Revista Românească pentru Educație Multidimensională
ISSN: 2066-7329 | e-ISSN: 2067-9270
Covered in: Web of Science (WOS); EBSCO; ERIH+; Google Scholar; Index Copernicus; Ideas RePeC; Econpapers; Socionet; CEEOL; Ulrich ProQuest; Cabell, Journalseek; Scipio; Philpapers; SHERPA/RoMEO repositories; KVK; WorldCat; CrossRef; CrossCheck

2022, Volume 14, Issue 4 Sup.1, pages: 68-92 | https://doi.org/10.18662/rrem/14.4Sup1/660
Submitted: April 15th, 2022 | *Accepted for publication:* September 20th, 2022

Diagnosing the Personal Component of the Culture of Safety of Professional Activity in Future Occupational Safety and Health Engineers

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Abstract: The article focuses on issue of formation of the culture of safety of professional activity (hereinafter CSPA) in future occupational safety and health (hereinafter OSH) engineers. The purpose of the study is to analyze the method diagnosing the levels of formation of the personal component of CSPA in future OSH engineers and analysis of the results of pedagogical experiments on the studied component. It is established that the personal component reflects professionally important qualities (volitional, emotional, moral, communicative, organizational) and abilities (gnostic, organizational, constructive, communicative, prognostic) of an occupational safety engineer, which characterize his high level of safety culture and professionalism. With the help of theoretical research methods (analysis, systematization, synthesis, generalization) and empirical research methods (pedagogical experiment, questionnaire, expert assessment, self-assessment) based on special psychological and diagnostic methodology, we determined indicators of subjective-reflective criteria at three levels of formation of CSPA of future OSH professionals in control and experimental groups. The results of this research and experimental work, which involved 226 students of control groups and 221 students of experimental groups, are substantiated. The results of the influence of the pedagogical system of formation of CSPA of future OSH engineers on the evolvement of professionally important qualities of future safety engineers are analyzed. On the basis of the quantitative analysis of the received results of pedagogical experiment, the indicators confirming positive dynamics of formation of the personal component of CSPA in future OSH specialists are stated. Positive dynamics of growth of the personal component formation levels of CSPA of students from the experimental groups is revealed.

Keywords: *culture of safety of professional activity; vocational training; OSH engineer; vocational education; professionally important qualities.*

How to cite: Abiltarova, E., & Radkevych, V. (2022). Diagnosing the Personal Component of the Culture of Safety of Professional Activity in Future Occupational Safety and Health Engineers. *Revista Românească pentru Educație Multidimensională, 14*(4Sup1), 68-92. https://doi.org/10.18662/rrem/14.4Sup1/660

1. Introduction

1.1 Problem statement

The concept of zero injury, the concept of sustainable development, and the risk-oriented thinking require the occupational safety and health engineer to reorient and move from taking measures focused on consequences of accidents at workplace to preventive ones. In this aspect, the main tasks of the occupational safety service at work are providing preventive measures aimed at reducing occupational injuries and diseases; control over observance of legislation and other normative acts on occupational safety; formation and development of safety culture of personnel; motivating and stimulating employees to safely carry out professional activities and improve occupational safety. Given the above provisions, the CSPA formation in future OSH professionals is an urgent task today.

1.2 Analysis of recent studies and publications

Different aspects of formation and development of the safety culture have been addressed by many researchers in the domestic and foreign space. The results of the scientific publications analysis reveal that some scientists like D. Zohar (1980), R. Díaz and D. Cabrera (1997), M. Griffin and A. Neal (2000), M. Cooper (2000) link the safety culture with organizational culture and safety climate in a team. Other teachers like I. Alekseeva (2011), A. Balashov (2007), I. Golubeva (2011), A. Dronov (2007), V. Evteev (2008), T. Zyryanova (2011), A. Kazmina and A. Gaponenko (2012), L. Kolyvanova (2011), S. Kosynkina (2006), L. Mossoulina (2002), I. Nemkova (2004), A. Sadretdinova (2008), A. Snegiryov (2007), M. Trunov (2012), D. Chagin (2011) pay much attention to the formation, education of life safety culture in preschool children, pupils, students, teachers of life safety. In Ukrainian domestic science, this aspect was studied by O. Kuzmenko (2017), N. Kulalaeva (2018), V. Malimon (2019), V. Prokhorova and S. Mushnikova (2019), O. Pulyak (2015), Yu. Razlivinskikh (2018), L. Romaniv, O. Pishak and R. Boychuk (2017), O. Tretyakov and O. Dashkovska (2012), V. Fedorchuk-Moroz and O. Visyn (2019), O. Sharovatova (2018).

In the ascertaining stage of the experiment, we saw CSPA of the future occupational safety engineer is an integrative formation of the specialist's personality, expressed in values to preserve life, the ability to work and human health; reflects the system of developed professionally valuable qualities, skills and knowledge on occupational injuries prevention,

and is characterized by a high degree of responsibility, self-organization and self-development, based on a deep recognition of priority of safety in solving professional problems.

