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CONVERGENCE OF EDUCATIONAL TECHNOLOGIES AS AN IMPERATIVE FOR THE DEVELOPMENT OF INNOVATION COOPERATION IN THE CONTEXT OF CIRCULAR TRANSFORMATION

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The object of the study is the process of convergence of educational technologies as an imperative for the development of innovative cooperation under the conditions of circular transformation. The central element of circular transformations is a person who must quickly react and adapt to changes in the external environment and solve management problems through systematic professional growth. This can be achieved thanks to the introduction of high-quality modern educational technologies, which require both special knowledge of the theory and practice of management, as well as personal development qualities.

To achieve a state of sustainable development, managers making management decisions must quickly respond and adapt to changes in the external environment to solve various management problems. This requires systematic professional growth through the transition to high-quality new educational technologies.

Combining the principles of global cooperation, defining the key imperatives of sustainable development and finding innovative measures of cooperation under the renewed conditions of the circular economy must be based on education.

The main generally accepted indicator of the level of development of any country in the world is GDP. But under conditions of uncertainty and change, the real state of development and progress can be determined using the Genuine Progress Indicator (GPI), which is an integral indicator.

One of the main issues is the determination of the level of sustainable development in the context of circular transformations, taking into account the influence of the level of education and existing approaches to its assessment. If we take into account that the conditions for cyclical transformations must occur, including through raising the level of education and the constant transfer of education into practice, then the inclusion of the Index of the level of education is necessary to calculate the real state of development of any country

Keywords: circular transformations, genuine progress indicator (GPI), convergence, educational technologies, knowledge economy

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1. Introduction

In the last three years, the global economy and society have been accompanied by new crisis phenomena. This is caused, first of all, by the spread and fight against the Covid-19 pandemic, the energy crisis. The consequences of this are an increase in the cost of the most traditional forms of fuel (coal, gas, oil, electricity, nuclear energy), a change

in energy capital flows, a divergence of political and social systems, etc. As a result, there was a decrease in the quality of life of the population of both individual countries and in the world community as a whole, a decrease in the level of education. The way out of the current situation is to use the conditions and principles of circular transformations, which are aimed, among other things, at the consumption of renewable energy. Considering the fact that energy in all

its forms ensures the growth of the economy and well-being, is a factor in achieving sustainable development, a more attentive attitude of consumers to environmental issues and changes in regulatory regulation is also an important issue. Accordingly, world energy demand will change depending on changes in needs and the situation at the global level. This requires a review of the terms of cooperation, a search for the newest relationships between subjects, between educators and practitioners.

Under the current conditions, in order to overcome the crisis conditions of the world economy and achieve a state of sustainable development, the persons who make management decisions must promptly react and adapt to changes in the external environment in order to solve various management problems. This requires systematic professional growth, and for this, a transition to high-quality modern educational technologies, which require both special knowledge of the theory and practice of management, as well as the development of personal qualities. Innovative cooperation, precisely on the basis of the convergence of educational technologies, aims to modify the goals, content, methods, forms of education, and adapt the education process to new requirements. In this sense, education turns into an effective lever of the knowledge economy in an innovative environment, in which you can acquire skills and abilities to independently master knowledge throughout your life and apply it in practical activities.

That is why research into the issues of the process of convergence of educational technologies, as one of the main forms of innovative cooperation, should contribute to the sustainable development of socio-economic relations and is relevant under the conditions of circular transformations.

2. Literature review and problem statement

With the support of the world's largest oil company, ExxonMobil, an analysis of energy development until 2040 was conducted [1]. The results indicate that global energy consumption continues to shift proportionally towards countries where population and economic growth rates are ahead of the world average. According to the forecast, in 2040, countries that are not part of the Organization for Economic Co-operation and Development (OECD) will account for about 70 % of global economic demand. Moreover, the demand of China and India will make up about 50 % of the global energy demand. The rate of growth of energy efficiency is ahead of the rate of economic growth in the OECD countries, which accounts for about 60 % of the world GDP, which makes it possible to compensate for the increase in demand and is traditionally associated with economic growth. The combined share of energy consumption in the US and European OECD countries will decline from about 30 % in 2017 to less than 25 % in 2040. Oil, as before, plays a leading role in the structure of the world energy balance. Natural gas shows the highest growth among all energy carriers and already meets a quarter of all energy demand: these types of energy account for more than 40 % of the additional volume of supply in response to the growth of energy demand.

In some developing economies, coal consumption remains significant, but its share of global consumption is declining below 20 %. Moreover, countries such as China and OECD member countries are switching to more low-carbon energy sources – renewable sources, nuclear energy, and nat-

ural gas. The demand for electricity as a carrier rather than a source of energy is growing approximately three times faster than the total energy demand [1].

On the other hand, the Declaration “Transforming the World”, which was adopted by the UN General Assembly on September 25, 2015, characterizes the main goals of sustainable development (Transforming our world: the 2030 Agenda for Sustainable Development) [2]. The declaration reflects the main general goals until 2030 and short-term tasks for achieving balanced economic, social and ecological sustainable development, as a single system by the countries of the world.

Among other goals, the main, all-encompassing one should include saving the planet's resources. Achieving the set goal is possible, including, if the conditions of the circular economy are met, namely:

- effective use of natural resources;
- processing of secondary raw materials;
- transition from fossil fuels to the use of renewable energy sources.

