

Construction of the Detector for Synergetic Educational System Based on Quality Standards

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Abstract The article is an exposure to the construction of the detector for synergetic educational system. The structure of the detector is determined based on the international quality standards ISO, European standards of the quality management in education, and qualifications frameworks. The suggested detector forms the basis for defining the technology of teaching Stochastics to future economists.

Keywords: *synergetics, detector, attractor, training system, stochastic, standard quality management, educational technology, training economists*

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1. Introduction

Synergetics deals with systems composed of many subsystems which may each be of a very different nature, in particular, synergetics treats systems in which cooperation among subsystems creates organized structure on macroscopic scales (Haken 1993). According to V. Budanov [1], adaptive resource of synergetics is

- the use of Synergetics as Postnonclassical research direction that allows to find adequate answers to global challenges faced by modern civilization;
- the relationship with mathematics;
- openness to new images and concepts, which are formed in a wide range of science;
- interdisciplinary tolerance to new methods and hypotheses, search for adequate contexts;
- constant development;
- philosophical reflexivity and dialog.

Synergetic methodology is widely used in scientific research, conducted in various fields of science. Modern educational systems, which include stochastic education system, can also be researched using synergetic methodology of knowledge based on universal laws of nonlinear dynamic open complex systems capable of self-organization in non-equilibrium environments [1,2].

Methodical system of teaching Stochastics future economists is a synergetic system [2,3,4], which significantly influenced by external factors. Changes in the functional principles of educational environments of universities are the main external factors that determine the structure of the methodical system of training the stochastic. The most influential of these is *an orientation on a subject in learning* serving as a basis for self-organization of synergetic education systems, *holism* as a provider of the synergetic structural units, and *openness* as a guarantee of

non-linearity, dynamics, and the education system variability.

Synergetic methodical system of teaching Stochastic to economics students moves from chaos (that cause external influences and internal fluctuations) to order (which is achieved through self-organization in the system). In this way, the system is able to build any of the bifurcation dissipative structures that could potentially arise in the depths of the relevant existing structure as a result of the loss of stability. These structures are called *thesaurus*. The structure of dissipative structures thesaurus can be determined based on the activity approach as the interaction of the triad components: value (motivation, motives, goals), cognitive-instrumental (principles, contents and tools of knowledge management), and predictive (reflection, monitoring, analysis, evaluation, adjustment results).

The particular qualities of the interaction between the environment and thesaurus determined the *attractor*, which is a set of relatively stable states of the system evolution. With the existing thesaurus, under the influence of the environment and the attractor there was formed a limited bifurcation combination of the elements that are the most optimal for the further evolution of the system. The choice of the future structure of the system depends on the *detector*. The detector is defined as a group of tools that make it possible to select from an existing thesaurus optimal dissipative structures to facilitate the transition of the course stochastic system in the homeostatic state.

Let us consider the possibility of forming the detector methodical system of teaching Stochastics on the basis of the principles and guidelines underlying the international standards: standards of quality management ISO 9000, Standards and Guidelines for Quality Assurance in the European Higher Education, international and national framework qualifications, National Strategy for the Development of Education, etc.

2. Theoretical Principles of the Quality Management System Construction

ISO 9000 was developed to help the institutions to implement and to ensure the effective functioning of the quality management systems. In general, there have been developed four types of standards that together form a coherent series of standards needed to create a coordinated national and international quality management system: ISO 9000:2005 describes the main provisions of quality management systems and specifies the terminology regarding data systems; ISO 9001:2008 specifies requirements for quality management systems aimed at monitoring the compliance with regulations and customer requirements for products supplied by the organization; ISO 9004:2009 is directed at identifying of the increasing efficiency of the quality management system; ISO 19011:2011 delivers guidance on auditing the quality management systems and environmental management.

The basis of the ISO 9000 was formed on the following eight principles: 1) focus on the customer, 2) leadership, 3) the involvement of employees, 4) process approach, 5) system approach to management, 6) continuous improvement 7) making decisions on the basis of facts, 8) mutually beneficial supplier relationships.

Based on the process approach, defining numerous interrelated processes at work, and systematic approach to the interaction between the elements of the process that determines the organization of quality management, we build a model quality management system (QMS) (Figure 1).

