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Analysis of Experimentation Results on University Graduates' Readiness Formation to Act in Extraordinary Situations

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ABSTRACT

The article presents the experimentation on graduates' readiness formation to act in extraordinary situations conducted in the Tyumen Industrial University in training bachelors in "Oil and Gas Business". The criteria of graduates' readiness formation to act in extraordinary situations are the following: practicability, validity, timeliness, feasibility, specificity. There are three levels of readiness to act in extraordinary situations: low, average, high. There were used method «The level of subjective control» by J. Rotter, method for determining neuro-psychological stability and the risk of maladjustment in stress – "Forecast", method of constriction measurement, method of identification and analysis of professionally important traits of a specialist in "man-technique" system as diagnostic instruments. In the experiment, there is developed a program of "Preparing for action in extraordinary situations of technogenic nature" focused on data of the region that includes the use of professional simulation in the learning process. There is a statistical analysis of experimentation results. The experimentation results demonstrate the effectiveness of developed program in university graduates' readiness formation to act in extraordinary situations.

KEYWORDS
Extraordinary situations (ES); readiness to act in extraordinary situations; engineer specialization; bachelor training; academic model.

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Introduction

Extraordinary situations – terrorism, fires, production accidents – are an integral part of the modern world (Syzdykov et al., 2016; Sageman, 2016). Because of extraordinary situations, there are about 3 million people dying annually in the world, the population is decreased by 4.5%. (Makhutov, 2014). The human readiness formation to a competent act in extraordinary situations (ES), allowing adequate assessment of events, to see the perspective of what is happening, responding faster, ensuring the survival, minimizing the damage caused by a disaster, is an important objective of vocational education (Sternberg, 1988; Moussaïd, 2009; Pleskac & Hertwig, 2014).

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In this context, there is a need in results-oriented preparation of people, especially the youth, to adequate actions in extreme conditions (Charlesworth, 1976; Meili, 1981; Thurstone, 1938). In students' readiness formation to ES, as well as in methodological recommendations' creation, there must be taken into account the specific characteristics of each specific major (Krikunov, 2007; Bondarev, 2009; Biodiversity and ecosystem services fundamentals, 2016). The general in the work is the understanding of readiness to act in ES by the students as a set of personality traits, psychological status, knowledge and skills that ensure adequate behavior, performance and results of the action in extreme conditions *not separately, but as a single force*. The proposed models and methods of students' readiness formation to ES are aimed at ensuring its validity, integrality, completeness, consistency; they have a similar structure (objective laws, principles, contents, methods and instruments, forms, terms, types of training). The article presents its own experimental material relating to previously studied aspect – readiness formation to act in ES of future engineers in oil and gas industry. The relevance of the study is in strategic importance of facilities for national economies and in the high risk of natural and technogenic accidents (Brody, 1994; Chausi, 1996; Raigorodskii, 2015).

In accordance with the papers above (Krikuno, 2007; Sukharev, 2009; Suleymanov, 2014) there was designed a model of bachelors' preparation in "Oil and Gas Business" to act in extraordinary situations. The model includes such blocks: theoretical-methodological, target, informative, procedural, analytical-performing and correctional. *Theoretical-methodological block* includes pedagogical approaches and design principles of bachelors' training in "Oil and Gas Business" to act in ES. *Target block* determines diagnosed training objectives in the form of specific competences identified based on engineers' tasks analysis in the situations of natural and technogenic accidents. *Informative block* is the selection of training content based on Federal State Educational Standard analysis and the above-mentioned objectives. *Procedural block* is presented in substantiation of pedagogical methods and means of readiness formation to act in ES. *Analytical-performing block* includes means of results monitoring, their generation and analysis. *Correctional block* is to correct the overall training or its individual blocks.

Aim of the Study

The purpose of the article is the experimental efficiency verification of developed logically informative method and bachelor-level program in "Oil and Gas Business" to act in extraordinary situations.

Research questions

What characteristics should be in decision making in emergency mode?

Method

The methodological basis of the research are the statements of dialectical materialist philosophy on the theory of knowledge, the leading role of activities in personality development, on dialectical unity of theory and practice.

