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О РОЛИ МАТЕМАТИЧЕСКОГО ОБРАЗОВАНИЯ В УСТОЙЧИВОМ РАЗВИТИИ

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Аннотация

В статье анализируется место образования в решении проблем социально-экономического характера в обеспечении устойчивого развития в последние декады. В этом контексте выделяется роль математического образования и изучается основные направления вовлечения математического аппарата и методов в обеспечении устойчивого развития на основе опыта передовых стран.

КЛЮЧЕВЫЕ СЛОВА: устойчивое развитие, образование, математическое образования для устойчивого развития, математические методы, курикулум.

ON THE ROLE OF EDUCATION OF MATHEMATICS IN SUSTAINABLE DEVELOPMENT

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Abstract

Paper is devoted to the analisys of place of education in resolving of socio-economic problems in ensuring sustainable development in the last decades. In this context the role of mathematical education is marked out, as well as it was studied the main directions of involvement of a mathematical apparatus and methods in ensuring sustainable development on the basis of experience of the advanced countries

KEYWORDS: sustainable development, education, mathematical education for sustainable development, mathematical methods, curriculum.

Today's interrelated global challenges and risks demand new holistic approach to the role of education being an effective catalyst for building a better and more sustainable development of our world. According to the wide-spread definition of sustainable development, it is due to cover the needs of the present without compromising the ability of future generations to meet their own needs.

In this regard the main priorities of activities within education for sustainable development (ESD) were initially reflected in the well-known declaration of the United Nations Decade of Education for Sustainable Development in 2005. Afterwards in 2014 when the UN Decade came to end, UNESCO developed a Global Action Programme on Education for Sustainable Development. Being a follow-up to the Decade, the Global Action Programme was formulated as tangible contribution to the post-2015 development and education agendas. This document with a detailed implementation of Roadmap was endorsed by the UNESCO General Conference in 2013 and launched

at the World Conference on Education for Sustainable Development in Aichi-Nagoya, Japan (November 2014).[1,2].

There is nowadays a growing international recognition of ESD as an integral element of quality education and a key enabler for sustainable development. So it's not surprising that Sustinable Development Goals **(**SDGs) adopted by the global community for the next 15 years also include ESD in the targets.

It's doubtless fact that twenty-first-century livelihoods require critical thinking, problem solving, and relevant content knowledge like environmental and climate change education, disaster risk reduction and preparedness, sustainable consumption and lifestyles, green technical and vocational education and training. Nowadays empowering learners to contribute to sustainable development helps to make education more relevant and responsive to the contemporary and emerging challenges. For instance, Rio+20 Conference's focus on a green economy calls for seizing opportunities to advance economic and environmental goals simultaneously. Consequently, contemporary education should assist in the process of shifting the global demand away from resource- and energy-intensive commodities and toward greener products and technologies, less pollution, and sustainable lifestyles. Moreover, restructuring toward a green economy will require transferable skills, those that are not necessarily linked to specific occupations. Hence thinking critically, solving problems, collaborating, and managing risks and uncertainty are core competencies that are critical for employment in a green economy and living together peacefully in a sustainable society [3, 4]. Despite these advances, the role of education, unfortunately, continues to be seen as secondary to other priority issues such as the green economy, natural disasters, climate change etc. However, given the world's limited natural resources, rising population, and the looming challenge of climate change, sustainable development cannot be attained without education that equips learners with the skills needed to live healthy, safe, and productive lives in the 21st century, while also safeguarding the ability of future generations to meet their own needs.

In the light of the Rio+20 Conference if we have a look at the list of actual global challenges such as climate change, protection of biodiversity, tackling pollution, controlling epidemics, ocean sustainability, averting natural disasters, particularly manmade ones etc. we could conclude that they mostly subject to basic sciences. More detailed scientific analyze of these challenges shows that they all subject to various differential equations, i.e. mathematics [5].

Moreover, nowadays the main field of the economy such as transport, communication networks, the internet and business transactions are all practical applications of researches in mathematics, concretely graph theory and number theory, as well as the energy, other resources efficiency, cleaner production issues are practical application of various mathematical theories such as linear optimization, mathematical modeling etc. For energy sustainability alone, mathematics has much to contribute in finding better and less polluting ways to explore for new energy, in increasing combustion efficiency, in the development of alternative energy, in the management of energy grids and networks, and in minimizing the climate consequences of energy use. For sustainability of financial markets and economic systems, the role of mathematics is equally ubiquitous and essential.

Regarding the close interrelation of mathematics and sustainable development one may find in the paper [6] the correlation of two components of sustainability such as profitability and compatibility on the base of an abstract model of the system, where the first component takes into account only the socio-economic compartment of sustainability, while another is concerned with the environment aspects. It was proved in strong mathematics language that the study of these two components of sustainability can be carried out through the bifurcation analysis of the positive attractors of the nonlinear dynamical systems. Nonlinear dynamical systems and attractors theory have been subjects of mathematical researches of a lot of scientists during last thirty years all over the world.