Systematization and analysis of scientific literature let us identify the following components of CSPA of future safety professionals: motivational and value (value orientations and attitudes, motives for safe professional activities); cognitive (knowledge of laws, regulations and standards in the field of labor protection); activity (ability to identify and assess hazards and risks to safety and health at work; ability to prevent hazards, accidents; ability to determine the adequacy of planned and effective measures to protect from hazards and risks; skills and abilities to use safe methods and tools); personal (professionally important qualities and abilities that ensure the safety of professional activities in the workplace). In the current research we study the results of the experimental work on forming the personal component of CSPA.

1.3 Purpose of the research

The purpose of the article is to confirm the method of diagnosing the levels of formation of the personal component of CSPA in future OSH engineers and to analyze the results of the pedagogical experiment on the studied component.

1.4 Research hypothesis

The research hypothesis is based on the assumption that the developed method of diagnosing the levels of formation of the personal component of CSPA in future OSH specialists will provide qualitative assessment of positive changes in the levels of formation of CSPA in future OSH professionals.

1.5 Research methods:

Analysis and systematization of scientific literature, generalization and synthesis of theoretical positions, pedagogical experiment (ascertaining, formative, generalizing), questionnaires and testing of students, self-assessment, expert evaluation, conversation, observation, methods of measurement and mathematical processing, qualitative and quantitative analysis, graphical interpretation of the information, prognostic analysis, generalizations to formulate research conclusions.

1.6 Research ethics

All participants of the experiment voluntarily agreed to participate in the study and were able to quit it any time on their own free will. Because the size of the sample was large, such permission was obtained at the educational institutions' administrations.

2. Literature review

Personal component reflects the professionally important qualities and abilities of the occupational safety engineer, which characterize his high level of safety culture and professionalism. Professionally important qualities are understood as psychological qualities of a person which define productivity (productivity, quality, efficiency) of activity (Zeyer, 2003, p. 25). According to O. Evdokimova, professionally important qualities are a system of stable personal qualities that create the opportunity to successfully perform professional activities (Evdokimova, 2006, p. 19). K. Levitan understands professionally significant qualities as a constant attitude of the individual to his profession, himself, work, people, things, and a certain system of motives, forms and ways of professional behavior in which these relationships are realized (Levitan, 1991, p. 27). E. Zeyer's research presents a theoretical model of formation and development of professionally significant personality traits, which includes: motivational (the need to successfully solve professional problems, interest in the process of solving them, the desire to succeed and show oneself better, etc.), cognitive (understanding of professional tasks, assessment of their significance, knowledge of ways to solve, ideas about possible changes in the work environment, etc.) and operational-activity (personality traits adequate to the requirements of professional activity, also abilities and peculiarities of perception, thinking, emotional and volitional processes) components (Zeyer, 2003, pp. 17–32).

I. Androschuk (2018, pp. 92-93) identified the following groups of professionally important qualities of future teachers of labor education and technology: intellectual (developed intellect, intellectual flexibility, ability to solve problems in typical and unusual situations, broad erudition, developed intuition and logical thinking, intelligence, observation); moral and ethical (humanism, kindness, sincerity, goodwill, politeness, decency, honesty, personality orientation, compassion, sensitivity, tact); communicative (sociability, ability to listen and hear the interlocutor, empathy, perceptiveness, speech development, ability to express one's opinion, mastery of facial expressions and gestures); strong-willed (persistence,

determination, emotional stability, balance, restraint, independence, endurance, purposefulness, discipline, flexibility of behavior, organizational skills, speed of reaction, responsibility); creative (initiative, ability to generate new ideas, ability to creativity and innovation in their various manifestations, developed imagination, unconventional thinking, sense of humor).

O. Borodienko (2017, p. 209) in the process of developing the professional competence of heads of structural units of Ukrainian enterprises in the field of communications considers it necessary to form the following professionally important personality traits: persistence, confidence, activity, initiative, adaptability conditions (ability to restructure work in changing conditions); stress resistance (ability to control one's emotions with maintaining one's ability to work despite the presence of stressors), being not prone to conflict (ability to change a tone of conversation with a subordinate, a colleague, or a client from emotional to constructive to avoid conflict), ability to control emotions and to self-regulation; ability to independently organize work, determine priorities in the implementation of tasks, clear planning of activities and structuring their own activities; focus on results (ability to find the optimal solution); endurance, high efficiency (ability to withstand the workload for a long time while maintaining high quality work); ability to accelerate learning and assimilation of a large amount of information.

Based on the highlighted views of scientists, features of the professional activity of a occupational safety engineer, as well as during a survey among students (future occupational safety engineers), and teachers of higher education institutions that train these specialists, we have identified the following professionally valuable qualities of future OSH engineers:

– volitional – persistence, adherence to principles, exactingness and strictness in relation to the personnel in observance of norms and the legislation on labor protection, self-control, restraint, discipline;

– emotional – balance, emotional stability, stress resistance, self-control;

– moral – honesty, justice, decency, obedience to the law, mutual respect, tact;

– communicative – sociability, business communication skills, charisma, public speaking skills to motivate employees for occupational safety improvement;

– organizational – responsibility, diligence, purposefulness, initiative, determination, rationality of decision-making, efficiency, mobility.