The achieving this goal led to the use of complementary research methods:

- Theoretical methods: study and analysis of specific philosophical, psychological, educational, scientific and methodical literature on the research problem; analysis of academic documentation, general theoretical methods of analysis and synthesis.
- General logical methods: pedagogical experience study and generalization on the research problem, educational practice conceptualization.

There was also conducted a pedagogical experiment, which was attended by 115 students in "Oil and Gas Business".

Data, Analysis, and Results

University graduates' readiness to act in extraordinary situations includes the following special competences on decision making in ES: *practicability* – the best decision of all potential options; *validity* – decision is taken based on knowledge of the specific situation, the whole complex of internal and external factors; *timeliness* – decision is not far behind and ahead of the needs and problems of response to the situation; *feasibility* – decision is based on knowledge of the actual conditions and is feasible; *specificity* – decision contains specific plan and ways of its realization. Each competency can be assessed under relevant criteria (Molozhavenko, 2014). At the initial stage of experimentation, it was revealed that the readiness to act in ES has three levels of formation: *the low* as unconscious sensorimotor regulation based on skills (behavior regulation); *average* as the perceptual-conceptual regulation, based on certain rules and readiness to accept certain signals and information (neuro-psychic regulation); *high* as a conscious results-oriented regulation by means of knowledge-based feedback (intellectual regulation). There are selected the proper diagnostic methods (Table 1).

Table 1. Psychognostic methodology for determining the level of students' readiness to act in extraordinary situations

The level of social competence formation in ES	Psychognostic methodology
Low level of regulation – unconscious sensorimotor regulation (based on skills) – *behavior regulation*	«The level of subjective control» J. Rotter Adaptation of Bazhin E.F., Golynkina S.A., Etkind A.M. (Method 3) [17].
Average level of regulation – perceptual-conceptual regulation based on certain rules, when much depends on mental readiness to perceive certain signals (information) – *neuro-psychic regulation*	Method for determining neuro-psychological stability and the risk of maladjustment in stress – "Forecast" (Method 1) [17].
High level of regulation – regulation based on knowledge, it is deliberated and results-oriented with feedback – intellectual regulation	Method for constriction measurement (Method 2) [17]. Method of identification and analysis of professionally important traits of a specialist in "man-technique" system (Method 4 4) [17].

To conduct experimentation, we formed the control and experimental groups of bachelors in "Oil and Gas Business". The groups meet the following requirements:

1) experimental and control groups are representative in terms of social environment, students' ethnic composition, availability of teaching staff, conditions for educational-bringing-up process;

2) groups are parallel. This provides a correct comparative analysis;

3) groups differ statistically not significant in terms of initial level of readiness formation to ES (Mann-Whitney U-test).

In the experimental group, there was conducted a formative experiment aimed at the formation of three levels of regulation and, in particular, intellectual regulation. Professional simulation is a prerequisite of intellectual regulation, which manifests itself in goal formation, planning, programming, forecasting and anticipation, decision-making, self-control correction. Professional simulations are used educational-bringing-up process at the university, on facultative and extracurricular courses ect, (Molozhavenko, 2014) (Table 2).

In the course of the experiment, there were carried out the following tasks:

1. Specification of the program "Preparing for action in extraordinary situations of technogenic nature" by adding data of the region and oil and gas companies.

2. Methodological recommendations design for experimental class with the use of ES professional simulations of technogenic nature.

3. Professional simulations' introduction in educational-bringing-up process in the experimental group.

4. Experiment data processing and analysis.

The 115 students in "Oil and Gas Business" took the experiment – e*xperimental and control groups*. The experimental group (n = 60) was under an educational experiment with professional simulations.

In the control group (n = 55), there was no experiment carried out, educational programs' implementation at the university proceeded unchanged. The logic of the study was constructed as follows. Subjects in "Oil and Gas Business" were examined to identify the level of ES special competence formation before and after the educational experiment on selected methods.

Educational experiment efficiency checking was carried out by means of mathematical statistics. We used the following mathematical processing methods: Mann-Whitney U-test; φ^* criterion of Fisher's angular transformation (Nekrasov, 2014). The assessment of the degree of students' special competence formation to act in ES was carried out according to the following logic. The survey results on methods 1, 3, 4 (*indicators: neuro-psychological stability (NPS), the level of subjective control (LSC), professional traits*) were tested by Mann-Whitney U-test before and after the educational experiment. The survey results on method 2 (*indicators: constriction – mobility*) were tested by multifunctional φ^* criterion of Fisher's angular transformation before and after the educational experiment.

