

# The Method for Self-Analysis of the Level of a Technology Teacher's Research Skills Development

## El método para el autoanálisis del nivel de desarrollo de habilidades de investigación de un profesor de tecnología

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#### ABSTRACT:

The relevance of the research is conditioned by the necessity of expanding social-pedagogical, psychological-pedagogical knowledge, and mastering teachers' practical skills in the research activity. The objective of the article is to present qualitative and quantitative analysis of the research findings on revealing the formedness level of technology teachers' research skills based on reflexive methods of self-assessment according to five-component structure of pedagogical activity. Method: Self-assessment and expert assessment are the leading methods of the research. Findings: Looking at research skills as a five-component structure of pedagogical activity: gnostic, projecting, constructive, communicative, and organizing skills, the authors have revealed the levels (low, middle and high) of maturity in teachers of technology. During the experimental work it was found out that for the effective self-assessment of their research activity, teachers need to make it an object of realization, analysis and estimation, which means that a teacher should be able to enter a methodological and methodical position. The data analysis has shown that a teacher needs dialectic help of university scientific associates who supervise

#### RESUMEN:

El objetivo del artículo es presentar un análisis cualitativo y cuantitativo de los resultados de la investigación sobre la revelación del nivel de formación de las habilidades de investigación de los docentes de tecnología basadas en métodos reflexivos de autoevaluación según la estructura de cinco componentes de la actividad pedagógica. Método: la autoevaluación y la evaluación de expertos son los métodos principales de la investigación. Hallazgos: Al considerar las habilidades de investigación como una estructura de cinco componentes de la actividad pedagógica: habilidades gnósticas, de proyección, constructivas, comunicativas y de organización, los autores han revelado los niveles (bajo, medio y alto) de madurez de los profesores de tecnología. Durante el trabajo experimental se descubrió que para la autoevaluación efectiva de su actividad investigadora, los docentes deben hacer de ella un objeto de realización, análisis y estimación, lo que significa que un docente debe poder ingresar a una posición metodológica y metódica. El análisis de los datos ha demostrado que un maestro necesita ayuda dialéctica de los asociados científicos universitarios que supervisan la escuela en metodología de

school in pedagogical research methodology and methodical issues; it is necessary to arrange individual approach to each teacher who takes up research activity by rendering special consultations, practical assistance from specialists, methodologists, educators. The article substantiates dependence of a teacher's research activity efficiency on the level of correspondence of real pedagogical activities aimed at researching the problems of teaching and educational process, with their expediency in the real conditions of teacher's activity. Improvements: The materials of the article are of practical value for educators of higher educational institutions that implement educational programs in the 'Pedagogical Education' field, and also for research teachers.

**Keywords:** teacher's research skills, teacher's self-reflection, self-assessment.

investigación pedagógica y cuestiones metódicas; es necesario organizar un enfoque individual para cada profesor que emprenda una actividad de investigación mediante consultas especiales, asistencia práctica de especialistas, metodólogos, educadores. El artículo corrobora la dependencia de la eficacia de la actividad de investigación de un docente en el nivel de correspondencia de las actividades pedagógicas reales dirigidas a investigar los problemas de la enseñanza y el proceso educativo, con su conveniencia en las condiciones reales de la actividad docente. Mejoras: Los materiales del artículo son de valor práctico para los educadores de las instituciones de educación superior que implementan programas educativos en el campo de la "Educación Pedagógica", y también para los profesores de investigación.

**Palabras clave:** habilidades de investigación del docente, autorreflexión del docente, autoevaluación.

## 1. Introduction

The research goal is to find out the formedness level of technology teachers' research skills based on reflexive methods of self-assessment.

The research objective is to reveal the structure of technology teachers' research skills, as well as to present qualitative analysis of the research findings obtained.

The research hypothesis is the following: the self-assessment methodology of technology teachers' research skill formedness allows a technology teacher to realistically evaluate their research activity.