In addition, the review of scientific, pedagogical and psychological research works highlighted the following professionally important abilities of future occupational safety engineers:

– communicative – the ability to communicate, work in a team, cooperate and establish interaction with OSH Administration, heads of structural units of enterprises, employees of the organization and the employer; prevention and resolution of conflict situations in the process of professional activity; skills of reports preparation and conducting negotiations;

– organizational – the ability to create a system of OSH management at the enterprise, organization, and to motivate staff to meet and comply with safety requirements; to make management decisions in off-pattern production scenario, and to organize the work of personnel to ensure occupational safety;

– constructive – the ability to select laws and regulations, plans and programs of labor protection measures that ensure the creation and operation of occupational safety management system;

– gnostic – the ability to obtain, generalize and systematize knowledge in the OSH field, in the rapid processing of incoming information, and to highlight the main issues;

– prognostic – the ability to predict dangerous situations, occupational injuries and diseases.

3. Research methodology and methods

The logic of scientific research covered four stages. At the first search stage, we used theoretical methods of scientific research (analysis, synthesis, systematization, induction, deduction) to carry out theoretical analysis of pedagogical, psychological, sociological, philosophical, technical literature and information sources, as well as to determine the content of structural elements of personal component of CSPA of future OSH professionals and to substantiate the diagnostic apparatus of the research.

At the ascertaining stage of the research we used a pedagogical experiment (ascertaining experiment), which helped us to specify the method of diagnosing the levels of CSPA formation in future safety specialists, select control and experimental groups, determine the initial level of personal component of CSPA. At this stage of the study, in addition to the pedagogical experiment, we used the following methods: questionnaires, testing, observation, interviews and self-assessment of students on the level of formation of the personal component of CSPA. The experiment involved students majoring in 263 "Civil Safety" in the field of knowledge 26 "Civil

Safety" with specialization "Occupational Safety" (226 students of the control and 221 students of experimental groups). In addition, 127 teachers of higher education institutions and 112 labor protection engineers of industrial enterprises and organizations took part in the study. The pedagogical experiment was carried out in higher education institutions of six regions of Ukraine (Volyn, Zaporizhzhia, Khmelnytskyi, Lviv, Rivne and Kharkiv regions).

The third stage of the study included a formative pedagogical experiment. This stage involved the introduction of an experimental methodology for forming CSPA in future OSH specialists, which covered the following pedagogical conditions: shaping the motivation to master CSPA; updating the content of vocational training taking into account the component of the culture of safety of professional activity on the interdisciplinary basis; introduction of innovative learning technologies; application of methods and forms of modeling dangerous situations of professional activity.

The generalizing stage of scientific research included the analysis of results of pedagogical experiment, formulation of conclusions, forecasting of prospects of CSPA formation in future OSH professionals. At this stage of this study we used the following research methods: generalization, systematization, abstraction and forecasting.

In this study of the personal component of CSPA in future OSH specialsts, we were interested in the willingness of students to make decisions in problematic situations in the presence of threats to life and health, which manifests itself in professionally important qualities, for this purpose we used tests and methods of diagnostics of formation of students' CSPA of future engineers on labor protection. The set of qualities allows us to talk about a confident choice of decisions and actions from the standpoint of safety. For this purpose, we used the method of M. Chumakov which allows to demonstrate the actual state of professionally important qualities of students (Shamlyan, 2016, p. 169). The method involves assessing the quality in the scales that have been converted to points. The basic level the formation of qualities corresponded to 2.5 points, the sufficient level – 3.75 points, the high level – 5 points.

Additionally, appropriate methods were used to study personal qualities and traits. In particular, to diagnose the ability to adequately assess and correct one's own level of safety culture, awareness of responsibility we used the test "Are you a responsible person?" by A. Makhnach (Greben, 2007; Savchin, 2016), which is a questionnaire of twenty-five statements that allow to determine the level of the person's responsibility. Using this test, we

aimed at obtaining the information about the indicators of responsibility, which the author considers as a feature of the individual, his traits. The semantic analysis of the content of A. Makhnach's test scale allows us to conclude that in terms of its semantic load it is relevant to the scale of internality-externality.

To diagnose the level of emotional resilience in the event of accidents at workplace, occupational diseases, and emergency situations, we additionally used the method of determining the stress resistance by Holmes and Razi (Arshava & Nosenko, 2008; Greben, 2007). This method allows us to study the dependence of emotional response on a variety of stressful life situations. Holmes and Razi's scale of stress resilience and social adaptation consists of 43 examples of life situations; each of the life events corresponds to a certain number of points depending on the degree of its stressfulness. The results are processed by summing the total number of points. The number of points (their sum) expresses the degree of the person's stress load. The method of Holmes and Razi was chosen to assess the stress load of students depending on the response to various stressful life situations. Based on the fact that this technique allows to assess not only the degree of emotional stability, but also to show students that not some minor events in life are the cause of stress, but their complex impact. The intensity and duration of experiences negatively affect a person's behavior, physical and mental health, emotional background and his activities.

