional field (the content of vocational training) can be created on the basis of modular technology, developed by ILO experts in the crisis of the 80s of the last century, and widely known in the world as the concept of “Modules of Labor Competencies” (MLC–ILO concepts) [10], where an activity-based approach to the formation of the content of vocational training was proposed. The basic principles, underlying the creation of educational systems under an activity-based approach, are the following [10]:

- *Efficiency and flexibility.* When creating a vocational training system, it is necessary to monitor the situation on the labor market, and train specialists in accordance with the demand for a range of professions and qualifications;

- *Continuity and openness.* The training system should provide the employee with a potential opportunity for continuing education, i.e., connecting at any time to the learning process and continuing education at the next professional level (vertical training) or mastering a new (related) profession (horizontal training), and then returning to the labor market;

- *Democratization*. It is necessary to ensure the possibility of vocational training, considering the inclinations and wishes of the trainees, which will lead to an increase in the motivation of the educational process, and therefore the quality and effectiveness of training;

- *Accessibility*. The system and content of vocational training should ensure the implementation of the educational process both in educational institutions and centers under the guidance of teachers and instructors, and independently, including remotely using modern information and communication technologies;

- *Modularity*. It involves structuring the learning process and quantization of the content of educational material using separate training modules, each of which serves to achieve certain learning goals. The formation and development of training modules can be carried out based on various approaches (discussed below);

- *Efficiency and quality*. To obtain high-quality and required learning outcomes, it is necessary to clearly formulate goals and set learning objectives, achieving their unconditional implementation. This is possible only using resultant training programs. To develop such programs, along with highly qualified teachers and methodologists, the experienced specialists from relevant subject areas should also be involved. The developed programs are subject to mandatory expertise, are being finalized, evaluated and certified;

- *Standardization*. To assess the quality of specialist training, it is very important to normalize and standardize the requirements for knowledge, skills and abilities that a graduate should have. The highest level of standardization in the training of personnel is the professional standards, that determine the result of training. In the Republic of Belarus, the normative documents of this type are the qualification characteristics, included in the Unified Tariff and Qualification Handbook, as well as educational standards, developed in the system of the Ministry of Education for some specialties;

- *Individualization* of the learning process. Individualization of learning can be implemented in two ways, either by regulating the rate of assimilation of educational material (with a uniform volume for all), or by choosing the volume of educational material in accordance with the wishes and capabilities of the trainees themselves (with the same training time for all);

- *Focus on the final result; Activation; Pluralization, etc.*

Almost all the principles given here are set out in the Concept of the Development of the Education System of the Republic of Belarus until 2030 [6]. The use of these principles in professional training [10] makes it possible to implement an activity-based, activating and variable approach to the educational process. The very process of professional training based on a modular approach involves the student's educational activities independently, or under the guidance of a teacher,

through his work with an individual package of scientific and methodological support provided to him. which should contain [10]:

- targeted action program (curriculum, training programs, etc.);
- educational information bank (vocational training content in convenient formats);
- methodological guidance for achieving the set educational goals;
- means of control or self-control over the quality of education;
- ways and means of adjusting the level of training.

2.3 Main Provisions of the Concept “Labor Competencies Modules”

The Basis for the development of curricula and the content of MLC–training, as noted earlier, is an exhaustive description of the future professional activity of the student. The description is prepared by a group of highly qualified experts. They use the relevant professional standards, qualification characteristics, employers’ work assignments or job descriptions, as well as the personal professional knowledge and experience of the group members themselves.

The future activity of a specialist, described in this way, is then divided into separate logically completed parts, called *Modular Unit* (MU) [10].

MU is a logically completed and acceptable part of the work within the framework of a production assignment, profession, or field of activity, with a clearly defined beginning and ending, which, as a rule, is not further divided into smaller parts.

The set of MU, grouped for a specific type of work, forms a Module of Labor Competencies (MLC). MLC presents a description of the work expressed as a set of MU (MLC describes in the form of MU the work, performed within a specific production task).

The work within each MU is divided into clearly defined steps (operations) that must be performed in a certain logical sequence. To be able to perform these operations in the future, the student needs to master certain knowledge, skills, abilities and competences (psychomotor, intellectual and emotional). A detailed analysis of the work steps in each MU, skills and competencies required to perform them, allows us to determine the volume and content of the necessary and sufficient training material.

