СТОПАНСКА АКАДЕМИЯ Д. А. ЦЕНОВ“ – СВИЩОВ

Факултет "Мениджмънт и маркетинг”

катедра „МЕНИДЖМЪНТ”

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MANAGEMENT OBJECTIVES AND MEASURABILITY OF HIGHER EDUCATION QUALITY

ABSTRACT

of dissertation thesis for awarding of educational and scientific degree "doctor", area of higher education 3. "Social, economic and legal sciences", professional field 3.7. "Administration and Management", scientific specialty "Social Management"

Scientific adviser:

Assoc. Profesor, Dr. Tsvetan Dilkov

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The dissertation work is discussed at a departmental council and is addressed to the Scientific Jury of the Department of Management at the Faculty of Management and Marketing of the Economic Academy "D. A. Tsenov "- Svishtov, in the field of higher education 3."Social, economic and legal sciences", professional field 3.7."Administration and Management", Scientific specialty "Social Management".

The dissertation consists of an introduction, five chapters, a conclusion, a list of the used literature (111 sources in Latin and Internet sources). The exhibition contains the main text, presented in a volume of 217 pages. The main text contains 32 illustrations and 3 tables. The number of dissertations is 19.

The author is a PhD student through his own preparation at the Department of Management at the Faculty of Management and Marketing of the "D. A. Tsenov "- Svishtov.

The defense of the dissertation will take place on .... in .... Hall of the Economic Academy "D. A. Tsenov "- Svishtov.

The defense materials are available to those interested in the "Doctorate and Academic Growth" sector at the Economic Academy "D. A. Tsenov "- Svishtov.

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I. GENERAL CHARACTERISTIC OF WORK

The relevance of the research topic.

Education in general and higher education, in particular, determines the direction and prospects for the development of the state and society. In the whole world and in Latvia the concepts of education are under the influence of democratization, globalization, optimization, and development of information technologies. The relevance of changes in Latvian education is also connected with entering the unified sphere of European education, joining the Bologna process, where the main mission of education is to help everyone, as the acquisition of knowledge and skills occurs along with the development of the human character, understanding of the world and personal responsibility for everything that happens.

A unified approach to the evaluation of the whole education was confirmed by the formation of the structure of the European qualification of continuing education, which includes all levels of education with the requirements of its required quality. This definition of quality is accepted for higher education and ratified within the framework of the Bologna Process, defining ENQA standards and guidelines for the quality assurance of higher education in Europe.

The diversity of students, educational programs and all those who are interested in and engaged in education, creates difficulties in implementing and evaluating common quality criteria. The implementation of the provision of these quality criteria depends on the capabilities of individual social actors.

Analyzing the global trends in the world, we come to the conclusion that the future society should be oriented towards education throughout the active life of the majority of the population. At the same time changing the learning style and way of thinking to ensure competitiveness at the local, regional and global level.

From the well-known two-level model: education - work without going back to school, it is necessary to move to a four-level model: education (including practice) - work, then return to study (at the level of increasing the qualification periodically every five years) and back to work.

Communication with other components of management sciences - management of society, business management allowed to create new concepts for managing subjects of higher education: the concept of quality, quality management, HEI management, management functions, management theory and management hierarchy.

Over the past decade, a significant number of reforms have been carried out in Latvian education, but they did not lead to the expected results, for example, since 2014 the Ministry of Education and Science of Latvia has been implementing significant reforms in the system of higher education. Their main goal is to provide high-quality, internationally competitive and research-based higher education offered by well-managed higher education institutions. Reforms are aimed at reassessing the role of higher education institutions and should stimulate the country's economic development as knowledge centers.

The author proposes the solution of these problems by changing the models of activity and management of the higher school of Latvia and the purposeful introduction of reforms at the highest state level.

The above factors have determined the choice of the topic of doctoral work: *Management Objectives and Measurability of Higher Education Quality*.

The study was conducted from an interdisciplinary point of view, applying aspects of management sciences, sociology, and mathematical modeling.

Working hypotheses.

- ✓ The strategic goal of improving the content and technological education is provided through the implementation of program activities to introduce new educational technologies and principles of the educational process to ensure the effective implementation of new models and content of continuing education, including the use of modern information and communication technologies.
- ✓ The strategic goal of quality assurance is achieved through the implementation of program activities in the following areas:

• Improvement of the state system of evaluation of educational institutions and organizations intending to coordinating the indicators of the development of the modern education system and the regulatory, methodological and information support for licensing, certification and state accreditation of educational institutions;

• Development of new forms and mechanisms for assessing and monitoring the quality of educational institutions for the implementation of educational programs, including the participation of communities and professional associations, to ensure the objectivity, reliability, and transparency of the assessment of educational institutions;

- ✓ The strategic goal of improving the management of education is provided through the implementation of institutional management programs in the changing organizational and legal forms of educational institutions and in accordance with educational priorities that will provide conditions for improving the economic independence of educational institutions, increase their responsibility for the final results of activities, increase efficiency and transparency of education financing;
- ✓ The strategic goal of improving economic mechanisms in the field of education is provided through a model for introducing funds to finance educational institutions at all levels of education, providing a multi-channel flow of funds and greater independence for their use

The object of the dissertation work is the state policy of providing and developing the quality of higher education in HEIs of Latvia. The role of quality assurance in the development of higher education institutions in Latvia, to increase their competitiveness.

The subject of the research is the effectiveness of the state management policy for ensuring and developing the quality of the work of the higher education system. Analysis of the role of the quality of education for a successful financial activity of higher education institutions in the process of changing market relations.

The purpose of the thesis:

Based on the results of scientific research and drawing on practical experience gained, to improve the conceptual approaches and methodologies for ensuring and developing the quality of curricula and curricula in relevant specialties, to develop the necessary models for collecting and applying information that will be used in the process of changing external and internal conditions be useful for quality management of higher education.

The implementation of this goal implies the solution of the following main **tasks**:

1. Conducting a literature review of existing studies on the quality of higher education;
2. Analyze higher education as an instrument for the development and management of the state;
3. To substantiate possible approaches to increase the competitiveness of higher education in Latvia;
4. Conduct comparative analysis of ranking methods in the formation of national and global rating tables;
5. Development of a mathematical model for rating a higher education institution
6. Application of the developed model to find the correct impact of the state on improving the quality of higher education;
7. Empirical verification of the developed methodology for planning and constructing the learning process and in the formation of training groups.

Methods of research. In the process of research methods of the system approach, sociological research, theory of decision-making, questioning, comparison methods, classifications, groupings, statistical methods of analysis, forecasting were applied.

The theoretical and methodological basis of the thesis was the work of scientists Kjell Raaheim, Ruth Williams, Peter De Vries, Stamenka Uvalic-Trumbic, John Radford, Stephen Hanney, Mary Henkel, Maurice Kogan, Thomas M. Stauffer and Martin Cave, a. v.

In Latvia, research and analysis of the quality of higher education institutions and quality criteria, their role in the accreditation process were conducted by A. Brishka, Ļ. Frolova, A. Raukhvargers, J. Dzelme, V. Niedrite, A. Brox, A. Heske, A. Greenfields, A. Kangro, J. Walbis, R. Harleja, B. Yudrooppa, O. Yudrups, a.v.

After the restoration of the state sovereignty in 1991 in Latvia, except for state HEIs, private higher education institutions have been created. However, their experience in ensuring the quality of education has not been studied. There are only a few publications in which the quality assurance policy is analyzed on the basis of such experiences of some state-based HEIs.

The reports and materials of international conferences, normative documents of the European Union and the Ministry of Education and Science of Latvia, scientific literature, periodicals and Internet resources served as an information and analytical basis for the dissertation research.

Restrictions.

The vastness and complexity of the tasks of the dissertation work limit the general study, for greater concreteness and importance of labor the study was carried out in certain permissible limits. The boundaries of the study are limited to the study of conceptual features, methodological and scientific and practical problems in the field of higher education in Latvia.

Scientific novelty of the study:

1. The necessity of developing models of the educational process under different approaches of the state is substantiated.
2. The essence of higher education as an instrument for the development and management of the state has been updated
3. A comprehensive review of methodologies for assessing the quality of higher education
4. A mechanism for improving the methods for assessing the quality of higher education
5. The objectives of public policy management in the field of higher education
6. Models of rating evaluation of a higher educational institution

Basic provisions to be protected:

1. The objectives of public policy management in the field of higher education
2. The methodological disadvantages of using ratings are grounded
3. The factors preventing the increase of the efficiency of the work of higher educational institutions

Theoretical and practical significance of the results of the research consists in identifying and proposing solutions to a number of problems when applying existing methods of ranking higher education establishments and creating rating tables, the main provisions of the thesis can also be applied in the formation of the state concept of the development of the higher education system in Latvia, the theoretical research material may be specialists recommended in the field of higher education to study the problems of the development of higher education, especially in Barrier-demographic crisis in Latvia.

The materials of the thesis can also be used in the preparation of training courses and training on the development of public policy management objectives and models of the educational process.

The approbation of research results. The main provisions and conclusions of the dissertation research were discussed at international scientific and practical conferences: International Conference "Innovation, Technology Transfer and Education" (Prague, 2018); International scientific conferences "Information technologies, management and society" (Riga, 2012- 2017); International Conference First Conference, CIT & DS 2015 (Volgograd, Russia, 2015), International Conference 6th International Conference of Technology, Education and Development (INTED), (2012, Valencia, Spain).

In addition, the findings of the thesis were presented in the collection of the conference included in the database "Thomson": Linde I., Rjaschenko V., First Conference, CIT & DS 2015, Volgograd, Russia, September 15-17, 2015, Analysis of the University Rankings Assessment Reliability, 802-817 lpp., Proceedings, Creativity in Intelligent Technologies and Data Science, Springer International

Publishing Switzerland 2015, A. Kravets et al. (Eds.): CIT & DS 2015, CCIS 535, 2015. DOI: 10.1007 / 978-3-319-23766-4_64, ISBN 978-3-319-23765-7

The results of the thesis are implemented in the development of an innovative development strategy for some private higher education institutions in Latvia.

II. STRUCTURE AND CONTENT OF THE THESIS

The structure of the work is determined by the logic of the research, its purpose, and tasks. The thesis consists of an introduction, five chapters, conclusions, conclusions, a list of references and ____ applications. The main text is set out on 223 pages. The list of literature contains 145 items. The thesis includes 25 figures and 28 tables, where the factual material is presented.

CONTENT

III. MAIN CONTENT OF DISSERTATION WORK

Introduction

In the introduction, the relevance of the research presented in the doctoral dissertation is justified. It is shown that the effectiveness of higher education largely determines the direction and prospects for the development of the state and society, as well as the relevance of changes in the Latvian public education sector, which results from Latvia's accession to a single sphere of European education and accession to the Bologna process.

A unified approach to the assessment of education is subject to the creation of a European qualification of continuing education - a European qualification framework that includes all levels of education with the requirements of the required quality of education.

Chapter 1 Education as an instrument for the development and management of the state

In the first chapter, the role and responsibility of the state in creating a competitive education system is characterized - the role of education in the solution of the state's socio-economic development is to create conditions for increasing the competitiveness of the state and a single individual, restructuring the economy in favor of high-tech industries, developing human resources capable of creating and develop the material and intellectual potential of the country.

1.1. Role, purpose, and place of higher education for the state and society

The section characterizes the importance of the state's attitude to the sphere of education. The basis for strengthening the political and economic role of any state and the welfare of its people is to increase the country's competitiveness.

The author believes that the low level of government-guaranteed wages and the decline in the prestige of the teaching profession are the main reasons for the loss of qualified personnel in higher education. The search for a solution to the crisis in higher education lies in the development of management and control mechanisms adequate to the tasks of the higher education system, as well as the creation of economic mechanisms to ensure investment attractiveness of education.

Ensuring the necessary quality of education can be achieved by continuously improving the state system for evaluating educational institutions and improving the effectiveness of regulatory, methodological and information support for licensing, certification and state accreditation of educational institutions.

The strategic goal of improving economic mechanisms in the field of education should be provided through the development of models for the introduction of funds to finance educational institutions at all levels of education and the introduction of mechanisms that promote the economic independence of educational institutions in order to improve the efficiency of resources allocated to education.

The EU Council recommends that the Member States establish transparent systems for quality assessment and quality assurance in higher education.

1.2. Developing the objectives of public policy management in higher education.

The second section proposes the goals of managing state policy in the field of higher education.

The state. The primary task of the state in education is the development of state policy in the field of education and the creation of the conditions necessary for its implementation and existence.

Higher educational institution. The primary task of the higher educational institution is to manage the state order for the training of educated specialists.