As an additional diagnostic tool for assessing the formation of communicative qualities and abilities for the implementation of communicative interaction, we used the method of diagnosing the general communicative tolerance by V. Boyko (Greben, 2007). It includes a number of scales like "Rejection or misunderstanding of the person's individuality"; "Using yourself as a model in the evaluation of others"; "Categoricalness or conservatism in assessing people"; "Ability to hide or smooth out unpleasant feelings"; "Desire to change, re-educate a communication partner"; "Desire to attune other participants in the communication to yourself"; "Ability to forgive others for their mistakes"; "Tolerance to uncomfortable (illness, fatigue, lack of mood) states of the communication partner"; "Ability to adapt to other participants in communication."

Furthermore, the level of development of students' relevant professionally important qualities was determined by self-assessment. (Table 1). Using a 9-point scale, students assessed the level of personal qualities necessary for the culture of safety of professional activity (1 - very low level, i.e. quality is not fully formed, 9 – quality is formed at a high level; intermediate states of personal quality were assessed by students with

appropriate points). Then the scores were grouped as follows: 1, 2, 3 scores – basic (reproductive) level; 4, 5, 6 – sufficient (constructive) level; 7, 8, 9 – high (creative) level.

Table 1. Questionnaire for self-assessment of the formation of the personal component of CSPA of future OSH engineers

Dear students! We are studying the problems of formation of the culture of safety of professional activity of future occupational safety and health engineers. You are kindly requested to state the level of formation of this criterion for each of following indicators on a 9-point scoring scale. 1 point is assigned if the indicator is not formed, and 9 points if fully formed. The results of the survey will be used in a generalized form.	
Indicators of the subject-reflexive criterion of development of CSPA of future OSH engineers	Scoring scale
1. Ability of the occupational safety engineer to adequately assess and correct his own level of safety culture, awareness of responsibility for ensuring safety at work	1, 2, 3, 4, 5, 6, 7, 8, 9
2. Showing emotional stability in case of accidents at workplace, occupational diseases and emergencies	1, 2, 3, 4, 5, 6, 7, 8, 9
3. Maturity of communicative qualities and abilities for the implementation of communicative interaction with staff, heads of structural units of the enterprise, representatives of state control and supervision on occupational safety	1, 2, 3, 4, 5, 6, 7, 8, 9
4. Maturity of managerial skills and constructive abilities for design and organization of occupational safety management system at the enterprise; mastering the skills to plan and construct a model of safe behavior and improvement of occupational safety	1, 2, 3, 4, 5, 6, 7, 8, 9
5. Showing volitional qualities in the process of solving problems of professional activity	1, 2, 3, 4, 5, 6, 7, 8, 9
Evaluation of results: 0-22 points basic (reproductive) level, 23-37 points sufficient (constructive) level, 38-50 points high (creative) level.	

Source: Authors' own conception

4. Results and discussion

The personal component of CSPA of future occupational safety and health engineers reflects professionally important qualities (volitional, emotional, moral, communicative, organizational) and abilities (gnostic, organizational, constructive, communicative, prognostic) of the labor protection engineer, which characterize his high level of safety culture and professionalism. . We have chosen a subjective-reflexive criterion to

diagnose the personal component of CSPA of the future occupational safety engineer.

According to the subjective-reflective criterion, we tested the formation of CSPA in future OSH professionals using a questionnaire with special psychological and diagnostic methods. The level of development of students' relevant professionally important qualities was determined by self-assessment.

Subjective-reflexive criterion was diagnosed by the following indicators:

1. Ability of the occupational safety engineer to adequately assess and correct his own level of safety culture, awareness of responsibility for ensuring safety at work;

2. Showing emotional stability in case of accidents at workplace, occupational diseases and emergencies;

3. Maturity of communicative qualities and abilities in the flow of communication with staff, heads of structural units of the enterprise, representatives of state control and supervision of occupational safety;

4. Maturity of managerial skills and constructive abilities for design and organization of occupational safety management system at the enterprise; mastering the skills to plan and construct a model of safe behavior and improvement of occupational safety;

5. Showing volitional qualities in the process of solving problems of professional activity.

Statistical data on the levels of development of CSPA in future OSH engineers by the subject-reflexive criterion are shown in Table 2.

Table 2. The results of diagnosing the levels of CSPA formation according to the subject-reflexive criterion (at the ascertaining stage of the experiment)

Indicators	Groups / Total number of persons	Levels						χ^2
		Basic (reproductive)		Sufficient (constructive)		High (creative)		
		Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	
1. Ability to adequately assess and correct one's own level of safety culture, awareness of responsibility	CG	84	37.2	95	42.0	47	20.8	0.5047
	EG	89	40.3	90	40.7	42	19.0	
2. Showing emotional stability in case of accidents	CG	68	30.1	100	44.2	58	25.7	0.114
	EG	69	31.2	98	44.3	54	24.4	
3. Maturity of communicative qualities and abilities for the implementation of communicative interaction with employees, heads of structural units of the enterprise, representatives of state control and supervision on occupational safety	CG	85	37.6	96	42.5	45	19.9	0.9329
	EG	89	40.3	84	38.0	48	21.7	
4. Maturity of managerial skills and constructive abilities for design and organization of occupational safety management system at the enterprise; mastering the skills to plan and construct a model of safe behavior and improvement of occupational safety	CG	75	33.2	95	42.0	56	24.8	0.3309
	EG	77	34.8	87	39.4	57	25.8	
5. Showing volitional qualities in the process of solving problems of professional activity	CG	68	30.1	94	41.6	64	28.3	2.636
	EG	64	29.0	107	48.4	50	22.6	
The general level of formation of the component	CG 226	76	33.6	96	42.5	54	23.9	0.1715
	EG 221	78	35.1	93	42.2	50	22.7	

Source: Authors' own conception

Most representatives of the studied groups have a sufficient (constructive) level of personal responsibility. Those with sufficient level have a sense of responsibility and commitment. But it is important for them to be sure that no one will demand more than they can do. Sometimes they are prone to excessive passivity to avoid responsibility for what happens.

