International Journal of Instruction *April 2022 ● Vol.15, No.2*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 1057-1074

Article submission code: 202108101401
Received: 10/08/2021 Revision: 23/12/2021
Accepted: 18/01/2022 OnlineFirst: 24/03/2022

Improving the Efficiency of Mathematics Education through the Development of a Stochastic Worldview of Students

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This research is about developing stochastic worldview formation among high school students (grades 10 and 11) based on integrating scientific approaches, namely, information and technology, interdisciplinary, system, and activity approaches. Developing the structural components of a stochastic worldview, such as motivation–value relations, intuitive–figurative perception, and rational–logic acceptance, determines the most effective way for students in grades 10 and 11 to form a worldview when teaching stochastics. The research site was School Gymnasium No. 11 in Yelets, located in the Lipetsk region. Tests, questionnaires, and documentation were used as data collection methods. The methodology of data analysis included descriptive statistics. According to Fisher's angular transformation criterion (φ), the validation of the experimental data confirmed the research efficiency. This study showed that the proposed tool improves students' motivation, value, and worldview constructs, guiding them to understand the stochastic component of the world around them.

The results complement the methodological and methodical features of math education, which aims to develop helpful worldview qualities of students. These results can be beneficial for methodical science since, with their help, it specifies the known approaches, ideas, methodological means in mathematics education, and upbringing of high school students.

Keywords: stochastic worldview, math education, digital technology (DT), intuitive–figurative perception, rational–logic acceptance

INTRODUCTION

Some of the most important education tasks today are personal preparation for critical and independent thinking and promoting human culture, values, and worldview, as indicated (Ministry of Economic Development of Russia, 2020). The basic education program of high school students of the Russian Federation (RF), Federal State Educational Standard of Secondary General Education, includes the formation of a worldview that corresponds to the current state of science and social practice.

Citation: Shcherbatykh, S. V., & Lykova, K. G. (2022). Improving the efficiency of mathematics education through the development of a stochastic worldview of students. *International Journal of Instruction*, *15*(2), 1057-1074. https://doi.org/10.29333/iji.2022.15258a

Synthesizing nature of the worldview generates a generalizing-objective view of the world and makes it possible to balance the results of cognitive forms. The specific features of the stochastic worldview should include the formation of a positive attitude towards randomness in high school students, the development of skills to establish interdisciplinary relationships of stochastic and assessing situations filled with probabilistic statements and statistical data.

The term "stochastic" combines mathematics branches such as combinatorics, probability theory, and mathematical statistics. By the "stochastic worldview" of pupils in grades 10 and 11, we mean a system of views, beliefs, and attitudes through which students express more subtle and richer attitudes to the world around them; it is a system formed under the influence of methods and ways of knowledge of the world based on the elements of stochastics, which is a set of scientific knowledge. The stochastic worldview provides basic guidelines for creative and practical activities, contributes to expanding the humanistic paradigm, and aims to value system development among senior pupils. "In the learning environment," the worldview equips pupils with a scientific methodology and ways of thinking, as well as enables them to explain the world from scientific positions, understand the world based on the laws of dialectics, and participate in its transformation (Likhachev, 2010).

This study aimed to develop and justify the foundations of stochastic worldview formation among senior pupils, develop and pilot methods of teaching stochastic elements using digital technology (DT) at a comprehensive school, and identify effective didactic mechanisms for developing a stochastic worldview. For assessing the results of students' learning activities, special surveys, questionnaires in Google Forms were developed; control works, tests, laboratory works, and projects were implemented.

As a result of solving this problem, for the first time in the theory and methodology of teaching mathematics, a methodological system for teaching elements of statistics, combinatorics, and probability theory was designed and implemented in public education institutions of the Lipetsk region, aimed at forming a stochastic worldview of schoolchildren. That led to the rapid mobilization of available resources for the personal development of trainees and their effective use in educational activities.

A Stochastic Worldview

Having analyzed the content and specificity of individual subject areas of mathematics, we introduced the stochastic worldview concept into the fragmentary worldview phenomenon. In our opinion, a stochastic worldview is broader than a mathematical worldview because it enables the study of random events and random variables.

Studying a stochastic worldview through its functions improves the representation of examined quality content and its constitution and structure. Andreeva (2013) and Pozharskaya (2017) identified the following main stochastic worldview functions: evaluation, orientation–regulatory, information–reflective, and reflection functions (Figure 1).