According to I. Menter and J. Murray (2012), one of the problems of insufficient research in pedagogical education is that new educators usually face the problem of shifting to academic activity without appropriate research skills and readiness to deliver high-quality research results. [1]

V. V. Kraevsky (1991) makes an assumption that not only a scientist, but each practicing educator should be able to give a scientific description of their pedagogical activities and the background at the phenomenon level and even at the essence level. Herewith, the scientist does not focus merely on the research activity, but at the research creative activity because the difference between a teacher (practicing scientist) and a theorist scientist is that a teacher does not only research a process or a phenomenon but also introduces this into practice being a creator of their research idea. [2]

According to T.M. Willemse (2013), researches made by educators are considered important for their professional development, their actual pedagogical practice and their scope of knowledge. Educators emphasize the necessity of creating scientific associations where they could cooperate in scientific research field, develop their skills, cultivate common language and make their input in forming knowledge base in pedagogical education field [3].

In his research, A. I. Kochetov (1996) comes to conclusion that "each pedagogue is able to create a researcher out of themselves and to cultivate: lateral pedagogical thinking; ability to foresee, forecast after-effects of pedagogical measures taken; objectivity of mind, which means finding the reasons of failures and their future prevention; ability to create multi-variant methods to solve the same pedagogical task; analytical approach to any pedagogical problem; contact methodology of interaction with children" [4].

Considering a contradiction between cognitive theory and learning theory, P. Cobb, J. Bowers (1999) outline prospects for educators who take up research in class and scientific research in cooperation with educators of psychological pedagogical disciplines. They look into the potential input of these two aspects into academic practice opposing them with different formulations of interrelation between theory and practice [5].

## 2. Literature review

V. I. Zagvyazinsky (1980) maintains that a teacher is to first adopt what has been

discovered by science. Pedagogical process is so mobile, dynamic, and dialectical that one is not able to comprehend all the mysteries of pedagogy once and forever. The thing that has efficiently worked today turns out to be insufficient or even inapplicable tomorrow. [6, p .9]

All this requires constant analysis, assessment of the chosen teaching and education methods, and results of studying activity in a teacher's transforming activity; in turn, this characterizes the relation of transforming activity to other aspects, that is, gnostic and control-evaluating ones.

Researchers of problems of teacher's attitude to psychological pedagogical knowledge have discovered that there is a real connection between a teacher's need for new knowledge, the level of professional self-awareness and self-assessment development, and the general value system in professional sphere. [7, 8]

The basis of a teacher's selectivity and preferences in knowledge is their recognition of the importance of the professional functions: the wider the range of practical problems a teacher recognizes as professionally important is, the ampler their requirements for knowledge are, the wider their professional reading scope is. [9]

Fred A. J. Korthagen (2004) emphasizes methodical assistance to a teacher from a mentor on the basis of researching the problems of a teacher's professional growth. [10]

The fact that the activity itself is a teacher's special subject of analysis, comprehension and assessment allows one to characterize this process as pedagogical reflection. Reflection is a principle of human thinking referring one to comprehension and recognition of their own forms and premises; an objective consideration of knowledge itself, a critical analysis of its content and cognition methods; self-actualization activity that discloses internal structure and specifics of a human spiritual world. [11, C. 396]

A so-called normal duality of consciousness underlies the psychological mechanism of reflection, when a person for themselves is both an object of reflection and its subject who regulates their own actions and behavior. According to L. S. Vygotsky (2005), interiorizing the forms of social relations between people, a person simultaneously exercises control and performing functions, while the control function can be aimed at oneself. [12]

In a teacher's professional and, especially, research activity, reflexive processes reveal: first, in the process of practical interaction of teacher and students, when a teacher strives to adequately understand and pointedly regulate students' thoughts, feelings and actions; second, in the process of projecting the students' activity when a teacher elaborates academic goals and constructive schemes of their achievement, while he/she elaborates them with due account for the students' psychology and their abilities to develop; third, in the process of self-analysis and assessment of their own activity by a teacher and themselves as its subject. At the same time, a teacher helps students to evaluate and comprehend their own activity, which means treating it reflexively.

Reflexive processes in teacher's activity are defined also by the fact that the individual activity of any teacher makes sense only in the general system of teaching and educational process. On the one hand, a teacher continuously compares their experience with the experience of other teachers and with achievements of pedagogical science while organizing their individual activity; on the other hand, they make their own contribution to mass pedagogical experience development, sharing their individual achievements with others.

Yu. N. Kulyutkin and G. S. Sukhobskaya (1990) identify the most distinctive features of reflexive processes implemented by teachers in the 'me and others' system, a subject matter of analysis being one of them, which is a practical solution obtained from other teachers' experience or from their own activity. [13, p.74].

