Analysis of the Problems of Training Bachelors in the Direction of "Technosphere Security" Taking Into Account the Cognitive Characteristics of New Generations of Students

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The research aims to analyze possible ways to improve undergraduate student performance in current conditions. The use of new directions in the methods of training and conducting training in undergraduate agricultural higher education institutions in the "Technosphere safety" training program. When developing teaching methods and technologies, teachers should consider changes in the cognitive abilities of the Generation Z students, which differ significantly from previous generations in terms of attention, information perception, and communication abilities. The author argues a need for the digital transformation of education in the wake of the trend towards the digital transformation of the economy and agriculture. This is primarily an opportunity to activate the combination of the group educational process in the classroom using the capabilities of current computer technologies with the individualization (personification) of education when each student gets the opportunity for independent creative work with remote control and correction by the teacher.

Keywords: agriculture, technosphere security, professional education, cognitive abilities, generation z, digital transformation of education

INTRODUCTION

Agriculture is an industry that makes a significant contribution to Russia's GDP and foreign trade balance. However, its' working conditions are the most unsatisfactory of all sectors of the economy. In agriculture, at the end of 2019, 33.8% of workers were employed in harmful or hazardous working conditions. The health of agricultural workers is negatively affected not only by hard physical labor but also by unfavorable microclimatic conditions, various chemical and biological substances, and in some technological operations – directly poisons (Galyanov & Studennikova, 2015; Shirokov & Smirnov, 2018). At the same time, the system for identifying occupational diseases and protecting the rights to appropriate compensation for workers in the industry does not work. The level of general injuries in agriculture is also one of the highest among all economic activity types and exceeds the average value in Russia by 1.5–1.7 times.

The main causes of accidents are organizational and managerial: (1) unsatisfactory organization of work – 648; (2) violation of labor discipline by employees – 149; (3) violation of driving regulations – 145; (4) violations of the technological process – 121; (5) insufficient training of workers in labor protection – 106. That is why agricultural workers are not satisfied with working conditions, and fewer people want to work in this important industry and feed the country. The industry needs a new approach to labor protection for agricultural workers and a modern labor protection management system. The base should be the provision of labor protection services of agricultural enterprises with highly qualified specialists according to the requirements of professional standards (Koshechkin & Barabanova, 2017; Shirokov, 2019).

Therefore, high requirements are imposed on bachelors' training as future specialists in labor protection and agricultural enterprises' safety. According to the 40.054 professional standard "Specialist in the field of labor protection" (Ministry of labor of Russia, 2014), a specialist must know and control:

- Strict observance of legislative and regulatory documents of labor protection and safety, requirements for the safe performance of technological operations in all types of crop production, animal husbandry, primary processing of agricultural products, repair, and maintenance of the machine and tractor fleet, equipment of technological lines, power equipment, etc.;
- To be able to assess professional risks and ensure their minimization down to "zero injury." **The research aims** to analyze possible ways to improve the efficiency of an undergraduate student's teaching methods in the "Technosphere safety" training program in current conditions.

MATERIALS AND METHODS

The methodological basis is the study and generalization of research materials (Galyamova, 2012; Gushchin, 2012; Kashcheeva, 2019; Uvarov & Frumin, 2019), changes in information perception by new generations of students due to their deep immersion in digitalization and the use of new directions in the methods of training and conducting training. The main goal of the future professional activity of undergraduate students in the "Technosphere safety" training program focused on "Safety of technological processes and production" – prevention of accidents at work and occupational diseases, reducing the level of exposure (elimination of exposure) harmful or hazardous production factors on workers, and levels of professional risks.

The professional activity objects of bachelor graduates are, namely:

- Human and dangers associated with human activities;
- Habitat hazards associated with human activities;
- Habitat hazards associated with natural hazards phenomena;
- Hazardous technological processes and production;
- Regulatory legal acts on security issues;
- Methods and tools for assessing human-made and natural hazards and the risk of their implementation;
- Methods and means of protecting humans and the environment from human-made and natural hazards;
- Rules for the regulation of hazards and anthropogenic impact on the natural environment;
- Methods and means of human rescue (Ministry of Education and Science of Russian Federation, 2016).

Thus, this is a large and complex range of issues that require deep knowledge in legal, management, biological, technical, and economic disciplines. In the agriculture sphere, such a list should be supplemented with specific knowledge of hazardous areas and harmful production factors of crop farming and animal husbandry, primary product processing, service and repair of the machine and tractor fleet, equipment of technological lines, electric power equipment, etc. In most agricultural enterprises with hazardous production facilities, the following are added to this list: (1) boilers and pressure vessels, (2) gas consumption and heat supply systems, (3) workshops (sections) for feed production (feed mixtures), (4)

stationary installed lifting equipment, etc. Only well-trained specialists who mastered all competencies stipulated by the Federal State Educational Standard of Higher Education [FSES HE] can organize a management system for labor protection and health of such diversified enterprises that strew across the vast expanse (it can be thousands of hectares) (Ministry of Education and Science of Russian Federation, 2016).

RESULTS

The research shows a large shortage of technosphere safety specialists who meet the requirements of the 40.054 professional standard in agriculture. Less than 2% of specialists work in the agro-industrial complex system with higher specialized education in the "Technosphere safety" training program on "Safety of technological processes and production." Due to the shortage of qualified personnel, the absolute majority of agricultural enterprises appoint specialists in other areas far from technosphere safety to the position of the head of the occupational safety service (labor protection specialist). This led to the fact that a little more than 12% work in this position with higher engineering education. The rest have mainly vocational secondary education – agronomic, veterinary, technical, and specialists with pedagogical education. Every fifth labor protection engineer has a liberal arts degree. 6% work without special education (Fig. 1) (Faynburg et al., 2018; Koshechkin & Barabanova, 2015).