The prepared educational material is structured and divided into separate *Learning Elements* (LE), each of which is devoted to the formation of a certain type of knowledge, skills, abilities or competencies in the student. LE is an independent educational brochure (electronic learning element), designed for training, focused on both the student’s independent work, and work under the guidance of a teacher. Each LE is designed for certain practical competencies or theoretical knowledge, i. e. it contains the entire volume of educational material, necessary for the formation of these competencies in the student, or obtaining these theoretical knowledge.

The MLC program has a component structure, the elements of which are MLC, MU and LE (see Fig. 1). The LE database serves as the main source of educational information for trainees. It can be created both for a separate profession, and for an entire professional field. The availability of modern LE databases (in electronic format) is ensured by using cloud technologies. An *Instructional Unity* (IU) can be developed for teachers and educational institutions that organize training. IU is a modern form of lesson plan, developed for a modular learning system. It facilitates the systematic planning and preparation of classes by teachers. IUs can also serve as a basis for the development of LEs. Depending on the educational objectives, individual MLCs that are part of MLC – programs may consist of a different number of MU within one or more different professions.

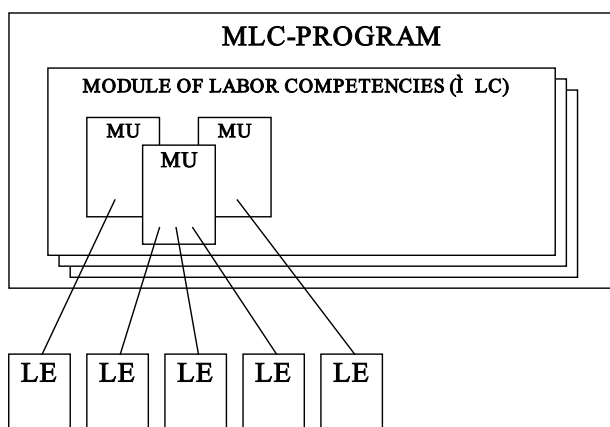


Fig. 1. Generalized Block Diagram of the MLC-program components

3 Results and Discussion of the Findings

3.1 Professional Field Model for the adaptive training of “Labor Protection”

Within the framework of the project “Development of a modular education system in the Republic of Belarus” from the International Labor Organization “*ILO BYE/96/M01/FRG Project*”) [10, 11], the MLC-program “*Labor Protection*” was developed as one of the first. The program is intended to be used as a professional field model for training managers and specialists of enterprises and organizations on occupational safety issues. It was used both in the process of traditional and adaptive training of the specified contingent. The use of the program for adaptive learning turned out to be more effective.

This MLC-program was used for targeted training, retraining and advanced training. The educational material in the program is divided into 6 separate logically completed parts – six MU. From this set of MU, it is possible to create

MLC–programs for various groups of trainees, as well as for various types or stages of training.

The division of educational material into MB for the MLC–program “*Labor Protection*” is presented in Table 1.

Table 1. The list of MB forms the MLC–program “*Labor Protection*”.

№	Name:
1	MU1 Basic provisions of labor law
2	MU2 Legal basis of labor protection
3	MU3 Organization of work on labor protection at the enterprise
4	MU4 Dangerous and harmful production factors and measures to protect against them
5	MU5 Procedure for investigation, registration and accounting of accidents and occupational diseases at work
6	MU6 Assistance to victims of occupational health injuries

The division of educational material within the framework of individual MU into learning elements is shown by the example of MU3 “*Organization of work on occupational safety at the enterprise*” and is presented in Table 2.

Table 2. The list of LE for MU3 from the MLC–program “*Labor Protection*”.

№	Name:	Number of pages
	MU3 Organization of work on labor protection at the enterprise	
3.1	Organization of occupational safety management at enterprises	16
3.2	Ensuring the safe production of works	15
3.3	Rules and instructions on labor protection	30
3.4	Certification of workplaces according to working conditions	26
3.5	Occupational safety training and instruction	21
3.6	Development and approval of documentation for facilities	34
3.7	Documentation on the products used and manufactured	15
3.8	Medical and sanitary provision of workers	30
3.9	Statistical reporting on labor protection	26
3.10	Certification of workplaces	21

In the process of using modular programs, as one accumulates one’s own experience, the emergence of new research results, new methods and techniques for performing work, improving production equipment and labor items, and in recent decades, due to the rapid development of Information and Communication Technologies, Artificial Intelligence, Digitalization of the Economy and almost

all areas of human activity, there is a need to refine the educational material of modular training programs.

