

Digitalization of Mathematical Education and its Influence on the Formation of Stochastic Worldview through the Development of Probabilistic Thinking Style*

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Abstract. The digitalization in education has started the process of social and economic transformation which has entailed not only cardinal changes in approaches to training, principles of interaction of subjects of educational relations, but also has led to reconstruction of methodical system of schools. As a result, in the system of secondary general education the process of integration of digital educational environment into traditional education is being implemented in order to provide unlimited access to information of any form. The digital environment directly influences consciousness of the person, expanding his cognitive abilities, changing system of values, world understanding and world outlook of the person of schoolboy. In this regard, it is important during school years to develop an "objective" world view of students, designed to help substantiate the cause and effect of the surrounding reality. In our opinion, this is the stochastic worldview formed through the development of students' probabilistic thinking style.

Keywords: digitalization of mathematical education, probabilistic thinking style, stochastic worldview, secondary general education, digital educational environment, digital technologies.

1. Introduction

Modern society is characterized by high speed, an abundance of events and changes that entail states of instability and instability, misunderstanding of oneself, one's attitude towards events and changes. The daily increasing flow of all kinds of information and falling on a person is so great that its constructive perception and analysis in this environment becomes difficult. Therefore, it is important, in the context of the digitalization of mathematical education, to develop in students a probabilistic style of thinking that promotes knowledge of the phenomena around them that cannot be directly perceived. The probabilistic style of thinking is characterized by flexibility, criticality, adaptability, dynamism, ability to act in conditions of uncertainty, is defined by the possibility of designing non-standard patterns of actions, refusal of tradi-

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tional schemes of thinking, harmonious display of interconnected links of the objective world [1].

Analysis of probability and statistical data, ability to make decisions in situations of uncertainty will help students to model natural and social patterns, predict random phenomena and processes. Establishing the probabilistic thinking style of high school students while studying elements of stochastics will allow them to form a complex, structural vision of the world, i.e., to approach such a phenomenon of thinking as stochastic worldview. N. D. Andreeva believes that the scientific worldview of students formed during school years: "under the conditions of the ambiguity and contradictions of the modern world, it may play the role of a 'fulcrum point' in solving a variety of problems, namely, to perform an information-reflective, orientation-regulatory, and evaluation function" [2, pp. 8-9].

The digitalization of the education system defines the application of the newest methods and means of education, construction of individual educational trajectories, influences qualitative change of the content of education and increase of its technological level: possibilities of management and control of the results of education, work in virtual and supplemented reality. Digital technologies provide huge educational opportunities to organize effective learning: instant access to learning applications and materials, work with visual learning tools and electronic simulators, mobile learning technology, virtual and augmented reality technology. A variety of digital technologies used in the learning process: training and simulation programs, information resources, interactive modules, cognitive programs, social services Web 2.0, 3.0, etc., there is a manifestation of them in the form of private individual environments. New educational technologies are aimed at improving the culture of thinking of students, the disclosure of intellectual potential.

In the framework of the national project "Education", which includes such federal projects as "Modern School", "Digital Educational Environment", "New Opportunities for Everyone", one of the main goals is the full-scale digitalization of schools. As a result, the education system is making a smooth transition to the digital era.

Despite the wide spread and introduction of digital technologies among researchers abroad (Bersin J., Janice L, Koole M, Kuiper K., McMurtrie C, Ronald G.) there is no unequivocal point of view on the effectiveness of digital learning, the possibilities to improve its quality, content and control. Fatherland scientists (A.A. Andreev, S.A. Beshenkov, I.P. Gladilina, M.V. Voropaeva, E.V. Minzayeva, A.V. Morozov, S.S. Neustroev, V.A. Pleshakova, I.N. Turkulova, T.S. Shikhnabieva, M.I. Shutikova, etc.) have no unequivocal opinion on the effectiveness of digital learning, its content and control.) are of the opinion that digital technologies have both positive and negative impact on the development of a student's personality, their use in the learning process is carried out spontaneously, and most importantly, the latent nature of information means in teaching is noted. On this basis, the task of research and clarification of the features of the influence of digitalization of mathematical education on the development of probabilistic thinking style in order to form a stochastic worldview of high school students is extremely important.