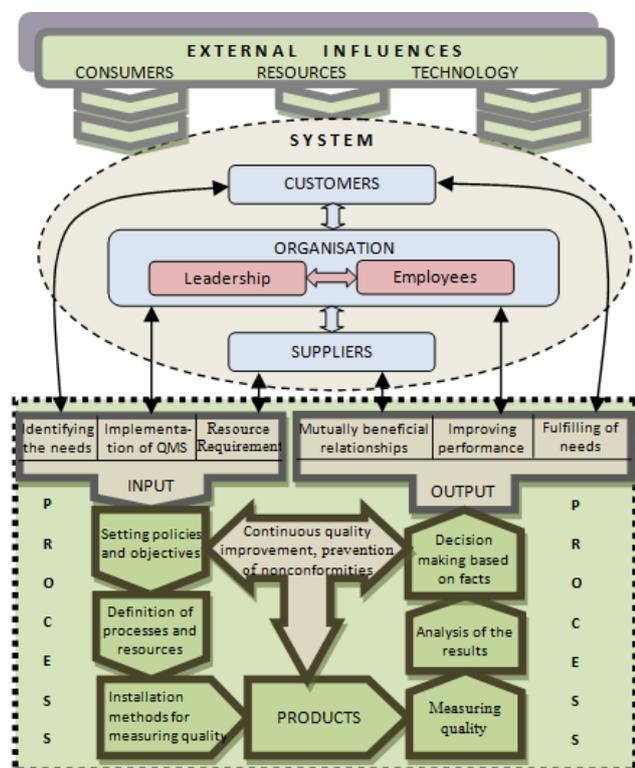


Figure 1. Model Quality Management System (QMS)

The basic units of meaning in the quality management system are:

- Quality (poor, good or excellent), which determines the degree of satisfaction of requirements (needs or expectations);

- Organization - identifies a group of people with specific responsibilities, authorities and relationships and the necessary means of production and control;
- The customer - the organization or person who receives the product;
- The supplier - organization or person that supplies products;
- The system as a set of interrelated or interacting elements, including the quality management system - a system that is designed for directing and controlling the activities of the organization concerning quality;
- Process as a set of interrelated or interacting operations that transforms inputs into outputs;
- Production - the result of a process executed in the prescribed method (procedure) that has four generalized categories of services, intellectual products, hardware, and processed materials;
- Documents regulating the management of quality, specifications, guidelines for quality, program quality, and quality testing protocols;
- Quality control at the expense of inspection, testing, verification, attestation, critical analysis based on specified programs, plan, criteria, and data [5,6].

3. Building the Detector Model of Teaching Stochastic to the Economics Students in the Universities

In the guidelines for the application of ISO 9001 in education it is stated [7] that this standard aims at helping the educational institutions in implementing effective quality management systems. Quality control is important for the education system, because it supports the effectiveness of the learning-teaching process through a permanent evaluation of educational programs and processes that support learning.

Let us consider the features of the creation the quality management system in teaching Stochastics to the economics students. Educational Institutions are three-level (university, school/faculty, and department) *organizations* that render educational services. To ensure their own competitiveness, education institutions should determine the policy and related procedures to guarantee the quality training programs and compliance with educational standards in training for the labor market. Development and implementation of the continuous quality improvement strategies should include participation of the communities, students and the parties interested in these processes [8]. The distribution of responsibility, authority and relationships in higher education is also based on the three-level hierarchy:

- *Leadership*: an educational institution is responsible for the policy, goals, and strategies to ensure the quality of the educational process; the development of procedures and criteria for the selection of a qualified and competent teaching staff; selection of the students who have proper training in the field of education; the guarantee of the resources required for the implementation of the educational process and those that meet the objectives and content of training programs. For effective quality assurance, university leadership should determine the necessary means to collect the data about their activities

and analyze them. Monitoring the quality of learning should reflect not only the achievements of students, their performance indicators and results of employment but also the level of their satisfaction with the educational programs they are engaged in, their evaluation of the teacher's work, availability of appropriate learning resources [8]. The training of the economist in the rapid growth of the information field presupposes the analysis of a significant number of indeterminate situations and random processes. Therefore, in this specialty curriculum there should be the discipline that provides the mathematical apparatus for the analysis and forecasting of accidents;

- *Teachers*: they are the most important educational resource available. The teacher is to know and understand their subject perfectly; to possess the necessary teaching skills and experience that will ensure the effective transfer of knowledge in the discipline and skills of its application in different situations; to be highly competent in the development of the plans of academic disciplines and curricula, the introduction into the educational process interdisciplinary connections; to have the ability of self-improvement, analysis of the latest achievements in pedagogy and the introduction of advanced technologies in the educational process. The main role of the teacher in the management of the quality of the educational process is to assess (current, interim, and final) a student's achievement in the discipline. The assessment procedure should be unbiased, impartial, objective, and consistent with the objectives and content of the discipline, unique, and regularly; the teacher ought to respect their students, regardless of their learning potential [9]. Stochastics teacher should provide teaching materials (lecture notes, guidelines for practical laboratory work, package tasks for tests, exams) on the following topics: *The empirical and logical foundations of the probability theory; Basic theorems of the probability theory, and their economic interpretation; The scheme of the independent trials; Random variables and their economic interpretation; Laws of distribution and numerical characteristics of random variables; Multidimensional random variables; Functions of random argument; Limit theorems of probability theory; Analysis statistical data parameter estimation distribution; Testing statistical hypotheses; The theory of regression; Analysis of variance; The theory of correlation; The theory of stochastic processes and queuing theory;*