Thus, reflective processes take place in the whole professional activity of a teacher and require constant analysis of their own pedagogical activity, comparing it to other teachers' experience and achievements of pedagogical and psychological sciences, critical evaluation of their failure and success.

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### 3. Methods

The 'Technology' Department of North-East federal university named after M.K. Ammosov has served as the experimental facility for the research. The research sample consisted of technology teachers. 140 respondents were involved in total.

In order to assess teachers' self-evaluation on research skill formedness, the authors conducted a survey when teachers were proposed to evaluate according to a scale from one to five the level of research skill formedness on the following components of pedagogical activity: gnostic, projecting, constructive, communicative and organizing skills.

The content of gnostic skills is an ability to distinguish the problems of teaching and educational process and give reasons for them; to give ground for one's choice of a research topic; to choose literature on the research topic; to conduct analysis and synthesis of main ideas, to form a system of concepts in the literature studied; to comprehend and formulate goals and objectives, hypothesis, object and subject of a research; to use research methods; to restructure a research based on newly found scientific information; to analyze and summarize the research findings.

Projecting skills can be characterized as a skill to project the innovative methods of pedagogical influence under investigation aimed at students' personality development; to foresee possible difficulties while planning a research; to plan one's research activity with due account for personal abilities; to connect the topics of one's own research to the concept of innovation school development; to plan the sequence of scholarly work execution.

Constructive skills are skills of research method selection in order to solve the strategic, tactical and operative tasks; to distinguish the main, key task for a specific research objective; defining the research direction at its different stages; restructuring the academic paper whenever necessary; foreseeing the study results and correlating them with the results obtained by other researchers in the same and related fields of science.

Communicative skills include skills to establish creative cooperation with colleagues, methodologists and teachers from other institutions; to adopt the requirements of research and methodical counsels, school administration; to establish appropriate relationship with students during the research process; to generate sustainable interest in their research, to share the findings; to ensure a creative atmosphere during a scientific search.

Organizational skills reflect skills of organizing the research activity so that it facilitates professional growth; in organizing a complex study of a research problem; in controlling the scientific work progress and condition; in rational time allocation for scholarly work; in organizing the research and methodical counsel's assignments fulfillment on research topics carefully and in due time; in self-organization, self-regulation and independence of the scientific activity.

The criteria of self-assessment are the following indicators: very good (5) – research skills are always evident, in any situation; good (4) – research skills are evident in a number of types of situations; average (3) – research skills are evident in familiar situations; weak (2) – research skills are insufficiently evident in familiar situations; not formed (1) – research skills are not evident.

While conducting the research to define the formedness level of teachers' research skills, their ability to recognize and implement the research skills in the professional activity aiming to ensuring as objective as possible evaluation of research skill formedness level, the authors used expert assessment on a scale from one to five. A group of experts consisted of university professors who had taught teachers at a problem seminar. The comparison was made in terms of each skill by an average grade.

While organizing the research, the authors proceeded from two assumptions:

- 1) recording a teacher's endeavor and skill to enter methodological and methodical reflexive position or, possibly, recording a presence or absence of a research activity in them;
- 2) monitoring a teacher's reflexive activity or, possibly, finding out the research skill development level.

It was suggested that the teachers should analyze in writing difficulties related to research activity. In the second task, it was proposed to conduct self-assessment of the research skill

formedness. A teacher's self-assessment was compared to the expert assessment for study validity. In the third task, it was proposed to elaborate a short-term program of self-development as a research teacher and, optionally, a program for a longer term.

The following individual indicators were measured for all the teachers:

- 1) the adequacy degree of the development program as a research teacher each teacher elaborated individually based on correlative analysis of the outcomes of the first and second assignments;
  - 2) readiness to enter a reflexive position, the ability to conduct a proper self-analysis were identified during an individual interview.
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## 4. Results

Methodological and methodical reflection is of an interest in the context of the study. Methodological reflection gives a research teacher an opportunity to critically comprehend and improve their scientific work. Methodical reflection is viewed from the position of a teacher conducting an analysis of research experience of other teachers aiming to adjusting their own research activity, an analysis of behavior and activity products of students with the purpose to assess their work and analyze their own research activity.

The survey results among teachers have shown that in their minds, seminars contribute to knowledge accumulation in methodology and methods of pedagogical research, broaden the horizon of a researcher, which is so essential to their research activity.

The knowledge gained have helped teachers in preparing their own research programs on individual thematic issues, for example, how to define a research problem, to find out the object and the subject, to formulate the hypothesis, etc.