Table 2. Methods of special competence formation

Name of the block, criteria of competences' formation	Example of professional simulation
Goal formation: awareness and self-regulation forms of subjective goals (goal-image, goal-outcome, goal-level); awareness and the ability to structure goals in order of importance, forming a "tree of objectives"; awareness and self-regulation method for generating purposes (based on the awareness of motive and finding the goal, which will allow to realize this motif; new objectives' determining, since the primary objective is impracticable, the objective as a choice of a given set), ability to manage the process of goal formation.	«Three destinies», «The finest hour, hot-shot Charlie»
Planning: the ability to recognize and differentiate the form of planning (strategic, tactical, individual, joint, collective), the ability to determine and fulfill the strict sequence of events and performing activities, the ability to activity management in the space-time aspect, the ability to develop common activities and specific means of implementation , the ability to reflect the plan according to criteria: freeness, flexibility, possibility assumption of its transforming in a case of need.	«Silent city» «Five steps» «Epitaph»
Programming: ability to determine the final action not in a tree, but in one-dimensional structure, as a result, the product of planning.	«Silent city» «Five steps» «Epitaph»
Forecasting and anticipation: ability to recognize and differentiate the forms of subjective forecasting (actual, special, strategic), ability to recognize and manage the level structure of anticipation (subconscious level – based on the feeling and perceptions, to hold actions not only based on actual perceived image, but also by taking into account its trends; the representation level – based on schemes – a holistic view of certain situations, with the tendency of their probable changes; verbal and cogitative level – situations' generalization and classification activity planning out of the situation, hypothesis formulation; reflective level – maturity of not only the individual, but also the collective forecast, achieving a better sympathy between the participants).	«Self-portrait» «Who is who»
Decision making (DM): awareness and management phases of DM (definition of the problem situation, content analysis, alternatives' formulation and evaluation, the choice of alternatives, decision implementation, performance monitoring, performance evaluation and correction of decision); the reflection of made decision on the criteria: effectiveness, validity, timeliness, feasibility, concreteness.	«Traps»
Self-control: realization and management of temporary principle of self-control (preliminary, current, result); reflection and management of the principle of self-control modality (visual, auditory, tactile, kinesthetic, combined); realization and management of the structural level (biological level – (homeostasis), physiological self-regulation of the main systems of life activity, psychophysiological regulation of state, psychological self-activity, social control and self-control of behavior); regulation by goal setting - "to monitor, test yourself"	«Epitaph»
Correction: ability to interpret the results by comparing them with an ideal target; ability to determine how the result complies with the goal; ability to determine the degree of disjoint between ideal goals and results, ability to make corrections – actual result developing to ideal goal or near to it.	«Here I am!»

The obtained results' check on each method at the level of statistical significance of the subjects before the educational experiment is important to confirm *samples' equality* and *testing integrity*. Their dynamics' check on each method at the level of statistical significance of the subjects after the educational experiment confirms its effectiveness in terms of presented indicator of professional competence. We provide a comparative analysis of diagnostic results of the survey on each method in two groups – experimental and control. *Let us analyze the survey results on the first method*. According to research data, the number of low levels is significant – 73% and 78%. This confirms the need in a results-oriented neuro-psychological stability (NPS) development.

The hypothesis H0 is assumed. The experimental group of students did not exceed the control group in terms of NPS development. Thus, samples' equality for this indicator is met. At the end of experimentation, we can make a conclusion confirmed by mathematical calculations. We can state significant differences – Uemp is in the area of signification under Uemp $\leq$ Ukr, namely, 893 <1234. Thus, the hypothesis H1 is assumed: the experimental group of students exceeds the control group in terms of NPS level. The educational experiment results on students' NPS dynamics are in Figure 1.

