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РОЗРОБКА МЕТОДІВ ТА МОДЕЛЕЙ МІНІМІЗАЦІЇ ПОХИБОК МАШИНО-ЛЮДСЬКОЇ ВЗАЄМОДІЇ В АВТОМАТИЗОВАНИХ СИСТЕМАХ ДІАГНОСТИКИ РІВНЯ ПРОФЕСІЙНОЇ ПІДГОТОВКИ

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DEVELOPMENT OF METHODS AND MODELS OF INACCURACY MINIMIZATION OF THE MACHINE-TO-HUMAN INTERACTION IN AUTOMATED SYSTEMS OF PROFESSIONAL READINESS LEVEL DIAGNOSTICS

Purpose. To increase the level of reliability of computer testing of specialists in the sphere of professional training. To formalize mathematical models and algorithms of inaccuracies of machine-to-human interaction in all the links of data exchange system in the information network of automated system of diagnostics of professional readiness quality.

Methodology. We have used the methods of system analysis and of general theory of systems, and the main thesis of the theory of measuring and automated control.

Findings. We have carried out the structural analysis of the reasons of misinformation in the system of automated testing and the classification of parameters of evaluation of information authenticity in the metric channels of data exchange in the information network of testing control of professional readiness. We have developed the criteria of evaluation of information authenticity, adaptive algorithms and mathematic models of minimization of inaccuracies in the measurement of machine-to-human interaction in the exchange tracks of information and telecommunication networks of automated testing control systems.

Originality. We have stated and solved the reliability and preciseness increase problem concerning the methods of control and provision of information authenticity by means of developing the methodology of minimization of measurement inaccuracies in the systems of machine-to-human interaction, which are used for testing the professional readiness quality.

Practical value. We have received a scientifically grounded toolset, which is a system of models and algorithms of minimization of irreversible information losses in the exchange tracks of information and telecommunication networks. The toolset is aimed at the complex phased increase of the main indices of diagnostics quality: reliability and validity of a test, effective organization of a testing session and objectivity of testing results identification. We have developed a tool defining the empiric superposition of the law of inaccuracies distribution on the basis of entropic coefficient and antikurtosis.

Keywords: *inaccuracy, machine-to-human interaction, automated system, diagnostics, algorithms, testing material, superposition, entropic coefficient*

Introduction. Modern situation with human resources in economy and business require specialists' certification as an integral procedure, which testifies the quality of their professional readiness and competency. Besides, systematic satisfaction of society's needs in the sphere of professional education is impossible without the analysis of the results of matching the information about the actual condition of controlled process with its characteristics set by the controlling program. These facts stipulate the necessity of creation of the methodological bases and instrumental means of measuring the actual level of knowledge and its correlation with the required level.

Problem statement. As is known, due to the intensive development of information technologies the computer testing becomes the most progressive tool of diagnostics of educational achievements of the testee as well as his/her readiness for realization of any type of professional activity. And we should not forget that the instrumental means of automated testing create a powerful tool of feedback. Quality and efficiency of certain management tasks depends on the authenticity and accuracy of this tool. That is why there is an urgent problem of development of methodology of inaccuracy minimization in the exchange channels of information and telecommunication networks in the created automated systems of knowledge quality diagnostics.

Analysis of the latest publications. The works of originators of the theory of changes, professor P.V. Novitski, G.A. Yemelianov, O.V. Shvartsman possess the essential value for the development of the methodology of inaccuracy minimization in the exchange channels of automated systems knowledge quality diagnostics.

Works of many scientists (O.A. Kozlov, A.A. Pavlov, Yu.A. Romanenko, V.I. Serdiukov etc.) are devoted to the usage of formal mathematical and cybernetic methods of increasing the efficiency of various stages of study and control. There are also some works in the sphere of fuzzy logic, adaptation of complex systems, automation of personnel evaluation control (L.A. Rastrigin, V.N. Vagin, V.I. Vasiliev, D.I. Popov).

Traditional approach to the evaluation of study achievements, connected with automated calculation of separate parameters qualifying characteristics, is developing widely in the works of such authors, as: V.S. Avanesov, A. Anastazi, A.I. Berg, J. Glass, N. Grunlund, K. Clein, E.A. Mikhailychev, I.D. Rudinski, S.A. Safontsev, A.G. Shmelev.