2. Results

For the modern younger generation, the "children of the digital age", digital technology is a connecting link in the relationship between people, and the virtual world extends their social life. They spend a lot of time on the Internet, not sharing their own identity in the digital and real world, actively use information technology to express themselves, interact with each other, access all kinds of sources of information, resulting in the formation of new knowledge and creative work of a new type. As a result, the functioning of the environment in which human life is intertwined with technology is constantly evolving and improving.

According to J. Palfrey's research: "The children of the digital age fundamentally transform many sectors of the economy, education system and world politics" [3]. This situation generates a lot of problems, including the development of orientation skills in the information space and the formation of a critical attitude towards information. That is why it is necessary to learn how to make samples of qualitative and reliable information, to be able not to give in to manipulation and disinformation. The National Project "Education" provides for the development of students' skills in data processing and analysis, which is closely related to the process of developing the probabilistic thinking style of students in the framework of mathematical education.

Probabilistic thinking style of students contributes to the objective analysis of conditions and situations, the correct interpretation of trends that give rise to their functioning. Skills of statistical information processing are an indispensable condition for vision of integrity and objectivity of the world picture: determination of industrial production index; estimation of living standards of population; analysis of pricing theory; identification of factors influencing economic interest; possibility of establishment of gross regional product volume, etc.

Formed stochastic worldview lays the guidelines for creative and practical activities, helps to create favorable conditions for the development of intellectual potential of the student. The specifics of the stochastic worldview are revealed in its characteristics: "flexibility" of thinking due to the ability to quickly switch attention; improvement of thinking actions and operations (abstraction, analysis, analogy, generalization, concretization, synthesis, etc.); predominance of creativity in the use of elements of stochastics - the ability to use associations to objects, to go beyond the scope of the problem under study, to generate original ideas and apply them in specific tasks. Due to the unique features of stochastic worldview: the formation of a positive attitude to chance, the ability to identify mutually intertwined connections of the world, to predict the behavior of objects in the environment, students will succeed in learning about the world around them, will be able to better navigate in it and adapt (in particular, "adapt") to constant changes in it.

By studying the elements of mathematical statistics, combinatorial science, probability theory, high school students get ideas about the influence of random events on the regularities in the result of the experiments, visualization of which is extremely useful. Thus interactive models, software of cognitive character, board Smart serve as a tool basis at training and allow to reach efficiency of educational process by stimulation of conscious cognitive activity of pupils, as a result of integration of availabil-

ity, memorability and interactivity inherent in the specified means. Digital technologies in the study of the probability-statistical line of a school mathematics course provide access to new sources of information (interactive tables, meteorological service sites, election commissions, sports statistics, etc.). The functionality of statistical application packages (Statistica, Stadia, SyStat, etc.) facilitates fast and accurate processing of statistical information: sorting, grouping of data, and demonstration of results in the form of histograms, diagrams, and polygons. The applied tools and technologies facilitate unconventional organization of classes and other management of the educational process.

In conditions of digitalization of mathematical education the basis of information support is orientation on effective application of information or digital technologies and work in the digital educational environment by creation of optimum conditions of development of each schoolboy's personality. Applied means and technologies increase motivation for learning, allow organizing classes in a different way and managing the educational process. Local, network databases are created for realization of collective forms of work and realization of training courses; development of training programs and computer games (as the tool of diagnostics and rehabilitation) for development of sensory, perceptual and cognitive functions of the person, studying and improvement of thought functions of the person is carried out [4].

The digital environment realized in educational institutions provides new possibilities for display of creativity of the person of the schoolboy, repeatedly raises efficiency of independent work of pupils, realization of essentially new forms and methods of the organization of educational activity is carried out (for example, joint educational, creative and research work in profile network communities and projects; preparation for olympiads and examinations; work with gifted children). The digital environment operates continuously, regardless of the user, is not limited by time or geographical or any other framework, contains huge amounts of data, supports various forms of communication, in particular, interactive communication. Given that the digital environment has a direct impact on a student's mind by changing their cognitive abilities and value systems. In turn, the stochastic worldview is a mechanism that determines the personal position of the student to the world and to himself in this world, and has specific capabilities: building his worldview on the basis of stochastic knowledge, methods and ways of knowing reality, overcoming situations of uncertainty in the conditions of multiple choices, individual adaptation to a constantly changing environment in the direction of further activities.