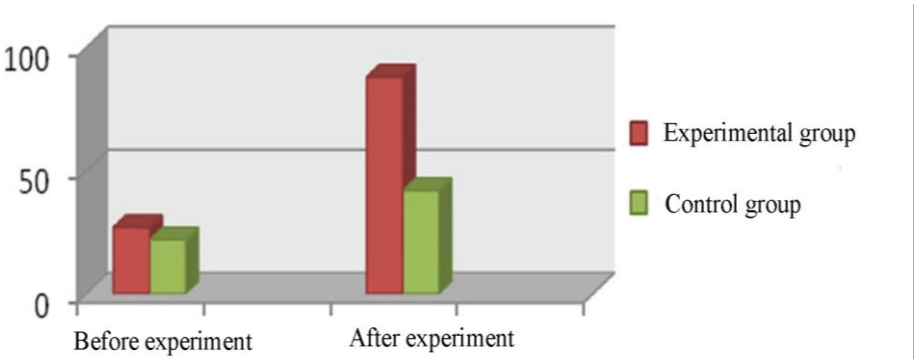

Figure 1. The dynamics of neuro-psychological stability as an indicator of students' professional competence

According to the chart, the neuro-psychological stability after the educational experiment in the experimental group is higher than in the control group.

Let us analyze the survey results on the second method.

According to research data, constriction parameters in both groups are quite significant – 60% and 70%. This is a negative factor in bachelors' actions in ES. We verified the accuracy of obtained results by φ^* criterion of Fisher's angular transformation. We are interested in whether two groups differ in terms of mobility as a positive personality trait for the bachelor under ES. In the experimental group, there are 24 of 60 people and in the control group –17 of 55 people. In the first case, % fraction is: 24/60 x 100 = 40%, and in the second – 17/55 x 100 = 30%

We verified the accuracy of these % fractions' differences under n1 and n2 data. Since we are interested in the absence of constriction, manifestation of mobility will be considered as an "effect" under solving non-standard tasks. Let us make an experimental hypothesis:

H0: The proportion of people, who showed mobility in solving non-standard tasks in the experimental group, is no greater than in the control group.

Imagine a tetrachoric table of empirical frequencies on two indicators: "an effect" - "no effect" to calculate the criterion under comparing two groups of subjects, who demonstrated mobility in a percentage fraction. Firstly, we define the φ^* value corresponding to percentage fractions in each of the groups A and B.

$$\varphi^* 1\ (40\%) = 1.369; \varphi^* 2\ (30\%) = 1.179 \quad (1)$$

In this case, φ*emp. corresponds to 1.03. Thus, we set up a critical φ^* corresponding to accepted in psychology levels of statistical significance: φ*kr. = φ*emp. = 1.03; φ*emp. < φ*kr.

The hypothesis H0 is assumed. The proportion of people, who have shown mobility in solving non-standard tasks in the experimental group, is no greater than in the control group. Thus, the samples of two groups (experimental and control) are statistically equal in terms of studied indicator – mobility.

After the educational experiment, this methodology was carried out on the same subjects. These studies indicate a significant difference in mobility formation between the two groups in favor of the experimental group of students.

We verified the accuracy of statistical results on the amount of samples by φ^* criterion of Fisher's angular transformation comparing samples in terms of defining indicators. We are interested in whether two groups differ in terms of mobility. In the experimental group, there were 52 of 60 people, and in the control group – 31 of 55 people. In the first case, % fraction of mobility will be: 52/60 x 100 = 86.7%, and in the second – 31/55 x 100 = 56.4%. We verified the accuracy of these % fractions' differences under n1 and n2 data. Since we are interested in manifestation of mobility in solving non-standard tasks, it will be regarded as "an effect", but manifestation of constriction – "no effect". Let us make an experimental hypothesis:

H0: The proportion of people, who showed mobility in solving non-standard tasks in the experimental group, is no greater than in the control group.

H1: The proportion of people, who showed mobility in solving non-standard tasks in the experimental group, is higher than in the control group.

Let us define the φ^* values corresponding to the percentage fractions in each of the groups A and B. φ*1 (86.7%) = 2,395; φ*2 (30.9%) = 1.699; φ*emp. = 3.76; φ*emp. > φ*kr.

The obtained empirical value is in the area of signification.

The hypothesis H1 is assumed. The proportion of people, who have shown mobility in solving non-standard tasks in the experimental group higher than in the control group. The experiment result on mobility formation as a professional competence of students in "Oil and Gas Business" training for action in ES is represented in Figure 2.