3.2 MLC-program for Adaptive Study of the Discipline “Conversion Technology”

It seems very effective to use the advantages of Modular Technologies in creating a Professional Field Model for adaptive study of conversion technology, both in training radio electronics engineers within the framework of the Specialty “*Industrial Electronics*” in Belarusian State University of Informatics and Radioelectronics, and in targeted training, retraining and advanced training of engineering personnel of the corresponding profile.

The educational material on converter technology can be easily divided into separate logically complete parts – MU. It is advisable to compile MLC for each section of the discipline from them, which, in turn, will serve as the basis for the MLC-program for studying the discipline. One of the options for dividing the educational material on converter technology into MU, forming the corresponding MLC from the obtained MU for each section of the discipline program and ultimately obtaining an MTC-program for the adaptive study of converter technology, is presented below.

Considering that the curriculum of the discipline “Conversion Technology” provides for dividing the educational material into two sections, the MLC-program includes two MLCs: MLC1 *Power Electronics*; and MLC2 *Information Electronics*.

Table 3 presents one of the possible options for dividing the educational material into separate MUs within the framework of MLC1 *Power Electronics*. Table 4 presents one of the possible options for dividing the educational material into separate MBs within the framework of MTC1 *Information Electronics*. The successful application of the specified MLC programs in the educational process, including for the adaptive study of the discipline, is possible provided that all educational elements and methodological materials are developed.

Table 3. The list of MBs forming MLC1 Power Electronics.

№	Name:
	MLC1 Power electronics
1	MU1 Magnetic materials used in pulse technology and their properties
2	MU2 Key elements of pulse technology
3	MU3 Overview of the main types of power converters
4	MU4 Rectifiers, smoothing filters and voltage stabilizers
5	MU5 Pulse regulators of direct voltage (DC-DC converters) without galvanic isolation of input and output

№	Name:
6	MU6 Pulse regulators of direct voltage (DC-DC converters) with galvanic isolation of input and output
7	MU7 Resonant converters
8	MU8 Inverters (DC-AC converters)
9	MU9 Power converter units and control elements
10	MU10 Contents under development

Table 4. The list of MBs forming MLC2 Information Electronics.

№	Name:
1	MU1 Functional units of information electronics
2	MU2 Oscillation generators
3	MU3 Measuring circuits for physical quantity sensors
4	MU4 Contents under development

3.3 Modular Program for adaptive study of electric vehicles

At present, it is very relevant to include a few academic disciplines on studying electric vehicles in the curricula of training radio electronics engineers within the framework of the Specialty “*Industrial Electronics*” in Belarusian State University of Informatics and Radioelectronics (BSUIR). Because electric vehicles are increasingly continuing to occupy their niche in the motor transport market and in society. The teaching staff has defined the structure and started developing a global modular program, based on the MLC concept of the ILO [12,13], for studying electric vehicles. The general MLC-program is designed for a comprehensive study of electric vehicles. It begins with studying their impact on the reflective environment. Then it contains educational material on the device and maintenance and ends with studying the features of their operation. The general global program should contain a few separate, more specialized MLC-programs.

Table 5 presents one of the possible options for implementing the global MLC-program for studying electric vehicles, which includes 14 private MLC-programs. Specialized programs MLC10 and MLC11, each of which must contain the required number of LE and methodological materials, provide the opportunity to study all issues related to the principles of operation, design and application of displays for various purposes in electric vehicles [14].

Table 5. The list of specialized MLC for the Global MLC-program.