Being afraid of the responsibility for others and common cause, they often restrain their desire to do something, while natural activeness and ability to work would allow them to make responsible decisions and accomplish the task. This affected the overall results of the indicator "Ability of the safety engineer to adequately assess and correct their own level of safety culture, awareness of responsibility for safety at work." Thus, this indicator is demonstrated by students mainly at the basic (reproductive) and sufficient (constructive) levels. This figure was 37.2% and 42.0% for CG students, and 40.3% and 40.7% for EG students, respectively.

According to the results of the study, most students showed normal stress resistance, high stress resistance was observed in 4.3% and in others – stress resistance was low (30.9%), which accordingly affected the results on the formation of the second indicator on the subject-reflexive criterion "Showing emotional resilience in case of accidents at workplace, occupational diseases and accidents", in particular, this indicator is shown by students of CG and EG mainly at the basic and sufficient levels, the number of students with sufficient (constructive) level is: 44.2% – in CG and 44.3% – in EG.

The results of V. Boyko's method of general communicative tolerance determination on the scale of "Rejection or misunderstanding of person's individuality" show that most respondents do not know how or do not want to understand and accept the individual features of others. The distribution of data on the scale of "Using yourself as a model in the evaluation of others" shows that most respondents evaluate the behavior, way of thinking or individuality of people, taking themselves as a model. The indicators on the scale of "Categoricalness or conservatism in assessing people" show that most respondents lack flexibility and breadth of vision, which leads to categoricalness and conservatism in people's assessments and complicates communication. The results of the scale of "Ability to hide or smooth out unpleasant feelings" show that most respondents do not know how to disguise or defuse negative emotions when confronted with uncommunicative qualities in partners, which indicates a low level of control over their emotions and low levels of empathy. The majority of respondents on the scale of "Desire to change, re-educate a communication partner" showed a medium or low level of tolerance, which indicates a desire to change the communication partner based on their own preference. This position will meet with resistance and may lead to conflicts. The results on the scale of "Desire to attune other participants in the communication to yourself" show that the majority of respondents want to situationally impose their positions, adjust the character, habits and demands of their

communication partners to themselves. According to the scale of "Ability to forgive others for their mistakes", data were obtained shows that the majority of respondents are not ready to forgive other participants in communication inconveniences, unintentionally caused troubles and mistakes. The data obtained on the scale of "Tolerance to uncomfortable (illness, fatigue, lack of mood) states of the communication partner" indicate that the vast majority of respondents are not ready to experience physical or mental discomfort in which he or his communication partner appeared. This is a very alarming signal of too much egocentrism, emotional coldness and low levels of empathy.

According to the scale of "Ability to adapt to other participants in communication", half of the respondents have an insufficient level of communication skills that allows them to show flexibility in communication by changing strategies. Thus, the results of diagnosing students' communicative qualities indicate a low level of tolerance in communication in the majority of respondents (42.5% of CG students and 38.0% of EG students have a sufficient (constructive) level). Respondents are diagnosed with pronounced selfishness, emotional coldness to other people's problems, intolerance to positions different from their own, as well as the inability to control emotions. For future occupational safety engineers, these are completely unacceptable qualities that require thematic preventive measures.

Other personal qualities and characteristics of future occupational safety engineers are mainly formed at the basic (reproductive) and sufficient (constructive) levels. In particular, the presence of volitional qualities in the process of solving professional problems is demonstrated by CG students mainly at a sufficient (constructive) level, their share is 41.6%, and the share of EG students at the same level is 48.4%.

The results of mathematical processing showed that at the beginning of the experiment CG and EG on the personal component were identical. Table 2 shows that $\chi^2_{emp} = 0.1715 < \chi^2_{cr} = 5.99$, i.e. the differences are considered insignificant, which proves, respectively, the homogeneity of the sample. In addition, the table presents statistical data on individual indicators of this component, so for the indicator #1 $\chi^2_{emp} = 0.5047 < \chi^2_{cr} = 5.99$, for the indicator #2 $\chi^2_{emp} = 0.1144 < \chi^2_{cr} = 5.99$, for the indicator #3 $\chi^2_{emp} = 0.9329 < \chi^2_{cr} = 5.99$, for the indicator #4 $\chi^2_{emp} = 0.3309 < \chi^2_{cr} = 5.99$, for the indicator #5 $\chi^2_{emp} = 2.6357 < \chi^2_{cr} = 5.99$. Accordingly, the characteristics of the compared samples for the personal component as a whole (as well as for the individual indicator) at the ascertaining stage coincides with the level of significance $p = 0.05$. Thus, at the ascertaining stage of the research the generalized indicators of levels of development of professionally important

qualities of future engineers on labor protection in CG and EG have insignificant deviations (Fig. 1).

