Designing an Education System for Sustainable Development

Tatiana Matekina*, Marina Soroka, and Valentina Stolyarova

Platov South-Russian State Polytechnic University (NPI), Novocherkassk, Russia

Abstract. This article is aimed at theoretical comprehension of foreign and domestic experience in designing and implementing education for sustainable development and creating a technological model of advanced education in a technical university in the interests of sustainable development. Constructing a technological model that includes an integrated system of pedagogical technologies aimed at the formation of personal achievements and opportunities. Each student constructs and reconstructs their own capabilities based on reflection, which can act as a universal goal of using the models of anticipatory learning technologies, being also the result of anticipatory education. The analysis shows that the transition to sustainable development starts with forming a strategy implemented in education for sustainable development. The study considers the basics of the modern vision of sustainable development: the environmental component and education model. Moreover, the education model is considered from the perspective of the future as a forward-looking education. The paper uses methods of analysis of philosophical, psychological, and pedagogical research and synthesis of theoretical ideas on the problem of conceptualization, design, and modeling, which allowed highlighting the main trends of scientific search in the world and domestic theory and practice of advanced education in terms of its sustainable development. The concept of sustainable development is considered from different positions of domestic and foreign researchers. Experience of education for sustainable development implementation both in Russia and other countries of the world shows that so far, sustainable development in education is represented in the environmental sense; therefore modeling of system concept of education for sustainable development and optimal ways of its implementation is actualized.

1 Introduction

Aggravation of global problems, as well as the increase of negative processes in social-ecological and economic spheres in the modern world, may cause a catastrophe of planetary scale. Therefore, the methods and means of dealing with global crises should aim to anticipate or prevent the effects of local social, environmental, or economic problems in the world.

* Corresponding author: tan-matekina@yandex.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).
It is all the more relevant to seek collective action for the elaboration of the social development strategy. In 1983, the International Commission on Environment and Development was established by a UN General Assembly resolution. As a result of the work of this commission, a sustainable development strategy was defined that integrated several components of the environment, namely nature, society, and ecology.

The concept of sustainable development in its modern meaning was first formulated in 1987 in the report of the International Commission on Environment and Development "Our Common Future" (Brundtland Commission, chaired by the Norwegian Prime Minister Gro Harlem Brundtland).

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs". [1] This definition of sustainable development has become the most common since its actual adoption at the UN Conference on Environment and Development in 1992 in Rio de Janeiro. [2]

In this sense, sustainable development is understood as development in the socio-economic sphere that does not harm the natural environment. That is why there is a growing interest in global education in designing models and integrated systems to anticipate and correct negative trends in developing global world problems.

The essence of sustainable development for teachers is to move from the trivial transfer of knowledge and skills to building human capacity to live in a rapidly evolving world, to act thoughtfully in real-time, and to anticipate actions in the context of the conservation and sustainability of the biosphere.

It should be noted that sustainable development implies the provision of equal opportunities to meet the needs of humanity, also taking into account the developmental gradient of each individual in his or her pursuit of a life of dignity. Education for sustainable development must be a lifelong process, with both formal and non-formal education activities orienting teachers towards sustainable development.

Sustainable development is not just one of the new global problems, but a planetary and civilizational super problem, the solution of which will determine the future of all mankind, its fate in the third millennium. This is both a problem and in its solution - a completely new form (model) of development of the entire world community, which is becoming on the path of its survival and reduction of existential risks. [3]

The goal of sustainable development is the survival of humanity as a whole and improved quality of life for every individual. The key question of the concept of sustainable development is how to live to preserve the world for present and future generations.

2 Research Methodology

Research Subject. The implementation of mathematical training as an element of the system of advanced education in a technical university reveals a number of problems. The necessity of transition to the methodology of advanced development has appeared; accordingly, it has become urgent to design a technological model including an integrated system of pedagogical technologies aimed at forming personal achievements and opportunities. There was a need to create an algorithm defining the tactics of restructuring the pedagogical process into an integrated system of pedagogical technologies to optimize learning outcomes.

Research Problem. The revealed contradictions defined the topic of the present study, the problem of which is to develop a technological model of advanced mathematical training in a technical university.
The aim of the study is to justify the conceptual foundations and modeling of anticipatory pedagogical technologies of mathematical training of students of a technical university.