№	Name:
	Global MLC – program for adaptive study of electric vehicles
1	MLC1 Environmental impact of vehicles

№	Name:
2	MLC2 Fundamentals of vehicle motion theory
3	MLC3 Vehicle transmission
4	MLC4 Electric vehicles
5	MLC5 Hybrid electric vehicles
6	MLC6 Electric propulsion systems
7	MLC7 Hybrid electric vehicle design
8	MLC8 Peak power supplies and energy storage
9	MLC9 Fundamentals of regenerative braking
10	MLC10 Design principles of OLED displays for electric vehicles
11	MLC11 Design principles of LCD displays for electric vehicles
12	MLC12 Optimization of vehicle transmission
13	MLC13 Features of electric vehicle maintenance
14	MLC14 Features of electric vehicle operation

3.4 MLC-program for Adaptive Study of the Discipline “Circuit Engineering”

The program being developed is intended for adaptive study of material on circuit engineering [15], both in the training of system engineers within the framework of the specialty “*Computers, systems and networks*” in Belarusian State University of Informatics and Radioelectronics, and in targeted training, retraining and advanced training of engineering personnel of the appropriate profile.

The educational material on circuit engineering can be easily divided into separate logically completed parts – modular unities, from which it is advisable to make modules of labor competencies for each of the sections of the academic discipline, which, in turn, will serve as the basis of the MLC-program for studying the discipline. One of the options for dividing the educational material on circuit engineering into MU, forming the corresponding MLC from the received MU for each section of the discipline program, and eventually obtaining an MLC-program for adaptive study of material on circuit engineering in general, is presented in Table 6. Examples of possible division into MU of educational material, necessary for the study of discipline material within the framework of individual MLCs are presented in Tables 7 and 8.

Table 6. The list of MLCs forming for adaptive study of circuit engineering.

№	Name:
	MLC – program for adaptive study of circuit engineering
1	MLC1 Circuit design of logic semiconductor elements of Computers, Systems and Networks
2	MLC2 Circuit design of trigger circuits and elements, memory cells of Storage Devices

№	Name:
3	MLC3 Diagrams of operating nodes and Computer Devices
4	MLC4 Circuit design of analog Signal Processing and Conversion Devices
5	MLC5 Circuits of electronic Oscillation Generators
6	MLC6 Elements of memristor devices. Elements of integrated circuits on Schottky field-effect transistors. Programmable devices. Optoelectronic circuits of logic elements

Table 7. The list of MUs for MLC1 (Circuit design of logic semiconductor elements of Computers, Systems and Networks).

№	Name:
1.1	MU1 Parameters of logic elements
1.2	MU2 Diode-transistor logic
1.3	MU3 Transistor-transistor logic with Schottky diodes
1.4	MU4 Logic gates based on gallium arsenide
1.5	MU5 Transistor logic elements connected by emitters
1.6	MU6 Injection integrated circuit technology
1.7	MU7 Field effect transistor circuit design
1.8	MU8 The content is being developed

Table 8. The list of MUs for MLC2 (Circuit design of trigger circuits and elements, memory cells of Storage Devices).

№	Name:
2.1	MU1 Trigger circuitry
2.2	MU2 Registers
2.3	MU3 Counters
2.4	MU4 Static storage elements of an operational storage device
2.5	MU5 ROM Elements
2.6	MU6 Dynamic memory elements of RAM

3.5 The MLC-program for Adaptive Study of the Discipline “Metrology, Standardization and Certification”

The academic discipline “Metrology, Standardization and Certification” is one of the most important in the training of specialists in the fields of “Information Systems and Technologies”, “Energy Efficiency Technologies and Energy Management” and “Nuclear and Radiation Safety” at the International State Ecological A. D. Sakharov Institute of the Belarusian State University [16]. This discipline is also widely used in targeted training, retraining and advanced training of

engineering personnel and specialists of the relevant profile. Therefore, it became necessary to develop a modular program for adaptive study of this discipline to increase the effectiveness of its study.

The educational material of the discipline can be easily divided into separate logically completed parts (MU). They can be used to create an MLC for all sections of the discipline. The MLC of each section, in turn, will serve as the basis for creating an MLC – program for studying the discipline as a whole.

One of the options for dividing the educational material in the discipline “Metrology, Standardization and Certification” into MB, forming from MB the corresponding MTK for each section of the discipline program and eventually obtaining an MTK program for the adaptive study of the discipline “Metrology, Standardization and Certification” is presented in Table 9.

An example of a possible division into MUs of educational material necessary for studying the discipline material within the framework of individual MLC1 and MLC2 is presented in Table 10.

Table 9. The list of MLCs forming the MLC–program for adaptive study of the “Metrology, standardization and certification”.