Moreover, on the other hand, it’s well-known that the Earth itself is a subject to constant change and almost all related processes, i.e. interior mantle, terrestrial crust, atmosphere anomalies etc. The last frequent earthquakes in Italy and other countries reconfirmed the necessity of enlarging, deepening of the relevant researches in the basic sciences in order to get more profound prognosis knowledge for avoiding of the terrible consequences of such catastrophes. And it’s very essential that the description of these processes in mathematics language requires the relevant knowledge on the mathematical models described again in dynamics systems. Nevertheless only on the base of these modeling approach recreating closer the real processes we could anticipate, make prognosis and control them, as well as eliminate or alleviate their destructive effects in the future.

So it’s not surprising that with support of UNESCO, the International Council for Science and the International Mathematical Union the 2013 year was announced as a year of Mathematics of Planet Earth. It’s once more a pertinent proof of the fact that every phenomena on Earth is subject to

mathematics and mankind has to factor this basic science into any approach tackling the abovementioned challenges.

So resuming the approaches of involvement of mathematics to global challenges of sustainable development we could assert that one of the milestones of this involvement is promotion, stimulation of the relevant mathematical researches in order to identify the major problems facing the planet and their solutions. In [7] the main research directions allocated into four groups:

- A planet to discover, focusing on oceans, meteorology and climate, mantle processes, natural resources and solar systems;
- A planet supporting life, covering issues such as ecology, biodiversity and evolution;
- A planet organized by humans, looking at political, economic, social and financial systems, organization of transport and communications network, management of resources, and energy;
- A planet at risk, covering climate change, sustainable development, epidemics, invasive species and natural disasters.

In addition in [8] we may find very interesting approach and useful information, references on the contribution of mathematics to such aspects of sustainable development as protection of ecosystems services, i.e. food, fiber, fuel, pharmaceuticals, climate mediation, the sequestration of toxics etc.. There was identified a set of mathematical challenges towards achieving sustainability of these services: developing a statistical mechanics of ecological communities, socio-economic systems, and the biosphere; modeling the emergence of an ecological pattern; determining indicators of impending critical transitions between states; developing schemes for robust governance in these multiscale systems.

The paper [9] focused on the problem of educational potential for sustainable development. The authors of the paper came to the conclusion that for the holistic study the ways of further development of the society should be based on the relevant dialectic scientific projects and not only the metaphysical ones like in some western countries.

Even in some countries of Africa in recent years UNESCO organized successful actions in the framework of the “Mathematics of Planet Earth 2013” focusing on mathematics research and education in managing some societal concerns related to the management and eradication of infectious diseases, sustainable management and exploitation of natural resources, secure data transfer through the internet

and mobile telecommunications, desperately-needed solutions in the supply of energy in impoverished regions etc. [10].

The actual paper is devoted the second milestone of involvement of mathematics as well as other basic sciences to global challenges of sustainable development which is raising the quality of education of basic sciences, particularly mathematics education at all levels of education: i.e. from kindergartens programs to bachelors, specialist and master of science programmes.

So it's getting more and more importance to adopt education, particularly in mathematics, at its all levels to global challenges of sustainable development via modernization, enriching the relevant curriculums. This preparation of these curriculums is crucial process in terms of designing of sustainable development outlook of young generation. It should be done by involvement of experienced scholars from various branches of sciences in interdisciplinary and problem-solving manner.

Moreover each country has to check up what its country education looks like by taking the indicators to be used to compare. For example, nowadays it's well-known that the countries like China, Japan, South Korea, Hong Kong, Singapore, India and Malaysia have strong and dynamic economy in the 21st century and one of the most important factors which contribute to these countries to come to the existing position is due to the curriculum that they have designed last decades in mathematics for their young generations. Now China, Japan and South Korea are the top three countries on the 2016 Nature Index, a ranking based on the scientific output of over 60,000 research articles [11]. This is the result of the science and mathematics curriculum they have designed for their competency. So it would be wise to encourage all developing and developed nations who are attempting to progress and bring sustainable development to learn the experience of the mentioned countries.

If we try to resume the crucial ways for change for sustainable development within mathematics education we could list them as encouraging critical thinking; adaptation of curriculum to the challenges, problems of sustainable development; indevelopment of the problem-solving competencies regarding global problems of sustainable; encouraging of practicality, i.e. the ability to apply the knowledge and skills imparted by education to real-time situations; learning through participation in goups in nature problems-oriented events, expeditions etc.

In the same time it's necessary to upgrade the competences of the educators in the relevant interdisciplinary way, because namely they are one of the most important levers to realize educational change and to facilitate learning for sustainable development [12-13]. Thus teachers of mathematics at

all levels have to endeavor to teach and enlighten students about the relevance of mathematics of this science in bringing about a change to issues being faced in economy, environment, and society for sustainable development.

Another very important field of activities is informing the general public of the essential role mathematics has to play. It could be done via the propagation of ideas and information about environment protection, conservation and sustainability; the promotion of the mathematical methods by which specialists of various branches of sciences, technology can contribute to the relevant ; the development and dissemination of specialized, problem-focused knowledge and resources required to underpin the training of professionals active in environmental careers; the preparation of elementary and secondary teachers, university level faculty and wider staff in the field of sustainable development-oriented mathematical education.

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