Dealing with the issues of automated control and study on the basis of modern informational and communicational technologies we can found on crucial aspects, received in the works of many native and foreign scientists, such as: V.I. Soldatkin, A.S. Kutsenko, M.D. Godlevski, A.N. Tikhonov, A.D. Ivannikov, G.A. Krasnov, I.S. Konstantinov, Mohamed Ally, Vincent Ambrock, David Annand, Terry Anderson, Fathi Elloumi, Dean Caplan.

Unsolved parts of the general problem. Active development of progressive technologies in the sphere of information and telecommunication networks of automated systems of diagnostic of professional readiness quality did not completely solve the problems of increasing the accuracy of control methods and provision of information authenticity. It is connected with a number of reasons. Main reasons are as follows:

1. The absence of system methodological approach to the increase of accuracy of control methods and provision of information authenticity on every stage of data exchange in the information network of professional readiness testing control, on the stages of testing material preparation, organization and realization of the testing session, identification of testing results.
2. The questions of the structural analysis and classification of the most essential inaccuracies of the automated systems of diagnostic of professional readiness quality, which are the reasons and sources of low information authenticity in automated systems of diagnostic of professional readiness quality, are not examined.
3. The absence of scientifically-justified set of tools, being a system of models and algorithms of minimization of irreversible information losses in the exchange channels of information and telecommunication systems and directed on complex gradual increase of the main indices of diagnostics quality: reliability and validity of the test, effectiveness of testing session organization and objectivity of testing results identification. All this factors block the effective usage of information technologies in the sphere of diagnostics of professional readiness level.

Thus, the contradiction between requirements of development and creation of high-performance automated systems diagnostics of professional readiness quality and the insufficient level of scientific and methodological research concerning the increase of reliability and accuracy of methods of control and provision of information authenticity allows stating the existence of problem and makes the realization of researches in this field very urgent.

The purpose of the research consists in the formalization of aggregate principles and approaches of the methodology of inaccuracy minimization in the exchange channels of automated systems of professional readiness control on the basis of the structural analysis and classification of inaccuracies of the systems of professional readiness control.

Findings. Proceeding from the fact that the deviation of the true value of the range from the measured one is called the measurement inaccuracy, in this work we observe inaccuracies, which arise due to the change of knowledge in the system of automated testing knowledge control. As is known, from the point of view of the probabilistic theory of information the sense of measurement lies in the contraction of the interval of uncertainty from the value known before the measurement, to the value d_{ent}, called the entropic interval of uncertainty, known after the measurement. The evaluation of entropic value of the inaccuracy Δ_e^* with the usage of experimental data is defined as $\Delta_e^* = \frac{dn}{2}\,10^{-\frac{1}{n}\sum_{i=1}^{m} n_i \lg n_i}$, where d is the width of a column in the histogram of m columns, received from n observations (Shennon K).

We have carried out both the structural analysis of the reasons of misinformation in the system of automated testing and the classification of parameters of information authenticity evaluation in metrical channels in the data exchange systems of informational network of the testing control of professional readiness (table 1).

Table 1

Classification of parameters of evaluation of information authenticity in the metrical channels in the data exchange systems of informational network of the testing control of professional readiness

Methodical inaccuracies	Subjective inaccuracies	Inaccuracies of measuring conditions	Instrumental inaccuracies
Metrical channel of inaccuracy of testing tasks quality			
Test reliability	Quantitative interpretation of the level of testing tasks complexity	Sample representativeness	Technical inaccuracies in the work of the system
Test validity			
Metrical channel of inaccuracy of quality of testing session organization			
Time of session	Objectivity of formalization of session purpose	Feedback effectiveness	Economy Adaptability Confidentiality
Session effectiveness			
Metrical channel of inaccuracy of quality of testing results interpretation			
Results adequacy to the real tasks	Objectivity of identification of the fact of guessing	Adaptation to the sphere of measurement	Technical inaccuracies in work of the system

Based on the terms, notions and indications given above the calculation scheme of mathematic modeling of inaccuracies in the channels of data exchange in information networks of testing control of professional readiness was developed (Fig. 1).

The task of reduction of irreversible losses of information (inaccuracies of measurements) between subjects (objects) – participants of the testing session, held with the help of automated system of professional readiness diagnostics, is brought to the minimization of complex evaluation of entropic value of the inaccuracy Δ^*_e in the system

$$F = \sum_{i=1}^{M} \sum_{j=1}^{N_i} \sqrt{\Delta^{2*}_{eij}} \to \min , \qquad (1)$$

where M is the quantity of metrical channels; N_i is the quantity of inaccuracies in the metrical channel "*i*".