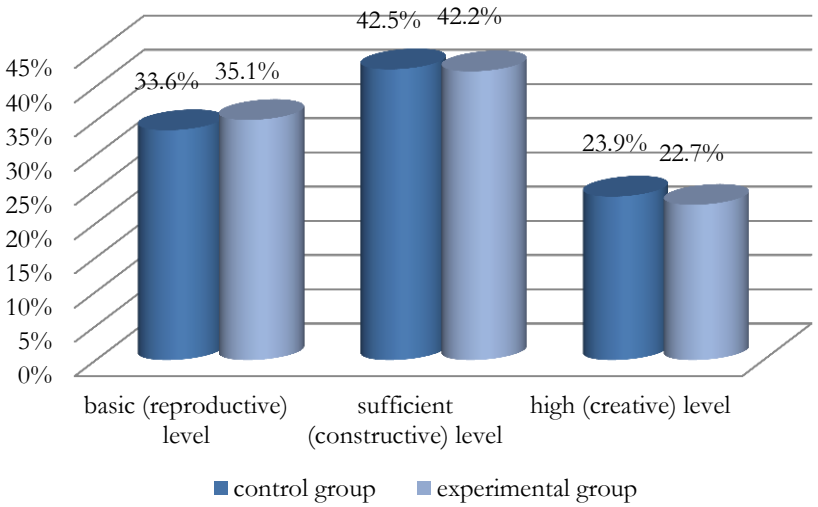

Fig. 1. Generalized results of diagnosing the levels of CSPA formation in future OSH professionals on the subject-reflexive criterion (at the ascertaining stage of the experiment) Source: Authors' own conception

Thus, the number of students with a basic (reproductive) level in CG is 1.5% less than in EG; with sufficient (constructive) level in CG is more than 0.3% than in EG; with high (creative) level is more than 1.2%. Quantitative and qualitative distribution of students majoring in 263 "Civil Safety" in the field of knowledge 26 "Civil Safety" with specialization "Occupational Safety" in accordance with criterial indicators substantiated in the study on subject-reflective criterion at the stage of the ascertaining experiment has the following meanings: professionally important qualities of students of experimental group are formed at the basic (reproductive) level in 35.1% of respondents, at a sufficient (constructive) level – in 42.2%, at a high (creative) level – in 22.7%, among the students of the control group – 33.6% , 42.5% and 23.9% respectively.

The results of diagnosing the levels of CSPA formation in future safety engineers by the subject-reflexive criterion during the formative stage of the experiment are given in Table 3. The tabular data show that at the formative stage the CG students still have mostly basic (reproductive) and

sufficient (constructive) levels of formation of indicators of the personal component of CSPA. Thus, the indicator "Ability to adequately assess and correct their own level of safety culture, awareness of responsibility" is demonstrated by them at the basic (reproductive) and sufficient (constructive) level of 29.9% and 48.7%. The number of CG students at a high (creative) level on this indicator was 21.4%. At the same time, in EG high (creative) level reached 32.7% with a sufficient level of this indicator at 50.0%.

The data of further analysis show that in CG the indicator of "Readiness to analyze traumatic situations, readiness to use modern trends in engineering and technology in their professional activities" is demonstrated by students mainly at the basic (reproductive) and sufficient (constructive) levels – 35.7% and 50.9%, while in EG this indicator is presented at sufficient (constructive) and high (creative) levels – 50.0% and 30.0%. The indicator of "Showing emotional stability in case of an emergency" in CG is mainly represented at sufficient (constructive) and basic (reproductive) levels: 48.2% and 25.9%, respectively, and in EG this figure is 32.7% at a high (creative) level.

Table 3. The results of diagnosing the levels of CSPA formation according to the subject-reflexive criterion (at the formative stage of the experiment)

Indicators	Groups / Total number of persons	Levels						χ^2
		Basic (reproductive)		Sufficient (constructive)		High (creative)		
		Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents %	
1. Ability to adequately assess and correct one's own level of safety culture, awareness of responsibility	CG	67	29.9	109	48.7	48	21.4	12.7791
	EG	38	17.3	110	50.0	72	32.7	
2. Showing emotional stability in case of accidents	CG	58	25.9	108	48.2	58	25.9	6.0593
	EG	41	18.6	101	45.9	78	35.5	
3. Maturity of communicative qualities and abilities for the implementation of communicative interaction with employees, heads of structural units of the enterprise, representatives of state control and supervision on occupational safety	CG	58	25.9	119	53.1	47	21.0	8.4589
	EG	38	17.3	113	51.4	69	31.4	
4. Maturity of managerial skills and constructive abilities for design and organization of occupational safety management system at the enterprise; mastering the skills to plan and construct a model of safe behavior and improvement of occupational safety	CG	61	27.2	107	47.8	56	25.0	12.0570
	EG	31	14.1	118	53.6	71	32.3	
5. Showing volitional qualities in the process of solving problems of professional activity	CG	58	25.9	102	45.5	64	28.6	7.476
	EG	34	15.5	111	50.5	75	34.1	
The general level of formation of the component	CG 224	60	27.0	109	48.7	55	24.4	8.5141
	EG 220	36	16.5	111	50.3	73	33.2	