- *Students*: they are an integral part of an organization that provides educational services. To ensure the quality of the learning process, students must study diligently and responsibly, fulfill the requirements written in the curriculum and programs of training. The acquisition of the knowledge of the academic disciplines requires a pre-formed knowledge base and skills. Thus, for the efficient assimilation of the course "Theory of Probability and Mathematical Statistics" the student should possess well-formed arithmetic skills, basic knowledge of the theory, the ability to solve problems using the apparatus of differential and integral calculus, and the ability to analyze graphical and tabular information. During training, a student must be provided with the necessary tools and mechanisms to support the educational process, tailored to the characteristics of the discipline and the students' needs. In order to be objectively assessed, students should be

informed about the assessment strategy and the assessment methods.

The tools for ensuring the quality of the educational process:

- *Technologies*: a) pedagogical - as new approaches to learning in general (changing education paradigm) and some of its manifestations (study of the effective mechanisms of educational process, formation requirements for technical support, etc.) develop the most appropriate methods and means used in teaching some disciplines; b) software - in the form of new developed programs of the academic disciplines that meet the requirements of the current state of science and technology as well as those of the new computer software training process; c) evaluation – setting development objectives, possessing reasonable tools for assessing knowledge that mostly exclude the possibility of bias in assessing the academic performance;

- *Resources* - a variety of printed (books, newspapers, magazines) and non-printed media (Internet access, electronic textbooks, visualization tools of learning process), equipment necessary for the actualization of the educational process, etc;

- *Human Resources* – institutions training personnel for educational institutions (managers, teachers, and students) should ensure the development of the competencies at the level required for the efficient performance of professional duties.

Customers in the educational sector these are the organization or person who receives products - highly competitive specialists capable of effective performance of their professional duties. Customers make demands on product creation, define specifications for the product and assess its quality and competitiveness. Thus, customers define the structure of the educational system attractors.

Attractor - a relatively stable state system, which directs all the set of trajectories, reflects the evolution of the possible ways. Through attractor, customers indirectly affect providers of educational systems, determining the direction of their services and manufacturing specifications of products. Customers in the education sector can be

Consumers - usually *students*. Students' requirements are formulated in the form of competences that they want to receive as a result of learning. Competence is defined as a demonstrated ability to apply knowledge and skills, a combination of relevant knowledge, experience, abilities that allow drawing justified conclusions about a specific field of activity, and to effectively act in it. Educational and professional competence of the economics specialists is key, industry-wide, and subject-specific competencies. A key competence is characterized by the readiness of graduates of the higher economic education institution to carry out complex multi-functional and culturally appropriate activities. Industry-wide competences are formed during mastering the content of any educational area and characterizing the readiness of graduates of higher economic education establishments to perform professional duties. Subject competence is formed in the course of learning a particular academic subject. Stochastics can distinguish deductive thinking, discipline and critical thinking; a creative approach to finding solutions to problems, intuition; self knowledge; the search and processing of information; construction of

mathematical models of real processes, their research; mathematical interpretation of research results, computing their errors; spatial representation;

- *Users* - individuals or organizations that have benefited from a young professional, usually *employers*. The requirements of the employers to the educational systems attractor are provided in the National Qualifications Framework (NQF), which is a tool in contact labor and education. NQF is a systemic and structured description of qualifications, educational levels, qualification standards for different levels and types, established on the basis of certain set of criteria. The main idea around which the requirements are formed is not the account of formal education (the information of the level of the educational institution which had trained the employee, of the programs studied and the number of academic hours), and not merely the evaluation of the main competences. Qualification is always the result of mastering a certain educational program and experience that can be achieved in various ways (training in educational institutions, retraining courses, etc.) and can be improved through assimilation of additional educational programs and training programs. Basic requirements in NQF are revealed through the following concepts a) knowledge (empirical and theoretical) - the assimilated scientific information that is the basis of one's conscious and purposeful activity, b) the ability (cognitive and practical) - the ability to apply knowledge to tasks and solving problems and issues, c) communication - for the purpose of transmitting information, coordination, and joint-venture activities [10], [11];