We suggest providing the increase of information authenticity in *the metrical channel of evaluation of testing material quality* of the information system of testing control of professional readiness by means of minimization: on the stage of testing material formation – to minimize inaccuracies connected with the low objectivity of expert interpretation of quantitative indices of level of testing tasks complexity Δ^*_{e11}; on the stage of realization of evaluation algorithm of testing tasks quality – to minimize inaccuracies connected with the labor intensity (durability) of receiving a full correlation matrix of testing results Δ^*_{e14}; on the stage of analysis of the testing material quality – to minimize inaccuracies connected with the absence of methodology of interpretation of reasons of testing tasks low quality Δ^*_{e12}; on the stage of technical support of the process of testing material quality evaluation – to minimize accidental instrumental inaccuracies Δ^*_{e13}.

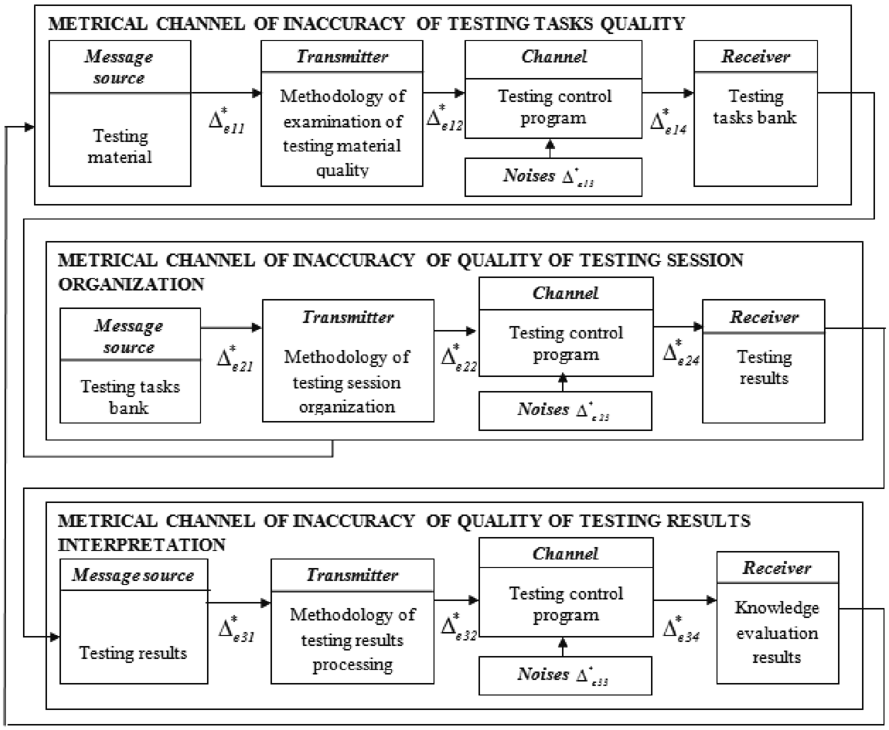


Fig. 1. The calculation scheme of mathematic modeling of inaccuracies in the channels of data exchange in information networks of testing control of professional readiness

The model of minimization of systematic progressing *subjective inaccuracies* in the process of testing tasks scaling is formulated as follows

$$\Delta^*_{e11}(Q_v,\ T_{norm}, D_t) \to \min , \qquad (2)$$

where Q_v is the complex expert identifier of testing task complexity; T_{norm} is the actual time for testing task fulfillment; $D_t = T_f / T_{norm}$ is dynamic coefficient of testing task fulfillment speed. This model allows increasing the accuracy of professional readiness diagnostics by means of fulfillment of the following heuristics, substantiated by the authors: tasks in the testing material are characterized by different complexity level, in the evaluation and identification of which it is reasonable to use the methodology of fuzzy sets, which allows handling a complex of qualitative and quantitative results of expert evaluation [1]; index of time of testing task fulfillment is an objective characteristic of the testing task complexity level because it simultaneously considers both the time of testing task reading and the time of thinking and giving the right answer. Time standard T_{norm} for the testing task fulfillment is the average time spent on it by the group of tutors-experts [2]; to increase the objectivity of identification of normative number of points for the right answer it is possible to correct it taking into account the dynamic coefficient as the correlation between the normative T_{norm} and actual T_f time of testing task fulfillment [3].