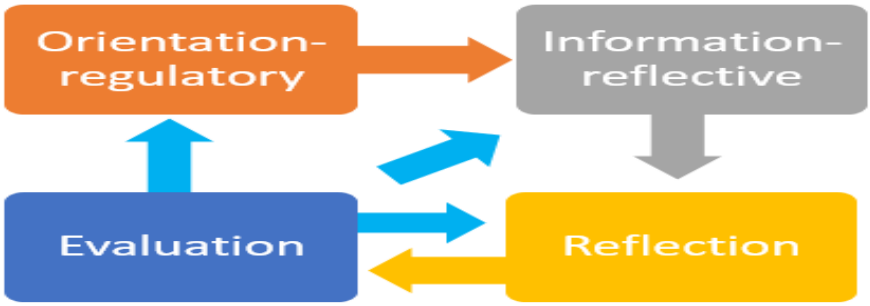

Figure 1
Functions of the stochastic worldview

The evaluation function is aimed at the personal development of a pupil. It enables one to assess the phenomena surrounding reality following one's views and worldview. Evaluation guides decision-making. The evaluation function is of particular significance as it serves as a mechanism that favours decision-making based on limited, sometimes incomplete, information during uncertainty. It is carried out by consciously choosing ways and methods of action, generating non-standard ideas, planning, and achieving goals and objectives. The orientation–regulatory function is manifested in senior pupils' behaviours, actions, and activities (grades 10 and 11). A pupil tries to find means of interacting with stochastic components in the surrounding world.

The information–reflective function pertains to a pupil's perception of information about events and phenomena in the outside world. This information first passes through the prism of the pupil's views, beliefs, and ideals and is then reflected upon in his/her mind. The reflection function helps the pupil to analyse his/her cognitive activity, comprehend results, and address gaps. As a focus on oneself, reflection is the realization of such thought processes as self-knowledge, self-perception, self-observation, self-analysis, and self-understanding (Lapp & Shipilova, 2020). On these bases, we classified reflection as a stochastic worldview function.

The functions highlighted above enable us to find the structural components of a stochastic worldview, representing a harmonious unity of motivation–value relations, intuitive–figurative perception, and rational–logic acceptance (Figure 2).

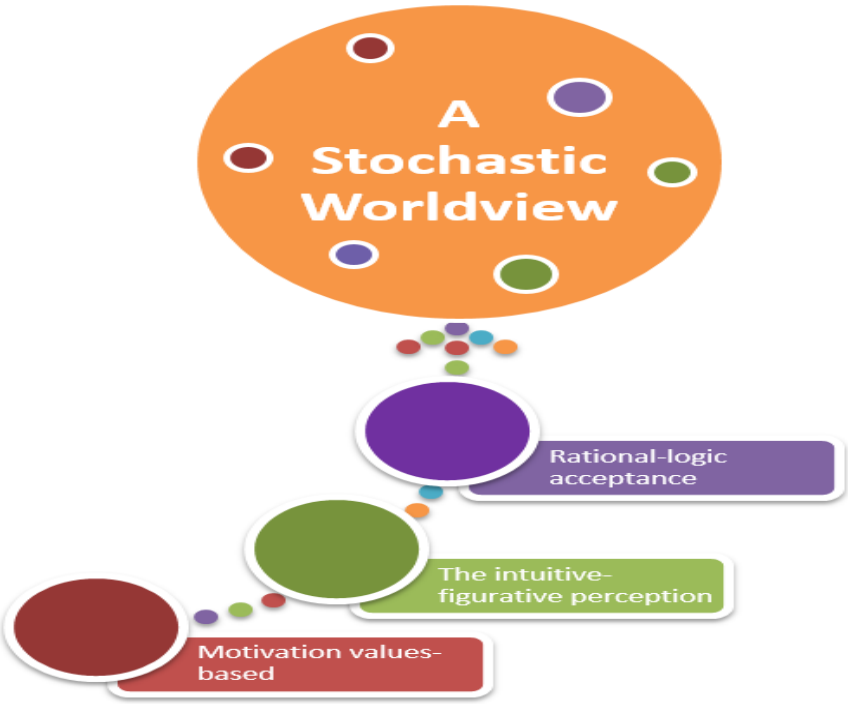

Figure 2
Structural components of the stochastic worldview

Motivation–value relations in the stochastic worldview of senior pupils take on motivating, regulating, and semantic roles. Such relations are needs, interests, beliefs, goals, motives, aspirations, attitudes, and values. Intuitive–figurative perception in the stochastic worldview of senior pupils can be attributed to its functional capabilities, which are manifested in the ability to feel in one's bones (i.e., to know intuitively), perceive, interpret, and create an image of objects and intuitively realize what is happening. Intuitional development in the study of stochastic elements makes it possible to activate the internal potential of senior pupils, thereby motivating a more active cognitive activity.