№	Name:
1	MLC1 Fundamentals of Metrology
2	MLC2 Measurements of electrical and non-electrical quantities. Measurement automation
3	MLC3 System of Technical Normalization and Standardization of the Republic of Belarus
4	MLC4 National Conformity Assessment System of the Republic of Belarus

Table 10. The list of MUs for MLCs.

№	Name:
	MLC1 Fundamentals of Metrology
1.1	MU1 Interrelation of metrology, standardization and certification
1.2	MU2 General information about metrology and measurements
1.3	MU3 Measurement errors, processing of measurement results
1.4	MU4 Metrological support of measurements
1.5	MU5 The State system of ensuring the uniformity of measurements
1.6	MU6 Reference base of the Republic of Belarus
1.7	MU7 Measurement procedures
	MLC2 Measurements of electrical and non-electrical quantities
2.1	MU1 General measurement issues
2.2	MU2 Measurements of electrical quantities

№	Name:
2.3	MU3 Measurements of electrical and non-electrical quantities
2.4	MU4 Methods and means of measuring resistances, capacitances and inductors
2.5	MU5 Methods of transmission of measurement information (tele-m.). Measurement automation

It should be noted that the highly effective use of MLC–programs, both for traditional and adaptive study of disciplines, is achieved only with the development of all educational elements and methodological materials, which is associated with significant time and material costs.

In accordance with the Ministry of Education of the Republic of Belarus Order No. 411 dated August 28, 2023 “On experimental and innovative activities in the 2023/2024 academic year” [17], the Belarusian State University of Informatics and Radioelectronics implemented the project “Testing the blended learning model in IT specialties (2020–2024)”. This project was based on the course “Metrology, standardization and certification in IT”. Among the implementers of the project was the author of this research work (Paramonov A. I.). The essence of the project was to build a modular course system using ICT, distance learning and MLC approach. Students completed individual modules of the discipline in an independent asynchronous mode under the guidance of a tutor. To identify the level of quality of the educational process and the degree of competencies mastery with the classical and experimental approaches, two focus groups of students were formed. Throughout the course of study, both groups took intermediate tests, monitoring the pace of learning was conducted. For teams of students (selected according to the pace of learning the materials), separate individual learning paths were formed [18]. The results of the project showed that the academic performance in the experimental group was on average 30% higher.

3.6 Some results of the MLC–program “Straw Weaving and Straw Inlay” Application

One of the first and highly successful MLC–programs implemented within the framework of the ILO project BYE/96/M01/FRG “Development of a modular education system in the Republic of Belarus” [10] was the “Straw Weaving and Straw Inlay” program. It served as the professional field model for adaptive training of the unemployed in the Mozyr Department of the Employment Service, Gomel region of the Republic of Belarus.

Training using the specified MLC–program made it possible to reduce the training time of the experimental group of unemployed by almost two times compared with the control group. Most of the unemployed students from the experimental group were very encouraged by the opportunity to study the material on their own, as well as use the acquired knowledge and skills in the manufacture

of straw products as their graduation products. This contributed to a creative approach to learning and the use of acquired competencies in practice.

4 Conclusions

The article shows that the successful development of the economy and social sphere depends entirely on the human resources available in the country, and therefore on the state and level of the education system, and vocational education in particular [19]. The directions of improving the effectiveness of vocational education are analyzed, and ways to improve the quality of adaptive learning through the creation of effective models of the professional field are identified.

Examples of the pilot implementation of MTK programs developed within the framework of the ILO project BYE/96/M01/FRG “Development of a modular education system in the Republic of Belarus” are given [10]. The many years of experience gained by the authors and their foreign colleagues confirm a significant increase in the effectiveness of the educational process when using modular educational materials. The advantages of modular educational materials are even more evident when creating a professional field model for modern adaptive learning based on the ILO’s MTK concept [20].

The main obstacle to the widespread use of adaptive learning systems is their cost. Creating adaptation models, algorithms based on them, and software requires huge expenditures of human resources, financial and material investments. Adaptive learning is very expensive, but it pays off with high quality and efficiency of education, while reducing the duration of training.

A special area where adaptive learning based on ICT and modular ILO technologies is the most effective and, in a certain sense, the only possible and necessary is inclusive education of people with special needs. Originality and value. The research contributes to the understanding that the economic development of both – individual countries and the global economic community as a whole – is possible only based on innovative development of vocational education systems and strict adherence to the Sustainable Development Goals.

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