Besides, to reduce the technological inaccuracy in the process of calculation of time, spent on an answer, the authors suggest memorizing the time of video memory cache clearing with the full download of the current testing task image and the time of pressing the button of finishing the current testing task – all that allows minimizing *the accidental instrumental inaccuracies* [4]

$$\Delta^*_{e13}(T^n_{norm}) \to \min , \qquad (3)$$

where $T_{norm}^{n} = Finish_{i}^{j} - Start_{i}^{j}$ is net (without considering the technological time) time for testing task fulfillment, which is calculated as the difference between the time pressing the button of finishing the testing task "*i*" $Finish_{i}^{j}$ by the testee "*j*" and the time of video memory cache clearing with the full download of the "*i*" testing task image $Start_{i}^{j}$.

Model of minimization of additive progressing inaccuracies of *the conditions of measurement fulfillment* is formulated as follows

$$\Delta_{e12}^{*}(M, M_{Dp}, M_{Dk}, D_{Dp}, D_{Dk}) \rightarrow \min . \qquad (4)$$

It allows optimizing the procedure of express-analysis of the testing material quality by means of reducing the durability and labor intensity of forming a full correlation matrix of M testing results as well as extending the range of expertise criteria of testing material. For this purpose the authors offer the algorithm of forming the full correlation matrix of testing results by means of its gradual guaranteed creation from two incomplete matrixes – results of the preliminary M_{Dp} and control testing M_{Dk} as a part of one lesson as well as the expert evaluation of testing material quality in the real time scale, which includes the comparison of indices of full correlation express-matrix *M* and dynamic correlation express-matrix-columns of the results of the previous D_{Dp} and control testing D_{Dk}.

The model of optimization of systematic *inaccuracies* connected with the absence of *methodologies* of finding the cause of testing task low quality is formulated as follows

$$\Delta_{e14}^{*}(D_t, A_D) \rightarrow \min , \qquad (5)$$

where A_D is heuristic algorithm of extended analysis of testing material quality on the basis of the index of actual speed D_t of fulfillment of testing tasks of different complexity [5].

The increase of information authenticity in *the metrical channel of quality evaluation of testing session organization* in the information system of professional readiness testing control the authors offer the following minimizations: on the stage of selecting testing tasks for the current session – to minimize subjective inaccuracies connected with the formalization of the testing measuring session Δ_{e21}^{*}; on the stage of testing session organization – to minimize methodical inaccuracies connected with low measurement efficiency Δ_{e22}^{*}; on the stage of testing session fulfillment – to minimize inaccuracies connected with ineffective use of testing measurement results as a feedback instrument Δ_{e24}^{*}; on the stage of technical support of the testing session – to minimize inaccuracies connected with adaptation of the software program and the insufficient level of technical characteristics of computers Δ_{e23}^{*}.

The model of minimization of systematic progressing *subjective inaccuracies* in the process of validation and formalization of testing session purpose is formulated as follows

$$\Delta_{e21}^{*}(V_t, P_t, U_t, L) \rightarrow \min , \qquad (7)$$

where V_t is type of the closed testing task; P_t is boundary probability of guessing; U_t are levels of professional skills possession; L is target level of testing measurement of professional aptitude. Initial factors for model development [6] – it is reasonable to formulate the purpose of testing measurement of professional aptitude on the basis of the four-level testing tasks classification, developed by the authors:

* A_1: V_1 = {With one correct answer}, U_1 = {Recognition of objects, notions, facts, laws and models}, P_1=0,200;

* A_2: V_2 = {With multiple choice}, $U_2 = U_1$, P_2=0,125;

* B_3: V_3 = {To set the relations}, U_3 = {Solving the typical tasks, action in accordance with the sample, with a familiar algorithm or rule}, P_3=0,025;

* C_4: V_4 = {To set the correct sequence}, U_4 = {Analysis of the situation, development and realization of algorithms of solving non-typical tasks on the basis of familiar operations}, P_4=0,002.