Source: Authors' own conception

According to the results of mathematical processing, after the experiment in CG and EG there were differences. The tabular data show that $\chi^2_{emp} = 8.5141 > \chi^2_{cr} = 5.99$. Accordingly, the reliability of the differences of the compared samples by personal component with the significance level $p = 0.05$ is confirmed. In addition, Table 3 presents

statistical data on individual indicators of this component (χ^2_{emp} = 12.7791; 6.0593; 8.4589; 12.0570; 7.4762; > χ^2_{cr} = 5.99). Thus, we can state there is a statistically significant assurance of the differences in CG and EG after the experiment, both for the individual indicator and for the component as a whole.

Comparative characteristics of the levels of formation of indicators by the subject-reflexive criterion are presented in Table 4. High (creative) level of formation of professionally valuable qualities in EG at the formative stage of the conducted study was found by 33.2% of future safety engineers; sufficient (constructive) level – 50.3%; basic (reproductive) level – 16.5%. Compared to the results of the ascertaining stage of the experiment with a high (creative) level, the share of students increased by 10.5% (from 24.4%); with sufficient (constructive) level increased by 8.1% (from 48.7%); with basic (reproductive) level decreased by 18.6% (from 27.0%), among CG students these figures are lower: + 0.5%, + 6.2%, and -6.6%, respectively.

Table 4. Dynamics of the levels of CSPA formation of future OSH professionals according to the subject-reflective criterion (at the ascertaining and formative stages of the experiment)

Levels	Ascertaining stage of the experiment				Formative stage of the experiment				Dynamics, %	
	Control groups		Experimental groups		Control groups		Experimental groups			
	Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	Number of respondents, persons	Relation to the total number of respondents, %	Control groups	Experimental groups
Basic (reproductive)	54	23.9	50	22.7	55	24.4	73	33.2	0.5	10.5
Sufficient (constructive)	96	42.5	93	42.2	109	48.7	111	50.3	6.2	8.1
High (creative)	76	33.6	78	35.1	60	27.0	36	16.5	-6.6	-18.6
Total	226	100	221	100	224	100	220	100		

Source: Authors' own conception

The results of the analysis of the data given in Table 4, indicate effective positive changes in the CSPA formation levels of future OSH specialists on the subject-reflexive criterion. To illustrate these results, we construct a diagram (Fig. 2). The results of the diagram analysis show that the increase in indicators that characterize the high (creative) level and, accordingly, the decrease in indicators that correspond to sufficient (constructive) and basic (reproductive) levels are more pronounced in students of the experimental group.

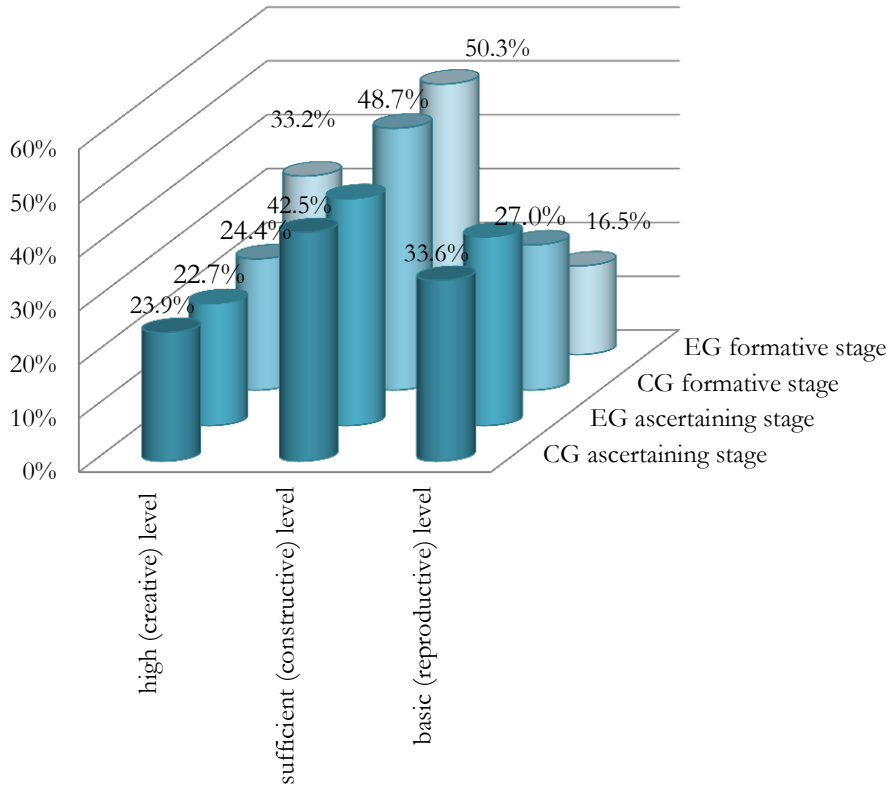

Fig. 2. Dynamic changes in the levels of CSPA formation in future OSH professionals according to the subject-reflective criterion

Source: Authors' own conception

The share of future OSH engineers who demonstrated the CSPA formation on the subject-reflexive criterion at a high (creative) level at the stage of the formative experiment is 8.8% higher than CG; on sufficient (constructive) level is 1.6% more; on the basic (reproductive) level is less by 10.5%.