Experiment Methods. In our research, we used methods of analysis and synthesis, which allowed us to highlight the main trends of scientific search in the world and domestic theory and practice of advanced education in terms of its sustainable development.

3 Findings

The 70th UN General Assembly Sustainable Development Summit (SDGs) in September 2015 adopted the 2030 Agenda for Sustainable Development, which included the new 17 Global Sustainable Development Goals (SDGs). According to UN leaders, the adoption of the official document "Transforming our world: the 2030 Agenda for Sustainable Development", marks a new historic stage in the transition to SD of the entire world community. [4]

Among the SDGs, Goal 4 was singled out: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all".

This goal is presented as a new vision for world education to transform lives through education, recognizing the important role of education as a key driver of development and the other goals proposed by the SDGs.

Incorporating education for sustainable development into educational disciplines will equip people with knowledge and skills for sustainable development, enhancing the quality of life in a rapidly changing world. Teachers, in this sense, have the important task of integrating sustainable development issues into the subjects they teach, designing and implementing pedagogical systems that promote education for sustainable development. Educational tools and teaching aids that incorporate ideas of education for sustainable development need to be made available.

The problem of training specialists possessing knowledge in sustainable development faces almost all educational organizations of formal and non-formal education. Higher education institutions have a special role to play here. In modern conditions, universities have a huge intellectual resource, can take the main role in preparing to address such national challenges as the transition of society to sustainable development, and have the opportunity to provide a harmonious transformation of the traditional model of education in the system of education for sustainable development, based on interdisciplinary knowledge, based on an integrated approach to the development of society, economy and the environment. [5]

It is important to define the concept of sustainable development, which will be implemented in education. The process of training and education can be considered as a way of pedagogical systems functioning, the content of which is the management of human development, when in the process of learning activities, a new type of person is formed, who understands the expediency and necessity of his actions, is capable of self-management and self-development, can predict and assess the consequences of his activities in the future on the environment. In this sense, advanced education will help to focus on creating a future in which humanity develops inextricably with the preserved natural environment.

Education becomes forward-looking when it is based on the consideration of a person who is able not only to realize the way to achieve the goal but also to determine the possibilities of personal development in this way. The main cause of personality development is not external, but an internal one, as a transition from awareness of one's abilities in terms of increasing the complexity of tasks to be solved.
Thus, anticipatory pedagogical technologies should be built on the consistent construction of human capabilities to a given level of complexity. Each student constructs and reconstructs their own capabilities based on reflection, which can act as a universal goal of using the models of anticipatory learning technologies, being also the result of anticipatory education. In this case, the following algorithm of transition of alignment of one's own capabilities takes place: level 1 - experience, level 2 - intuition, level 3 - meaning, level 4 - sense. Reflexion determines the possibility of transition from one level to another.

The design and implementation of creative actions, while moving to the solution of tasks of a higher level of complexity, allows approaching the set goal, taking into account the methodology of anticipatory education.

Education for sustainable development is now considered as a pedagogical system capable of raising a new kind of mindset. A person with this type of thinking has an enormous potential of perception and processing of information, the task of teachers is to form a creative activity in education, which allows them to learn and transform the world and themself in harmony with the environment. Self-knowledge, as a manifestation of intelligence, contributes to personal self-improvement. The process of developing intelligence involves the development of reflection.

Reflection in the pedagogical process is a rethinking of the state of self-development. If any kind of reflection is activated (intellectual, personal, cooperative, communicative) participants in an educational situation not only observe their own and other people's behavior but also analyze their own cognition, behavior, and understanding of this behavior by other people.

When using reflexive methods, assessment is a natural process that involves self-assessment and evaluation of the actions of other participants primarily through multiple marking, given their variability and anonymity. A person understands by his own feelings whether he likes what he is doing or whether he should change his behavior.

Schroefer G., Wrenger K., Lindemann I. note in their study that "the majority of students perceived the experience of classes with "reflection" positively and would like to work more often in this format", with this approach to learning "In the German-speaking world, the focus of education for sustainable development is the competencies of systemic thinking and evaluation, which condition the readiness for action". [6]

The social self-development of an individual on the basis of his/her ability to reflective activity guarantees him/her independence and free realization of his/her rights and duties.