In general, the experiment has shown middle level teachers' methodological and methodical reflexive position development. Most of them were able to productively evaluate their challenges, mostly mentioning insufficient knowledge in methodology of pedagogics (65%) and in skills to use statistical methods of research data processing (75%) as complicating factors in their research activity. While analyzing their difficulties, teachers also noted their mistakes determined by personal qualities, such as low emotionality, misconduct in class, erroneous choice of ways to interact with students (35%).

Some teachers named time shortage as a complicating factor (25%), although this is a result of their poorly developed ability for self-management, self-organization, but not a cause of difficulties in the research activity. Besides a low level of self-organization, a low level of methodological and methodical reflection was also noticed in the same teachers - they did not express a desire to take up research activity.

Looking into methodological and methodical reflection from the position of endeavor and skills, the authors can note a difference in their development level. While a need for self-cognition as a researcher was displayed by almost all teachers (92.5%), the skill to analyze difficulties, errors, mistakes, to come up with specific ways to eliminate them was demonstrated only by 75% of the teachers. This is due to the fact that a teacher at school did not use to be required to be a researcher; therefore, a rare teacher used to turn to methodological reflection.

According to the research findings analysis, there are differences among teachers in terms of self-assessment of research activity development level and its expert assessment. In teachers of the first group, the self-assessment of research skills formedness is inadequate as compared to expert assessment by all the five components of pedagogical activity: it is overestimated by gnostic, projective, communicative skills and underestimated by constructive and organizational skills. In teachers of the second group, self-assessment is adequate to expert assessment by gnostic skills and is underestimated by all the other ones.

In terms of the expert assessment in teachers of first group, communicative and organization skills turned out to be the best formed, while in teachers of the second group communicative skills did. What the teachers of the first group appraise the highest themselves is the formedness of communicative skills, while the teachers of second group

emphasize gnostic skills.

Thus, both expert assessment and self-assessment of research skills formedness level in teachers has shown that its average level is insufficient. The assessment has also shown that the average level of research skill formedness in teachers may vary depending on their pedagogical experience. Analysis has shown that the lowest level of research skill formedness is found in teachers who have work at school for less than five years.

Thus, teachers from this category of the first group overestimate the research skill formedness level in terms of gnostic and projective skills, while they underestimate it in terms of constructive, communicative, organizational skills; all the components of pedagogical activity are underestimated by the teachers of the second group through self-assessment.

What is the best formed in the first group of teachers, according to expert assessment, is communicative skills, while projective skills are the most poorly formed, and, accordingly, by self-assessment, gnostic skills are the best formed and projective skills are the most poorly formed. According to expert assessment, in teachers of the second group, gnostic skills are the best formed and constructive skills are the most poorly formed, while according to self-assessment, gnostic skills are the best formed and constructive and organizational skills are the most poorly formed.

Dependency between research skill formedness and pedagogical experience is reflected in the fact that young teachers are confident of their command of methodology and methods of pedagogical research, but insufficient pedagogical experience does not allow them to rationally fulfill theoretical tasks in research activity. Teachers of the senior generation are experienced practicing educators are very well placed in terms of implementing innovation and creativity. They are perfectly aware of their possessing incomplete theoretical knowledge; therefore, they strive to enhance their scientific potential by problem seminars, courses on problems of pedagogical research, self-education, through creative union with academic advisors of methodical associations. Analysis has shown that the lowest level of research skill formedness in the teachers of both groups, regardless their pedagogical experience, occurs in constructive skills: to identify the essentials, the fundamentals for a specific research objective, to establish a research trend at its different stages, to restructure the academic paper if required. In terms of skills to select appropriate research methods for solving strategic, tactic and operative tasks, by skills to foresee research findings and compare them with the results obtained in their other studies and related fields of science, the second group of teachers did not appraise themselves as highly as the first group of teachers. Comparison of the results of self-assessment and expert assessment by constructive skill formedness reveals that experts appraise teachers more highly than the teachers themselves by each of the skills; this is with the exception of the first group teachers of II and IV categories who overestimated themselves.

It is characteristic that by the level of self-estimation adequacy, the second group of teachers views their potential more realistically. These indicators, as well as the analysis of quality parameters of teachers' goal-setting in programs of self-development as a research teacher given by them have shown that the second group of teachers possesses a higher level of reflexive activity as compared to the first group of teachers.