Three measurement parameters determine different approaches to solving the problems of education management in all cases. These include the knowledge of graduates of the HEI, the time of training and its cost. The presence of these three parameters allows, in the language of optimization theory, to formulate three different strategies for the management of higher education institutions.

The first strategy relates to fixing the training time ($T = const$) and for the given resources (C) to maximize the quality of the educational process ($Q = Qmax$).

The second strategy relates to a fixed training time ($T = const$) and a quality level of education ($Q = const$) in order to minimize the costs of teaching the educational process ($C = Cmin$).

The third strategy relates to fixed costs ($C = Cconst$) and education quality level ($Q = const$) to minimize training time ($T = Tmin$).

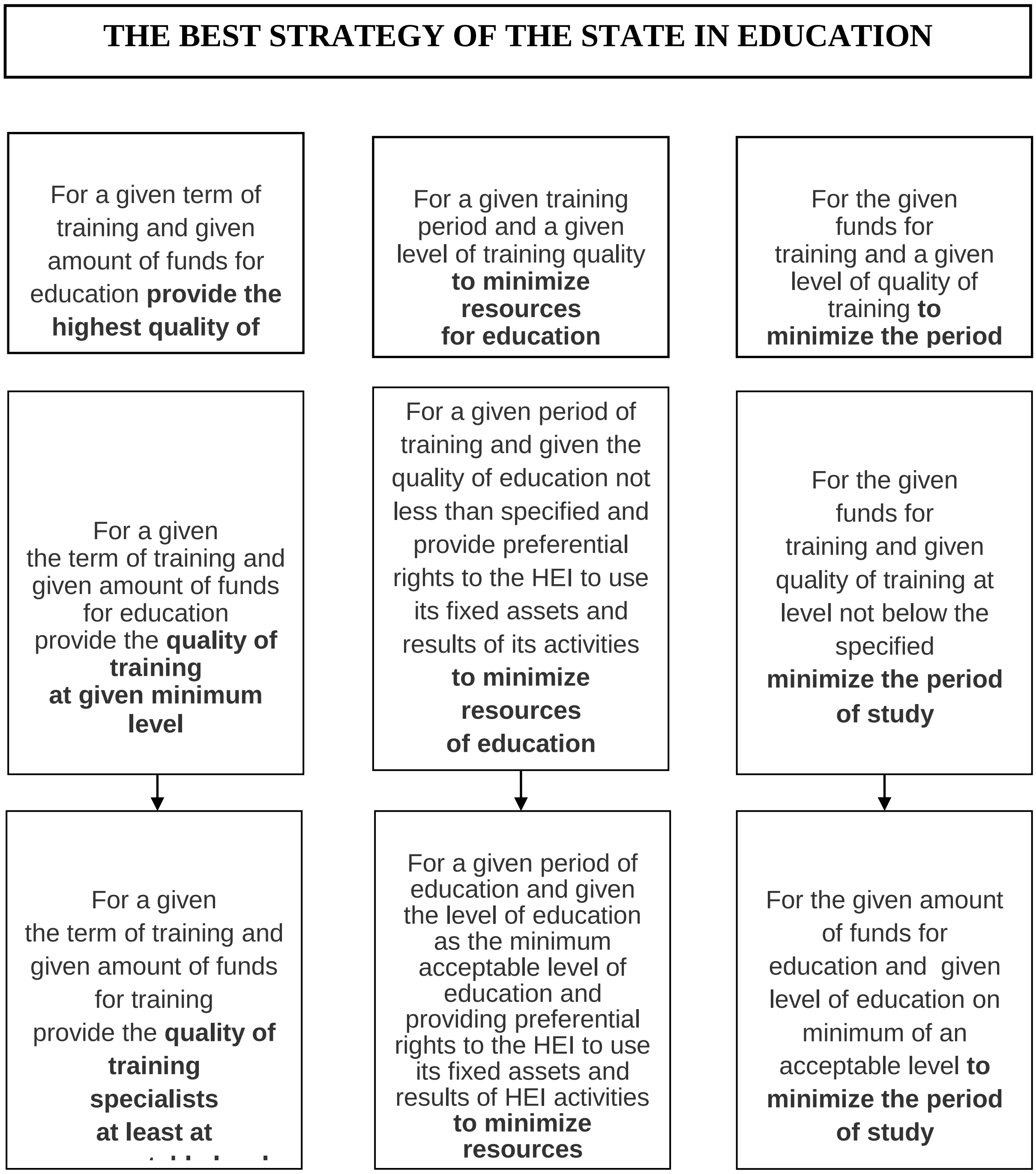


Fig.1.1. Possible state strategies in education

The choice of strategy refers exclusively to the prerogative of the state, reflecting the interests of the society (taxpayers) and the financier of higher education. Possible variants of the strategy are presented in Fig.1.1.

1.3. Analysis of the factors hindering the implementation of improving the efficiency of HEI's and the possible solutions.

In the third section, the factors that interfere with the implementation of the increase in the effectiveness of the work of higher educational institutions are analyzed, as the government is currently implementing an approach to implementing a strategy close to the first; the learning time is fixed, the resources try to fix, but the quality of education, based on the accepted realities, suits the state at a satisfactory level.

The interest of the student in obtaining good knowledge should be realized in the form of a final document on education, which in the future within the framework of state structures will allow, at least for those who are better students, the right to a better job.

The second partner in education - the teaching staff is more objectively irrelevant to the quality of education because of the complete lack of feedback between the quality of his teaching activities and the level of knowledge of his students.

The state should have at the forefront the realization that without a modern quality education, the state has no prospects for the future.

1.4. Development of models of the educational process at various approaches of the state to the material maintenance of the HEI.

Evaluation of the learning process in the HEI can be characterized by three main parameters - the quality of the knowledge obtained by $\boldsymbol{Q}$, the learning time $\boldsymbol{T}$ and the costs of education, which can be expressed through its cost $\boldsymbol{C}$.

The quality of knowledge can be expressed through the average score obtained in all training courses and will reflect the student's knowledge level of $\boldsymbol{L}$ quantitatively. In general, the level of knowledge of college graduates is quite tricky depending on the time of training, and on its cost. The cost of training is complicated in a complicated way from the time of training and the level of knowledge of graduates. Therefore, various approaches related to the problems of education management and HEIs, in particular, relate to the following aspects: the level of knowledge obtained by graduates - ***L***, the cost of training - ***C***, the time of training - ***T***.

From what has been said, possible tasks arise which, when managed, allow one or another optimization strategy of the training process of a specialist:

- Maximize the quality of training specialists with restrictions on material and cash allocated for training;
- Minimize the costs of training at a given level of quality training.

Analysis of the accumulation of knowledge with certain material resources presented for training shows that the study of any particular discipline included in the curriculum of the specialty being studied depends on the time of training in this discipline.

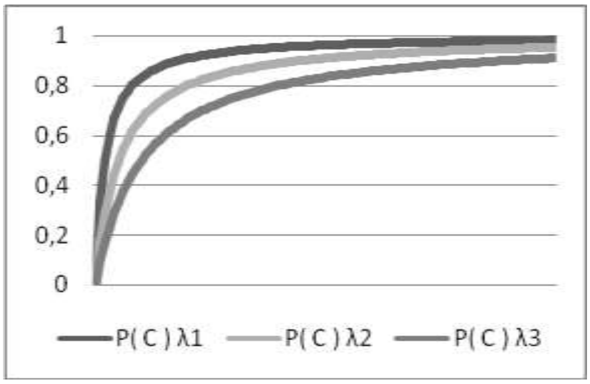
Exposed evaluation of one trainee is a consequence of averaging knowledge throughout the course since different parts of it cannot be assimilated in the same way. This allows us to talk about a statistical assessment of the level of knowledge. Therefore, we can introduce the notion of the level of knowledge as the probability of obtaining it for a given time interval *t-P (t).*

Concerning this, it should be a monotonically increasing function, the typical form of which is shown in Fig. 1.2

A convenient mathematical notation is describing the curve in Fig. 1 is the exponential function $P(t) = 1 - e^{-\lambda t}$;

Where t - is the learning time; λ – is the coefficient determining the rate of change of the function.

The parameter λ reflects in the learning process the money invested in it. If we take for comparison as an experienced teaching professor, assistant professor and a lecturer, it is clear that at different levels of one's knowledge, the first at the same time can give more knowledge than the rest. However, the "value" of the professor is higher than that of the rest. Therefore, the more money is invested in the learning process, the greater the value λ.



$\lambda_1 > \lambda_2 > \lambda_3$

Fig. 1.2 The probability of obtaining knowledge of a given level in time t.

The knowledge that the student receives over time t_i can be determined based on the knowledge that the relevant teacher has, and the probability of acquiring this knowledge over time t_i.

We accept conventionally the knowledge that a professor, an assistant professor and a lecturer have, respectively α, β, γ.

Then, the change in the level of knowledge in time $L(t)$ is equal, respectively

$$\alpha(1 - e^{-\gamma_\alpha t}); \beta(1 - e^{-\gamma_\beta t}); \lambda(1 - e^{-\gamma_\gamma t}).$$

From the ratio $L(t) = \alpha(1 - e^{-\gamma_\alpha t})$, you can calculate the achievements of the required level of knowledge L_{tp}.

It will $t_{tp} = e_n(1 - L_{tp/\alpha})_{\gamma_\alpha}$. Similarly, one can obtain the same expressions for α_β and α_γ.

When considering the dependence $L= L(c)$, applying the same arguments, we obtain a similar time probability model of the dependence of the level of knowledge on the cost of training $p(c) = 1 - e^{-jt}$, where j - is a coefficient analogous to the coefficient λ.

The costs of training for the entire period of training specialists consist of the costs of material and technical support for *Cmt*, for salaries for the teaching staff of the *Cts* and the auxiliary staff *Cas*.

The quality of training specialists in the learning process is formed at all its stages, and each subject contributes to the overall level of knowledge obtained by graduates.

As an assessment of the effectiveness of both the education process and the specialist obtained, it is advisable to use the general criterion *F* as a function of the received quality (the level of knowledge α and the costs incurred $F = F(L, C)$.

Because of the above, the total level of knowledg *L* is the sum of knowledge received from all categories of lecturers *L*= $l_{prof} + l_{ass.prof} + l_{lect}$, and the total amount of costs for the teaching staff will be formed following this equality. This allows, in the framework of linear programming, for a given *L*, to minimize the costs for the total lecturers' pay. The higher *L*, the higher the value of *F* and simultaneously, the more costs, the smaller. Proceeding from the foregoing, the expression for the efficiency criterion *F* can be written in the form

$$F = \frac{L(C)}{C}$$

With such a record, the efficiency criterion is the value of the received quality level of a specialist per unit of costs.

Based on these conditions, one can obtain an expression for the optimal costs for the quality of knowledge obtained. Taking the derivative of *F* concerning *C* and equating to zero, we obtain:

$$\frac{dL(C)}{dC} = \frac{L(C)}{C}$$

This relation shows that the condition *maxF* shows a point on the curve *L (C)*, in which this equality is satisfied. To determine *Lopt* and *Copt*, it is necessary to know the dependence *L=L(C)*. Having completed the necessary mathematical transformations, we get $F(C) = jCe^{-jC}$.

For different *j*, which can be established experimentally, we will have our optimal costs, which ensure maximum obtaining the knowledge level *Lmax(C)* of the specialist.

Let's turn to Fig.1.3. - the probability of obtaining knowledge of a given level over a time *t* for different values of the coefficient λ.

It seems possible to determine experimentally these coefficients, corresponding to the capabilities of the professor (λ_1), assistant professor (λ_2), and a lecturer (λ_3). It is clear that this will be averaged data, but they will give an opportunity to determine the cost of wages, depending on the number of professors, associate professors, and lecturers, and Fig.1.1 for this particular case will have the form (Fig.2.2):

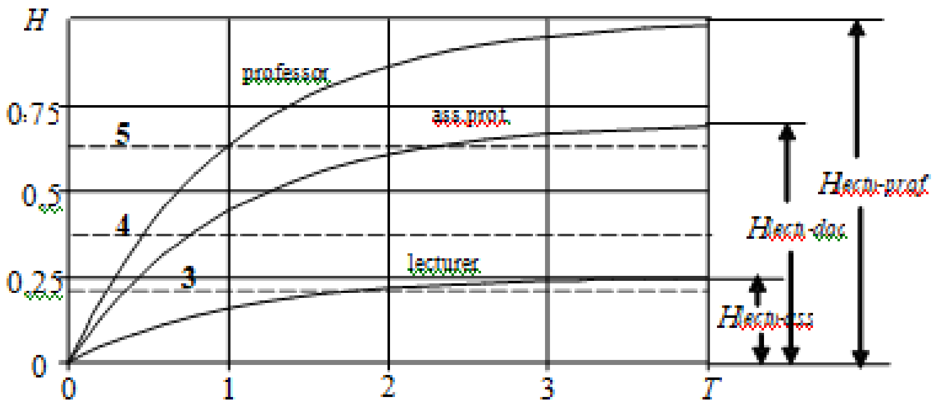


Fig. 1.3. Change the level of knowledge obtained by the student in the case of his education as a professor, associate professor, teacher.

