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BACHELOR IN EDUCATION (LIFE SAFETY) COMPETENCY ASSESSMENT

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Abstract

The paper deals with the problem of training the Bachelors in Education (Life Safety) (BE (LS)) which is relevant today. The paper presents the results of the research conducted by the authors during the time span from 2008 up to 2018 that reveal the particularities of training of bachelors on the basis of modular, noxological and information-environmental approaches. The main directions of organizing the educational process of bachelors training based on an experimental technique are detailed. For understanding the role of the same aspects in a teacher's expertise, the regularities of development of the "Life safety" educational space (LS ES) have been determined. For assessing the noxological, information-environmental and methodical contents of the professional competency of a Bachelor in Education (Life Safety), the technique of additive and multiplicative convolution has been suggested that allows considering the contribution of each Academic subjects & modules (ASM) and each competence into formation of the professional competency. The research conducted has enabled the authors to obtain results definitely proving the efficiency of including the practice-oriented noxological content into the bachelors training educational process. This can be seen in a higher stability of forming of the professional competency in students of experimental groups. The question about the influence of today's complex of challenges, threats and hazards of the environment on the content of profile subject training of life safety teachers and on formation of their professional competency remains debatable.

Keywords: Bachelors in Education (Life Safety), education in life safety, Life safety, professional competency components, professional competency.

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1. Introduction

One of the leading contemporary trends in the higher education is the search for and development of the relevant qualities in new formation teachers. Such teachers have to possess a set of knowledge, abilities and skills that will allow them to master the future profession. The total spirals into a brand-new characteristic of a teacher - professional competency (Bolotov & Serikov, 2003; Carr & Skinner, 2009; Boulet, 2015; Day, 1994; Hedges, 1996; Zimnyaya, 2006).

1.1. Definition of the problem situation

The fundamental change in today's education system of Russia is conditioned by certain modifications urging new views on the organization of professional training of higher education institution students within the new educational paradigm (The Bologna Declaration, 1999; Stankevich, Abramova, & Boyarov, 2016).

Today's global problems of the humanity - a higher birth rage, depletion of natural resources and biological diversity, reduced quality of food products and worsening of people's health, increased volume of consumption waste and anthropogenic pollution of the atmosphere, hydrosphere, and lithosphere lead to the multiple increase and expansion of the range of threats and hazards for people (Poirier & Feder, 2001). The environmental aspects of LS ES determine the normal functioning of biosphere and are considered as the main condition of existence of the humanity. The contemporary environmental situation has increased the significance of man in the environment (Simpson, 1988). In its turn, this brings up the necessity for the society's needs to be reconsidered. Meanwhile, the contemporary education system is in much determined by such conceptual documents as the Russian Strategy of national security, the Federal laws "On production and consumption waste", "On protection of the environment", as well as the international level ratification of Stockholm Declaration of the UN Conference on the Human Environment (1972) and Rio de Janeiro Declaration of the UN Conference on Environment and Development (1992), etc.

A wide range of problems of modern society is exacerbated by the penetration of information and information technologies into all spheres of human life.

Analysis of the conceptual provisions of the National Security Strategy, the Doctrine of Information Security and the Concept of the Information Society in Russia showed that the problems of the security of the information educational environment are becoming ASM of close attention on the part of politicians, military, and academic science. This requires ensuring a guaranteed state of security for all participants in the educational process from the negative impact of the information environment and information flows and ensuring the security of the information educational environment of educational institutions.

All these factors require the improvement of the content of the education system in Russia and all over the world, which belongs to one of the state-forming systems.

The quality of modern education is the most important condition for the survival and development of Russian society in the face of new dangers and threats. Therefore, it is necessary to improve the quality of the professional competency of the teacher, capable at a high methodological level, to teach students how to counter contemporary threats and dangers.