This is aimed at increasing the life cycle of the product, a high level of its further reuse, including through recovery and recycling. These conditions are an important component of the sustainable development of the world economy [1].

At the same time, education is the driving force for achieving sustainable development, one of the significant factors of both domestic and world economy. A large number of scientific works address this issue. The general opinion of scientists [3, 4] is the statement that through the continuous transfer of education with the acquisition of knowledge and the acquisition of practical skills in society, it is possible to achieve sustainable socio-economic development. The authors of [5, 6] have a different point of view claiming that sustainable development can be achieved through the materialization of education in engineering and technology. It is through combining the efforts of the educational space with practical activities, forming innovative cooperation through the introduction of modern educational technologies, that it is possible to develop the economy. Moreover, an economy capable of being competitive and providing a modern standard of living for the population [6, 7].

In accordance with the task set, modern educational technologies with the introduction of new educational tools are intensively developing in Ukraine. This contributed to the emergence of competition between educational institutions both in the domestic and foreign markets of educational services. The processes of depoliticization, democratization of the educational process, diversification of approaches and methods of teaching and upbringing, contributed to the revival of national consciousness, humanism and pluralism of views, people-centeredness, and the choice of a course for European integration [8].

Among the authors, there is a lack of a single approach to the definition of the concept of “educational technology”. There is a huge number of author schools, innovators who are in constant search under social and humanitarian conditions that change with the change of the external environment [4, 9]. Taking into account the opinion of scientists, it can be noted that educational technology is a way of joint activity of the teacher and the student of education. It is primarily characterized by consistency in the implementation of actions, constant and systematic measurement of the level of educational achievements and the formation of educational qualities. And also, the relationship of the main

elements of technology, which are the purpose, content, forms, methods, means of interaction of the participants of the educational process, the result (systematicity) [10]. However, only the principles of systematization of the main elements of educational technologies under the conditions of circular transformations are not enough to achieve the conditions of innovative cooperation. A separate issue is the process of convergence of the main components of educational technologies.

The needs of the world community and the economy for sustainable development under the conditions of circular transformations of individual countries bring to the fore the deepening of innovative cooperation. Convergence as a process of convergence, convergence (in different meanings), compromise, stabilization [11] of educational technologies is the basis for obtaining special competences throughout life.

Convergence processes are most often found in enterprise management. All this gives reason to assert that it is expedient to conduct a study into the process of convergence of educational technologies as an imperative for the development of innovative cooperation under the conditions of circular transformations.

3. The aim and objectives of the study

The purpose of this study is to determine the role of education in sustainable socio-economic development under the updated conditions of the circular economy based on the convergence of educational technologies. Thanks to this, cooperation between the educational environment and practical activities acquires innovative relationships.

To achieve the goal, the following tasks were set:

- to substantiate the relationship between educational technologies and practical activities under the conditions of circular transformations;
- to create a model of the Genuine Progress Indicator (GPI) taking into account the Education Level Index;
- on the basis of statistical information, forecast the Genuine Progress Indicator (GPI) taking into account the Education Level Index of Ukraine for the period up to 2025;
- to propose a scheme of the process of convergence of the components of educational technologies as an imperative for the sustainable development of innovative cooperation under the conditions of circular transformations.

4. The study materials and methods

The object of our study is educational technologies as an imperative for the development of innovative cooperation under the conditions of circular transformation.

The subject of the research is a set of methodological and scientific and practical recommendations regarding the process of convergence of educational technologies under the conditions of circular transformations.

The study of the relationship between educational technologies and practical activities under the conditions of circular transformations is possible thanks to the use of methods of theoretical generalization, comparison, and logical-structural analysis.

When substantiating the components of the complex model of the Genuine Progress Indicator (GPI), which is

defined by many European countries as an indicator of the country’s real level of development, the methods of comparison, synthesis, analysis of actual data and theoretical generalization are involved.

Thanks to the use of economic and statistical methods of analysis of actual data, the method of forecasting, it is possible to obtain forecast results of the study of the Index of real progress in Ukraine for the nearest period (up to five years).

As a process of convergence, a combination of traditional and innovative technologies through the human-centered orientation of educational technologies, the convergence of educational technologies should reveal the qualities of the individual through personally oriented learning. Thanks to the methods of comparison, synthesis, theoretical generalization, etc. it is possible to obtain research results.

5. Research results of the process of convergence of educational technologies as an imperative for the development of innovative cooperation

5.1. Interrelationship of educational technologies and practical activities under the conditions of circular transformations

The results of the study of the global energy development forecast until 2040 showed that with the growing demand for energy carriers, the structure of their supply will become more diversified. The weight of renewable sources of solar, wind, biological, hydro- and geothermal energy will grow at a faster rate, together with carbon-free atomic energy (Table 1, Fig. 1–3) [1]. At the same time, oil, natural gas and coal will, as before, play a significant role in providing reliable and affordable energy carriers, which are needed all over the world for the further development of the world economy.