MAIN CONCLUSIONS TO THE FIRST CHAPTER

To achieve the main strategic goal of the society - ensuring the needs of citizens, society and the labor market in quality education, it is necessary to solve the following strategic tasks:

- improving the content and technological education;
- development of quality assurance of educational services;
- improving management in the field of education;
- Improvement of economic mechanisms in the field of education.

2 Comparative analysis of the types and methods of ranking HEIs.

The second chapter analyzes the problems of quality assessment of higher education institutions in the international - global scale and the methods of comparison of HEIs. A formalized approach to the definition of a rating in higher education is presented as an example of a complex assessment containing some independent parameters.

The critical consideration in the development of multidimensional rating tables is the complexity of choosing the quality criteria of the institution. The rating table reflects the growing global competition between HEIs for talent and resources. It is shown that the main problem lies in the methodological basis of the rating table and the political consequences of the ranking.

In the first years of its existence, the main part of national ratings was aimed at informing potential HEI students in a particular country. The ratings were mainly focused on indicators that reflected aspects of teaching and learning, but many of them also included data on research, reputation, and other aspects. Global rating tables have also been developed. For example, one of the most influential is the Academic Ranking of Universities of the World (English ARWU), which since 2003 is compiled at the Institute of Higher Education of Shanghai University, Jiao Tuni.

Next comes the Leiden Bibliographic Ranking, developed by the Leiden University Center for Science and Technology (CWTS, Leiden University) and the Taiwan rating (HEEACT). These ratings reflect growing global competition.

2.1. Overview of transparency tools

In section 2.1. an analysis of existing transparency tools and research publications in the ranking literature has been carried out, and recommendations have been developed for transparency tools.

Table 2.1. Ratings and ranking

Type	Name
Ranking	• ranking of the Carnegie ranking (U.S.) • U-Multirank (Europe)
Global Rating Tables	• Shanghai's Jiao Tong HEI (SJTU) Academic Ranking of World Universities (ARWU) • Times Higher Education (Supplement) (THE) • Leiden Ranking

National rating tables	• U. S. News & World Report (USN &WR; USA) • Good Time Education Guide (UK) • ranking of the Guardian (UK) •Forbes (USA) • Das CHE Ranking / HEI Ranking (CHE, Germany) • Studychoice123 (SK123, The Netherlands)
Dedicated rating tables	• Financial Times ranking of business schools and programs (FT, globally) • BusinessWeek (Business School, USA + globally) • The Economist (Business School, globally)

It should be noted that rankings and rating tables fulfill a dual role that can be used to provide information about the level of education or research. Most national ratings provide information to prospective students on educational indicators or on a combination of education and research indicators.

2.2. Research by types and methodologies of ranking

The purpose of the section is to give a brief overview of the situation in connection with the research on ratings and ratings. The review is conducted in three directions: methodological criticism of ratings, good practice, and research for ranking and effect of rating tables.

Rankings and rating tables have been investigated by many authors (for example, Klein and Hamilton 1998, Yorke in 1998, Gottlieb 1999, Leeuw 2002, Merisotis 2003, Dille and Soo 2005, Van Dyke 2005, van Raan 2005, Brown 2006, Marginson 2006, Usher and Savino 2006, Enserink 2007, King, Locke, etc. 2008; Marginson 2008, Saisana and D'hombre 2008, van der Wende 2008, Högskolverket 2009 Marginson, 2009; van der Wende and Westerheijden 2009). Later the author summarizes the main arguments used by these (and others) authors in his works, analyzing the ranking tables, ratings, and methodology for their creation.

Stakeholders need a variety of information for decision-making, so a multidimensional tool is needed. The ratings should also provide information on the necessary financial investments in education and on the possibility of returning a loan for study in the future (for example, what are the prospects of the labor market for specific professions) and the motives for consumption (for example, a sports hall / student council / hostel) and, thus, choice of social preferences of a particular institution.

The reputation of "good" HEIs of leaders (van Vught 2008), having a good reputation, helps the parties concerned to conclude. The excellent reputation of the HEI facilitates access to various funds, testifies to active and motivated staff and attracts well-trained first-year students, and so on.

Therefore, rating tables tend to exaggerate differences between institutions and serve as a vertical scale for ranking higher education institutions. From a statistical point of view, the rating table ignores the possible standard error of the output data. You can apply only those rating tables that use information about a similar profile of higher education institutions or training programs.

Indicators that measure the number of publications in individual rankings are based on various global publications databases, such as the Thomson Reuters Web of Science database or the Elsevier Scopes database, and, unfortunately, global rating tables do not take into account academic, cultural and linguistic diversity of HEIs. Also important language, which is published, for example, the database Thomson Reuters (WOS) mainly takes into account the English-language publications.

2.3. Good practice of the HEIs ranking

In Section 2.3. samples of good practice are considered, as the methodological criticism of ratings leads to the idea that ranking and rating tables are wrong. To avoid such an impression, the chapter analyzes examples of good practices and identifies the main problems.

The second conference of the Global Expert Group (IREG), which was convened in Berlin in 2006, agreed on the structure of so-called active practice, the so-called Berlin Principles for Ranking Higher Education Institutions (Global Rating Expert Group, 2006)

Application of quality assurance principles to the highest ranking: providing mutual understanding and intersubject management by including feedback, providing feedback capabilities to end users and taking measures for feedback to correct errors and failures.

In terms of transparency tools designed to help potential students find alternatives to the rating table, there are positive examples - Germany has developed a rating published by CHE, recognized as good practice (Dill and Soo 2005, Van Dyke 2005, Usher and Savino, 2006 Thibaud 2009), Dutch rating studiekeuze123 (SK123) is very similar, it was published for the first time in 1980 and is available on the Internet since 2006 - Table 2.2.

Table 2.2. Key indicators in some sectors of the national ratings

	CHE Excellence Ranking	**https://www.studiekeuze123.nl/**	**USN&WR 'America's Best Colleges'**	**Forbes 'America's Best Colleges'**	**Latvijas Avīzes Ranking**
Research output	• Publications				Publications
Research impact	• Citation 'crown indicator' (CPP/FCSm) • Highly-cited books		Global research reputation		• Citation 'crown indicator' (CPP/FCSm) Highly-cited books
Quality of education	• Students' overall satisfaction • Students Mobility • Participation in Erasmus Mundus programs	• Student opinion on the quality of the course • Students' views on the university premises • The labor market for specific professions	• Dropouts % (20, 25%) • Student's selection criteria (with high average grade) (15%) • Financial resources for education (10%) • Level of graduates (0,5%)	• Student's survey results, from Ratemyprofessors.com (25%) • The success of graduates: Alumni representation on Who's Who in America + the average salary from Payscale.com (25%) • The quality	• Student opinion on the quality of the course • Students' views on the university premises • Students' overall satisfaction • Students Mobility Participation in Erasmus Mundus programs

				of graduates for the last 4 years (16%)	
Quality of staff	• Erasmus mobility program for lecturers • Foreign lecturers		• Faculty resources (lecture-room size, salary, qualifications of teaching staff, full-time lecturer% (20%)		Faculty resources (lecture-room size, salary, qualifications of teaching staff, full-time lecturer% Foreign lecturers
Reputation			• A peer review of academic quality (25%)		A peer review of academic quality
General	• MBA students from other countries • Ph.D. students from other countries	• Premises and availability • Admission Requirements and distribution by courses	• Alumni rating (5%)	• Students and faculty who have received national awards (16%) • The average student loan debt in 4 years (20%)	• Premises and availability
Websites	https://ranking.zeit.de/che/en	www.studychoice.123.nl	www.usnews.com/rankings	https://www.forbes.com/value-colleges/list/	http://www.la.lv/wp-content/uploads/2014/05/Augstskolu_reitings.pdf
Notes	More information is available in in-depth comparison of user-selected study programmes.	Mentioned here are headings, each encompassing 3-10 'rankable' indicators and/or 4-6 non-'rankable' items of information. Besides, there is more information in the form of 'basic facts' for higher education	There are alternative weightings for master and baccalaureate colleges as opposed to liberal arts colleges and 'national universities' on retention and graduation.		No more published since 2015

		institutions, locations, etc.			

In the Bologna Process, attention is focused on global cooperation in quality assurance, the creation of qualification frameworks, and the expansion of the use of tools to promote the compatibility of research in Europe (CHEPS, INCHER Kassel et al., 2009). The primary attention is paid to the results of students' training.

The European Commission's Specialized Research Group collected data on the work of European HEIs. The studies conducted according to the Lisbon Strategy outline the main trends in the development of higher education. In 2008, a group of AUBR experts was created, which included examples of successful practices in the development of the U-Multirank ranking. Global ratings should inform about possible trends and accurately describe their purpose of rating development. Multidimensional approach U-Multirank compares the effectiveness of the HEI in some different activities, evaluating them from "A" (very good) to "E" (weak).

The indicators of the U-Multirank rating are divided into six groups:

1. Learning and learning profile
2. Student profile
3. The research work
4. Region involvement
5. Engaging in knowledge sharing
6. Global Activities

U-Multirank does not issue numbered rank lists but allows users to identify the strengths and weaknesses of the HEI or the aspects that most interest them.

2.4. Information, indicators and data sources of transparency instruments

A feasibility study used actual figures will be described in the next section. However, a brief review of data sources available and are used in drawing up the rating charts and types of ranking. The author also includes the quality assurance aspect of this chapter, because this field is the relevant experience of working with different data sources. Will be included in the currently used database, as well as data sources from other areas, but which could also play a role in the development of global rankings. Ratings have different intentions and goals, so they use a variety of one-dimensional parameters. Global ratings on the process of choosing HEIs are influenced by choice of methodology and various indicators - see table. 2.3.

Table 2.3. Global HEI ratings, indicators, and their weight

	CHE University Ranking	**Academic Ranking of World Universities (ARWU)**	**THE** *Times Higher Education* World University Rankings	**CWTS Leiden Ranking**
Research output	Publications	Publications		
Research impact	• Citation frequency • Citation journals	• Citation frequency • Citation journals		
Quality of education	• Students' overall satisfaction • Students mobility • Participation in Erasmus + program's	• Student opinion on the quality of the course • Students' views on the university premises The labor market for specific professions	• Dropouts % (20, 25%) • Student's selection criteria (with high average grade) (15%) • Financial resources for education (10%) • Level of graduates (0,5%)	• Student's survey results, from Ratemyprofessors.com (25%) • The success of graduates: Alumni representation Who's Who in America + the average salary from Payscale.com (25%) • The quality of graduates for the last 4 years (16%)
Quality of staff	• Lecturer mobility in Erasmus + • Foreign lecturers	• Number of highly cited researchers selected by Clarivate Analytics	• Faculty resources (lecture-room size, salary, qualifications of teaching staff, full-time lecturer% (20%)	
Reputation		• Number of	• A peer	

		alumni and staff winning Nobel Prizes and Fields Medals	review of academic quality (25%)	
General	• Master students from other countries • Doctoral students from other countries	• Premises and availability • Admission Requirements and distribution by courses	• Alumni rating (5%)	• Students and faculty who have received national awards (16%) • The average student loan debt in 4 years (20%)
Websites	www.excellenceranking.org	http://www.shanghairanking.com/index.html	www.usnews.com/rankings https://www.timeshighereducation.com/world-university-rankings	http://www.leidenranking.com/
Notes	More information is available in in-depth comparison of user-selected study programmes	Mentioned here are headings, each encompassing 3-10 'rankable' indicators and/or 4-6 non-'rankable' items of information. Besides, there is more information in the form of 'basic facts' for higher education institutions, locations, etc..	There are alternative weightings for master and baccalaureate colleges as opposed to liberal arts colleges and 'national universities' on retention and graduation.	

MAIN CONCLUSIONS TO THE SECOND CHAPTER

1. The role of ranking and rating tables that can be used to provide information about the level of education or research is defined. Most national ratings provide information to prospective students on educational indicators or a combination of education and research indicators.