It is obvious that levels of professional skills possession, controlled with the help of testing tasks of higher target level, include a range of professional skills, repeated by all preceding target levels, which are lower

$$A_1 \subset A_2 \subset B_3 \subset C_4 .$$

The model of minimization of additive progressing *methodical inaccuracies*, which are connected with the negative influence of tiredness factor during the testing session as well as with the low level of motivation to get stable knowledge and which stipulate low efficiency of measurements, is formulated as follows [6]

$$\Delta_{e22}^{*}(A_R, A_i, \chi) \rightarrow \min , \qquad (8)$$

where A_R is the algorithm of adaptive sequence of testing tasks supply in the order of decrease of the examined level of professional readiness ($C_4 \rightarrow B_3 \rightarrow A_2 \rightarrow A_1$); χ is the heuristic algorithm, of identification of the "sufficiency" index $\chi(L, G_{NL}, G_{FL}, Step_L)$ of passing the individual number of target levels *K*, defined on the basis of actually set (during the testing session) degree of a testee's readiness. This index consists in following: the necessity of moving $Step_L^1$ to a lower target level L or finishing the testing session depends on the results of comparison of indices of boundary (luminal) G_{NL} and actual share $G_{FL} = N_L / Q_L$ of correct answers on testing tasks of the current target level, where N_L is the number of correct answers on testing tasks from the normative quantity of tasks on the current target level Q_L; A_R is the algorithm of adaptive informing during the testing session about the number of correct and incorrect answers with the purpose of stimulating cognitive activity and confidence in the testee's knowledge.

The model of minimization of systematic inaccuracies of *measurement conditions*, connected with ineffective use of results of professional skills measurement as the feedback instrument, is formulated as follows

$$\Delta^*_{e24}(M_s, M_k, M_t, M_a) \to \min \ . \qquad (9)$$

Optimization of this index is carried out by means of realization of the system, developed by the authors, the gradual system of methodologies of usage of knowledge testing measurements with the purpose of maximum individualization of the professional education (reeducation) process as well as with the purpose of increasing the level of objectivity of material adoption evaluation, that is: M_s is organization of the process of preliminary obtaining of structures material for individual adoption; M_p is realization of the preliminary test of readiness level in the beginning of a current lesson; M_k is correction of structure of the material for group discussion on a lesson according to the set readiness level; M_t is repeated testing at the end of the current lesson with the purpose of receiving information about the change dynamics of quality and quantity of professional readiness in time; M_a is algorithm of defining the level of availability of material supply [7].

The model of minimization of systematic *instrumental inaccuracies* connected with the existence of problems of software program adaptation and the insufficient level of technical characteristics of computer park is formulated as follows

$$\Delta^*_{e24}(\mathrm{M_o}, \mathrm{S}_a, E_k, K_o) \to \min \ , \qquad (10)$$

where M_o is mobility, S_a is adaptability, E_k is economy, K_o is confidentiality of testing session. To solve the mentioned problems the mobile system of computer testing is offered. It stipulates realization of the following solutions: to use portable personal computers as technical means of carrying out the testing control – the tutor's computer should be necessarily provided by the facility for Internet connection (radio-modem); installation of the testing tasks database on the territorially detached server with the short-term access, set via Internet; presence of the standard set of the MS Office software in every personal computer – the software should include MS Access database; development of the unified system of computer testing using the programming tools VBA MS Access – files in the database of testing tasks and in the software shell of the testing have the same file type – *.Accdb [8].

The increase of information authenticity in the *metrical channel of evaluation of quality of testing results interpretation* the authors offer to carry out the following minimizations: on the stage of formation of testing results matrix – to minimize subjective inaccuracies connected with the absence of effective instruments of identification of guessing fact Δ^*_{e31}; on the stage of interpretation of results matrix – to minimize methodical inaccuracies connected with the low adequacy of measuring results to the real knowledge of a testee Δ^*_{e32}; on the stage of accumulation and statistic processing of testing results matrix – to minimize the inaccuracies of measuring conditions and increase of feedback efficiency, connected with the importance of considering measuring environment peculiarities Δ^*_{e34}.

The model of minimization of systematic progressing *subjective inaccuracies* in the process of identification of the guessing fact is formulated as follows

$$\Delta^*_{e31}(K(T^n_{norm}, T^n_f)) \to \min \ . \qquad (11)$$

This model is based on the dependence (set by the authors) of the level of knowledge stability on the correlation coefficient $K(T^n_{norm}, T^n_f)$ between numerical time series [4].