Table 1

Analysis and forecast of the structure of energy carriers in the world, % [1]

| Types of energy carriers | 2000 | 2010 | 2017 | 2020 | Forercast through 2040 |
|--------------------------|------|------|------|------|------------------------|
| Oil | 36 | 32 | 32 | 32 | 30 |
| Gas | 22 | 23 | 23 | 24 | 26 |
| Coal | 22 | 27 | 26 | 24 | 20 |
| Biomass | 10 | 9 | 9 | 9 | 8 |
| Atom | 7 | 6 | 5 | 5 | 7 |
| Wind/Sun | 1 | 1 | 2 | 3 | 4 |
| Hydro/geo/biofuel | 2 | 2 | 2 | 3 | 4 |

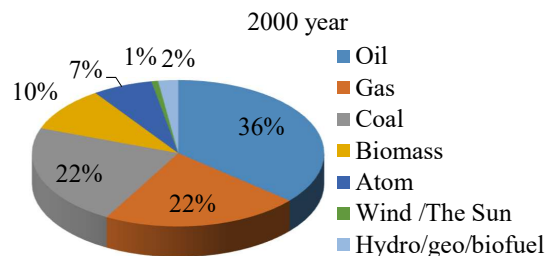


Fig. 1. World structure of energy resources in 2000, %

Undoubtedly, every country consuming energy resources has national characteristics under the conditions of the transition to a circular economy. Solving the issues of effec-

tive use of natural resources, processing of secondary raw materials, and use of renewable energy sources requires the growth of the role of education, interpersonal transformations caused by the latest models of not only work, but also cooperation. This determines the need to train specialists whose knowledge, practical skills and competences are aimed at obtaining the final result in transitional conditions, namely achieving the goal of sustainable development on the basis of convergence.

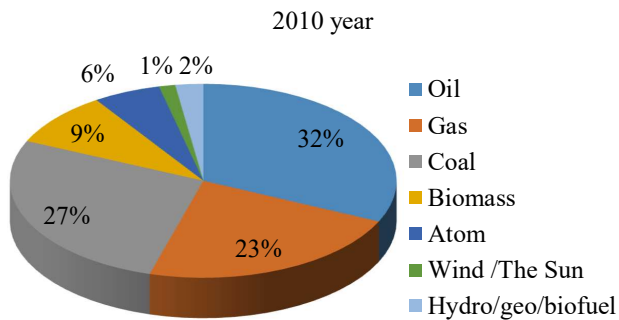


Fig. 2. World structure of energy resources in 2010, %

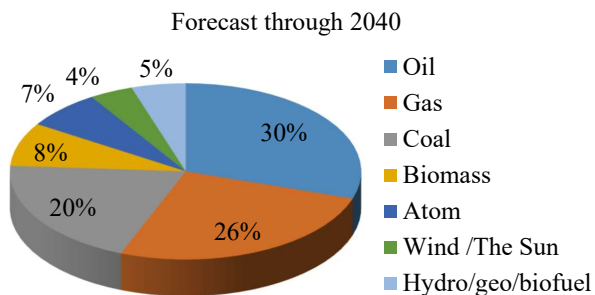


Fig. 3. Forecast of the world structure of energy resources until 2040, %

Summarizing the experience of scientists, the convergence of educational technologies can be represented as a process of convergence and stabilization of traditional and innovative educational technologies for obtaining special competencies throughout life.

Innovative cooperation of the educational environment and practical activity under the conditions of circular transformations requires, first of all, the convergence of the goal. Thus, the purpose of the functioning of the educa-

tional environment is the acquisition of knowledge, skills, and practical skills by an individual and is the basis for the formation of innovative cooperation. The goal of practical activities is to obtain specialists capable of making adequate management decisions in changing economic conditions. Under the conditions of circular transformation, the combination of the goal of the educational environment and practical activities provides an opportunity to formulate the goal of the circular economy as achieving the level of sustainable development of the world economy based on the principles and conditions of circular transformations (Fig. 4).

The convergence of the main components of educational technology, in particular general scientific and specific principles, is aimed at achieving the main goal of the circular economy. The general scientific principles of using educational technologies include: systematicity, efficiency, optimality, algorithmicity, diagnosticity, reproducibility, predictability, hierarchy, etc. Specific principles should include historicism, conceptuality and scientificity, structuredness, controllability, planned efficiency, optimality of costs, the possibility of replication and transfer to new conditions [7, 9]. The convergence of general scientific and specific principles can form the latest principles of educational technologies precisely as an imperative of sustainable development under the conditions of circular transformations. Such principles of innovative cooperation should include: the principle of systemic historicism, reflecting the principles of the systemic nature of educational technologies through the prism of their historical development; scientific validity, when each of the latest educational technologies must be justified from the scientific point of view of the feasibility of its implementation, etc.

Thanks to the convergence of individual components of educational technologies, it is possible to train specialists who are able to adapt and solve complex management tasks under changing economic conditions.

Scientists and practitioners note that sustainable development is inextricably linked to energy consumption [1]. Access to reliable and affordable energy sources is one of the determining factors in raising the standard of living. The imperative of sustainable development and raising the standard of living is education through the introduction of the latest educational technologies, forming innovative cooperation between the educational environment and practical activities.