Empirical values of the statistical criterion χ^2 of the results of diagnosing the levels of CSPA formation in future occupational safety engineers on the subject-reflective criterion at the ascertaining and formative stages in the control and experimental groups are given in Table 5.

Table 5. Empirical values of the χ^2 criterion of the results of diagnosing CSPA levels in future occupational safety engineers according to the subject-reflective criterion

Study groups	CG ascertaining experiment	CG formative experiment	EG ascertaining experiment	EG formative experiment
CG ascertaining experiment	-	$\chi^2_{emp.}$= 2.7071 $\chi^2_{cr.}$= 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	$\chi^2_{emp.}$= 0.1715 $\chi^2_{cr.}$ = 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	$\chi^2_{emp.}$= 18.1378 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%
CG formative experiment	$\chi^2_{emp.}$= 2.7071 $\chi^2_{cr.}$ = 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	-	χ^2_{emp} = 3.8332 $\chi^2_{cr.}$ = 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	$\chi^2_{emp.}$= 8.5141 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%
EG ascertaining experiment	$\chi^2_{emp.}$= 0.1715 $\chi^2_{cr.}$ = 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	$\chi^2_{emp.}$= 3.8332 $\chi^2_{cr.}$ = 5.99 The characteristics of the samples coincide at the level of significance p = 0.05	-	$\chi^2_{emp.}$= 21.3006 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%
EG formative experiment	χ^2_{emp}= 18.1378 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%	$\chi^2_{emp.}$= 8.5141 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%	$\chi^2_{emp.}$= 21.3606 $\chi^2_{cr.}$ = 5.99 The reliability of the differences in the characteristics of the samples is P = 95%	-

Source: Authors' own conception

When comparing CG and EG at the formative stage, EG at the formative and ascertaining stages, CG at the ascertaining stage and EG at

the formative stage, we claim that the reliability of the difference in the characteristics of the samples is P = 95%. Comparison of CG and EG at the ascertaining stage, CG at the ascertaining and formative stages, CG at the forming and EG at the ascertaining stages with probability $\varrho = 0.05$ we claim absence of essential difference at comparison. The values of the statistical criterion χ^2 represented in Table 5 give grounds to claim that as a result of the formative stage of the experiment there were effective positive changes in the levels of CSPA formation in future OSH professionals according to the subject-reflective criterion. The data of the comparative analysis show that the indicators of the personal component of CSPA in future OSH professionals, as well as cognitive, with traditional method of training also tend to the formation. However, the process is less effective.

5. Conclusion

The conducted analysis of results of the theoretical and experimental research stated the validity of the theoretical and methodological concepts and approaches, showed the prospects for achieving the goal of the study and the dynamics of the results of the experimental program. The experimental study substantiates the approach to diagnosing the levels of formation of the personal component of CSPA in future OSH specialists. These techniques allow us to assess the state of formation of the personal component of CSPA on the subject-reflexive criterion.

During the experimental study, the effectiveness of the pedagogical system of CSPA formation in future OSH engineers was tested. The results of the experimental work and mathematical processing of static data showed that according to the subjective-reflexive criterion, most students of CG and EG had a basic (reproductive) level of formation of the personal component of CSPA. Such qualities as personal responsibility, stress resistance, communicative interaction, volitional qualities needed improvement and development. The results of the ascertaining stage of the conducted research testified to the need to increase the level of formation of the personal component of CSPA in future occupational safety engineers by introducing a pedagogical system of CSPA formation in future OSH specialists.

Experimental verification of the effectiveness of the pedagogical system of CSPA formation in future OSH professionals showed that there was a significant increase in the levels of CSPA formation on the subject-reflexive criterion. The results of diagnosing the levels of CSPA in future OSH professionals on the subject-reflexive criterion after the stage of the formative experiment show an improvement in EG: high (creative) level was found in 33.2% of future OSH professionals, which is 8.8 % more than in

CG; sufficient (constructive) level was found in 50.3%, which is 1.6% more than in CG; basic (reproductive) level was found in 16.5%, which is 10.5% less than in CG. The results of the analysis of the levels of formation of the personal component of CSPA in future occupational safety and health engineers of CG and EG showed that data obtained in the process of ascertaining and formative stages of the conducted study indicate the effectiveness of the proposed author-developed measures and give grounds to assert the effectiveness of the developed pedagogical system of CSPA formation in future OSH specialists in institutions of higher education.

The study does not cover all aspects of this problem. We see the prospect of further research in creating a modern safe educational environment with priority in OSH, theoretical understanding of the process of CSPA formation in future OSH engineers, in search of innovative technologies and improving the methodological basis for effective formation of CSPA in future OSH professionals.

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