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1.2. Structure of a competence

For the rise of expertise of today's bachelors, *the competence-based approach* is considered as the priority one by the contemporary science. The scientific range of problems concerning training of a competent graduate is reflected by the numerous works of Chown (1994), Fernandez et al., (2012), Armstrong (1995), Whiddett and Hollyforde (2000, 2006), Kurz and Bartram (2002), Sternberg and Kolligian (1990) and others. Research on intercultural competence covers a wide variety of areas - from workplace diversity (Ghosh, 2014).

Ever since classical antiquity, teaching competence has been constituted via three main components. The first component of teaching competence is the noxological. This competence as a result of the Bachelor's training in the LS ES is manifested in the willingness and ability of the individual to use in the professional activities the acquired complex of knowledge and skills to ensure safety in the area of professional activities, the nature of thinking in which safety issues are prioritized.

In addition, noxological competence determines the content of noxological activities of Health and Safety teachers in which we define the following directions to realize their knowledge, skills and competences:

- the ability to identify the sequence of hazard situations, as well as logical analysis of their causes and consequences in the organization of Health and Safety specialist's activities;

- the ability to carry out the identification of hazard priori or posteriori using the direct and inverse methods (either before or after the occurrence of hazard; to study the causes of the latter with a view to anticipate or analyze its effects for identifying the causes);

- the implementation of hazards prevention as a set of measures to prevent exposure of hazards on the trainees;

- the introduction of the requirements of pedagogical valeology into the organization which trains specialists of education in the LS ES, to give the whole system of training recreational orientation and to study the impact of educational technology on the students' health, the formation of their valeological knowledge and skills.

Research shows that the second component of teaching competence is the Information-Environmental competence. This component determines the willingness to apply knowledge and skills of safe behavior in a dynamic information environment. In the information and educational environments, safe information and environmental activities are carried out at their junctions.

Such activities are:

- the ability to carry out professional activities and orientation while in the information and educational environments;

- the ability to flexible, mobile, operational adaptation to various types of professional activity in a progressive information educational environment;

- the ability to carry out safe information and environmental activities in the context of the development of the information educational environment of a university under the influence of external and internal challenges, threats and dangers of various origins.

Solomin & Andreeva (2015) describes the third component of teaching competence. They assumed the readiness of students to successfully transfer knowledge to the students, form their safety culture, and

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create conditions for the development and self-development of students using various methods, forms and means of subject teaching and development.

This is reflected in the formation of the bachelor's theoretical knowledge:

– in the development of the content and methods of conducting lessons, excursions and extracurricular activities on the Health and Safety lessons, aimed at developing the qualities of the personality of a safe type of behavior and safety culture;

– at the construction of educational and programmatic documentation;

– to advance learning and research in LS ES;

– in the evaluation and correction of the results of subject education;

– in self-evaluation of students' pedagogical activity in LS ES.

2. Problem Statement

Based on the paradigm "lifelong education", one should assume that a high level of development of professional competency would allow the bachelor to form and develop high personal consciousness of students and the readiness of children to act in conditions of potential and real dangers within the framework of the school course “Life Safety”.

They will also be able to help themselves, their friends and relatives and other people who have fallen into difficult life situations.

Therefore, the actual pedagogical and methodological task is to determine the level of the formation of the professional competency of the bachelor with the identification of Noxological, Information-environmental and Methodological components in it.

The problem is also determined by the inadequacy of existing technologies for assessing the level of professional competency of bachelors based on determining the influence of the content of ASM on the formation of specific components of the professional competency of the bachelor.

To assess the level of the formation of the professional competency of a bachelor, a well-founded tool is needed. It makes to reliably determine the level of the formation of professional competency.

3. Research Questions

3.1. What is a structure of a professional competency of the BE (LS)?

3.2. How to identify student’s level of the professional competency?

4. Purpose of the Study

Specify the components of the professional competency of the BE (LS). Determine the relationship between the acquired competences and the ASM to identify the components of the professional competency of the BE (LS). Determine the influence of the ASM on the formation of the professional competency of the BE (LS). Calculate the integrated indicator (supercriteria), which determines the professional competency of the BE (LS).