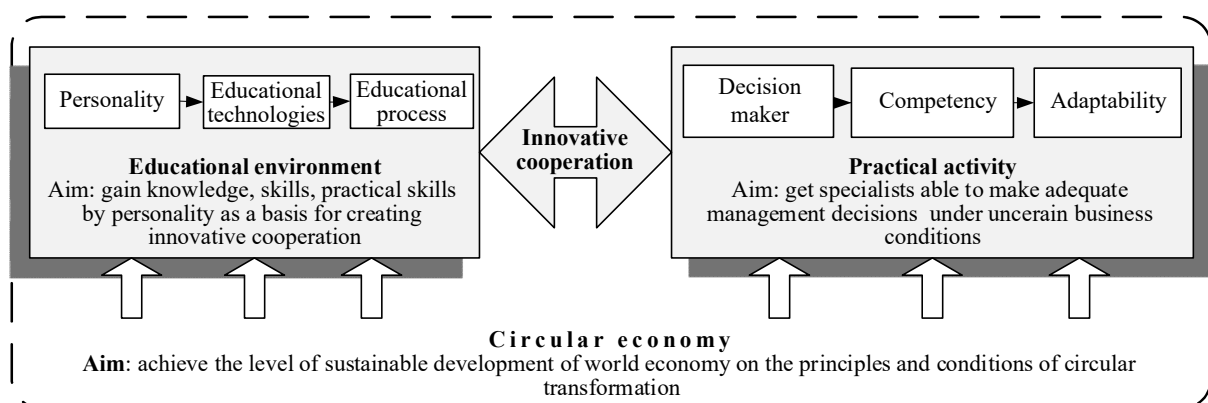


Fig. 4. The relationship between educational technologies and practical activities under the conditions of circular transformations

5. 2. Genuine Progress Indicator model (GPI)

One of the main issues is determining the level of sustainable development under the conditions of circular transformations, taking into account the influence of the level of education and existing approaches to its assessment. Until now, the main indicator of the level of development of any country in the world is GDP, and the well-being of the population - GDP per capita. Moreover, the growth of GDP in a country does not always indicate an increase in the well-being of its population.

In works [12–14], it was determined that under conditions of uncertainty and change, to achieve the real state of development and progress of any country and as an alternative indicator of GDP, there is a Genuine Progress Indicator (GPI), which has as its supporters, as well as opponents. The indicator has a monetary expression, but unlike GDP, GPI is based on the idea of division into categories of benefits and costs, and the summarizing indicator is defined as the difference between them.

The indicator of genuine progress is an integral indicator, the measurement of which makes it possible to more reasonably and accurately assess the system of ecological, economic, and social efficiency of the country's development. Eleven countries of the world (in particular, Austria, Australia, England, Germany, Canada, the Netherlands, the USA, France, Sweden) calculate the GDP indicator using the genuine progress indicator [15]. Of course, it is relevant to include GPI in the system of macroeconomic indicators in Ukraine, which characterize the achievement of economic, environmental, and social goals of sustainable development.

Among the scientists of the world, there are certain debatable questions regarding the advantages and disadvantages of using this indicator. Among the advantages of the genuine progress indicator (GPI) are [12, 13]:

- it is based on a relatively small set of initial components, on the order of twenty-six factors;
- it includes economic, social, and environmental components on an equal footing;
- it takes into account the uneven distribution of income in such a way that it decreases if the poor part of the population receives a smaller than average share of the national income;
- it takes into account such specific components as the cost of housework, or subtracts from GDP such as the losses of society due to the increase in crime or environmental pollution, etc.

The disadvantage of using GPI, according to scientists, include [12, 13]:

- the indicator is generalized; the possibility of its calculation is limited mainly by the availability of the information base of various types of data;
- contradictory and arbitrary nature of the choice of methods of financial assessment of a number of aspects of economic activity, which affects the divergence of the dynamics of GPI and GDP;
- lack of an indicator of quantitative assessment of uncertainties in its current form. The calculation of confidence intervals for the estimation of index values could increase its attractiveness for practical use;

– GPI is by its nature an economic and not an environmental indicator. In order to assess environmental sustainability, it is necessary to use biophysical indicators, etc. in addition to it.

One of the significant shortcomings of the calculation of the genuine progress indicator is the lack of consideration of the educational component in the list of factors, on the one hand, the economic part of the indicator, on the other – social. The conditions for circular transformations must occur, including,

thanks to the increase in the level of education and the continuous transfer of education into practical activity. Therefore, to calculate the real state of development of any country, it is necessary to include the indicator of the Education Level Index. By its essence, the Education Level Index is also an integral indicator and includes such factors as: index of the average duration of education; index of expected duration of education.

The index measures the country's achievements in terms of the achieved level of education of its population according to two main indicators:

- adult literacy index (2/3 weight);
- the index of the total share of students receiving primary, secondary, and higher education (1/3 weight).

The two specified dimensions of the level of education are summarized in the final index, which is standardized in the form of numerical values from 0 (minimum) to 1 (maximum). It is generally accepted that developed countries should have a minimum index of 0.8, although many of them have an index of 0.9 or higher. When determining the place in the world ranking, all countries are ranked based on the Education Level Index (Fig. 5), where the first place corresponds to the highest value of this indicator, and the last to the lowest.

The education level index, although it is a fairly universal indicator, has a number of limitations. In particular, it does not reflect the quality of education itself, which in some cases can be very low or significantly limited. It also does not fully show the difference in access to education due to differences in age requirements and duration of education. Indicators such as the average duration of education or the expected duration of education would be more representative, but the relevant data are not available in the statistics of most states. In addition, the Index does not take into account students who study abroad, which can distort the data for some small countries [15, 16].

The analysis of the Education Index for 2020 (Fig. 5) shows that Germany has the highest education index among the 50 countries of the world (0.946). Among the ten countries – leaders in education level with a value from 0.914 to 0.923, such countries as: New Zealand, Norway, Iceland, Finland, the Netherlands, Great Britain, etc. should be noted. In this ranking, Ukraine occupies only 47th place with the education index level of 0.797. Despite this, Ukraine also belongs to countries with a fairly high level of education [5, 15].