It conditions the relationship between intuitive–figurative perception and motivation–value relations in the stochastic worldview of senior pupils. The features of intuitive–figurative perception in resolving stochastic problems lie in the intuitive generation of the right decision. Rational–logic acceptance is aimed at choosing the best solution from various alternatives. This component of the stochastic worldview of senior pupils is conditioned by their ability to systematize received knowledge and learn to make rational and valid decisions.

The connection between value-based attitudes, intuitive-figurative perception, and rational-logic acceptance (Figure 2) aims to balance rational-logic and intuition in developing the pupil's mental cognition.

None of the presented components of senior pupils' stochastic worldviews (Figure 2) can be excluded since each influences the other. Each of the components and their synthesis is intertwined with the stochastic worldview functions, which aids the identification of the dynamics of the component features' development or the degree of their integration.

The stochastics of school math course for grades 10–11 is aimed at developing advanced skills and abilities: selection and identification of general patterns, assessment of the probabilistic nature of real-life dependencies, the definition of processes and phenomena of random character, processing of statistical data, working with the population and its samples, distribution of random variables, application of the law of large numbers and the probability sample method of measurement, working with statistical hypotheses and their verification, and calculation of the sample correlation coefficient and linear regression (Federal Educational and Methodical General Education Association, 2016).

Literature Review

An analysis of research on the worldview problem revealed that the concept belongs to an interdisciplinary branch of knowledge and is widely used in various mathematics studies. In English-language literature, there is no conceptual distinction between a worldview and a view of the world. In German, worldview (Weltanschauung) is also translated as "world outlook" as opposed to "view of the world" (Weltbild), which reflects a passive, contemplative perception of the world.

Psychological and pedagogical literature (Berestovitskaya, 2018; Lapp & Shipilova, 2020; Likhachev, 2010; Tsomartova, 2020; Zhokhov, 2011) reveals the need for important general theoretical, psychological, and methodological issues of formation of the worldview foundations among schoolchildren, defining scientific problems and ways to overcome them further. Worldview is studied through the psychological, internal, and external social factors of human life in unison. Attention is focused on a human's practical attitude and life philosophy and principles embedded in the worldview concept. Most researchers (Ananyev, 2010; Andreeva, 2013; Vygotsky, 2019; Karelina, 2005; Leontiev, 2004) believe that worldviews will deepen and expand throughout a person's life as they learn and accumulate personal experience. We adhere to the methodological concept of worldview. According to this, the formed worldview in conditions of ambiguity and contradiction of the modern world can play the role of a 'fulcrum' in solving various problems, namely, to perform information–reflective, orientation–regulatory and evaluation functions (Andreeva, 2013).

Many studies of domestic and foreign scientists-methodologists are devoted to developing the theory and methods of teaching the elements of stochastics (combinatorics, probability theory, and statistics). Most of them are focused on considering general issues related to the setting of stochastics teaching at school (Dvoryatkina, 2020; Tyurin, 2014; Shabanova, 2016; Krüger et al., 2015; Shcherbatykh,

2018). The studies noted that stochastic elements in the educational system are an important condition for increasing students' cognitive abilities. In the theory and methodology of teaching mathematics, the development of students' thinking, motivation sphere, and cognitive abilities are presented in a number of studies (Dvoryatkina, 2020; Nurjanah et al., 2021; Rezeki et al., 2021; Tsomartova, 2020).

During the analysis on the methodology of teaching mathematics in some dissertations, it was found that the key dominants of research are the formation of the foundations of the scientific worldview of students in the integrated classes, formation of the scientific outlook of high school students utilizing interdisciplinary communication (Mirzoev, 2014), school promotion of the self-determination of high school students (Berestovitskaya, 2018), and the formation of students' worldview based on the synthesis of scientific and artistic thinking (Tsomartova, 2020). Despite all these works, the given problem has not been sufficiently developed. In particular, the formation of a stochastic worldview of students at school utilizing mathematics has not been designed; further, technical and technological support for teaching stochastic in the digital educational environment has not been fully developed.