2. The research on ratings and methodology of ranking was carried out- methodological criticism of ratings given, examples of good practice of ranking and impact of the effect of comparative rating tables were given. Methodological disadvantages of using composite indicators of ratings are revealed. Ranking tables tend to exaggerate the differences between higher education institutions. From a statistical point of view, the rating table ignores the possible standard error of the output data.

3. The application of the principles of quality assurance to ranking itself is proposed: providing mutual understanding and intersubject management by including feedback, providing feedback capabilities to end users for correcting errors and failures.

4. Ratings have different intentions and goals, so they use a variety of one-dimensional parameters. Global ratings on the process of choosing HEIs are influenced by choice of methodology and different indicators.

3. Problems of evaluation of the quality of training.

Chapter 3. considers the problems of assessing the quality of the HEI, using rating tables. In different countries, the ratings include various components, the totality of which should quantify the characteristics of the institution, which allow it to be compared with other HEIs. However, in each HEI, there are several faculties and curricula in different specialties. Therefore, one numerical rating of the HEI cannot allow comparing the characteristics of the same programs in different HEIs.

3.1. Assessment of teacher performance.

In section 3.1. the factors that should make up the components of the HEI rating are determined. First of all, these are the characteristics of the training personnel: the number of professors assigned to a certain number of students.

In many HEIs, the comparative effectiveness of the assessment of (A) the work of all groups of lecturers was conducted, and the data of these assessments practically coincide.

An expression for the overall efficiency criterion can be presented

$$A_\Sigma = \alpha_{prof} \cdot A_{prof} + \alpha_{doc} \cdot A_{doc} + \alpha_{lec} \cdot A_{lec}, \quad (3.1.)$$

where α is the value of the specific weight of each component of efficiency.

If this is a full group, then: $\sum di = (\alpha_{prof} + \alpha_{doc} + \alpha_{lec}) = 1$.

3.2. Analysis and evaluation of the quality of education.

In Section 3.2. in addition to the characteristics of the faculty, a number of other indicators, such as laboratories, libraries, lecture audiences (the number of m^2 per student), the organization of the educational process, the methodological work and the system for managing the learning process as a whole are used in assessing the potential of the institution in addition to the characteristics of the faculty. Each of the above characteristics can be represented by a vector $\overrightarrow{R_\imath}$, and the set of all these vectors forms a multicomponent vector

$$\vec{R} = R(\overrightarrow{R_1}; \overrightarrow{R_2} \ldots \overrightarrow{R_\imath} \ldots \overrightarrow{R_n}) \qquad (3.2)$$

which reflects the rating of the HEI.

Each of these vectors $\overrightarrow{R_\imath}$ has its specific weight in the formation of the rating vector $\vec{R}$. Direct methods for measuring the specific gravity of each parameter are not possible. Therefore, it is necessary to resort to methods of expert assessments. The generalized result of the vector $\vec{R}$, using (3.2.), In the linear approximation can be represented:

$$\vec{R} = \alpha_1 \overrightarrow{R_1} + \alpha_2 \overrightarrow{R_2} + \cdots \alpha_i \overrightarrow{R_\imath} + \cdots \alpha_n \overrightarrow{R_n} \quad (3.3)$$

where α_i - the weight ratio of the contribution of the vector $\overrightarrow{R_\imath}$in the total amount of the rating $\vec{R}$.

To obtain practical results, it is necessary to identify those parameters that play a decisive role in the evaluation of the resultant vector $\vec{R}$. We call these parameters determinant.

The proposed approach to determining the rating of the HEI can be extended to the faculties of the HEI, as well as to individual training programs for specialists. In addition, it shows the impossibility of comparing the training of specialists in the same specialty on the basis of comparing the ratings of HEIs, rather than faculties or individual training programs.

3.3. Ranking as a stochastic model of the working efficiency of a higher educational institution.

In section 3.3. for the assessment of higher education institutions on the possibilities of training specialists, the concept of an HEI rating is introduced, the purpose of which is to reflect these possibilities, the HEI can be presented as a complex system with some parameters that determine its efficiency.

We call these parameters the defining (DP) rating. Making a measurement (evaluation) of each of the determining parameters, we can conclude the state of the institution of study. This can be interpreted as a classification of the properties of the HEI as an object, in which the HEI belongs to one of the possible states. In each state, the list of DPs may be different, but analysis shows that more than 90% of them are common. Therefore, we will take a description of the behavior of the set of DPs in time as a resultant vector of the random process, and each of the DPs $\beta_{i1} i = \overline{1,N}$ is a random variable over a relatively small time interval. The set $\overrightarrow{\beta_i(t)}$ forms a multicomponent state vector of the DP at an arbitrary instant of time τ_k:

$$\overrightarrow{B^N}(\tau_k) = \{\overrightarrow{B_i}(\tau_k), i = \overline{1,N}\}; \ \tau_k \in [0,T] \quad (3.4)$$

which is a random variable on a given range of possible values.

Consequently, it can be characterized by a multidimensional probability distribution density $f\left[\overrightarrow{B^N}(\tau_k)\right] \ \tau_k \in [0,T]$.

Since the HEI is not an established object once and for all, the various components of the DP can change over time. Qualitatively and quantitatively, the faculty and other components of the DP can change, then the consideration of the resultant vector of the DP rating as a function of time is entirely legitimate.

To solve the classification problem, we use the term "class" or its synonym "classified state" (CS).

Each class will be defined by the domain $\lambda(i,\tau_k) \in \lambda(\tau_k),\ \ i = \overline{1,M}$ of the value of the vector DP, having a certain generality of properties characterizing it, and assuming that the object (HEI) belongs to the CS with the number *i* if the value of its vector DP is in the region $\lambda(i,\tau_k)$ at a time τ_k, and *M* is the total number of classifying states, which must be finite (countable). The regions of classes themselves must be disjoint, i.e. each object at any time must belong to only one class.

Obtaining an estimate of the DP vector is inevitably accompanied by an error, which also has a stochastic nature. Each DP corresponds to its channel of measurement and transformation, then the error in estimating the DP can be similarly described by a vector random process $\overrightarrow{H^N}(\tau)$, $\tau \in [O,T]$.

The possibility of errors in the transformation of the state vector is determined by the conditional probability of the transition of the state vector from *i*-th to the other, an erroneous state.

Thus, the presented model allows describing the process of classifying an object (HEI), i.e., determine the probability of deciding whether the state vector belongs to one of the possible CS (classes) according to the known characteristics of the DP of a particular institution.

3.4. Models of evaluation of a rating of higher schools with a prediction of the state.

In section 3.4. the problem of forecasting the state of higher education on an unobservable time interval is considered. For future students choosing an HEI in which they will study, it is vital to know the forecast for maintaining or improving the state of the rating for several years ahead. This is important because the choice of an HEI can take place one or several years before the completion of schooling and the study at the HEI up to the end of the master's degree can take up to 6 years and study in doctorates for 3 years or more. Therefore, the forecast for the state of the HEI on an unobservable time interval τ_n is an actual task.

Under the classification of an HEI with a state-run through, it is assumed that it is decided to belong to a particular class on an unobserved time interval τ_n. The initial information for the decision is the results of the current ranking, as well as the conditional supplies of the object to the i-th class in the forecasting interval, as well as the analysis of the statistical characteristics of each vector $\beta_i(\tau_k)$ that direct the vector-rating of the determining parameters of the institution of study.

Because of the imperfection of the evaluation system, errors in the classification of an object with prediction are possible, i.e., the decision on the belonging of an object in this time interval is not to the class in which it is located. In connection with the fact that all these parameters are random, all estimates will be probabilistic:

$P(i,\tau_n)$ - the probability of finding an object in the -th class in the prediction interval;

$W_{ir}(\tau_n)$ - the conditional probability of making a decision on whether it belongs to the r-th class, if it actually was in the i-class. In fact, there is a probability of transition from the i-th state to the r-th state.

The quantitative results of measurements of the state vector $\overrightarrow{\beta^N(\tau_1)}$, $\overrightarrow{\beta^N(\tau_2)}$.... $\overrightarrow{\beta^N(\tau_k)}$ are transformed by means of the current evaluation into the numbers of one of the M, the different current states of the resulting vector. From the obtained set of results on the interval $[\tau_1,\ \tau_2..\ \tau_{1k}]$, the estimation system OT, using its predictive algorithm, generates the results of the prediction results and gives an opinion about the belonging of the object to a certain i-class in the prediction interval. The result of the assessment of the rating of the HEI allows comparison with other HEIs, by classifying them at the required moments of the forecasting interval τ_n. These results can be used by graduates of high schools to choose an

HEI, where they can go to study taking into account the projected rating for the points of interest that interest them.

3.5. Analysis of the reliability of the assessment of the rating of the HEI.

In Section 3.5. the concept characterizing an educational institution from the point of view of a quantitative assessment of a higher educational institution's ability to conduct educational and research work with the necessary quality is proposed. This characteristic is the rating of the HEI, which is a generalized vector, consisting of some vectors - components that determine the work capacity of the HEI in these directions.

Since educational and scientific work is crucial for rating evaluation, we introduce a vector characterizing the training work $\bar{R}_t$ and a vector characterizing scientific work $\bar{R}_s$. The vector $\bar{R}_t$ will include such components as the number of professors and associate professors, the amount of space per 1, 10, 100 students, equipping the library, equipped with technical training tools and other parameters that determine the educational process. All these components can be quickly reduced to a single vector $\bar{R}_t$ by weight coefficients. Similarly, the components that determine the level of scientific work, such as the presence of a master's degree, doctoral studies, specialized scientific councils for the protection of dissertations, etc., are reduced to a single vector $\bar{R}_s$ reflecting the level of scientific work in this institution.

The resulting vector $\bar{R} = \bar{R}(\bar{R}_t, \bar{R}_s)$ is a point on the plane. Since the numerical values of the vectors $\bar{R}_t$ and $\bar{R}_s$, and consequently, the resultant vector $\bar{R}$, can be continuous, then $\bar{R}$ can have an infinitely large number of values. In practice, possible ranges of $\bar{R}$ values are divided into discrete areas, each of which reflects a certain class within the existing classification system. Under any classification system, the whole area is divided into a set of subdomains (let their number be N) and if the vector $\bar{R}$ belongs to a subspace $\{R_i\}$, then the vector $\bar{R}$ must be assigned to the class "i".

The lack of tools for measuring the determining parameters inevitably leads to the need for expert assessments.

Expert judgment, as a rule, is defined as the arithmetic mean of the estimates made by experts.

With expert assessments, the picture will be fundamentally different. Each of the experts of the same qualification, being in identical "ideal" conditions, will differently evaluate the measured parameter and, with the real value of the parameter y_0, will give some estimate. For the *j*-th expert, we will denote it as y_{0j}, which in the general case will not naturally be equal y_0.

In addition, it is necessary to take into account the presence of various objective and subjective noise factors (health, well-being, mood, weather, etc.) that is inevitable in any tests, leading to a distortion of the estimate y_{0j}, as a result of which the expert will evaluate $y_{0j} + \xi_j$, where the introduced random variable ξ_j will be called the noise factor, which can take both positive and negative values. It is natural to assume that the statistically average value of this quantity is 0. Its mean squared value is denoted σ_ξ. Thus, the jth expert will make an assessment $y_j = y_{0j} + \xi_j = y_0 + \varepsilon_j^{sist} + \xi_j$.

Let us consider how this will affect the evaluation of the measured quantity, carried out by a group of *N* independent experts.

Let the *j*-th expert from the number *N* of experts determine the measured value, as y_j. In this case, an expert estimate is used as an expert estimate, determined as follows:

$$y_{med} = \frac{1}{N}\sum_{j=1}^{N} y_j = \frac{1}{N}\sum_{j=1}^{N}\left(y_0 + \varepsilon_j^{sist} + \xi_j\right) = y_0 + \frac{1}{N}\sum_{j=1}^{N} \varepsilon_j^{sist} + \frac{1}{N}\sum_{j=1}^{N} \xi_j \qquad (3.5)$$

This expression can be interpreted as a quantitative estimate of the one realization of random events that took place (a collection of values y_{0j}). With multiple tests from test to test y_{med} will take different values. What has been said makes it possible to talk about some realization of a random variable y_{med}, which makes it possible to lead to its statistical evaluation.

As for the term $\frac{1}{N}\sum_{j=1}^{N}\varepsilon_j^{sist}$ appearing in expression (3.5), it does not depend on the number of trials, since it is inherently determined by the individual characteristics of the expert, i.e. A systematic error appears in our measurements. The presence of this sum leads to a shift in the estimate of the mean value from its true value. Thus, for a statistically average value, we obtain the following expression:

$$\overline{y_{med}} = y_0 + \frac{\delta^{sist}}{N} \qquad (3.6)$$

where the bar denotes the operation of statistical averaging.