The difficulty of using the Education Index in the calculation of the Genuine progress indicator is as follows:

- obtaining initial data for its calculations;
- choosing the methodology and methods of calculating the indicator and adapting it within the framework of the definition of GPI;
- compatibility of measurement units of the Education Index and the Genuine progress indicator.

The generalized simplified model for determining the Genuine Progress Indicator (GPI) can be represented in the form (1), namely [2, 13, 14]:

$$GPI=A+B-C-D+I, \quad (1)$$

where A is consumer spending adjusted for income distribution;

B – value of non-market services;

C – individual costs for protection against deterioration of the ecological situation;

D – the price of degradation of the natural environment and depletion of non-renewable resources;

I – capital increase and balance of international trade.

Each component of model (1) represents an integral assessment and takes into account a sufficiently large number of fac-

tors. From the foregoing, we define the main factors of the components of the Genuine Progress Indicator (GPI) (Table 2).

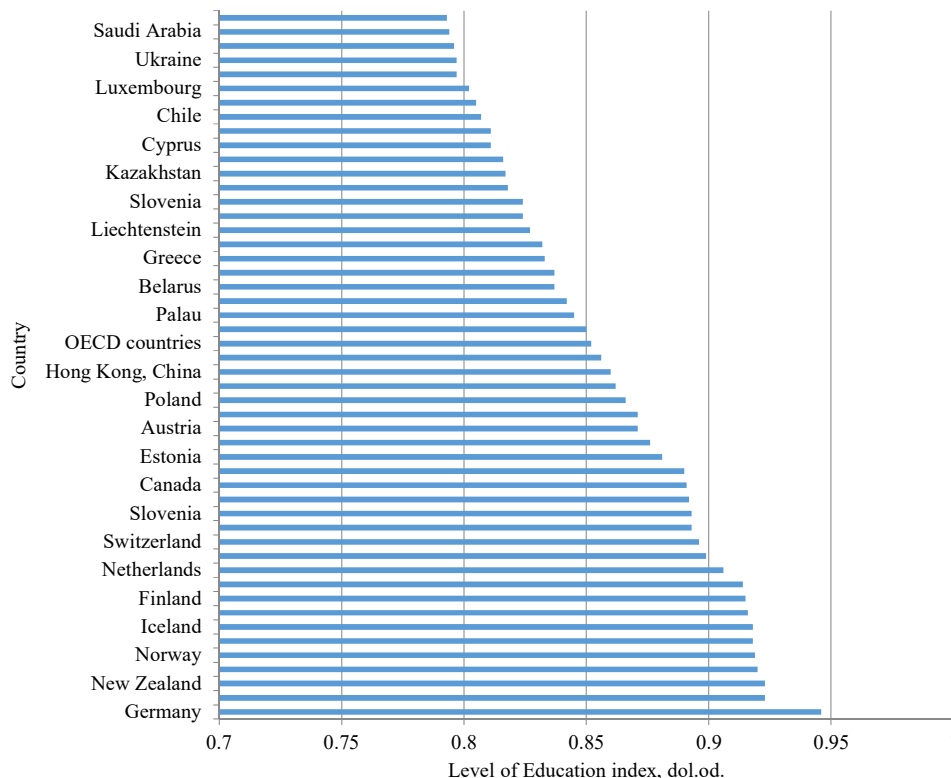


Fig. 5. World leaders in the Education Index

Table 2

The main factors of the components of the Genuine Progress Indicator (GPI)

| No. of entry | Designation | Factor content | The influence of the factor on the generalizing indicator |
|--------------|-------------|--------------------------------------|---|
| 1 | 2 | 3 | 4 |
| 1 | A | Income-adjusted consumer expenditure | |
| 1.1 | a_1 | Individual consumer expenditures | It is the initial value for calculating the GPI and the basis for assessing the welfare associated with the consumption of goods and services |
| 1.2 | a_2 | Revenue distribution | The Gini coefficient characterizes the difference between the real distribution of income and the equal distribution, and varies from 0 (equal distribution) to 1 (one household receives all income) |
| 1.3 | a_3 | Income-adjusted consumption | Adjusted individual consumption expenditure is the base value to which other components of the index are added (or taken from) |
| 1.4 | a_4 | The cost of domestic labor | Domestic work includes cooking, cleaning, childcare, etc |
| 1.6 | a_6 | Use of home capital | The cost of service of household equipment and durable goods available in the household is taken into account |
| 1.7 | a_7 | Durable goods costs | To avoid double counting, the real costs of durable goods are deducted from the GPI |
| 1.8 | a_8 | Use of roads and streets | This service, provided by the state, can theoretically be sold on the market, but the price for the individual consumer is determined |
| 2 | B | The value of non-market services | |
| 2.1 | b_1 | The cost of volunteer labor | Volunteer work is an important contribution to social welfare, it is not included in GDP |
| 2.2 | b_2 | The price of crime | Crime reduces public welfare, both directly (medical costs plus loss of property) and indirectly (costs of crime prevention) |
| 2.3 | b_3 | The price of divorce | Divorce and extra time spent in front of the TV lead to an economic burden on society, while they lead to GDP growth |
| 2.4 | b_4 | Reduction of leisure time | GPI takes into account the loss of free time from overtime |
| 2.5 | b_5 | Unemployment price | The chronically unemployed who have stopped looking for work and those who are forced to work part-time reduce the welfare of society, since unemployment results in crime, mental disorders and drug addiction |
| 2.6 | b_6 | Price of daily trips | Daily commutes result in direct cash costs for personal or public transport plus indirect costs from loss of time that may have been spent in a more useful or pleasant way |