The DT development is the subject of multidisciplinary research by foreign and Russian scientists (Abdrakhmanova et al., 2019; Gorbunova et al., 2019; Panchenko et al., 2019; Terkulova, 2019; Fedotova, 2020) in such fields as pedagogy, informatization, law, and economics. Most researchers believe that the implementation of DT in various branches of science, including education, increases the efficiency of the learning process and contributes to implementing a personal approach to learning. DT used in education is focused on a new worldview formation and the intelligent potential disclosure of each pupil (Dvoryatkina et al., 2019).

The key position is given to the methodology of system-based activity, synergetic, and information technology approaches. The system-based activity approach feature lies in the pedagogical principles, methods, and settings of learning activities. The system of pedagogical principles and methods aimed at developing stochastic worldview components, such as activating motivational components, strengthening cognitive components, implementing active–practical components, and improving the efficiency of knowledge application, is solving practice-oriented and problem–searching tasks.

The synergetic approach displays the creative effect, which is manifested in situations of resolving uncertainty. The use of the "synergetic computer" functionality in consideration of logical and intuitive processes is promising. The IT approach reflects the trend of informatization and digitalization of the secondary general education system. The educational standards, educational programs of secondary general education, curricula, work programs on the problem under study were studied.

METHOD

Research Goal

A critical, theoretical, and methodological analysis of relevant scientific and methodological literature was essential.

The following hypotheses were put forward in the course of the study.

1. If high school students shape their views and beliefs while learning probabilistic–statistical methods, they have a positive attitude toward the stochastic component in the world around them.
2. Suppose high school students develop motivational–value relations, intuitive–figurative perception, and rational–logical acceptance in the learning process due to the acquired personal experience and set of specific stochastic knowledge. In that case, their stochastic worldview formation is most effective.

In our study we relied on the particular methodological principles of constructing a school content-methodological line: applied orientation (considering stochastics as an applied science with its inherent activities; constructing a real situation mathematical model; and making result-based decisions); integrity (strengthening intrasubject connections); inter-scientificity (strengthening interdisciplinary connections of stochastics with related connections for mutual enrichment of mathematics and related disciplines to form a unified scientific worldview); permanence (formation of pupils' statistical experience over a long period, development of probabilistic intuition, and logical operations); creation (generating new ideas and non-standard solutions based on methods and knowledge of stochastics in the creative process); and world outlook (determining the worldview orientation of teaching stochastics in senior classes, the formation of a probabilistic perception of reality and scientific view of the world).

The theoretical and methodological basis of the study was the integration of system, activity, interdisciplinary, and information and technology scientific approaches.

DT was used to teach high school students the elements of stochastic learning through the following actions: by determining the purpose of teaching stochastics in grades 10–11 (for advanced and basic education); actualizing stochastic education; identifying the features of high school students' thinking; selecting content and structuring stochastic material; and developing an elective course, "Random nature of non-random regularities in stochastic problems." Teaching tools were interactive models of the software product "Mathematical Constructor" (Dubrovskiy et al., 2019) (Interactive models: "Random Choice", "Frequency and Probability", "The Law of Large Numbers", "Bertrand's Paradox") and others; cognitive software tools, mathematical and computer modeling, and Web-resources (Wolfram|Alpha calculator, Wolfram Demonstration Project "The de Mois-Laplace Theorem in Probability Theory", Wolfram Demonstrations Models. To design and implement a stochastic worldview methodology using DT, we used a triadic framework. The methodology is based on the ideas of synergetics for the development of the pupil's cognitive sphere (Dvoryatkina, 2020). The triad should be understood as the regular structural and logical relationships manifested in the unity created by three elements of one level, each acting as a degree of combination of the other two. There are three primary components in the educational space: informational, educational, and developmental. The systemic triad of education performs a synthesizing role, expressed in knowledge transfer (analytical principle – rationale), education (qualitative change – motive), and skill development (substantive – intuition). The framework principle is

complementary: it relates each aspect to the other and offers alternative opposites that provide comprehensive information about the phenomenon.