It is clearly seen from the expression (3.6) that experts should be independent of each other and the selection of experts in determining the rating should exclude the possibility of collusion between them and avoid a one-sided approach to determining the components $\overline{R_t}$and $\overline{R_s}$, which is also equivalent to the presence of collusion, an estimate of the mean. The experts determining the rating of the HEI are usually determined by the state structure (in Latvia - the Ministry of Education and Science), and it is entirely possible to shift towards one of the components of the vector $\overline{R}$. Indeed, it is well known that a great scientist is not always an excellent teacher and, conversely, an excellent educator is not always a good scientist. This should be taken into account when selecting a group of experts to observe the necessary balance of interests, objectively reflecting the rating of the HEI in the form of a vector $\overline{R}$.

MAIN CONCLUSIONS TO THE THIRD CHAPTER

1. For a quantitative assessment of the HEI's ability to conduct educational and scientific work with the required quality, it is necessary to have a concept characterizing the educational institution from this point of view. Such a rating can be the rating of the HEI, which is a generalized multi-component vector, consisting

of a number of vectors - components that determine the work capacity of the HEI in various areas of educational and scientific work. These areas are crucial in assessing the characteristics of the HEI and allow you to assess its potential for training specialists and scientific personnel.

2. A mathematical model of solution formulation according to the classification of higher educational institutions as objects was developed, allowing, within known characteristics of the condition vector (ranking of higher educational institution) and means of conduction of elementary operations, to define probabilities of conditions of a transformed condition vector at the output of the last in the sequence of conduction of its transformation by elementary operations within classification of objects in any of the classified conditions, and, thus, to evaluate the grade of adjustment of a classifiable object to the performance of tasks.

3. The model allows to access the influence of any single elementary operation on classification results and to choose its characteristics rationally.

4. A mathematical model can be used in the development of methods of calculation of reliability indicators and in the determination of requirements for the measurement of parameters, which need to be calculated, in the resulting vector of object conditions.

5. Analytical equations relating to indicators of accuracy in the conduction of various operations have been developed.

4. Developing the objectives of public policy management in higher education.

4.1. Statement of the problem

When allocating money for education on a nationwide scale, a scientific approach is necessary to justify the allocation of the required amount in the country's budget. Therefore, to assess the cost of training, it is necessary to develop a certain economic mathematical model of the learning process itself.

We introduce the *N*-dimensional space of features in the form of a vector R_N. The components of the vector of this space will be the entire set of knowledge that determines the formation of the trainee. For an example of a study in an HEI, each component vector reflects a separate subject from the whole set of subjects of the curriculum for a particular specialty. In this case, the state of each trainee at time *t* can be described by an *N*-dimensional vector $Y(t)$. This makes it possible, according to the selected criteria, to split the total education field into a specific number of subsets $B_j(j = \overline{1, M})$, i.e. $R_N = B_1 \cup B_2 \ldots \cup B_N$ and to understand by this the corresponding areas of primary, secondary, higher education, the field of doctors of sciences, etc., adopted in a concrete state.

Hence the task of the higher school, which is to transfer the student for the time of training T and for the allocated funds from the subset B_2 (secondary education) to a subset B_3 (higher education), i.e. formally, if $Y_{(t)} \epsilon B_2$, then through time T will be $Y_{(t+T)} \in B_3$.

The task of the higher educational institution is to translate the state of the student, who at the initial moment $t = 0$ has a coordinate $y(0)$ in a state in which $Y(T)$ meets the state's higher education strategies. The trajectory of the transition from $y(0)$ to $y(T)$ depends on a large number of random factors, the main of them - the organization of the educational process, the level and quality of teaching, the state of the educational and laboratory base directly depend on the funds invested in the learning process C, i.e. $y(T) = f(C)$ - a functional dependence that determines the state $y(T)$.

In the framework of linear approximation, we believe that

$$y(T) = \propto_0 + \propto_1 C \qquad (4.1)$$

Because students have a specific range of abilities, the coefficients and, can also have different values within a specified tolerance. Applying the average parameters for the student population in the analysis, we can take the average values of these coefficients.

4.2. The statistical model of the learning process in various modes of its implementation.

Because students have different abilities to master knowledge, each $y_k(t)$ will be a random number, and to describe its properties, knowledge of the probability density of this quantity $W(y_k(t))$ is necessary.

In the process of obtaining knowledge, the probability density will vary from moment $t = 0$ to some current moment. When studying each new subject $t = 0$, the level of knowledge is y (0) = 0, and, accordingly, the probability distribution density will represent δ-function, i.e. $W\big(y(0)\big) = \delta(y)$.

After a short learning time, students will gain a small increment of knowledge, and for each of them it will be their Δy, and the probability distribution density will differ from the δ-function. It will begin to expand, keeping its maximum near zero.

In order to obtain a mathematical expression for the dynamics of the change in the probability densities in time, depending on the learning in several discrete steps "n", we take as the initial probability density the δ-function in the form of an exponential law:

$$\delta(y) = \lim_{\mu \to 0} \frac{1}{\mu} e^{-\frac{y}{\mu}} \qquad (4.2)$$

The assumptions made allow one to obtain an expression for the density of the trainee's location at the level "n" at point C with the coordinate y_n:

$$W_n(y_n; \mu) = \frac{1}{\mu^n} \frac{y_n^{n-1}}{\gamma(n)} e^{-\frac{y_n}{\mu}}, \qquad (4.3)$$

where $\gamma(n)$ is the gamma function of *n*.

Expression (4.3) is the *n*-th order Erlang distribution. The corresponding curves are shown in Fig. 4.1.

The analysis of Fig. 4.1. and the expression (4.3.) show that with increasing "n", the probability density curve approaches a uniform law. If "n" is sufficiently small, then the whole group has a similar level of knowledge. If y is small enough, then the whole group has a similar level of knowledge. With the growth of "n"

begins to affect the unevenness in the abilities of students and the greater the "n", the, as seen in Fig. 4.1., there is a great deal of differentiation in the knowledge of the trainees.

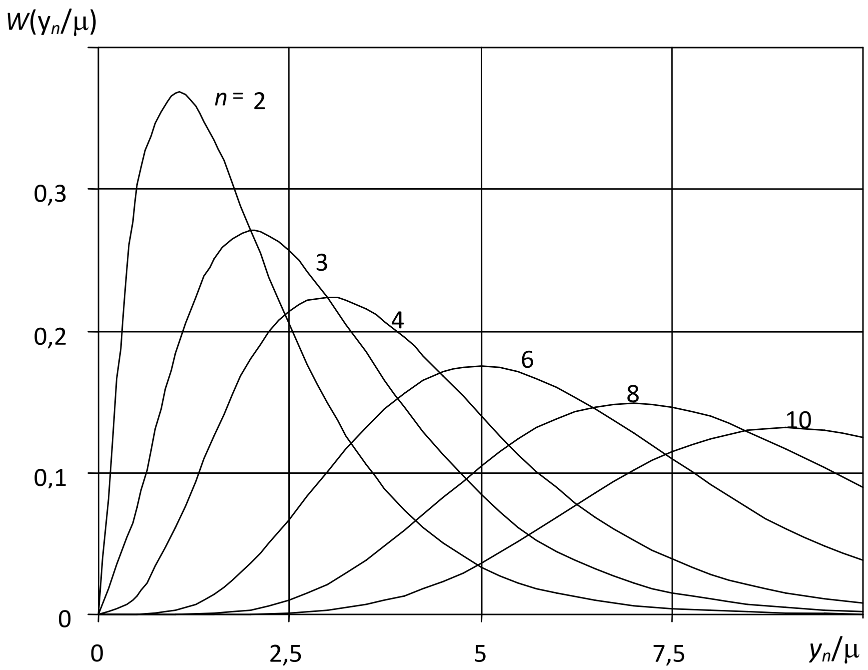


Fig. 4.1. The probability distribution density $W(\frac{y_n}{\mu})$ of finding the learner at the level n at a point

To eliminate this shortcoming and increase the number of well-performing students by the time of the training control, certain measures are taken for the instructors. There are additional seminars and self-training. All this tightens the students who are not quite in time to the group who are doing well. Consequently, the final probability density, taking into account the factors of self-training, will be higher than without it. The expressions obtained and the graph plotted on them (Fig. 4.2), allow one to explain why two humps appear on these curves.

For one part of the students, the normalizing factor will be much more significant than for the others; the effectiveness of independent work and, consequently, the contribution to the final result will be different, which allows the competent formation of groups of students for more successful learning, changing the proportions of specific training sessions

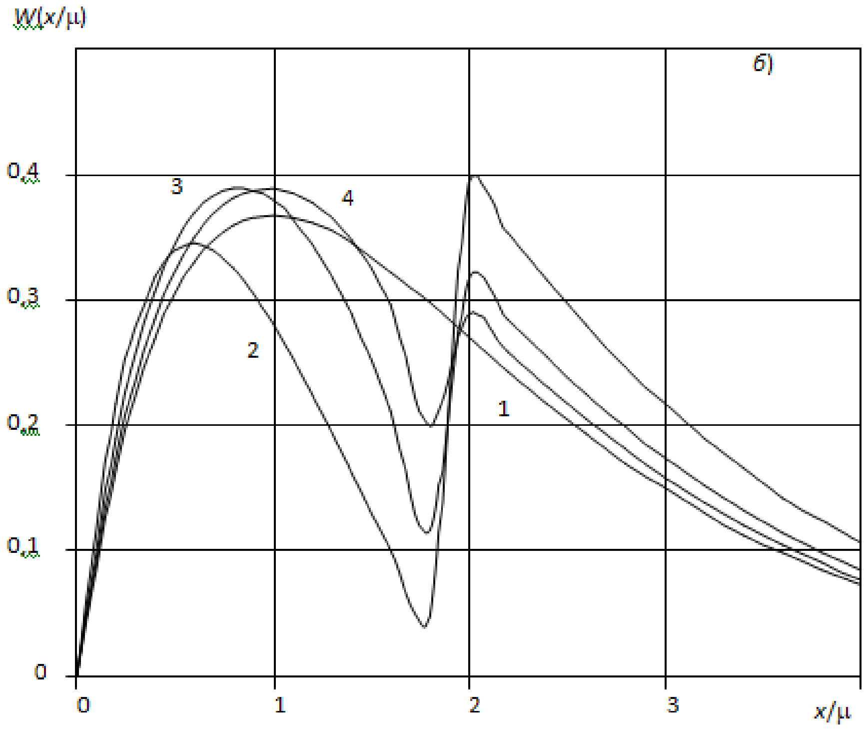


Fig.4.2. The density of probability distribution of *W*(*x*/μ) finding the trainee at the level of the second boundary control at a point with coordinate *y*/μ, with y_0/μ=1 (*a*) and y_0/μ=2 (b). The parameter ξ=μ/η is equal to: on the curve (2) – 0.1; on the curve (3) – 2.0; on the curve (4) – 5.0.

4.3. Analysis and forecasting of academic performance.

Quantitative measurement of the quality of academic achievement can be obtained using the received assessments in the subjects of specialization that are included in the curriculum of this specialty. We introduce the following divisions to assess the training of a specialist: unsatisfactory, satisfactory, good and excellent.

The obtained expression (4.3) for the density of the trainee's location at the level "n" at the point with the coordinate y_n, $W_n(y_n;\mu)$ allows determining the share of graduates whose knowledge is appreciated excellent. For this it is necessary to determine the boundaries between the entered divisions: $0 - y_1 - y_2 - y_3 - y_4$.

Then the probability of excellent students:

$$P_n^{excellent}(y_4;\mu) = \int_{y_3}^{y_4} W_n\,(y_n;\mu)dy_n \qquad (4.4)$$

For the remaining categories of estimates, we will have the expressions P_n^{good}, $P_n^{\text{satisfactory}}$, $P_n^{\text{unsatisfactory}}$. The data obtained by a specific calculation depends on the choice of threshold values that separate one level from another, which is an actual state task.