In the self-development programs, teachers of both groups emphasized an important need for developing experience and experimental work connected with approbation of new technologies and new academic programs. Besides that, the second group of teachers set the goal to study other teachers' experience, to learn at seminars and courses on pedagogical research problems at schools. Analyzing their challenges and failures, they were planning self-educative work in pedagogics, psychology, and their major.

**Table 1**

Average data on expert assessment and self-assessment of technology teachers of the control and experimental groups of the research skill formedness level

<b>Research skills</b>	<b>Control group I</b>	<b>Experimental group II</b>

	Average grade		Average grade	
	Self-assessment	Expert assessment	Self-assessment	Expert assessment
Gnostic	3.9	3.7	3.9	3.9
Projective	3.9	3.6	3.6	3.8
Constructive	3.2	3.3	3.2	3.4
Communicative	4.2	3.9	3.7	3.9
Organizational	3.5	3.7	3.6	3.8

Statistical analysis and pedagogical comprehension of this experiment has allowed the authors to make the following conclusions.

Teachers' knowledge of methodology and methods of pedagogical research, ways to organize research work following specific practical recommendations is one of the conditions of their research activity development because knowledge encourages a teacher to enter methodological and methodical reflexive position.

## 4.1. Discussion

In pedagogical and psychological literature, there are various approaches to evaluating the place and role of research skills in teacher's activity.

In a row of studies, a direct connection between rendering scientific and research activity of a teacher and the research components of a teacher's activity can be observed.

V. A. Slastenin (1976) defines pedagogical research skills as skills to monitor and analyze pedagogical phenomena (facts) and, based on this, to write and solve pedagogical problems; to make a hypothesis; to elaborate and conduct an experiment; to process and summarize the findings of the experiment; to summarize the material as a report, abstract, paper; to work with source material; to use the track record of allied pedagogical sciences [14, p.42].

Other studies emphasize the specifics of pedagogical activity that is displayed in a teacher using the framework of scientific research, more specifically, research components involvement into the structure of actual activity, their tight internal connection.

Thus, S. I. Kudinov (2005), while studying the characteristics of a teacher's gnostic activity, singles out four groups of gnostic skills depending on the object of analysis. The need to analyze all the indicated types of activity while preparing of a lesson class and conducting it, in the authors' opinion, is a sort of a teacher's research position. [15]

In the current research, the authors have come to a conclusion that in order to develop reflexive position in teacher's research activity, seminars alone are surely not enough. There is a need for a tight creative association of teachers with advanced training institutions who would arrange courses on pedagogical research problems at schools, and also with an academic advisor, both of the whole school and certain departments in order to provide for individual and group teachers' research activity development forms.

K. Goodnough (2016) upholds this statement of the research. According to him, educators who take part in collaborative studies together with teachers to alter their practice achieve more attractive and practical learning process. [16]

Academic teaching staff of the School of Engineering Sciences and Technologies, Science and Education in Indiana University Purdue University Indianapolis (IUPUI) (2016) elaborated a model that includes intensive training for teachers in carrying out research and elaborating a research program for its implementation during the academic year. [17]

It is considered important to organize individual approach to each teacher who works on a research problem. Using scientific and pedagogical staff of higher school is a tangible ground for the tightest integration of pedagogical science and school practice, for a shift to new forms of interaction.

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## 5. Conclusion

The data obtained allow for a statement that in order to develop methodological and methodical reflection, is a teacher's self-realization as a researcher, their self-education and self-training are an essential pedagogical condition.

In course of the experimental work it has been found out that teachers display deflated, adequate and inflated self-assessment of their research activity. For effective self-assessment of their own research activity, a teacher needs to make it an object of comprehension, analysis and assessment; this means a teacher should have a skill to enter methodological and methodic position.

The analysis of these researches has shown that a teacher needs didactic assistance in methodology and methods of pedagogical research, as well as a close creative association with academic advisors; it is also necessary to ensure individual approach to each teacher who takes up research activity by means of organizing special consultations, practical support from specialists, methodologists, professors.