Continuation of Table 2

| 1 | 2 | 3 | 4 |
|-----|------------------------|---|---|
| 3 | <i>C</i> | Individual costs of protection against environmental degradation | |
| 3.1 | <i>c</i> ₁ | Disadvantages of pollution control households | The costs of air filters and waste disposal do not increase well-being but compensate for the externalization of pollution costs during economic activity. They are an attempt to restore the basic level of environmental properties of the everyday environment |
| 3.2 | <i>c</i> ₂ | Price of traffic accidents | The GPI takes into account direct costs (loss of property and medical expenses) plus indirect costs (loss of wages) |
| 3.3 | <i>c</i> ₃ | Price of water pollution | Damage to water quality is a direct loss to public welfare, it is not taken into account in GDP. Estimates underestimated due to lack of data on distributed sources of pollution |
| 3.4 | <i>c</i> ₄ | The price of air pollution | Although air quality damage negatively affects households, infrastructure, the environment and public health, it is ignored in GDP |
| 3.5 | <i>c</i> ₅ | Noise pollution price | World Health Organization assesses noise pollution damage |
| 4 | <i>D</i> | The price of environmental degradation and depletion of non-renewable resources | |
| 4.1 | <i>d</i> ₁ | Wetland loss | The price of ecosystem services provided by wetlands is not included in GDP |
| 4.2 | <i>d</i> ₂ | Loss of agricultural land | Urbanization leads to the loss of agricultural land, which reduces the sustainability of local food supply, undermines the historical and aesthetic values of society and leads to the loss of habitats of biological species |
| 4.3 | <i>d</i> ₃ | Depletion of non-renewable resources | The expenditure of non-renewable resources makes it impossible to use them in the future and is unsustainable. The GPI estimates costs as the cost of replacing with renewable resources |
| 4.4 | <i>d</i> ₄ | Long-term environmental damage | In the GPI, the costs associated with long-term environmental degradation are taken into account as consequences of climate destabilization |
| 4.5 | <i>d</i> ₅ | Destruction of the ozone layer | The depletion of the ozone layer of the upper atmosphere threatens the well-being of all inhabitants of the planet due to an increase in harmful radiation from the Sun. The GPI estimates the expected economic costs of this long-term environmental problem |
| 4.6 | <i>d</i> ₆ | Forest cover reduction | Forest loss means the loss of many of the benefits they provide, including flood prevention, improved air and water quality, biodiversity maintenance, forest products, and aesthetic and recreational values |
| 5 | <i>I</i> | Capital increase and balance of international trade | |
| 5.1 | <i>i</i> ₁ | Total capital investment | To avoid consuming capital as income, society must maintain and increase investment in capital to meet the needs of the population. The purpose of this category is to take into account changes in accumulated capital per employee |
| 5.2 | <i>i</i> ₂ | Total external debts/loans | The sustainability of the economy depends on the level of its dependence on external sources of financing, support for current consumption |
| 6 | <i>EI</i> | Education Level Index | |
| 6.1 | <i>ei</i> ₁ | Average Duration of Study Index | Throughout life it is necessary to engage in self-development to increase economic efficiency |
| 6.2 | <i>ei</i> ₂ | Index of expected duration of study | |
| 6.3 | <i>ei</i> ₃ | Tuition costs | Expenditures for the support and development of education |

Note: compiled by the authors on the basis of [2, 13, 14]

Taking into account the individual factors in the calculation of the Genuine progress indicator (GPI), which are given in Table 2, the components of the indicator can be represented in the form of models, as:

– consumer spending adjusted for income distribution:

$$A = \sum_{i=1}^8 a_i; \tag{2}$$

– the value of non-market services (taking into account the sign of the impact of indicators):

$$B = \sum_{i=1}^6 b_i; \tag{3}$$

– individual costs of protection against environmental degradation:

$$C = \sum_{i=1}^5 c_i; \tag{4}$$

– the price of environmental degradation and depletion of non-renewable resources:

$$D = \sum_{i=1}^6 d_i; \tag{5}$$

– capital increase and balance of international trade:

$$I = \sum_{i=1}^2 i_i; \tag{6}$$

– Education Level Index:

$$EI = \sum_{i=1}^3 ei_i. \tag{7}$$

Taking into account the changes represented by formulas (2) to (7), a simplified model of the Genuine Progress Indicator (GPI) can be given:

$$GPI = \sum_{i=1}^8 a_i + \sum_{i=1}^6 b_i - \sum_{i=1}^5 c_i - \sum_{i=1}^6 d_i + \sum_{i=1}^2 i_i + \sum_{i=1}^3 ei_i. \tag{8}$$

Summarizing the factors of influence of each of the components, taking into account the index of the level of education, it is possible to more realistically assess the de-

velopment (degradation) of the true progress (regression) of a country, including Ukraine.