On the basis of this statement the authors developed the model of minimization of additive progressing *methodical inaccuracies* in the process of results matrix interpretation, connected with the low adequacy of measuring results to real knowledge of a testee

$$\Delta^*_{e32}(K(T^n_{norm}, T^n_f), A_k, \mathrm{Prof\_}Rate) \to \min \ , \quad (12)$$

where A_k – the algorithm of adaptive identification of testing results, in accordance with which: the level of professional readiness of the testees *Prof_Rate*, who showed confidence in their professional knowledge $K(\mathrm{T}^n_{norm}, \mathrm{T}^n_f) \geq 0,5$ – it is found as the sum of normative points for correct solution of testing tasks; *Prof_Rate* of the testees, stability and confidence of their knowledge can be disputed $0,3 \leq K(T^n_{norm}, T^n_f) \leq 0,49$ – it is found integrally by means of correcting the sum of normative points for right solution of testing tasks on the ratio of cumulative actual and normative time of the whole testing session; *Prof_Rate* of the testees with very unstable knowledge $K(\mathrm{T}^n_{norm}, \mathrm{T}^n_f) < 0,3$ is found as the sum of products of norms of points for correct answers and of correlation of time, actually spent T^n_f and the norm of time T^n_{norm} for the correct answer [4].

The model of minimization of systematic inaccuracies of *measuring conditions* in the process of accumulation and statistic processing of testing results matrixes, connected with the necessity of increasing the feedback efficiency by means of adaptation to the measuring environment is formulated as follows

$$\Delta^*_{e34}(Actual^a_s) \to \min \ , \qquad (13)$$

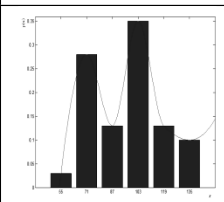
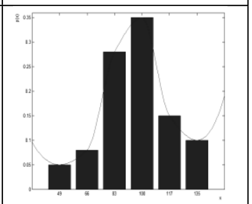
where $Actual^a_s$ are indices, used in the metrical channels of automated system of knowledge quality diagnostics and actualized taking into account the environment, where the measuring are made – on the basis of accumulated measuring results of professional readiness of the testees with rather stable knowledge [6].

The authors carried out a phased comparative analysis of a part of methodologies and algorithms (created by the authors) of improving the methodology of automated testing control of professional readiness concerning: their influence on the reduction of component evaluations of entropic values of the inaccuracy Δ^*_{ei}, as well as definition on the basis of received indices of entropic coefficient k_i and antikurtosis χ_i of superpositions of laws of random value distribution (total number of points, received as result of the testing session), which characterize measuring inaccuracies Δ^*_{ei}. Calculations were based on results of 100 testing sessions.

Results of the analysis of main characteristics of inaccuracies $SUP(\Delta^*_{e11}, k, \chi)$ on the stage of testing material formation, connected with the low objectivity of expert interpretation of quantitative indices of testing tasks complexity level, in the process of classic (expert) scaling (Method 1) and definition of testing task complexity with the use of methodology (suggested by the author) of minimization of systematic progressing subjective inaccuracies in the process of testing tasks scaling (Method 2), is presented in the table 2.

Table 2

Results of the analysis of inaccuracies main characteristics $SUP(\Delta^*_{e11}, k, \chi)$ on the stage of testing material formation

	Method 1	Method 2
Characteristics of measuring inaccuracies	*SUP* (40,00; 1,91; 0,61)	*SUP (41,53; 2,01; 0,55)*
Characteristics of superpositions of distribution laws	 *Fig. 2, a*	 *Fig. 2, b*

According to the received results the positive change tendency is seen. The composition of laws of random value distribution moves from the superposition of exponential and discrete two-modal (Fig. 2, *a*), which characterize the partiality of measuring as a result of a "dip" of average values of total points quantity to the symmetrical exponential law (Fig. 2, *b*); the absolute value of evaluation of entropic indices of inaccuracy showed a slight increase. It testifies the necessity of improving the methodology of finding the index of actual time for giving the correct answer.

Thereby, the authors analyzed the inaccuracies of measuring conditions and of feedback efficiency increase, connected with the necessity of considering the measuring environment peculiarities Δ^*_{e34}.

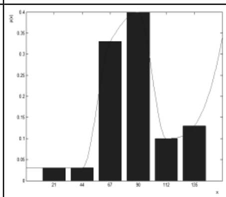
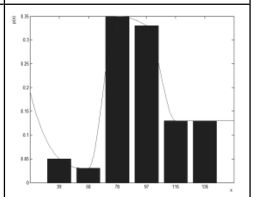
Results of the analysis of influence of methodology of this index actualization T^n_{norm} with the use of statistic material about the results of correct answers of testees with the high degree of knowledge stability testify: the contraction of uncertainty interval (decrease of irreversible losses of information) in average by 4%; distortion of the law of random value distribution under the influence of the introduced operating parameter (adaptation methodology) from the symmetric exponential to the symmetric, close to trapezoid.