5. Research Methods

The Research Methodology is based on the ideas of integrated assessment of the influence of the

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bachelors' education content (for each ASM) on specific components of their professional competency.

Complementary research methods were used to achieve this goal, in particular:

5.1. Method of comparative educational experiment.

The experiment covered Sakhalin State University (Yuzhno-Sakhalinsk, Russia) (Health and Safety Department) and Herzen State Pedagogical University of Russia (Saint Petersburg, Russia) (Faculty of Health and Safety) and involved over 630 students within the period from 2006 to 2018.

The object of the experimental study was an educational process of the BE (LS). At the initial stage of the experiment, the groups of students were selected to be homogeneous (ones with the similar average admission score of the applicants).

The organization of the educational process of bachelors' training based on the experimental technique featured the following particularities:

1. Organization of training: the modular main educational program based on asynchronous learning was used, with each student being granted an opportunity to choose their individual educational route;
2. Content of training of the students: the ASM of noxological content were included.
3. Characteristics of methods: at Sakhalin State University and at Herzen State Pedagogical University, the experimental technique based on the organizational and methodological conditions remained unchanged.

In the control groups, the traditional (linear) organization of the educational process was applied. In the experimental groups - a non-linear modular organization of the educational process was applied.

5.2. The qualitative and quantitative methods.

The basis for assessing the formation of competence were credits, got by a student in the ASM, forming competence. These credits are homogeneous, refer to performance indicators. Therefore, it is possible to use this convolution to assess the level of the formation of each competence of the student. For determining the professional competency formation level of bachelors, we used the vector optimization technique (Sibikina, 2013) in authors' interpretation (Stankevich et al., 2016, 2017).

5.3. The statistical treatment.

The averaged values of the professional competency formation level were further tested using statistical analysis methods in accordance with the variation coefficient based on the technique for assessing the distinctions between two samples by the level of the quantified attribute *(Mann-Whitney U-test)* (Mann & Whitney, 1947) and on the technique for assessing the degree of association of the samples multitude *(Kruskal-Wallis test)* (Kruskal & Wallis, 1952).

6. Findings

6.1. Defining the Competency Matrix.

Numerous studies conducted at the Life Safety department of Sakhalin State University and at the faculty of Life Safety of A.I. Herzen RSPU for over 10 years have allowed developing and justifying the

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procedure of determining the degree of influence (*p*) of each ASM (*M*) on the formation of the professional competency (*S*). For this, the authors ascribed code numbers to the ASM and competences (table 01, table 02):

Table 01. The Professional Competency components

Federal State Educational Standard of Higher Education (FSES HE) competence code	Components		
	Noxological	Information-Environmental	Methodical
OK-1	S_{11}	S_{12}	S_{13}
….	…	…	…
OK -m	…	…	…
OPK-1	…	…	…
….	…	…	…
OPK -p	…	…	…
PK -1	…	…	…
….	…	…	…
PK -k	S_{n1}	S_{n2}	S_{n3}

Table 02. Modules coding

Subjects / modules (ASM)	Code
1. Methods of teaching and education (profile)	
1.1. Methods of training and education of life safety	M_1
1.2. Training technologies	M_2
1.3. Extracurricular activities and extra-curricular work on the safety	M_3
1.4. Education at the lessons	M_5
1.5. Independent work of schoolchildren at lessons	M_6
2. Legal basis of life safety	
2.1. Theoretical basis of human safety	M_7
2.2. Legal regulation and bodies ensuring safe living	M_8
2.3. National Security, State Defense and Crisis Management	M_9
2.4. Civil Defense	M_{10}
2.5. Ensuring the safety of the educational institution	M_{11}
3. Ensuring safety in various spheres of life	
3.1. Hazards of nature and protection from them	M_{12}
3.2. Autonomous survival and safety in tourism	M_{13}
3.3. Environmental safety	M_{14}
3.4. Hazards of technogenic nature and protection from them	M_{15}
3.5. Social hazard and protection from them	M_{16}
3.6. Safety on the road and in public transport	M_{17}
3.7. Information security	M_{18}
4. Health-saving aspects of safe living	
4.1. Environment and human health	M_{19}
4.2. Psychophysiological foundations of health	M_{20}
4.3. Fundamentals of epidemic safety	M_{21}
4.4. Healthy lifestyle	M_{22}
4.5. Fundamentals of medical knowledge	M_{23}
5. Modules for the student's choice	