The multidimensional digital environment and the diversity of its aspects is manifested in the presence of basic tools necessary for its normal operation, and in information and communication technologies and interactive components.

Thus, to achieve the development of stochastic worldview of high school students through the development of components of probabilistic thinking style in the conditions of digitalization of mathematical education can be achieved through the implementation of a holistic, comprehensive organization of educational process: intellectual and sensory knowledge of reality and its practical development. A triadic system of principles based on the ideas of synergy [1, pp. 249-250] was introduced into the theory and practice of mathematics education by the example of studying the stochas-

tic line using digital technologies. The study used the following triad of principles: problems - clarity - flexibility and adaptability of organizational structure; saturation of educational environment - individualization and personalization of educational routes - intelligent control.

The principle of problem solving is aimed at the development of both intellectual and motivational spheres of activity, as well as at the formation of thinking abilities, cognitive needs and high independence of students, carries a pattern that leads to the comprehension of early experience, to the familiarization with knowledge and methods of creative activity. In turn, the principle of clarity in learning the elements of stochastics eliminates ambiguity and impedes the implementation of a linear gap of semantically related components. The principle of flexibility and adaptability of the organizational structure is responsible for the implementation of various options for building an individual educational strategy depending on the personal characteristics and capabilities of the learner. The principle permeates all aspects of the educational process: content, forms of organization, methods, technologies and means of learning. Adaptive learning system is aimed at qualitative changes of individual features and abilities of students, favors the strengthening of the speed of thought processes, increasing the level of knowledge and skills, work capacity, the level of cognitive and practical activity in educational activities, etc. The principle of flexibility is designed to respond quickly to changes in the content of learning, taking into account the needs and interests of students, constantly changing requirements of the educational paradigm. The adaptive digital educational process, which includes a system of diagnostics of individual learning styles and strategies, automatically adjusts to the needs of each individual student, provides an opportunity to create unique educational programs that adapt and adapt to the psychological and pedagogical features (determining the order, method and pace of presentation of educational material, the level of complexity of tasks, identifying the level of knowledge and skills, diagnosis of shortcomings in understanding, pedagogical assistance and advice, etc.). This principle is inherent in an effective restructuring of the educational structure: multilevel, multifunctionality, multistage.

The principle of saturation of the educational environment brings redundancy of resource opportunities when choosing elements of the content of educational material and the level of its development [5]. Such resource redundancy is created in the uniform information educational environment filled with components of the probability theory and mathematical statistics. The principle of individualization and personalization of educational routes allows organizing the educational process in such a way that it was directed to the formation of creatively active, initiative-organized personality of a student as a result of the development of probability thinking style, social and communicative abilities, intellectual abilities. The learning digital environment helps to implement, build an individual educational route for the development of a student's personality and adjust it through the use of automated learning, testing, and supervisory systems. The principle of intellectual management characterizes the management of a complex technological process. This principle is based on the elements of artificial intelligence, in particular, the active use of modeling or virtual reality models;

planning of trajectories of movement in the information environment; recognition of images by external information; diagnostics of the system status.

3. Conclusions

Experience in the use of digital technology: interactive models, software, interactive panel Smart, when studying the elements of stochastics shows that their use is characterized by clarity and interactivity, promotes not only visual perception, but also the organization of problem-search activities, activates cognitive interest in the subject, increases the efficiency of learning. Thus, training of mathematics (on an example of a stochastic line) in the general school, carried out with application of specially selected (developed) means of educational digital technologies, allows to raise level of formation of stochastic world outlook of high school students by development of components of probabilistic style of thinking: logic, intuition, creativity, criticality of thinking.

Digital technologies, on the one hand, increase productivity and efficiency, and on the other hand, promote the use of unique means of learning and implementation of individual approach. Their rapid development and improvement is directly related to constantly updated software, characterized by the construction of complex processes in three-dimensional space. For example, in many schools, students are able to see and apply in practice the functionality of 3D printing, individual parts made on this device, sometimes problematic to get in the traditional production.

Digital technologies arouse interest in their use in learning not by themselves, but only as a tool for learning the world around them and solving various tasks. It is impossible to do without them in the modern reality.

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