The methodology of teaching stochastic elements (taking into account the specifics of the educational process in the digitization of mathematics education) was based on the following triad principles: openness – closeness – transdisciplinarity; expediency – causality – poly motivation; problematicity – clarity – flexibility and setup adaptivity; and uncertainty – educational environment intensity – individualization of learning paths.

Upon implementing the above methodology, the reflexive activity of high school students was analyzed, and the level of motivation and cognitive interest in learning was revealed. The methodology's effectiveness was analyzed through diagnostic procedures to track the dynamics of changes in the cognitive sphere of the student and determine the level of formation of components of the stochastic worldview. To measure the formation of each of the components, we selected appropriate diagnostic methods: motivational–value relations (the method of studying learning motivation for students of the 10th–11th grade, M. Rokich's method of measuring value orientations), intuitive–logical perception (uncertainty tolerance questionnaire), rational–logical acceptance (R. Amthauer Intelligence Structure Test, S. Mednik Verbal Creativity Test).

The following evaluation criteria were developed: cognitive, reflexive–evaluative, practical–effective, the indicators of which were: the depth and strength of assimilation of the system of stochastic knowledge, skills of correct understanding and assimilation of information; self-evaluation and self-control of students' learning activities, abilities to assess the level of their knowledge, adequate assessment, and self-assessment of the results of the learning activity; ability to apply knowledge in a situation of uncertainty; readiness to act and solve problems, addressed to problematic situations of everyday life.

The primary results were obtained using such methods of practical research as the experimental and statistical methods.

Experimental Methods

The study was conducted in a school in the small town of Elets (Gymnasium 11 MBOU), Russia; the sample consisted of students in grades 10–11. Students were divided into control (n1 = 68) and experimental (n2 = 52) groups.

The mechanisms were active teaching, project and case methods, independent activities, and work with DT. The organization of research activities (case method) of high school students in studying the elements of stochastics is due to the possibility of conducting experiments and investigating objects in different aspects. The case method is an efficient teaching approach based on exploring and solving problem situations with elements of uncertainty, contributing to the achievement of the goals, namely the formation of a system of thought and belief of students, interdisciplinary system knowledge, and the ability to make decisions in conditions of excessive or insufficient information. Applying the case method, we were guided primarily by the fact that it

promotes a change in the attitude of high school students to the stochastic component in the world around them, revealing their subjective experience in resolving stochastic problem situations. The case methodology included the following algorithm of actions.

1. Problem announcement (the students knew the topic in advance);
2. Distribution of students into small groups (4–5 people in each subgroup);
3. Assignment of tasks, discussion of goals and objectives of the case;
4. Case workflow management. The students had to:
   - Decompose the problem into smaller sub-problems and think how to solve them;
   - Generate hypotheses based on them;
   - Collect data and test them experimentally to determine the validity of the proposed hypotheses;
   - Formulate the recommendations for solving the problem and distribute the work in a subgroup;
   - Present the case results (orally, as a written report, or presentation);
5. Synthesis of the obtained results and the work summing up.

The use of the case method helps high school students master the skills of exploring situations, forming skills of analysis and evaluation of alternatives, and developing decision-making skills in a situation of uncertainty.

In studying the stochastic line of school mathematics course, DT provides access to new information sources (interactive tables, sites of meteorological services, election committees, sports statistics, etc.). The implementation of creative activities acts as a kind of immunity to overcoming difficulties.

The use of DT in networking, work in pedagogical software products (Mathematical Constructor) allowed us to determine the technology of effective formation of a stochastic worldview of students in the conditions of digitization of mathematical education.

Statistical Methods

In order to measure the system of value orientations of high school students, determining the content of the personality orientation, its attitude to the world around, as a worldview basis, we used the M. Rokich method, based on the direct ranking of the list of values. Analysis of the data obtained allowed us to state that students, under the influence of the pedagogical impact, have positive dynamics of the value attitude to learning and cognitive activity in the experimental group.

To test the hypothesis about the impact of teaching methods on the formation of the stochastic worldview of students in the experimental group, the multifunctional criterion of φ^* - Fisher angular transformation was used. The advantages of this method are that it allows to compare two samples on the frequency of occurrence of the effect of interest and has no limitations on the number of samples.