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5.1. Road and transport safety	M_{24}
5.2. Social Preventology	M_{25}
5.3. Information Security in Education	M_{26}
5.4. Psychological safety	M_{27}

Thus, an appropriate Competency Matrix was formed (1):

$$S = \begin{bmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & S_{23} \\ S_{31} & S_{32} & S_{33} \\ S_{41} & S_{42} & S_{43} \\ \dots & \dots & \dots \\ S_{n1} & S_{n2} & S_{n3} \end{bmatrix} \qquad (1)$$

The degree of influence (p) was determined based on knowledge about the influence of each ASM on the degree of formation of certain competences obtained because of expert analysis. The expert analysis had the following features:

1. The survey was based on the opinions of experts (teachers of departments, graduates of The Herzen State University and Sakhalin State University of 2005-2017, postgraduate students and master students of various years of study).
2. The experts worked as an open group discussion.
3. The experts generated the shared opinion about the inclusion of each ASM into the list as a one forming this or that competence.
4. The degree of importance of each ASM for the formation of a certain competence identified based on determining its weight factor.

The data obtained revealed the relation between the competence's components acquired and ASM forming them in direction of training 44.03.01 "Pedagogical education", profile "Life safety education". The revealed interrelation is represented in the figure 01.

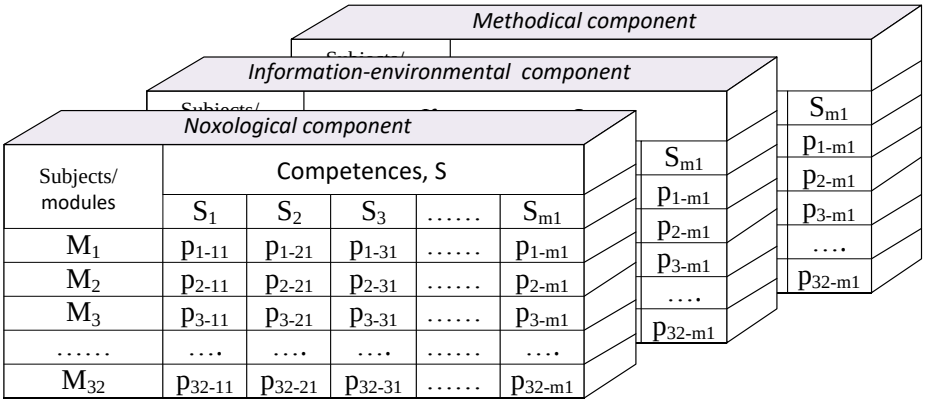

Figure 1. The revealed interrelation between the acquired competences and the ASM that form them (the weighting factor for each component)

The experts were also asked to determine the weight factor of each competence in the noxological content of the professional competency (Table 3).

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Table 03. Weight factors of the professional competency components

Components	Competences, S				
	S_1	S_2	S_3	….	S_m
Noxological	q_{11}	q_{21}	q_{31}	….	q_{m1}
Information-Environmental	q_{12}	q_{22}	q_{32}	….	q_{m2}
Methodical	q_{13}	q_{23}	q_{33}	….	q_{m3}

When assessing the contribution of each ASM into formation of a certain competence determining of the professional competency's components of the BE (LS), the authors used the method of additive convolution, which allows considering the level of students' mastering some ASM at the expense of others.

6.2. The procedure for assessing the professional competency of the BE (LS)

Thus, the authors have developed a procedure for assessment the professional competency of a bachelor. The procedure consists of three stages (Figure 2): 1) determining the level of development of each significant competence of FSES HE in the graduates; 2) assessing the graduates' competency level; 3) calculation of the professional competency based on the method of curtailing the criteria.