- *Interested parties* - a person or group of persons involved in the success of organizations, usually *public organizations, state bodies*. Requirements of stakeholders in the education system attractor are formed on the basis of the laws adopted in the field of education, development strategies, etc. [12]. So, in the National strategy of education development in Ukraine it is stated that the national system of education should be formed in accordance with modern integration and globalization processes, requirements, and in line with the transition to post-industrial civilization. Because of this, there should be ensured the sustainability processes and development of Ukraine, integration of the national system of education into European and world educational space. The key parameters of education systems should be: focus on the philosophy of "anthropocentrism", modernization of the structure, content and organization of education on the basis of competence approach, reorientation of educational content on the goals of sustainable development; ensuring availability and continuity of life-long education [13]. Economists are an important component of social relationships, because their professional duties are aimed at identifying opportunities for distribution in society various limited resources (land, labor, raw materials, technological and the like) on the production of necessary goods and services supply. Professional activities of the economist involve observation and research, data collection and analysis, monitoring trends that direct the social and economic activities of society, forecasting on the basis of the information containing a significant share of uncertainty. Therefore, training specialists in economic spheres should be a) based on the principles of academic mobility (defined as the ability of the educational process

participants to learn, to teach, to train or conduct research activities in another higher education institution), b) aimed at acquiring the competence necessary for the performance of professional duties (which is a dynamic combination of knowledge and practical skills, ways of thinking, professional, philosophical, and civic qualities, moral and ethical values, and determines the person's ability to successfully implement vocational and further training activities and is the result of learning at a particular level of higher education), c) confirmed certain level qualifications (officially confirmed by the evaluation of competencies achieved under the standards of higher education, as certified by the relevant document).

The result of the choice that was carried out by the detector from the current set of structures in the thesaurus is the formation of the selector system of stochastic training of the economics students. The selector identifies the ways of cooperation of the system elements that provide an opportunity to reduce fluctuations of internal and external influences, maintain the system in a state of homeostasis, and direct it towards the attractor. For the educational system as a selector there may be a defined technology training discipline.

A generalized structure of the detector system of teaching Stochastics to the students of economics is presented in Figure 2.

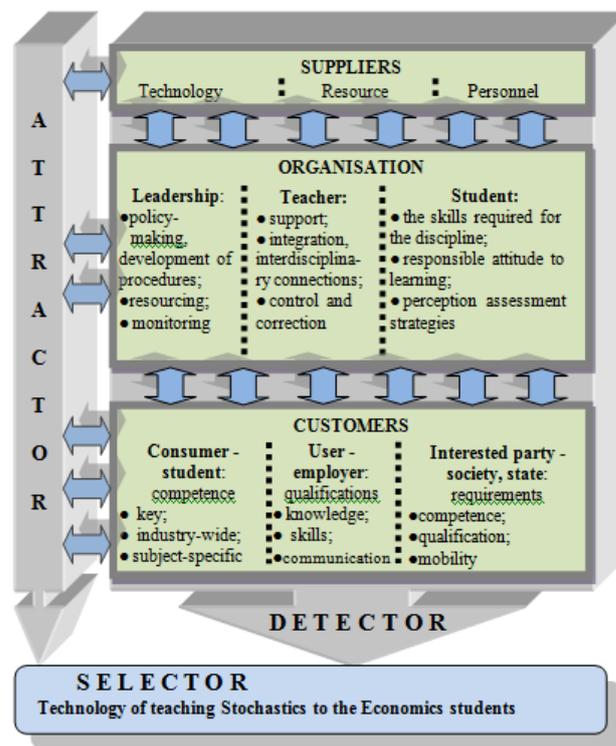


Figure 2. Detector Model of Learning Stochastics students of economic faculties of universities

4. Conclusions

1. Modern educational systems are synergistic systems for which
 - Openness is ensured by changing teaching and learning processes due to certain external factors;
 - Imbalance is a predetermined entropy entering the system in the form of a certain amount of information and leading to fluctuations in the learning process;

- Nonlinearity is realized through multiple content, alternative forms and teaching methods, etc. which together represent different ways of developing the system;

- Ability to self-organization is expressed in coherent actions of the structural elements of the educational process aimed at getting the attractor of education by reducing the entropy entering the system;

- Complexity is expressed by a hierarchical structure of the educational system that reflects the features of the interaction components.

2. Monitoring the quality of the learning process in a synergistic system can be made through the detector, forming a group of tools for continuous analysis and assessment processes that support learning.

3. Formation of the detector synergetic educational system is possible if it is based on the generally accepted standards of quality management.

4. Effectiveness of detector is provided by close interaction of the internal elements of synergetic educational system and also by their relationship with the environment represented by a customer of educational services putting forward certain quality requirements to the educational process and to the other suppliers of resources necessary to ensure the quality of education.

5. The result of the detector action and the impact attractor is the system of teaching Stochastics, which will meet the demands for quality training of economics students.

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