4.4. Analysis of the dependence of the amount of funding on the quality of training of specialists.

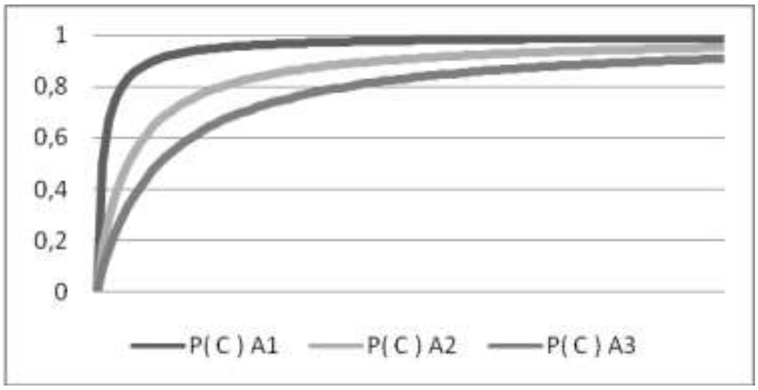
The task of optimizing the time of training, the allocated means of financing and the quality of the specialist's education, considered in the first chapter, was based on the exponential model of the dependence linking these characteristics.

You can also consider another model in which the quality of education and the amount of funding are related in somewhat different ways:

$$P(C) = \frac{C}{A+BC}\ , \qquad (4.5)$$

where *A* and *B* are constant coefficients, *C* is the volume of financing.

The graph of the dependence (4.3) is similar to the exponential graph:



$A_3 > A_2 > A_1$

Fig. 4.3. The probability of gaining knowledge from trainees depending on the amount of funding

$P(C)$ has a meaning similar to that discussed in Chapter 1. This is the probability of acquiring knowledge to learners depending on the amount of funding. Proceeding from this definition, we find the probability density of this model, which, taking into account the normalization condition, the probability density will be -

$$P(C) = C/(A+C)^2. \qquad (4.6)$$

When carrying out a study of this dependence, it must be borne in mind that to date there has been some funding C_0. When developing a model suitable for research, it is necessary to relate the cost of training to the quality of education, i.e. bind the parameters C and μ, which are variable relative to C_0.

Sufficiently convenient for further consideration is a model of the form:

$$\mu = \frac{2\mu_0 C_0}{C_0 + C} = \frac{2\mu_0}{1+\epsilon}, \qquad (4.7)$$

where μ_0 - is the parameter μ in the initial situation;

C_0 - costs of training in the initial situation;

$\epsilon = \frac{C}{C_0}$ - a relative increase in the funds allocated for training.

Using the expression for the density of the trainee's location at the level "n" with the coordinate y_n and taking into account expression (4.10), it is possible to calculate the relative values of the relative number, i.e. the shares of graduates rated excellent, good, satisfactory and unsatisfactory by the formula 4.4., taking into account the change in financing, i.e. taking into account the expression 4.7.

The proposed statistical analysis of the approach of assessing the impact of the cost of training at the level of qualifications of trainees will allow to competently approach the development of a state strategy for financing education.

If the state arranges a satisfactory level of training for specific professions, then there is no need to use lecturers of higher qualification, while saving a significant amount on wages. If the state needs a highly qualified specialist, then it is obliged to provide the HEI with more funding than in the first case.

MAIN CONCLUSONS TO THE FOURTH CHAPTER

1. In the end, in order to assess the cost of studies, a formalized economic-mathematical model of the study process itself needs to be developed. It appears to be more promising to use some abstract models that contain few parameters, which can be determined by experiment, and since the totality of students is in question, describing their individual behavior becomes unnecessary. This is why it is expedient to apply the statistical approach, which enables us to obtain some assessment variables. By developing this approach, it becomes possible to speak of a certain abstract student with undefined features which obey the statistics of the

totality of students. In this case, the condition of each student in the moment of time t can be described with a certain multidimensional vector $Y_{(t)}$, whose projections on each of the basic vectors (features) represent a quantitative assessment of knowledge in one subject or the other.

With this approach, it is convenient to split the features' field according to certain criteria into a finite number of subsets (M_j), which determine certain normative levels of knowledge (for example, in the framework of the entire education system – elementary, secondary, higher etc. education; in the framework of a higher educational institution – first, second etc. year level).

In this case, the task of studies is to transfer the studying individual in time T (time of study) and for assigned state funding from one subset to another. In formalized language this means that if $Y(t) \in M_j$, it must become $Y(t+T) \in M_{j+1}$.

The study trajectory of a specific student depends on a very large number of random factors, including a variety of factors related to daily life, the student's health, psyche, abilities and so on, and so forth. However they all have one common and perhaps decisive factor which determines the value of $y(T)$. This is the organization of the study process, the level and quality of teaching, the condition of study and laboratory facilities and so on. This is the factor directly linked to the means C invested in the study process and its organization. This means that the final value $Y_{(t)}$ of each student is functionally related to the invested means C. The corresponding functional dependence can be presented as a certain power series.

2. The fullest characteristic of the knowledge level $y_{(t)}$ of a studying person in a moment of time t is the corresponding density of probability distribution $W(y_{(t)}$. The paper posits that, if in the moment of time t=0 the source density of probability distribution (DPD) is considered to be the δ-function, then the starting DPD should be the exponential law, and its defining parameter μ depends, among other things, on the teacher's qualification, i.e. on their "value" (remuneration of labor). The higher it is, the higher the parameter. Moreover, μ variable is

influenced by the mutual understanding between the teacher and the student, whereas any insufficient understanding that requires additional labor to explain the material makes the studies more expensive, since it increases μ. The paper shows that in the course of time, the exponential law transforms into Erlang law, which depends on time. Based on the results obtained, the paper presents calculate the time dependence of the mean and average quadratic values of the level of knowledge of the trainee, assuming that the latter does not fix the teaching material (passive mode of study) that he describes. 3. Refuting the supposition of "uniformity" (from the point of acquiring study material) of studying persons requires accounting of random nature defining the exponential law of parameter μ. The paper presents the expediency to use the corresponding Erlang distribution for the variable λ, inverse to μ $(\lambda = 1/\mu)$, with a certain defining parameter ρ, unequivocally related to the statistical characteristics of parameter μ. Obtained correlations enable defining the change in the density of probability distribution for the level of knowledge with the course of time and, accordingly, finding out time dependences of its mean and mean square values supposing that the student does not strengthen the study material being taught (passive study mode)

4. The developed approach allows one to obtain the densities of probability distribution for the knowledge level of the student and the time changes for the case when the student reconstitutes their knowledge through self-preparation. Here, it appears satisfactory to view the process of the increase of knowledge level as random, also described by the exponential law with another defining parameter η. Based on the aforementioned, in the framework of the proposed model the study process appears as follows (active study mode). In the paper, clear expressions for the desired densities of probability distribution have been obtained and calculations of the necessary mean and mean square values have been made. The parameter is the correlation between two defining parameters $\xi = \mu/\eta$. Considerable changes in examined densities are present only in case of relatively small parameters $\xi = \mu/\eta$, i.e. in case one's own study process is substantially more effective than

mastering the material through simple perception. Moreover, if huge neglect is evident in the acquisition of the material y_0 (within $y_0 \to \infty$ range), there will be no change of source density in the totality of students with any given parameter η.

5. The developed study model enables approaching the issue of formalizing performance assessment in an essentially new way. Conducting appropriate assessments which characterize the knowledge level requires introducing certain milestone values y_1, y_2, y_3, the probability of attainment thereof is going to characterize performance. Moreover, the developed model allows introducing the level of teacher's demands (for example, liberal, average or heightened level of demands) which is equivalent to the choice of different benchmark levels of marks.

The obtained correlations allow seeing clearly the mechanism of "transfer" of marks from one category to another in the course of time. In the framework of the examined model, the aforementioned testifies to the equivalence of change of both the parameter characterizing the student and of the parameter μ characterizing the teacher and the study infrastructure as a whole. Thus, an obvious conclusion is that an insufficient level of education can be compensated only with the decrease of parameter μ, i.e., in the end, by the cost of studies.

6. In order to show the influence of the volume of funding assigned for studies on the quality of specialists' training (in this case on the performance) at least qualitatively, it is necessary to develop an appropriate model which could be used to solve the problem set. The following requirements can apply to such a model. Firstly, it must functionally link the cost of studies to the quality of studies (link the cost of studies – C with the parameter μ). Secondly, this model, since a qualitative description is being discussed, has to be relatively simple, at the same time reflecting the fact that with the increase of costs C the value of μ decreases.

Within the framework of the preceding, a hyperbolic model, in which the dependencies of the relative number of marks were estimated from the unsatisfactory to the excellent from the corresponding increase in the cost of training, seem to be quite convenient for further consideration.

Unfortunately, the obtained dependences cannot be used to get specific results. However, the proposed approach reveals a new way to look at the problem of financing higher educational institutions. Of course, serious experimental research on the definition of the aforementioned functional dependence, etc., is required to implement this approach. However, the overall trend is already rather visible in the proposed models.

7. The proposed statistical approach to the analysis of the influence of the cost of studies on the level of education of students is the first step in the research of this influence. This enables defining further steps in this direction. Three large experimental research projects seem to be necessary.

Firstly, a serious research related to the corresponding densities of probability distribution is needed, which requires effort on behalf of educators and psychologists.

Secondly, the dependence of the parameters of applied statistical laws on the cost of studies needs to be examined in greater detail. In this paper, one parameter μ was discussed; however, developing more complex statistical models of education may suggest two, three or more parameters to consider. Nonetheless, the approach suggested in this paper is a universal one and does not depend on the number of parameters, nor on a specific type of existing functional dependences.

5. The study of the pattern of learning by students of the studied courses

In the fifth chapter, the laws of assimilation of knowledge by conducting an experiment are investigated. Of the students studying, 4 groups with a total of 80 students were formed.

Before the beginning of the course, a test interview was conducted with students aiming to obtain "start statistics". This made it possible to construct the corresponding histograms of the "knowledge distribution" shown in Fig. 5.1. These histograms, as seen from the figure, are well described by the exponential distribution law -W(z)=exp{-z} is the Erlang law of the *0*-th order.

The X-axis is graduated with a 10-point rating system. The total number of students 80. The number of students belonging to a particular group is determined by multiplying the ordinate Y by 40. The rightmost column shows the number of students whose level of knowledge is unacceptably low.

The assignments of students to a particular group were made according to the number of correct answers to the test questions assigned to them.

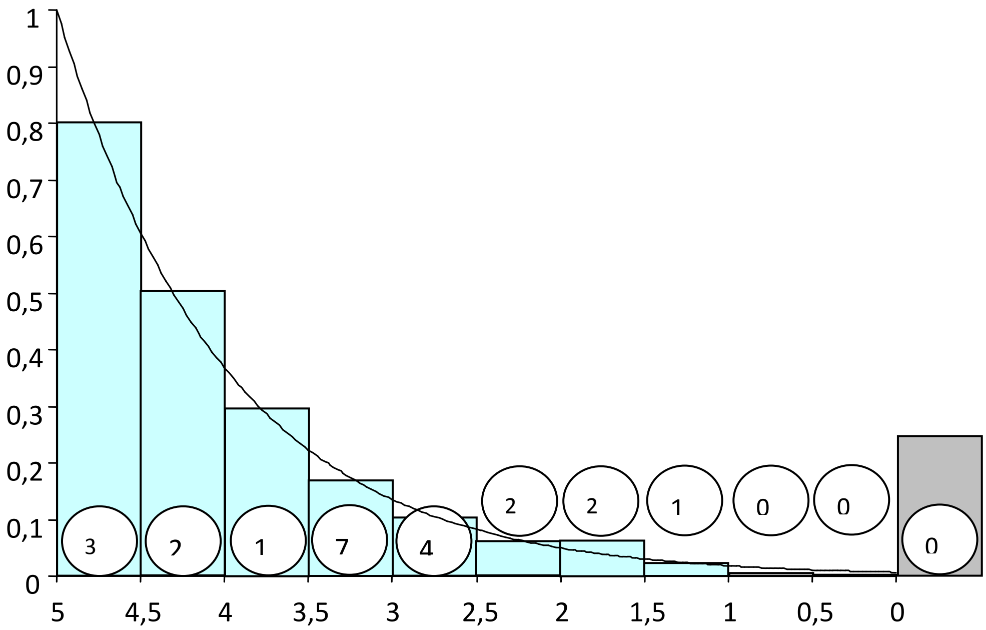


Fig. 5.1. The experimental histogram of the distribution of the number of trainees (the number in parentheses) according to the "knowledge level" before the beginning of the experiment and the probability density distribution approximating it is an exponential law.

After some time, coinciding with the end of the study of a particular section, a test survey was conducted on the material presented. According to the number of correct answers, students belonged to one group or another. According to the number of students assigned to groups (numbers in circles in the figures), histograms were built.

The results of the tests after the first section are shown in Fig. 5.2. As the approximating distribution density, the Erlang law of the first order is well suited - $W(z)=z{\cdot}\exp\{-z\}$ - is the Rayleigh law.