Since the formation of the stochastic worldview was carried out by developing each of its structural components (the motivation-value attitude, intuitive–figurative perception, rational-logic acceptance), trends were studied. For each of the main criteria of stochastic worldview (cognitive, reflexive–evaluative, practical–effective), threshold attribute values were established for the groups: "there is an effect", "no effect," according to the level of its formation. The attribute values were calculated as the arithmetic mean of all estimates. The null hypotheses for the corresponding three criteria are as follows: H0(1) = {the proportion of students scoring from 32 to 40 points in the experimental group (EG) is not greater than in the control group (CG)}; H0(2) = {the proportion of students scoring more than 4.5 points in the EG is not greater than in the KG}; H0(3) = {the proportion of students scoring from 16 to 20 points in the EG is not greater than in the KG}. Alternative criteria – H1(1)={the proportion of students who scored from 32 to 40 points in the EG more than in the KG}; H1(2)={the proportion of students who scored more than 4.5 points in the EG more than in the KG}; H1(3)={the proportion of students who scored from 16 to 20 points in the EG more than in the KG}.

FINDINGS

The stochastic worldview manifests through (1) thinking flexibility, i.e., the ability to switch attention quickly, examine problems from different perspectives, work with different data types, and restructure objects; (2) improvements in thinking actions and operations in problematic learning situations (abstraction, analysis, analogy, generalization, concretization, synthesis, etc.); (3) susceptibility to stochastic material (i.e., ability to notice and identify patterns in the environment); and (4) creativity in the use of elements of stochastic (ability to apply associations to objects, go beyond the study of the problem, and generate original ideas for decision-making in situations characterized by uncertainty) (Lykova, 2020).

It was found that in the process of worldview-oriented education, high school students formed stable cognitive motives for identifying the stochastic component in the surrounding world and revealed deep substantive knowledge of stochastic. They effectively applied probabilistic and statistical methods when solving problems, the focus of which was conditioned by uncertain variability of living organisms, Mendel's laws of inheritance, Brownian motion (or random motion of physical particles), Maxwell's laws, and Gibbs' rules. Students also explored problems related to human blood characterization, including Rh factor and antibiotic efficacy. The obtained knowledge and skills helped students explore the variability and uncertainty inherent in social and natural processes, allowing them to understand different science areas better. Because of this progress, high school students had a positive attitude to randomness, developed the capacity to establish interdisciplinary relationships, and attempted to predict the behavior of objects in the environment. Hence, the first research hypothesis was supported by the study findings.

Our results indicate that stochastic incorporated into the “Algebra and the elements of mathematical analysis” program taught in grades 10–11 (with some enhancement) allows students to achieve high individual results and develop intellectual abilities. They can measure and assess the phenomena associated with the concept of randomness,

conduct a thought experiment, test hypotheses, and elaborate on their findings. It became possible because appropriate teaching methods consisted of the problem setting, creating a problem situation, problem-solving (search for solutions), and solution analysis.

These methods allowed students to apply logical operations, transfer knowledge to new circumstances, implement research and creative activities, comprehend educational material, accumulate personal experiences, and draft a plan to solve problems. In sum, lectures on stochastic had enhanced high school students' understanding of the subject matter, their perception and cognition of the surrounding world characterized by complex interrelations.

As a result, in teaching, it was possible to develop intellectual operations and actions of students, and therefore intuitive–figurative perception and rational–logical acceptance in the context of the educational information processed by high school students. Students' probabilistic and statistical methods in the unique interpretation of the beauty and identity of the phenomena of the surrounding reality helped strengthen motivation, reinforce value orientations to the stochastic component, and develop motivational–value relations.

In summary, the development of each of the structural components allows us to judge the formation of a stochastic worldview in the general case. Therefore, it makes it possible to assess the feasibility of the formulated second hypothesis of the study.

Experimental Results

The implementation results of the stochastic teaching method using DT confirmed the research hypothesis. The positive influence of teaching the elements of stochastic in the development of the following components was revealed: motivating value-oriented attitudes, intuitive–figurative perception, and rational–logical perception, which characterize the formation of the stochastic worldview of students according to the main criteria: cognitive, reflexive–evaluative, practical–effective.

From the experimental study, indicator values were obtained characterizing the quality of learning material on stochastics among pupils in the control ($n1 = 68$) and experimental groups ($n2 = 52$). The control group consisted of high school students who traditionally studied the elements of stochastics. The experimental group consisted of high school students who were trained to implement the proposed methodology. The results were quantitatively analyzed using statistical methods.