The level of development of each competence depends directly on the integral score (credits, $b_1...b_n$) a learner gets in the competence forming ASM as well as on the weight with which each ASM influences the competence.

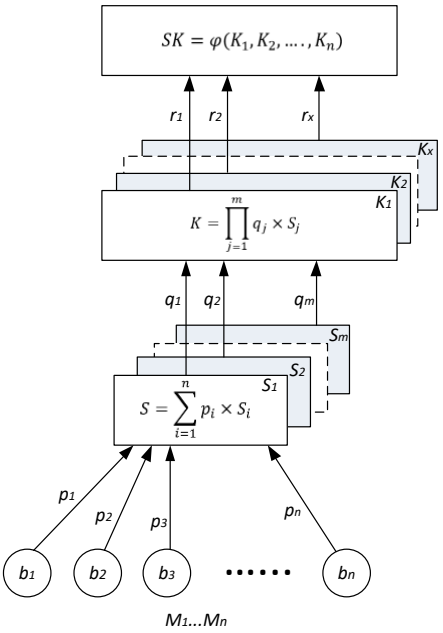

Figure 2. [Noxological content of the professional competency assessment procedure. ***Source:*** The authors]

The calculation is performed according to the formula:

$$S_i = b_i \times p_i \qquad (2)$$

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here i is the quantity of ASM influencing the formation of the competence, i = 1, ..., n; b_i is the credit that a student takes in this ASM; and p_i is the weight factor of the ASM influencing on i-th competence formation.

Next, the additive convolution of vector criterion is used and the numerical characteristic of each competence development level in the learner is obtained:

$$S = \sum_{i=1}^{n} p_i \times S_i \qquad (3)$$

The use of additive convolution in this case is conditioned by the fact that a low score (minimal credit) in one ASM influencing the formation of a competence can be compensated by a high score (maximal credit) in another ASM influencing the formation of the same competence.

For calculating the level of competency, it is necessary to know the development level of each competence S_j, as well as weight factor p_j showing the degree of influence of each competence of the professional competency. For this, the multiplicative convolution of vector criterion was used:

$$K = \prod_{j=1}^{m} q_j \times S_j \qquad (4)$$

Here j is the quantity of competences determining the competency, j = 1 ... m; S_j is the numerical characteristic of the development level of j-th competence; and p_j - weight factor of the degree of influence of j-th competence for each component of the professional competency.

To assess the contribution of the formation of each competence in the formation of each component (noxological, information-environmental, methodological) of professional the competence, we applied the method of contraction of criteria, which involves converting a set of available particular criteria into one supercritery *SK*.

$$SK = \varphi(K_1, K_2, \ldots., K_n) \qquad (5)$$

Thus, a new supercritery (professional competency) *SK* was obtained, which is a function of the partial criteria *K* (noxological, information-environmental, methodological components of professional competency).

Thus, using the technique suggested, the numerical values of the professional competency development level for each student were obtained and so were the corresponding to they weight factors of the degree of significance of each competence. Next, after applying the multiplicative convolution of vector criterion with weight factors of degree of influence of each competence on the noxological content of the professional competency considered, the corresponding professional competency development levels were obtained for each student.

In conclusion, based on the values obtained, a supercritery was calculated. It presented the required level of the formation of the BE (LS) professional competency.

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6.3. Statistical hypotheses checking

The statistical hypotheses were checked stage by stage for the experimental and control groups. For more convenient interpretation of the results of analysis, the years of students' admission to the higher education institution (2010-2015) and academic years (2012-2018) are indexed, with the indices obtained determining the code names of the control (*X*) and experimental (*Y*) groups (Table 4). To present the results, the data for the training groups are combined.