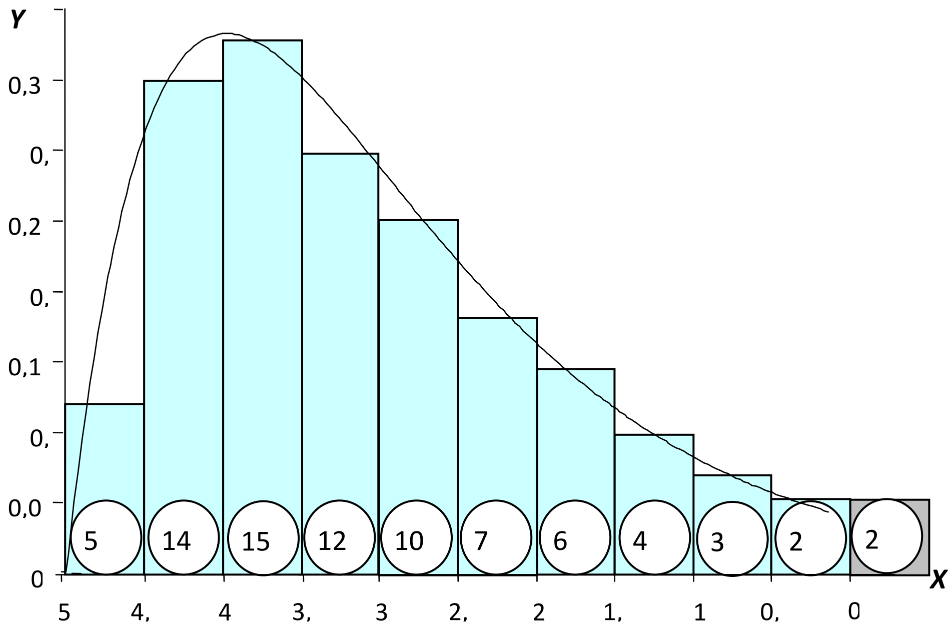


Fig. 5.2. The experimental histogram of the distribution of the number of trainees (number in parentheses) according to the "level of knowledge" after the first control period and the probability density distribution approximating it is the Erlang law of the first order. The rightmost column shows the number of students whose level of knowledge is unacceptably low.

After the end of the second section, a similar survey was carried out for both sections. The experimental histogram of the distribution of the number of trainees according to the level of knowledge and the corresponding probability density approximating it is mathematically best suited to the second order Erlang law.

$$w(z) = \frac{z^2}{2} \cdot \exp\{-z\}$$

Similar procedures were carried out after studying the following sections. In all cases, the successful approximation of the distribution density is the Erlang law of 2, 3 and 4 order - $W(z)=z^k \cdot \exp\{-z\} \cdot 1/k!$, where k – is the order of the law.

Such a manifested frequency concerning the Erlang law makes it possible to assume the presence of a certain regularity.

The control data after the first time, i.e. the second and third time show the degree of forgetfulness of the acquired material after teaching a particular section. After the 2nd check, the degree of forgettableness of the first section plays a role. Similarly, after the third check, forgetfulness of the first and second section, etc., is affected. This explains the increase in ignorance after each check and the change in the corresponding distribution law from check to verification.

If we introduce the natural limits of the estimates of 5-4-3-2-1, we get the picture shown in Fig.5.3., Which shows the distribution of the number of estimates at different control levels k = 0; 1; 2; 3; 4.

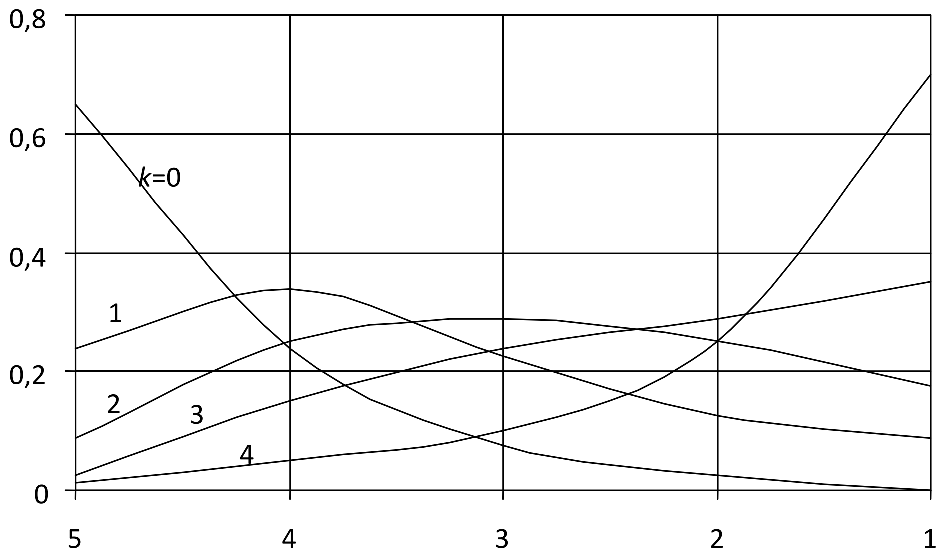


Fig. 5.3. The distribution of the number of estimates at different levels of control k = 0; 1; 2; 3; 4.

The next set of questions that need to be addressed is related to the analysis of the reverse situation, how the material is assimilated as a result of an independent study. In other words, it was necessary to determine the approaches to the justification, as it were, under the law of "restoration" of knowledge. To this end, an experiment was made, similar to the previous one.

Three control groups of students for 30 people were formed, having the "same" level of initial knowledge.

The first group was selected students with the "same" level of initial knowledge in the humanities, the second - in mathematics, the third - in general management.

Students of each group were asked to independently study a relatively large section of new material on the relevant profile of the group.

In Fig. 5.4. an example is given of an experimental histogram of the distribution of the number of students (number in brackets) according to the "level of knowledge" in each of the groups after an independent study of the new material and approximating the probability distribution densities, which is an exponential law with the value of the determining parameter $\eta=2$.

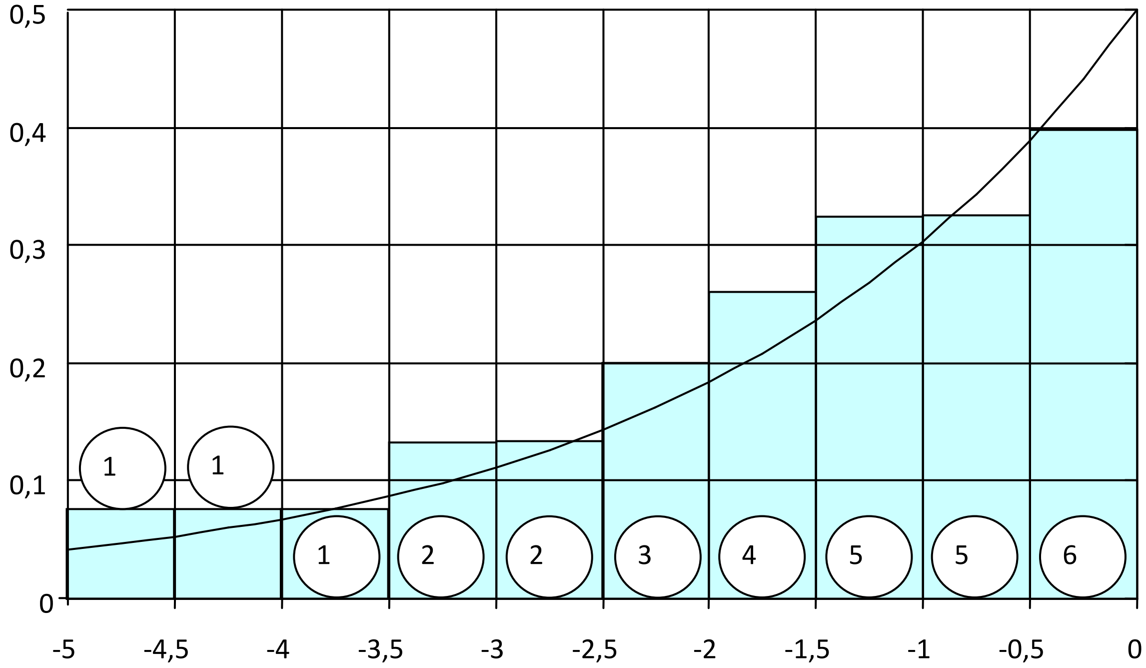


Fig. 5.4. Group 1 - students with the "same" level of initial knowledge for humanitarian disciplines with $\eta=2$.

It can be seen from the results of the research that a reasonably successful approximation for the display of experimental data is the exponential law, which can be interpreted as the law of "loss" of knowledge. The difference in these laws is determined only by the parameter η in the first case and λ - in the second.

From the experimental data, it can be seen that the development of new knowledge in humanitarian disciplines ($\eta=2$) is much more comfortable than in mathematics ($\eta=1,5$) and in management ($\eta=1$).

Based on the results obtained, another experiment was carried out with the same contingent of individuals. The audience was a group of students with different initial levels of knowledge, the probability distribution density of which obeyed an exponential law with the parameter $\lambda=1$. After some time, during which the "listening regime" was carried out without any material consolidation and self-preparation of students, the level of knowledge of these students was checked. The test measurement of the "knowledge level" of these students leads to a density of probability distribution in the form of the Erlang law of the 1 order, and after some time, which is a natural stage in the study of the discipline, the experiment deduced the law of Erlang 2 order.

At the end of the first stage, the students were transferred to the "self-training and material training" mode, after which again the tests were conducted according to the results.

Similar test procedures were made after the second "boundary" control. The corresponding results are shown in Fig.5.5.

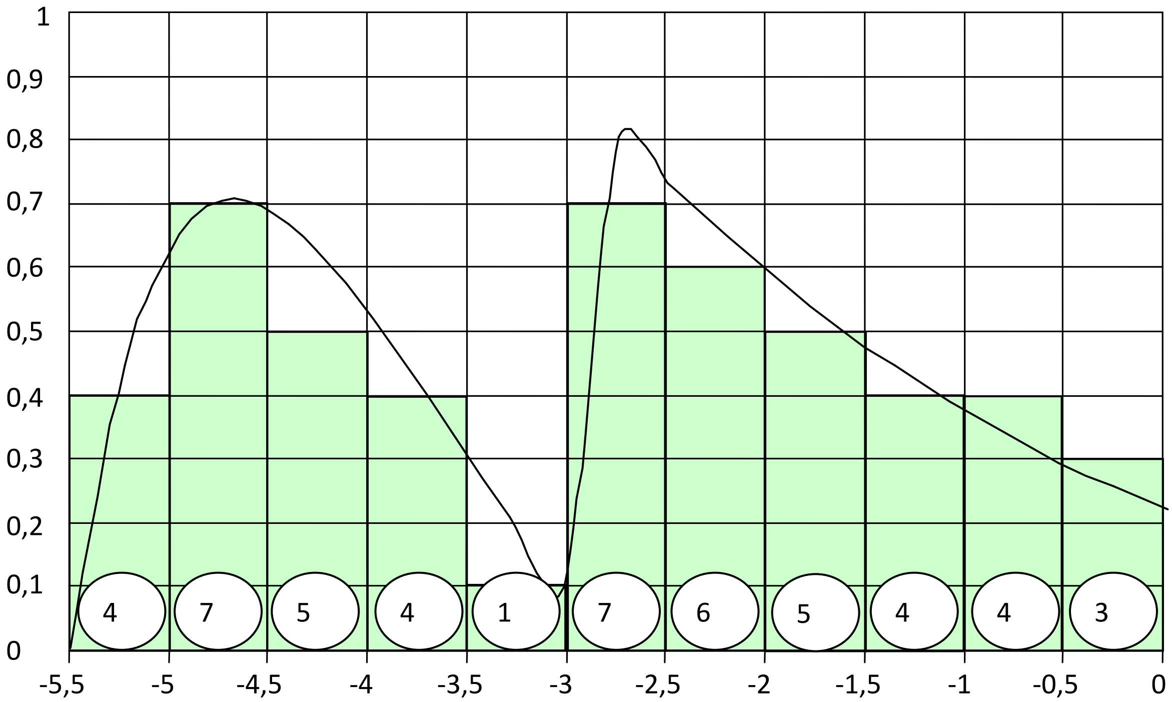


Fig. 5.5. The experimental histogram of the distribution of the number of students (number in parentheses) according to the "level of knowledge" after an independent study of the "studied" material from the level of the second boundary control and approximating its probability distribution density.

The presented experimental histogram of the distribution of the number of students according to the level of knowledge after an independent study of the material passed shows an explicit division of the general picture into two components - with a good and poor level of assimilation.