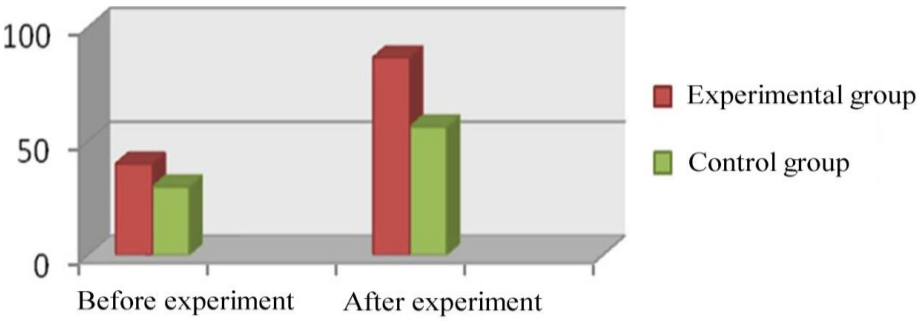

Figure 2. The dynamics of mobility as an indicator of students' professional competence

Let us analyze the survey results on the third method. We analyzed the results on the study of the level of subjective control (LSC) on the scale of general internality. The high score on the scale (10) corresponds to a high level of subjective control over any significant situations.

According to data, the internal (locus) level of control in both groups of students is represented in the least: 7 people (12%) in the experimental group and 8 people (15%) in the control group. The test was carried out by Mann-Whitney U-test. As a result, it was proved that the experimental group of students did not exceed the control group in terms of LSC – internality.

The research results may indicate that there was a formation of subjective (internal) level (locus) of control in the experimental group; the result has changed from 12% to 42%. These data on internal locus of control in the control group did not change significantly – from 15% to 18%. The data of experimental and control groups were tested for significance in terms of differences by Mann-Whitney U-test. There were calculated the rank sum (table bottom) and the total sum of ranks: 3605,5 + 3064,5 = 6670.

The calculation amount coincided with the real one. The equality of these amounts is met, then the calculations are correct. According to data, a large amount of rank falls on a sample of experimental group: 3605,5. Now it is necessary to assume the experimental hypothesis:

H0: The experimental group of students does not exceed the control group in terms of the level (locus) of subjective control.

H1: The experimental group of students exceeds the control group in terms of the level (locus) of subjective control.

We calculated Uemp for rank sum of two groups, as $(n1 \neq n2)$

We calculated Uemp for rank sum of two groups, as $(n1 \neq n2)$ according to received calculations: Uemp = 1524.5; Uemp = 1775.5

We selected a smaller value for comparison with the critical value: 1524,5. Then we determine the critical values for n1 (55) and n2 (60):

The significant differences can be noted if Uemp. $\leq$ Ukr.

Discussion and Conclusion

The experimental result on LSC formation as a professional competence of students in "Oil and Gas Business" training for action in ES is shown in Figure 3.

The hypothesis H0 is assumed: the experimental group of students does not exceed the control group in terms of the level (locus) of subjective control. The results can be interpreted as follows. The level of subjective control is associated with a sense of a man of his strength, dignity, responsibility for the situation that characterizes the emotional background of the youth (normal development). The absence of differences in research results between the experimental and control groups at the level of statistical significance may be considered as a confirmation of this statement and serve as a basis for further research.

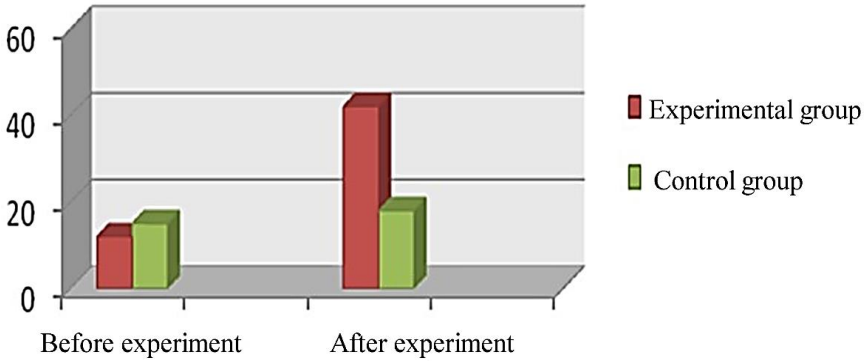

Figure 3. The dynamics of LSC formation as an indicator of students' professional competence

According to the authors of psychognostic methodology, the analysis of quantitative and qualitative results on LSC under 7 scales is carried out in comparison of individual indicators (got "profile") with the norm. Derivation to the right (> 5.5) indicates the Internal Locus of Control (LSC) in appropriate situations. Derivation to the left (<5.5) indicates the External Locus of Control (LSC). It is likely that most of individual parameters of two groups are distributed largely in the region of normal (5,5). This is not confirmed by differences in their samples at a level of statistical significance.