5.3. Ukraine Genuine Progress Index forecast

Based on the given model (8) and using statistical data, the dynamics of changes in the components of the Genuine Progress Indicator (GPI) in Ukraine, taking into account the Education Index for 2000–2020, are presented (Table 3, Fig. 6). According to the years of the study, the official exchange rate of UAH to the US dollar is: 2000 – UAH 5.44; 2005 – UAH 5.12; 2010 – UAH 7.93; 2015 – UAH 21.84; 2020 – UAH 26.96.

According to the results of our analysis, it is possible to assert that the level of macroeconomic indicators of Ukraine, such as GDP and GPI, is growing. But during 2000–2020 GDP growth is observed at a faster rate than GPI growth. If you look at the proportional change in indicators – components of GDP and GPI over the next five years, you can observe the anticipatory growth rates of GPI taking into account the Index of the level of education in relation to GDP. This may indicate real progress in the country’s economy (Fig. 6).

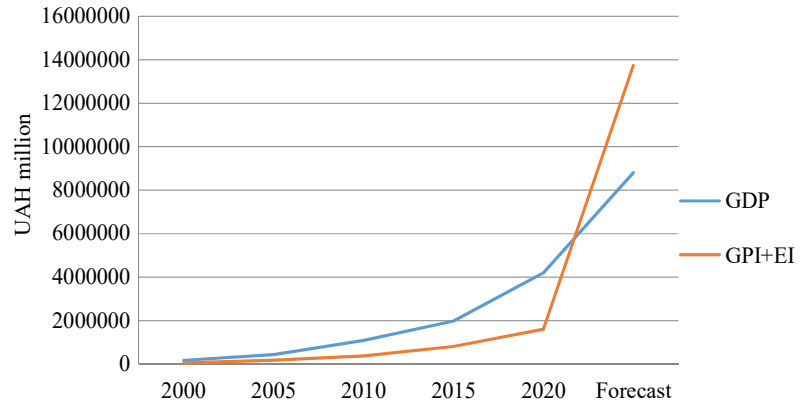


Fig. 6. Dynamics of changes in the level of GDP and the Genuine progress indicator (GPI) taking into account the Education Index in Ukraine for 2000–2025, UAH million

Note: compiled by the authors on the basis of [15, 16]

5.4. Generalized scheme of the process of convergence of educational technologies

Despite the gradual increase in the Education Level Index (EI) of Ukraine (Table 3), which indicates sufficiently high achievements in the field of education, there is a macroeconomic imbalance between the education system and its economic performance. Therefore, one of the priority areas of society is reforming the education system. This is necessary in terms of increasing its quality, economic efficiency, synergy, ensuring fair and equal access to knowledge and harmonization with the best world practices through the proposed scheme of the process of convergence of educational technologies (Fig. 7).

Table 3

Dynamics of changes in the components of the Genuine Progress Indicator (GPI) taking into account the Education Index*

| Year | GDP, UAH million | Expenditure on education, % to GDP | Expenditures on education, UAH million | EI | GPI, UAH million |
|-----------------------|------------------|------------------------------------|--|-------|------------------|
| 2000 | 170070 | 4.17 | 7091.919 | 0.705 | 75070.66 |
| 2005 | 441452 | 6.07 | 26796.14 | 0.765 | 222468.3 |
| 2010 | 1082569 | 7.4 | 80110.11 | 0.784 | 471795.2 |
| 2015 | 1979458 | 5.74 | 113620.9 | 0.796 | 1012164 |
| 2020 | 4194102 | 6.02 | 252484.9 | 0.797 | 2014070 |
| Forecast through 2025 | 8807614 | 6.0 | 528456.9 | 0.798 | 17218886 |

Note: compiled by the authors on the basis of [15, 16]

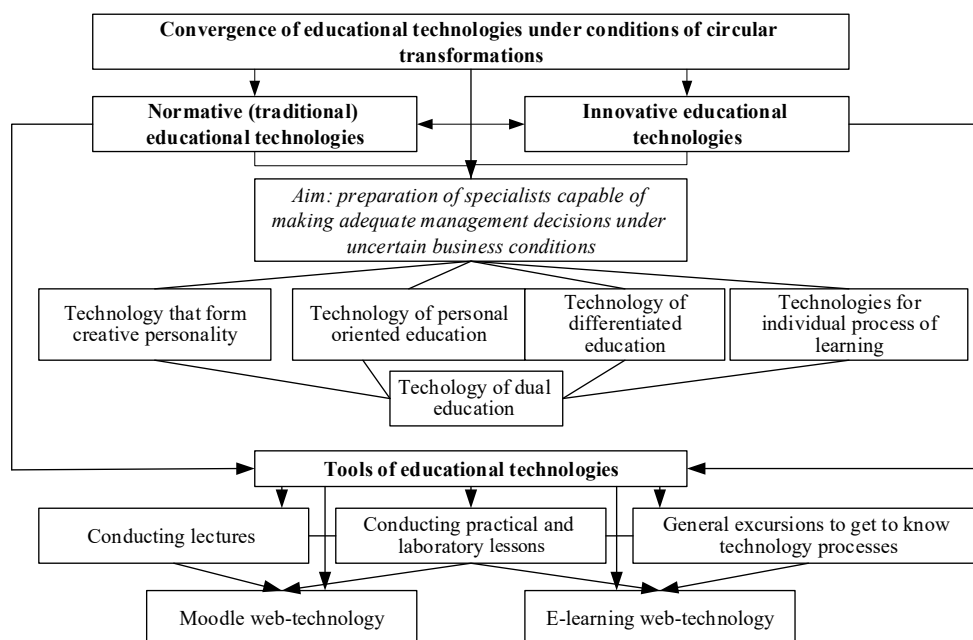


Fig. 7. Scheme of the process of convergence of educational technologies in the context of circular transformations

The basis of the convergence of educational technologies is their convergence, the combination of traditional and innovative technologies. The main task of the human-centered orientation of educational technologies is to reveal the qualities of the individual through personally oriented education. Educational technologies should be aimed at forming a creative personality with differentiated learning [17–19]. The need for the spread of dual educational technology, i.e., focused on the end user in practical activities, is a need under modern conditions to achieve the level of sustainable economic development.