With the approximately lone initial training of the main number of trainees, the presence of such a split suggests that not all students can effectively study the material themselves. This should be taken into account when planning and building the learning process and in the formation of training groups.

MAIN CONCLUSIONS TO THE FIFTH CHAPTER

1. As a model of "knowledge acquisition", the density of probability distribution of the level of knowledge can be in the form of an exponential law.
2. As a model of "loss of knowledge" can be the density of probability distribution of the level of knowledge in the form of an exponential law.
3. As a model of the "listening regime", the density of probability distribution of the level of knowledge can appear as the law of Erlang, the order of which increases with the course of time the actions of the "listening regime".
4. To build a model of "listening mode" with a periodic transition to the "self-training regime" you can use a synthetic model based on combinations of exponential law and Erlang's law.
5. Separation of trainees according to the degree of opportunities for independent learning is desirable to take into account when forming training groups at the beginning of the academic year to provide approximately the same abilities of trainees in each group and for effective planning of the educational process.

GENERAL CONCLUSIONS

1. The primary strategic goal of the society is to ensure the needs of citizens, society and the labor market in quality education by creating new institutional mechanisms for regulation in the field of education, updating the structure and content of education, developing the fundamental and practical orientation of educational programs, and the formation of a system of continuing education.
2. According to the recommendations of the Council of the European Union, Member States need to establish transparent systems for the provision and evaluation of quality in higher education. The aim is to guarantee and improve the quality of higher education, with due regard to national conditions, the European dimension and international requirements.

Quality assessment and quality assurance systems should be based on the following principles:

- autonomy and independence of the bodies responsible for quality assessment and quality assurance;
- Link evaluation procedures to how institutions themselves see themselves;
- internal (self-reflective) and external (peer review) assessment;
- participation of all players (lecturers, administrators, students, alumni, social partners, professional associations, the inclusion of foreign experts);
- publication of evaluation reports.

3. To quantify the possibility of a HEI to conduct educational and scientific work with the required quality, it is necessary to have a concept characterizing the institution from this point of view. This rating can be the rating of the HEI, which is a generalized multicomponent vector, consisting of a number of vectors - components that determine the work capacity of the HEI in various areas of educational and scientific work. These areas are crucial in assessing the characteristics of the HEI and allow you to assess its potential for training specialists and scientific personnel.

In the paper, it is proposed to represent the generalized rating vector as the sum of two resulting vectors. One of which determines the educational component, the other - the scientific component.

CONCLUSION

In conclusion, the main theoretical conclusions and results are summarized. Although the improvement of the functioning of the higher education system is one of the main objectives of the Latvian government, the study confirms that internal and external quality assurance procedures are still at an early stage in Latvia, and research work in higher education institutions and the quality of education are also not given enough attention.

The main strategic objective of the society is to ensure the needs of citizens, society and the labor market in quality education by creating new institutional mechanisms for regulation in the field of education, updating the structure and content of education, developing the fundamental and practical orientation of educational programs, and creating a system of continuing education.

To achieve this goal, it is necessary to solve the following strategic tasks:

- improvement of content and technological education;
- development of quality assurance of educational services;
- improving management in the field of education;
- improvement of economic mechanisms in the sphere of education.

The strategic goal of improving economic mechanisms in the field of education is provided through the implementation of program activities:

- Models for introducing funds to finance educational institutions at all levels of education, providing a multi-channel flow of funds and greater independence for their use;
- introduction of mechanisms that promote the economic independence of educational institutions (institutions) in order to improve the efficiency of resources allocated to education;
- Introduce a package of measures to increase the investment attractiveness of education that contributes to investment, financial, material, intellectual and other resources in the education system, and the consistent translation of

its development principles for the development and implementation of investment projects.

- To solve all these problems, first of all, it seems expedient to determine the tasks performed by the three higher education entities, namely the state, HEI, and student.

To quantify the possibility of the HEI to conduct educational and scientific work with the required quality, it is necessary to have a concept characterizing the educational institution from this point of view. Such a rating can be the rating of the HEI, which is a generalized multi-component vector, consisting of many vectors - components that determine the work capacity of the HEI in various areas of educational and scientific work. These areas are crucial in assessing the characteristics of the HEI and allow you to assess its potential for training specialists and scientific personnel. In the paper, it is proposed to represent the generalized rating vector as the sum of two resulting vectors. One of which determines the educational component, the other - the research component.

The strategic goal of quality assurance is achieved through the implementation of program activities in the following areas:

- Improvement of the state system of evaluation of educational institutions and organizations intending to agreeing on the indicators of the development of the modern education system and the normative, methodological and information support for licensing and state accreditation of educational institutions;
- development of new forms and mechanisms for assessing and monitoring the quality of educational institutions for the implementation of educational programs, including the participation of community organizations and professional associations, to ensure the objectivity, reliability, and transparency of the assessment of educational institutions;
- Improving the mechanisms for recognizing the equivalence of education to improve academic mobility, increasing the export of educational services that will facilitate integration into the global educational space;

- Creation of a national system of quality education to create mechanisms for an objective assessment of the quality of education at all levels and stages of education, which will ultimately ensure the quality and accessibility of education;
- Improvement of the system of state certification of scientific and scientific and pedagogical personnel for improving the quality and efficiency of the system for training highly qualified personnel and ensuring the reproduction and development of education and science in the field of human resources, as well as harmonizing national procedures for the certification of research institutes.

External and internal systems for ensuring the quality of education should be developed and applied jointly by state structures and HEIs. HEIs should continue to develop internal quality assurance mechanisms, and the structure of external quality control should take into account the internal mechanisms of HEIs when conducting the evaluation process. This requires establishing mechanisms to strengthen quality control procedures to ensure a good understanding of the most effective mechanisms and instruments.

IV SCIENTIFIC AND SCIENTIFIC AND APPLIED RESULTS:

A. Scientific results.

1. The necessity of solving the following strategic tasks in the field of higher education is grounded:

- improvement of content and technological education;
- development of quality assurance of educational services;
- improving management in the field of education;
- improvement of economic mechanisms in the sphere of education.

2. The essence of ensuring the needs of citizens, society and the labor market in quality education is updated by creating new institutional mechanisms for regulation in the field of education, updating the structure and content of education, developing the fundamental and practical orientation of educational programs, and the formation of a system of continuing education.

B. Scientific and applied results.

1. A comprehensive assessment and analysis

2. The mechanism of management of a modern HEI was proposed and developed, which allowed to consider it as a particular kind of social and pedagogical activity that provides identification of internal mechanisms and sources of innovative development of the higher education system that provides recommendations for making managerial decisions to improve the educational process, and at the level of the HEI;

4. A mathematical model of the solution formed in the classification of higher education institutions as objects is developed. It allows, under known characteristics of the state vector (HEI rating) and the means of implementing elementary operations, to determine the probability of states of the transformed state vector at the output of the latter in the sequence of performing its transformation by elementary operations when classifying objects in any of the

possible classified states and, thereby, to assess the degree of fitness of the classified object to the tasks facing it.

C. Proposals

The proposals made in this dissertation with a high degree of certainty are:

1. Creation and introduction of models of continuing professional education will provide each member of the society the opportunity to form individual paths of education for further professional education, career growth, and personal growth;

2. Integration and implementation of new educational technologies and principles of the educational process is necessary to ensure effective implementation of new models and content of continuing education, including the use of modern information and communication technologies;

3. Develop a model of the system to implement measures to ensure participation in the Bologna and Copenhagen processes to improve the competitiveness of vocational education in the international market of educational services and opportunities for the participation of students and graduates of educational institutions in the international system of continuing education.

V LIST OF PUBLISHED WORKS ON THE THEME OF DISSERTATION

The articles in the collections from the scientific conference are presented in Conference Proceedings in Thomson Reuters and/or SCOPUS

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3. **Linde I.,** Dzelme J., Krišjāne Z., *Direct Use Of Knowledge*; The International Scientific Conference NEW CHALLENGES OF ECONOMIC AND BUSINESS DEVELOPMENT – 2012 (May 10 – 12, 2012, Riga, University of Latvia, Faculty of Economics and Management), publication 142--147 p. ISBN 978-9984-45-519-8
4. **Linde I**., Petrova M., *The challenges of formalization and modeling of higher education institutions in the 21st century*. CBU international conference proceedings 2018 MARCH 21-23, In Prague, Czech Republic. CBU international conference proceedings 2018: innovations in science and education Book Series: CBU International Conference Proceedings Pages, WOS: 21.-23.03.2018
5. Dzelme, J (Dzelme, Juris); **Linde, I (Linde, Ivars**). Quality of Virtual Mobility. Edited by: Marek T; Karwowski W; Frankowicz M; Kantola J; Zgaga P., Source: HUMAN FACTORS OF A GLOBAL SOCIETY: A SYSTEM OF SYSTEMS PERSPECTIVE Book Series: Ergonomics Design

and Management Theory and Applications Pages: 791-797 Published 2014. Accession Number: WOS:000356255900070, ISBN: 978-1-4665-7287-4; 978-1-4665-7286-7

6. M. Zivitere, V. Riashchenko, **I. Linde.** THE DEVELOPMENT OF THE INNOVATIVE CAPACITY OF LATVIA, INTED2017, 11th International Technology, Education and Development Conference, pp.10071-10075, 6-8 March, 2017, Valencia (Spain); ISBN: 978-84-617-8491-2, ISSN: 2340-1079

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4. Елисеев Б.П., Ходаковский В.А., **Линде И.** *К оптимизации процессов высшего учебного заведения*, Научный вестник МГТУ ГА № 186 (12), ISSN 2079-0619, 2012, Москва, pp.165-169 (ВАК Министерства образования и науки РФ)
5. Juris Dzelme, **Ivars Linde.** *Importance and relevance of ratings*. LU 70. zinātniskā konference – Pedagoģijas zinātnes sekcija Augstskolu docētāju profesionālā pilnveide: pieredze un izaicinājumi,16. februāri, 2012, publikācija

Responsibility of student and professor about learning outcomes,autori Juris Dzelme (AIKNC/ LU), Ivars Linde,(RSEBAA), Zane Krišjāne (AIKNC).

6. Juris Dzelme, **Ivars Linde.** *Studiju programmu un salīdzināšanas problēmas*. LU 71. zinātniskā konference – Pedagoģijas zinātnes sekcija Pedagoģija nozaru attīstībai, 14. februāris, 2013, (AIKNC/ LU)

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2. **Linde I**., Riashchenko V., *Critical Approach to the Methodology for Evaluation of the University Ranking*. Materials of the III International Scientific and Practical Conference "Management of the 21st Century: Methodology and Practice", May 14-15, 2015, Poltava, 404-407 lpp. , ISBN 978-966-2989-29-8
3. **Linde I**., *Analysis of consistency of calculation of an estimate of the higher education institution ranking*. The 13th International Conference Information Technologies and Management, ISMA, Riga, Latvia, 16.-17. 04. 2015; 358-359 p.**;** Riga, ISMA, 2013, ISBN 1691-2489**.**
4. **Linde I.,** Hodakovskis V., Mrochko A.; *Specific features of modelling the process of HEI students' knowledge assimilation*. The 12th International Conference Information Technologies and Management, ISMA, Riga, Latvia, 16.-17. 04, 2014; Riga, ISMA, 2014, ISBN 1691-2489**.**
5. **Linde I**., Hodakovskis V., *Analysis of errors in classification of higher education institutions*. The 11th International Conference Information

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7. **Linde I.** *The formalization and modelling of the education processes and systems*. The 10th International Conference Information Technologies and Management, ISMA, *12-13. 04.2012., Riga, Latvia;* 133- 134 p.; Riga, ISMA, 2012, *ISSN 1691-2489*

VI DECLARATION OF ORIGINALITY AND ASSURANCE

of dissertation work

In connection with the procedure for acquiring the educational and scientific degree "doctor", I, Ivars Alfredovich Lynde, a PhD candidate free of charge, declare that my thesis, which I have worked on "optimization management in the field of education and training in the field of quality, "In the field of higher education 3. Social, economic and legal sciences, professional field 3.7" Administration and management "and scientific specialty" Social governance "contains original results contributions and contributions, and are not borrowed from studies and publications in which the author does not participate.

The results that have been received, described and published by other individuals and legal entities are quoted in the report and bibliography in an unambiguous manner.

The information provided by the author in the form of copies of documents and publications, personalized reports and more, corresponds to the objective truth.

The results obtained, described and / or published by other authors are duly and in detail described in the bibliography.

The dissertation thesis I have developed has not been presented in any other educational or scientific institution to obtain an educational or scientific degree "Doctor" or a Ph.D. "Science" degree.

DATE

Svishtov Ivars Alfredovich Linde