4 Discussion

Summarizing our theoretical research, we consider Education for Sustainable Development (ESD) as a new educational system proposed from the position of advanced education, designed to educate a person with a new type of thinking, which will allow bringing the rapidly developing world in line with the opportunities of the environment. Here is an analysis of theoretical research in education for sustainable development implemented in Russia and abroad.

The relevance of education for sustainable development requires international action. At the same time, the effectiveness of the Education for Sustainable Development strategy depends on support from various governments.

In our country, the first steps in the implementation of the idea of education for sustainable development were the parliamentary hearings of the State Duma of the Russian Federation "On the participation of the Russian Federation in the implementation of the Strategy of the UN Economic Commission for Europe for Education for Sustainable Development". (2006 r.)
Currently, there is an active research work of Russian scientists in this direction (S.V. Alekseev, N.F. Glazovsky, N.J. Dagbaeva, D.S. Ermakov, A.N. Zakhlebny, D.N. Kavtaradze, V.B. Kalinin, N.I. Koryakina, N.S. Kasimov, O.L. Kuznetsov, N.N. Marfenin, N.P. Tarasova, A.D. Ursul, G.A. Yagodin et al.). The National Education Strategy for Sustainable Development in Higher Education in Russia and the Action Plan for the Formation and Development of Education for Sustainable Development in the Russian Federation, ed. N. S. Kasimova (2008).

In 2017, Russia issued presidential instructions to the government that state "to include in the federal state educational standards requirements for mastering basic knowledge in the field of environmental protection and sustainable development (...)".

On July 14, 2020, the first Voluntary National Review of the Russian Federation's achievement of the UN Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development (Agenda-2030) was launched at the UN High-Level Political Forum on Sustainable Development. Head of the Ministry of Economic Development of Russia Maxim Reshetnikov presented the review; according to him, now the task of maintaining employment and income of Russians is in the foreground. "This is directly linked to achieving the goal of "Decent Work and Economic Growth" [SDG 8]. To this end, measures to support the population are already being implemented, as well as a nationwide action plan has been developed to ensure the recovery of employment and income, economic growth, and long-term structural changes," said the head of the ministry.

The work of Yagodin G.A., Argunova M.V., Plyusina T., A., Morgun D.V. named "Environmental Education for Sustainable Development as a Supra-Subject Area of Modernization of School Education" highlighted the features of traditional and innovative education (education for sustainable development), considering education for sustainable development - not as a new subject in the curriculum, but a change in approaches to education.[7]

A.L. Romanovich and A.D. Ursul, in their monograph "Sustainable Future (Globalization, Security, Noospheregenesis)" in the chapter "Formation of Mind Sphere Through Sustainable Development: Science, Education, Noosphere Intellect," emphasize that the process of futurization of education and other spheres of socio-natural activity will lead to the formation of the noosphere, information-ecological society. Using the notion of "advanced education," A.D. Ursul notes that "the model of advanced education turns out to be consonant with the idea of noosphere formation, as it means not the lag of consciousness from being, and education - from life, but their anticipation". A forward-looking education aims at the creation of a desirable future. [8]

Concerning education for sustainable development and its implementation in other countries of the world, scientific research in this direction of formation of education for sustainable development is quite active, especially in Europe. [9] It is important to analyze and integrate the theoretical and practical experience gained in this field into a single educational system.

The experience of European countries on the transition to sustainable development is relevant since it allows us to complement and clarify some traditional provisions of the concept of sustainable development, taking into account current trends. [10]

However, the studies of education problems for sustainable development have shown that in Russia, their solution does not fully correspond to the global trends. [11]

From the review made by Nelya Rakhimova, the founder and head of "Open School of Sustainable Development", we see that "so far Russia lags behind the international community in development and implementation of ESD, which is noticeable by the involvement of Russian organizations and initiatives in international dialogue on these issues. This is why there is a need to create an educational system that can both teach ESD skills and inform about the latest trends in the field" [12]. [12]
Thus, the implementation of education for sustainable development in the world is manifested in the development of the educational system, its improvement, and modernization in accordance with modern requirements.

As part of this strategy, we experimented with the implementation of a set of anticipatory technologies in the study of mathematics. The objectives of the experimental work were: modeling algorithms of learning activities, depending on the level of initial mathematical training of students; designing together with students the algorithm of advanced learning, involving a creative start.