For statistical analysis of empirical data, we applied a multifunctional F-test (φ^*), which made it possible to assess the credibility of differences between percentages of two samples (Tables 1, 2, 3).

Table 1
Processing of results using the F-test – Cognitive criterion

Average values	Empirical frequencies of scores		Total
	Control group n1 = 68	Experimental group n2 = 52	
0 to 20 (low)	24	12	36
20 to 32 (medium)	32	16	48
32 to 40 (high)	12	24	36
Total	68	52	120

Table 2
Processing of results using the F-test – Reflexive–evaluative criterion

Average values	Empirical frequencies of scores		Total
	Control group n1 = 68	Experimental group n2 = 52	
0 to 3.7 (low)	20	14	34
3.7 to 4.5 (medium)	38	18	56
4.5 and above (high)	10	20	30
Total	68	52	120

Table 3
Processing of results using the F-test – Practical–effective criterion

Average values	Empirical frequencies of scores		Total
	Control group n1 = 68	Experimental group n2 = 52	
0 to 10 (low)	30	11	41
10 to 16 (medium)	24	20	44
16 to 20 (high)	14	21	35
Total	68	52	120

Tables 1-3 used to test the hypothesis concerning the effect of the teaching methodology of DT stochastics on the development of stochastic worldview components of senior pupils.

According to Table 1, Table 2, Table 3, it is considered that "there is an effect" if, according to the conducted diagnostic procedures, the average value is 32 to 40 (high) – for assessing by cognitive criterion and "no effect" if the value is less 20, the average value is 4.5 or higher (high) – for assessing by reflexive–evaluative criterion and "no effect" if the value is less 3.7, the average value is 16 to 20 (high) – for assessing by practical–effective criterion and "no effect" if the value is less 10 (Table 4).

Table 4
Diagnostics of the quality of learning material for stochastics

Cognitive criterion			
Group	"There is an effect"	"No effect"	Total
Control	12 (17.6 %)	56 (82.4 %)	68
Experimental	24 (46.2 %)	28 (53.8 %)	52
Total	36	84	120
Reflexive–evaluative criterion			
Group	"There is an effect"	"No effect"	Total
Control	10 (14.7 %)	58 (85.3 %)	68
Experimental	20 (38.5 %)	32 (61.5 %)	52
Total	30	90	120
Practical–effective criterion			
Group	"There is an effect"	"No effect"	Total
Control	14 (20.6 %)	54 (79.4 %)	68
Experimental	21 (40.4 %)	31 (59.6 %)	52
Total	35	85	120

As a result of statistical testing, we rejected the null hypothesis that the proportion of pupils who manifested the effect under study in the experimental group was no more than in the control one ($\varphi^*emp=3.414 > \varphi^*cont(0.01)=2.31$ – for cognitive criterion; $\varphi^*emp=2.996 > \varphi^*cont(0.01)=2.31$ – for reflexive–evaluative criterion; $\varphi^*emp=2.367 > \varphi^*cont(0.01)=2.31$ – for practical–effective criterion).

We concluded that the proportion of pupils who scored from 32 to 40 points, and more than 4.5, and from 16 to 20 points in the experimental group was higher than in the control group, proving the efficiency of the implemented methodology in teaching mathematics.

DISCUSSION

Statistical processing of empirical data showed the efficiency of the teaching methods and means aimed at developing stochastic worldview components.

According to the results of assessments of tests, control, laboratory, research, and project works conducted at the final stage of training, the conclusion was made about the formation level of stochastic worldview, which indicators were interest and motivation to the study of stochastics, positive attitude to the stochastic material, the strength of stochastic knowledge system, formed volitional regulation, and self-correction.

In experimentation, it was found that the result of value–motivational settings is the student mastering stochastic elements. We were able to determine the student's nature and ways of cognitive activity. The result of intuitive–imaginative perception is a holistic intuitively perceived image arising in the student's mind; the result of rational–

logical acceptance is the optimization of the integration of knowledge from a specific subject area into a single whole and development of the ability to use the log.

The resulting dynamics show that the teaching of stochastic has developed sustainable motives for students and ways and means of mathematical cognition of reality. We have improved such essential mental actions and operations as analysis, synthesis, comparison, abstraction, generalization, systematization, concretization, etc. We have expanded the scope of knowledge and diversified creative activities.