Table 04. The level of formation of the professional competency as determined by the calculation method

Parameter	Value	
	X	Y
The level of formation of the professional competency, SK	54,69	64,76
The quantity of students having the relevant formation level, in %		
Minimal (0-30)	10,2	5,2
Low (31-50)	22,2	11,1
Medium (51-70)	43,5	22,4
High (71-84)	17,5	33,9
Top (85-100)	6,6	27,4
Dispersion if values *(D)*	146,78	151,022
Mean root square deviation of values ***(σ)***	12,11	12,29
Values variation coefficient ***(V),*** in %	21,70	16,88
Number of students in the sample	275	364

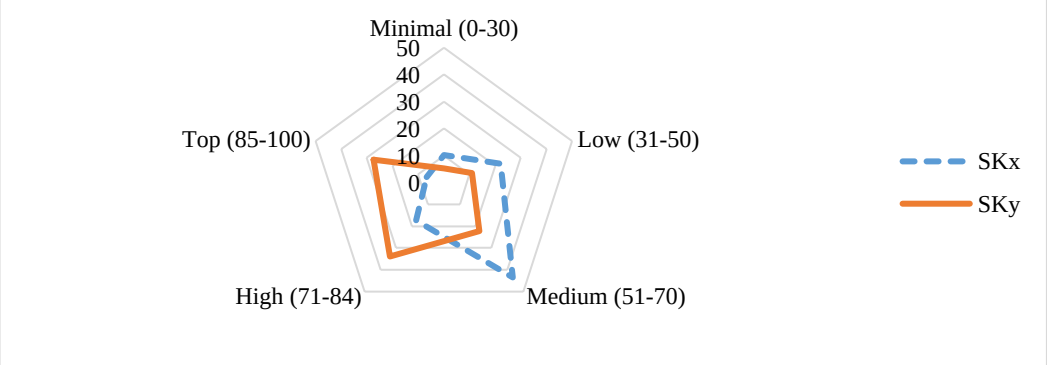

Figure 3. Professional competency for the control and experimental samples flowchart. (***Source:*** The authors)

In order to assess the differences in the level of the professional competency, for students of experimental groups, the following criteria were used according to terms of study: *Mann-Whitney U-test* for the case of two unrelated samples, and *Kruskal-Wallis test* for the case of three and more unrelated samples. The null hypothesis put forward is H_0 = {there are only random distinctions in the level of the attribute studied between the samples}, the alternative hypothesis is H_x = {there are stable distinctions in the studied attribute level between the samples}. Results of the calculations are given in Tables 5 and 6.

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Table 05. Empirical values in Kruskal-Wallis test

Sample	*Study term*	*Degrees of freedom, k*	*Critical value, N_{cr}*	*Criterion value, H*	*Hypothesis adopted*
$Y_1 – Y_2 – Y_3$	3	2	180,1	178,1	H_0
$Y_1 – Y_2 – Y_3$	4	2	175,4	173,4	H_0

Table 06. Empirical values in Mann-Whitney U-test] ***Source:*** The authors

Sample	*Study term*	*Degrees of freedom, k*	*Critical value, U_{cr}*	*Criterion value, U*	*Hypothesis adopted*
$Y_1 – Y_2$	5	1	175,7	170,2	H_0
$Y_1 – Y_2$	6	1	171,2	170,5	H_0

7. Conclusion

After processing of the obtained experimental results, it can be seen that the experimental group shows an increase of the high (33,9% against 17,5%) and a decrease of the medium (22,4 % against 43,5 %) level of the professional competency formation. Alongside with this, in the experimental group, the obtained variation coefficient is lower (16,88 % as compared to 21,70 %), which allows saying that it is in experimental group that the stabled results have been obtained.

Thus, the experiment conducted has demonstrated that formation of the professional competency of the BE (LS) is efficient under the longitude territorial assignments and aggregative experimental conditions.

Meanwhile, with the null hypothesis adopted in all end-of-term assessments at the level of significance 0,05, the effect of the experimental technique of the BE (LS) training can be considered similar, and the level of distinctions in formation of the professional competency in students of the relevant groups - insignificant. The situation gives evidence about the stable positive effect of the experimental technique on the formation of the professional competency in study groups.

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