This fact testifies the appearance of a sharp differentiation of testing results, possibly connected with the absence of account of individual peculiarities of thinking and information perception of particular testees.

Results of inaccuracies analysis $SUP(\Delta^*_{e32}, k, \chi)$ on the stage of interpretation of results matrix, methodical inaccuracies, connected with the low adequacy of measuring results to the real knowledge of a testee Δ^*_{e32} with the use of classical methodology of correction on the possible guessing of the right answer (Method 3) and the adaptive methodology (suggested by the author) of identification of testing results and students' motivation (Method 4) are presented in the table 3.

Table 3

Results of the inaccuracies analysis $SUP(\Delta^*_{e32}, k, \chi)$ on the stage of interpretation of results matrix

	Method 3	Method 4
Characteristics of measuring inaccuracies	*SUP*(47,73; 1,83; 0,51)	*SUP*(45,52; 1,94; 0,51)
Characteristics of superpositions of distribution laws	 *Fig. 2, c*	 *Fig. 2, d*

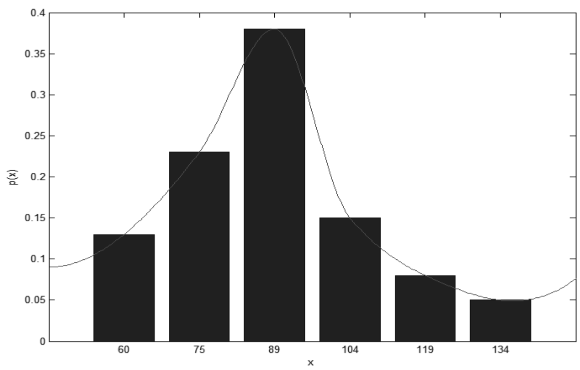


Fig. 2, e. Results of minimization of subjective, methodical and instrumental inaccuracies of measuring of quality of testing results identification

Data, given in the table, testify the contraction of the uncertainty interval (decrease of irreversible losses of information) in average by 9%; displacement of the law of random value distribution under the influence of the introduced operating parameter to the superposition of exponential and discrete two-modal (Fig. 2, *c, d*), which testifies about the still existing sharp differentiation of testing results in the process of introducing the correction coefficient, which slightly smoothes as a result of using the methodology suggested by the author.

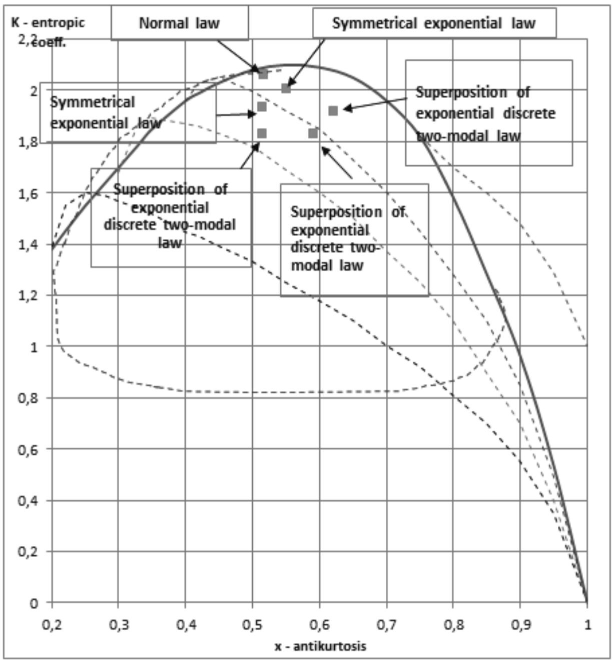


Fig. 3. Instrument of defining the empirical superposition of laws of inaccuracies distribution in the exchange channels of systems of professional readiness diagnostics

Results of the analysis of influence of the methodology of using the net (excluding the technical) time of testing tasks fulfillment on the measuring inaccuracies on the stage of technical support of the process of evaluation of testing material quality Δ^*_{e13} testify (Fig. 2, *e*): the contraction of the uncertainty interval (decrease of irreversible losses of information) in average by 15% in comparison with the inaccuracy, calculated without considering the methodologies (suggested by the author) of improving the testing control theory on the stage of identification of testing results SUP(36,40; 1,83; 0,59); smoothing of the differentiation of testing results (decrease of the index σ_4^2).