The presence of stochastic elements in the content of the school course for mathematics for grades 10–11 broadens students' horizons, conducive to the student's understanding of his abilities, promotes the formation of certain useful qualities of personality, and acts as the basis for the development of more complex mathematical knowledge or topics from related sciences.

Because of acquiring stochastic knowledge, high school students learn to build logically reasoned evidence, make decisions despite uncertainty based on the analysis of available data, assess the credibility of events and phenomena, and develop probabilistic intuition. Special attention when teaching the elements of stochastic is given to the formation and development of significant aspects of worldview in high school students' personalities: their thinking, logical and intuitive components, stochastic worldview, and separate groups of skills.

The proposed method helps ensure effectiveness in developing motivational, value, and attitudinal constructs of students within the framework of the implemented teaching technique.

However, the study does not yet allow us to accurately define the level of the stochastic worldview formation in students in only 10th grade and students in only 11th grade. The prospect of research development is highly multifaceted, and the educational potential of the worldview formation of students in the conditions of modern changes in society is colossal and subject to further improvement. However, it is safe to say that the science of randomness (stochastics) is necessary to form the students' worldviews.

The extension study needs to analyze the concept of the worldview based on the integration of philosophy, psychology, pedagogy and consider it a boundary concept at the junction of the listed sciences. Despite the complexity of the study, the obtained results have signs of qualitative scientific research characterized by representativeness (samples of students), reliability, and accuracy.

CONCLUSION

This paper has sought to add new methodological and methodical aspects to mathematics education, which improves the quality of students' training according to the demands of modern technological progress. The running process leads to increased susceptibility to positive trends in education: increased interest in knowledge and science. In this regard, the proposed method used in general educational practice will make the learning process more efficient and allow high school students to develop their intellectual abilities.

The study aimed to develop motivation for the elements of stochastic, ensure the strength of the student stochastic knowledge system, their comprehension of value orientations to the stochastic component in life, development of thought actions and operations, and increase activity and independence in educational and cognitive activity. The listed elements are part of the structural components of a stochastic worldview, the achievement of which allowed us to judge the success of the implemented teaching methodology.

The methodology of teaching the elements of stochastic using DT positively impacted the development of students' sustainable motives, methods, and means of mathematical knowledge and their subject knowledge. It also benefited the identification of the worldview potential of stochastic education.

The worldview potential of stochastic learning is expressed in the fact that the subject of stochastic as science allows us to look at the external world from a particular angle (metaphorically, symbolically, and systematically). It allows us to study random phenomena and processes, their relationships, and regularities, not just without the influence of sensory experience but also at the cost of practical needs.

Thus, it is safe to say that our method gives the results of the educational process a new quality of learning; makes it possible to realize the integrity of worldview, value, and motivational constructs; and creates the necessary conditions under which it becomes possible to generate knowledge by the students themselves based on self-actualization.

The study confirmed the proposed hypotheses and substantiated the impact of using the idea of forming a stochastic worldview of high school students based on integrating information and technological, interdisciplinary, system, and activity approaches.

It was recorded that students who have mastered probabilistic-statistical methods in teaching mathematics have a positive attitude towards the stochastic component in the world around them. Moreover, the successful development of motivation–value attitude, intuitive–figurative perception, and rational-logic acceptance in high school students learning mathematics contributes to the stochastic worldview formation.

Suppose high school students develop motivational–value relations, intuitive–figurative perception, and rational–logical acceptance in the learning process due to the acquired personal experience and set of specific stochastic knowledge. In that case, their stochastic worldview formation is most effective.

RECOMMENDATIONS

The specificity of stochastic education is to provide students with scientific knowledge, practical skills, and abilities in combinatory, probability theory, and mathematical statistics. It allows them to develop their mental, cognitive, and creative abilities and their world outlook, moral, and aesthetic culture. As a result of this, they acquire a certain personal image and individual identity (Shcherbatykh & Lykova, 2020).

The development of structural components, motivational–value relations, intuitive–imaginative perception, and rational–logical acceptance allows us to draw some conclusions regarding the formation of a stochastic worldview of students in general.

LIMITATIONS

A stochastic worldview is formed based on one's acquired personal experience and specific knowledge.

ACKNOWLEDGEMENTS

RFBR, project number 20-313-90019, funded the reported study.

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