Let us analyze the survey results on the forth method. The level of professionally important traits' formation (PIF) was determined as the sum of individual indicators of 11 scales survey (maximum score is 55). Referring to data reflecting PIF formation before the experimentation, the result over the low levels was 40% in both groups. According to research data, it is evident that the results over the low levels were down to 30% and 40%, and the results over the high levels and average (standard) levels were up to 70% and 60%. We verified the accuracy of differences at the level of statistical significance by Mann-Whitney U-test.

After ranking individual students' PIF values, we received a total sum of ranks: 3923 + 2747 = 6670.

The calculation amount coincided with the real one. The equality of these amounts is met. The high rank sum is in the experimental group: 3923. Hence, we assume the experimental hypothesis:

H0: The experimental group of students does not exceed the control group in terms of PIF development.

H1: The experimental group of students exceeds the control group in terms of PIF development.

We calculated Uemp for rank sum of two groups, as $(n1 \neq n2)$

Uemp = 1207; Uemp = 2093

We selected a smaller value for comparison with the critical value: 1207. Then we determine the critical values for n1 (55) and n2 (60):

The significant differences can be noted if Uemp. $\leq$Ukr.

The significant differences can be noted, as Uemp is in the area of signification under Uemp. $\leq$Ukr, namely, 1207 <1234. Thus, the hypothesis H1 is assumed: the experimental group of students in "Oil and Gas Business" exceeds the control group in terms of PIF development. The educational experiment result on professionally important traits' development of students in "Oil and Gas Business" is shown in Figure 4.

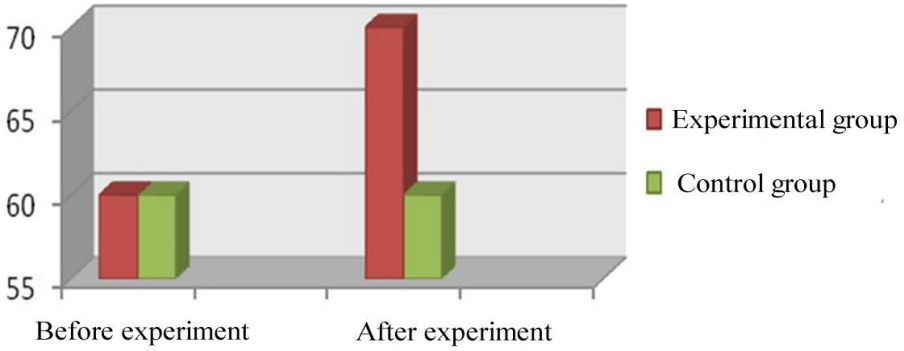

Figure 4. The dynamics of PIF development as an indicator of students' professional competence

According to the chart, PIF development after the educational experiment in the experimental group is higher than in the control group. There is being fixed reliability of differences in compared series at the level of statistical significance level in favor of the experimental group. This indicates the effectiveness of educational experiment.

The experiment results confirm the validity of developed model of graduates' readiness formation to act in extraordinary situations and the use of selected teaching methods. In general, the use of author's model and professional simulations matches the general trend provided in current educational studies (Sukharev, 2009; Tokareva, 2014; Suleymanov, 2014) in university students training for action in extraordinary situations as an overall process, as well as for use of active learning methods simulating real emergencies.

Implications and Recommendations

The results of pedagogical experiment show that results in the experimental group outperformed results in the control group. In subjects of the experimental group, there is an increase in dynamics of such indicators as courage, prudence, vigor; their actions are results-oriented.

Thus, pedagogical experiment results prove the effectiveness of developed ES bachelor-level program. The reliability of results is achieved by means of

mathematical statistics. Teaching methods are based on the use of professional simulations in the learning process.

The results of this article may serve as a theoretical source for methodology development in students' behavioral training in extraordinary situations for different specialties.

Disclosure statement

No potential conflict of interest was reported by the authors.

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