J. Dengerink (2015) outlined problem questions that are of interest for teachers. In his project, he elaborated 'education profiles' for four categories of educators. These profiles can help create more significant mechanisms for primary pedagogical training of educators and their further professional development in conditions when pedagogical education should have scientific research orientation. [18]

C. Hui (2017) notes that the modern paradigm of education development issues new requirements for professional and personal qualities of a teacher. Academic competency of future teachers is the key characteristic providing for these skills. Properly organized research activity of future teachers of science promotes not only the development of their research competency, but also their self-confidence as professionals, and, hence, maintains their motivation for future perfection in the field of teaching. [19]

Therefore, it is arguable that teacher's research activity will gain momentum provided the following groundwork is laid:

- - orientation of a teacher's research activity formats and forms to an integration of theoretical knowledge and practical skills aiming to realization, analysis, comprehension of the process and results of their own research activity, namely, with the goal to be able to enter to methodological and methodical reflexive position;
  - - organization of scientific and practical interaction and cooperation of all the subjects of educational activity: teachers, researcher scientists, methodologists, administrative staff;
  - - ensuring teachers' theoretical and practical training for research activity implementation that is targeted at developing knowledge, competence and skills in the fields of pedagogical research and facilitating further professional growth as a research teacher.
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## Notes

1 The quantitative values of the criteria are expressed both in physical and value terms that characterize the results achieved using public funds or the activity of the evaluated object.

2 The qualitative values of the criteria include characteristics of various aspects of the use of public funds or the activities of state bodies, such as, for example, the compliance of these activities with the provisions of regulatory legal documents; the required quality of operation of control and monitoring systems; the execution of established rules and procedures; the implementation of the developed measures.

3 Relative values of the criteria are expressed in the correlations between the various results achieved in the activities of government agencies or in the audited sphere of using public funds, and characterize their state. For example, this is the level of cost effectiveness and profitability, the share of university graduates who received a diploma with honors, the unemployment rate.

4 Dynamic values of the criteria reflect changes in both quantitative and relative values for certain periods of time. For example, this is the rate of increase (decrease) in products and services, profit and return, fertility and mortality.

5 The sum method is based on the summation of the actual absolute changes in the indicators. The disadvantage of the sum method is the possibility of a high evaluation of the results by the integrated index with a significant lag in



some particular indicator, which is covered by high achievements in other particular indicators.

6 The geometric mean method is based on the determination of the coefficients by partial indicators, when the highest value of this indicator is taken as a unit. It is advisable to apply this method with a relatively small number of indicators to be evaluated, and if most of their values are close to unity.

7 The assessment is obtained by multiplying the corresponding relative indices.

8 The sum-of-places method assumes preliminary ranging of each object of the analysis depending on a level of the investigated indicators. The number of places should be equal to the number of organizations analyzed. The smaller the sum of places, the higher rank is assigned to the analyzed object.

9 The use of methods of sums, sums of places, geometric mean is possible only in the case of unidirectional influence of all the estimated parameters on efficiency, i.e., the increase (decrease) in the value of any particular indicator is regarded as an improvement in the results of economic activity (and vice versa). Otherwise, when calculating the indicator of integrated assessment, the indicators that are reverse to the original values are taken as criteria.

10 The prerequisite for using the comparison technique is to ensure comparability of data, which is very important for budgetary expenditures, when the result of a measure can be expressed in physical terms. It can be based on: 1) normative values of indicators, achievement of which indicates the efficiency of using budgetary funds; 2) similar indicators of previous periods, obtained, for example, in the neighboring regions, at related facilities, in similar processes and in foreign practice.

11 The criterion for selecting 'sufficiently strong' correlations can be both the absolute value of the correlation coefficient itself (from 0.7 to 1), and the relative value of this coefficient, determined by the level of statistical significance (from 0.01 to 0.1), depending on the sample size. In small samples, for further interpretation, it is more correct to select strong correlations based on the level of statistical significance. For studies that are carried out on large samples, it is better to use absolute values of the correlation coefficients

12 The conceptual apparatus of synergetics allows explaining consistently the dynamics of endo- and exogenous factors in the development of system processes and, in particular, explaining the cyclical nature of development processes, phase transitions in dynamics, the periodic dominance of internal (necessary) forces and external (random) growth factors. Synergetics and the theory of self-organization give a new methodological basis for solving the problems of sustainable development of economic processes.

13 Systemic analysis in the narrow sense is a set of methodological tools used to prepare and substantiate decisions on complex problems of political, military, social, economic, scientific, technical nature; in the broad sense, the term 'systemic analysis' is sometimes used (especially in the English-language literature) as a synonym for the systemic approach.

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