As a result the instrument was received – to define the empirical superposition of laws of inaccuracies distribution in the networks of professional readiness diagnostics, which allows analyzing measuring inaccuracies and the corresponding laws of distribution of measurable values (on the Fig. 3, there are examples of superposition of above-analyzed stages of inaccuracies minimization in the channels of automated system of professional readiness control).

Conclusion. Received results testify the efficiency of the developed methodology of inaccuracies minimization in the exchange channel of information and telecommunication networks of automated systems of professional readiness quality diagnostics, which allows receiving a significant increase of reliability and precision of methods of control and provision of information authenticity on the stages of testing material preparation, organization and realization of testing session, testing results identification.

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Мета. Підвищення рівня достовірності комп'ютерного тестування спеціалістів у сфері професійної освіти. Формалізація математичних моделей і алгоритмів похибок машино-людської взаємодії в усіх ланках системи обміну даними в інформаційній мережі автоматизованої системи діагностики якості професійної підготовки.

Методика. Методика досліджень базується на методах системного аналізу й загальної теорії систем, а також основних положеннях теорії вимірювань та автоматичного управління.

Результати. Структурний аналіз причин дезінформації в системі автоматизованого тестування та класифікація параметрів оцінки достовірності інформації у вимірювальних каналах системи обміну даними в інформаційній мережі тестового контролю професійної підготовки; розробка критеріїв оцінки достовірності інформації, адаптивних алгоритмів і математичних моделей мінімізації похибок вимірювань машино-людської взаємодії у трактах обміну інформаційно-телекомунікаційних мереж автоматизованих систем тестового контролю.

Наукова новизна. Полягає в постановці та вирішенні проблеми підвищення надійності й точності методів контролю та забезпечення достовірності інформації шляхом розробки методології мінімізації похибок вимірювань у системах машино-людської взаємодії, використовуваних для діагностики якості професійної підготовки.

Практична значимість. Полягає в отриманні науково обґрунтованого інструментарію, що представляє собою систему моделей і алгоритмів мінімізації незворотних втрат інформації у трактах обміну інформаційно-телекомунікаційних мереж і спрямованого на комплексне поетапне підвищення основних показників якості діагностики: надійності та валідності тесту, ефективності організації тестового сеансу й об'єктивності ідентифікації результатів тестування; у розробці інструменту визначення емпіричної суперпозиції законів розподілу похибок на підставі показників ентропійного коефіцієнта та контрексцесса.

Ключові слова: *похибка, машино-людська взаємодія, автоматизована система, діагностика, алгоритми, тестовий матеріал, суперпозиція, ентропійний коефіцієнт*

Цель. Повышение уровня достоверности компьютерного тестирования специалистов в сфере профессионального образования. Формализация математических моделей и алгоритмов погрешностей машино-человеческого взаимодействия во всех звеньях системы обмена данными в информационной сети автоматизированной системы диагностики качества профессиональной подготовки.

Методика. Методика исследований базируется на методах системного анализа и общей теории систем, а также основных положениях теории измерений и автоматического управления.

Результаты. Структурный анализ причин дезинформации в системе автоматизированного тестирования и классификация параметров оценки достоверности информации в измерительных каналах системы обмена данными в информационной сети тестового контроля профессиональной подготовки; разработка критериев оценки достоверности информации, адаптивных алгоритмов и математических моделей минимизации погрешностей измерений машино-человеческого взаимодействия в трактах обмена информационно-телекоммуникационных сетей автоматизированных систем тестового контроля.

Научная новизна. Состоит в постановке и решении проблемы повышения надежности и точности методов контроля и обеспечения достоверности информации путем разработки методологии минимизации погрешностей измерений в системах машино-человеческого взаимодействия, используемых для диагностики качества профессиональной подготовки.

Практическая значимость. Состоит в получении научно обоснованного инструментария, представляющего собой систему моделей и алгоритмов минимизации необратимых потерь информации в трактах обмена информационно-телекоммуникационных сетей и направленного на комплексное поэтапное повышение основных показателей качества диагностики: надежности и валидности теста, эффективности организации тестового сеанса и объективности идентификации результатов тестирования; в разработке инструмента определения эмпирической суперпозиции законов распределения погрешностей на основании показателей энтропийного коэффициента и контрэксцесса.

Ключевые слова: *погрешность, машино-человеческое взаимодействии, автоматизированная система, диагностика, алгоритмы, тестовый материал, суперпозиция, энтропийный коэффициент*

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