Practical results of our research conducted among the first-year students of a technical university show that approbation of the anticipatory technologies as an integrated system with the inclusion of creative elements provide the anticipatory adaptation of the first-year students to the successful continuation of educational trajectory. The performance criteria were determined as follows: creativity in solving the tasks proposed both in the course of current classes and in testing conditions; presence or absence of higher-level tasks in the blocks of tasks formed according to the topics; the presence of the supposed search for non-standard solutions based on standard algorithms.

The integrated system of anticipatory technologies used in the research work is multidimensional and focused on individual-psychological features of students, which shows the anticipatory aspect of learning.

According to the results of the questionnaire, which included questions on the formation of some competencies, conducted before the experiment and after it, we note that not only the educational level of students has increased, but also qualitative, in terms of formation:
- system thinking competencies: the ability to establish interrelations, analyze complex systems, predict their performance in different conditions;
- critical thinking competencies: the ability to question established rules and norms, to critically reflect on one's views and actions, to defend one's position in the context of sustainable development;
- teamwork competencies: the ability to learn from others, to understand and respect other people's point of view;
- self-awareness competencies: the ability to critically examine one's own role in the immediate environment and in society.

5 Conclusion

When systematizing the above-mentioned, we shall highlight several major trends characteristic of foreign and domestic scientific research on the topic of education for sustainable development:
- methods of analysis of philosophical, psychological, and pedagogical research and synthesis of theoretical ideas on the problem of conceptualization, design, and modeling allowed us to highlight the foundations of the modern vision of sustainable development: the environmental component and the model of education. Moreover, the education model is considered from the perspective of the future as a forward-looking education.
- Education for sustainable development is considered as a pedagogical system capable of raising a new kind of mindset. A person with this type of thinking has an enormous potential of perception and processing of information, the task of teachers is to form a creative activity in education, which allows them to learn and transform the world and themself in harmony with the environment.

The identified trends determine the leading principles of research in the field of education for sustainable development, to which we refer interdisciplinarity and practice orientation. Implementation of these principles in research in the field of the theory and practice of education for sustainable development will allow forming a holistic perception
of the ideas of sustainable development as the main strategy for the development of modern society.

References

1. A. D. Ursul, T.A. Ursul, Sociodynamics 4, 1 (2016). DOI: 10.7256/2409-7144.2016.4.18218
2. Rio Declaration on Environment and Development 1992. http://www.un.org/ru/documents/decl_conv/declarations/riodecl.shtml
3. A.A. Tokarev, The role of sustainable development in the education system in Russia. Research by young scientists: II International scientific. conf., ed. I.G. Akhmetova et al., Kazan: Young Scientist, 62 p. (2019)
4. Transforming Our World: The 2030 Agenda for Sustainable Development. https://sustainabledevelopment.un.org/post2015
5. T. N. Kovaleva, Education for sustainable development: information and analytical review, Moscow State University of Economics named after A. D. Sakharov, 103 p. (2007)
6. G. Schrufer, K. Wrenger, I. Lindemann, Educational Studies Moscow 2, 152 (2020). DOI: 10.17323/1814-9545-2020-2-152-174
7. G.A. Yagodin, et al., Environmental education for sustainable development as a supra-subject area of school education modernization, Moscow Department of Education, Gos. autonomous educational institution of higher, prof. Education "Moscow Institute of Open Education" (MIOO), Moscow: GAOU VPO MIOO, 334, (2012)
8. A.L. Romanovich, A.D. Ursul, Sustainable future (globalization, security, noospherogenesis), 512 pp. (Moscow: Life, 2006)
9. Sustainable Development Action Plans. http://www.sd-commission.org.uk/data/files/publications/SDAPGuide.pdf
10. Education for Sustainable Development: Experience of Eastern Europe, Russia and Central Asia, ed. N.S. Kasimov. M., 2008; Empowering educators for a sustainable future. http://www.geogr.msu.ru/science/projects/our/docs/index.php
11. N. D. Guskova, E.A. Neretina, T.A. Salimov, St. Petersburg State Polytechnical University J. Humanities and Social Sciences 1(215), (2015)
12. Education for sustainable development: 30 years later. Plus-one. https://plus-one.ru/society/obrazovanie-v-interesah-ustoychivogo-razvitiya-30-let-spustya