Along with the traditional methods of teaching theoretical and practical direction, the role of independent practical and cognitive activity of the individual, aimed at developing self-control skills in the process of purposeful, organized search for knowledge with the help of web technologies, increased.

6. Discussion of results of the study on the convergence of educational technologies as an imperative of sustainable economic development

As confirmed by the results of the study (Table 1, Fig. 1–3), the global structure of energy use in the forecast period until 2040 will not change significantly. But, taking into account the conditions of circular transformations, thanks to which the secondary use of energy is possible, it is probable that the consumption of traditional energy carriers will decrease with an increase in the share of renewable energy.

But circular transformations have some limitations. First of all, it is related to innovative technologies of secondary energy use, the significant cost of their design, justification, and implementation of the technological process itself. On the other hand, as shown by the analysis of the education index of individual countries of the world (Fig. 5), far from all countries, even in Europe, due to the insufficient level of education, have the opportunity to implement innovative projects. Therefore, the driving force for achieving sustainable development, one of the significant factors of both domestic and world economy is education.

The most widespread macroeconomic indicator of the level of development of any country in the world is GDP, population welfare – GDP per capita. Under the conditions of uncertainty and change to achieve the real state of development and progress of any country, an alternative indicator is the Genuine progress indicator, which has recently been used by eleven countries of the world. The use of this indicator has its supporters and opponents [12, 13].

One of the significant shortcomings of the calculation of the genuine progress indicator is the lack of consideration of the educational component in the list of factors (Table 2), on the one hand, the economic part of the indicator, on the other – the social part. To calculate the real state of development of any country, it is necessary to include the indicator of the Index of the level of education (8), which in its essence is also an integral indicator and includes such factors as: the index of the average duration of education; index of expected duration of study (1) to (7).

Only through the continuous transfer of education with the acquisition of knowledge and acquisition of practical

skills (Fig. 4), forming innovative cooperation, it is possible to develop the economy. It is the process of convergence of educational technologies that is the basis for obtaining special competences throughout life. The convergence of educational technologies under the conditions of circular transformations should be with a human-centered orientation to the disclosure of personality qualities through personal oriented learning (Fig. 7). Educational technologies should be aimed at forming a creative personality with differentiated learning.

The limitations of this study are the difficulty of obtaining objective statistical information for each component of the calculated indicator of the Genuine progress indicator of that and another country, which makes it difficult to compare it. As a result of military aggression in Ukraine, the demographic condition of the country has significantly deteriorated, which limits the determination of the real level of the Education Index.

The disadvantage of this study is:

- sufficient generalization and theoretical character;
- conditionality of determining the forecast level of real progress of Ukraine for the period until 2025, taking into account the Education Level Index. This is primarily due to:

- research limitations;
- the complexity of calculations due to the need for a large sample of data;
- the situation in the country recently.

Despite some limitations and shortcomings of the research, its prospect is precisely in the search and justification of the tools of the process of convergence of specific educational technologies, aimed at the formation and development of innovative cooperation under specific conditions, including conditions of circular transformations.

7. Conclusions

1. It has been proven and substantiated that one of the main imperatives of sustainable socio-economic development is education. In contrast to the existing educational technologies, which are oriented towards theoretical training, the relationship between educational technologies and practical activities was carried out on the basis of convergence as a process of convergence, convergence, compromise, stabilization of educational technologies. The convergence of educational technologies, based on the combination of its individual components, makes it possible to acquire special competences throughout your life, and is aimed at achieving the main goal of the circular economy under the conditions of circular transformations.

2. We have formulated and proposed a model of the Genuine Progress Indicator (GPI) as one of the macroeconomic indicators that characterizes the real level of development and progress of any country. Unlike the existing models, the factors of which are: consumer spending; the value of non-market services; individual costs for protection against the deterioration of the ecological situation, etc., - the proposed model takes into account the Index of the level of education, which is important under the conditions of circular transformations.

3. Based on the proposed model of the Genuine Progress Indicator (GPI), taking into account the Education

Level Index and statistical data that take into account its expected size, the level of real progress of Ukraine for the period up to 2025 is predicted. Despite the fact that Ukraine ranks only 47th among 50 countries in terms of the education index in the world ranking, when determining the Genuine Progress Indicator (GPI) it will make it possible to predict its level more correctly.

4. A scheme of the process of convergence of the components of educational technologies is proposed, as a convergence, a combination of traditional and innovative technologies. Accordingly, it was noted that along with traditional teaching methods of theoretical and practical direction, the role of independent practical and cognitive activity of the individual is increasing. It is aimed at developing self-control skills in the process of purposeful, organized search for knowledge using web technologies.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

The data will be provided upon reasonable request.

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