The situation is very similar to the worker qualifications holding the position of labor protection specialist in other sectors of the economy (Bakiko, Serdyuk & Smaznoy, 2017; Feinburg & Fedorets, 2018).

Evidently, suppose an employee holding this position does not have the required competencies (knowledge, skills, and abilities). In that case, they are not ready to organize an effective management system for labor protection and safety, effective control over the application of legislative and regulatory requirements, and ensure the life and health protection of employees.

The author found that a significant part of employees holding labor protection engineers' positions do not fulfill even half of the actions of standard 40.054 and, accordingly, job descriptions (Bakiko et al., 2017; Zilberman, 2019). Moreover, the life and health of workers, production processes safety, and economic performance of production depend on it.

The research found that if we take the injury rate of an enterprise with a specialist of higher engineering degree as a unit, then with a specialist of incomplete higher degree, these indicators will be equal to 1.2; with a secondary specialized - 1.5; with vocational secondary education - 2.5; and there where this work was entrusted to an employee with primary education (practice), these indicators increase to 3.3 (Koshechkin et al., 2017).

FIGURE 1
LEVEL OF EDUCATION OF SPECIALISTS RESPONSIBLE FOR LABOR PROTECTION IN AGRICULTURAL ENTERPRISES OF THE RUSSIAN FEDERATION

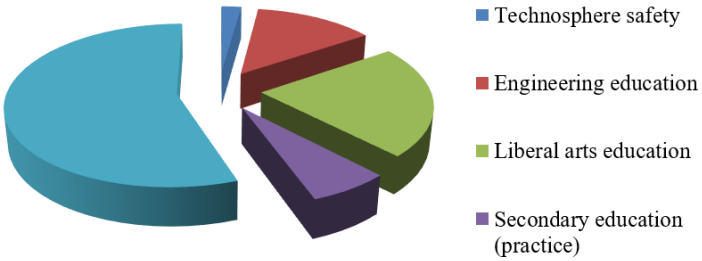


Fig. 2. shows the relationship between accident frequency [AF] and competence rate of labor protection specialists (Bakiko et al., 2017). The author revealed a dependency that in institutions where specialists have basic higher vocational education in labor protection, the AF value is lower than in organizations where specialists have a higher or secondary specialized technical degree. The authors used the scale of OS specialist competence levels. The OS specialists with secondary education are referred to the 14th level,

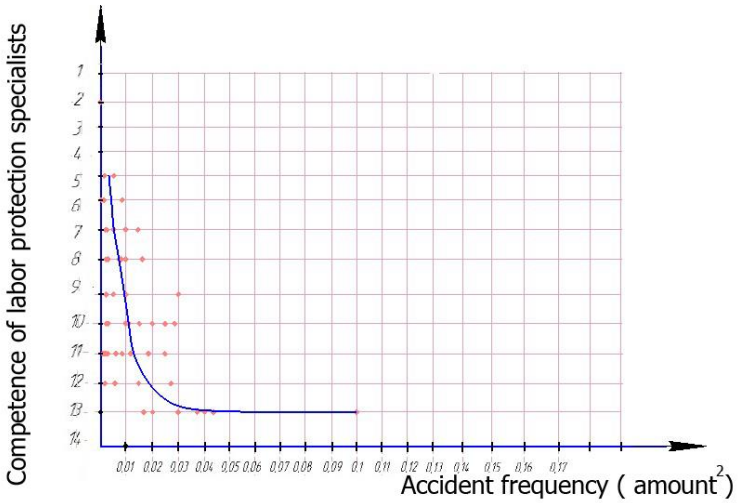
then, the levels are raised for specialists with higher and additional professional education, up to specialized – "Technosphere safety." High (4-1) levels are assigned to specialists – undergraduates and graduate students with experience (Bakiko et al., 2017).

Thus, the level of competence of a labor protection specialist, and, consequently, the quality of their work functions very seriously affects the AF and contributes to its reduction.

The shortage of qualified personnel leads to the fact that the country loses hundreds of people who do not return home from work alive every year. Production loses thousands of workers due to industrial injuries and occupational diseases, and more than 1.2 million working days due to temporary disability during the recovery period (in 2019, on average, it was 50.6 working days per injury). It means that there is only one factor – the specialists' competence level in labor protection services of agricultural enterprises can preserve the health of thousands and the lives of hundreds of agricultural workers every year.

The work defect of a labor protection specialist is, first and foremost, the lost lives and health of the enterprise employees, a decrease of their labor productivity, and production profitability. The specialists' competencies largely depend on two factors: teacher proficiency and the methods of information delivery (teaching methods).

FIGURE 2
GRAPH OF THE FREQUENCY OF ACCIDENTS DEPENDING ON THE COMPETENCE OF OT SPECIALISTS



The teacher is a mediator between the knowledge provided by FSES HE and the consciousness of students who must acquire this knowledge (competency) and learn how to apply it in various industrial situations. The teacher offers the path of cognition along which the student should go, organizes certain paths, methods, and techniques for mastering the educational material. Teaching technologies are methods of related activities of a teacher and a student, aimed at mastering the necessary competencies by students following the requirements. The use of rational teaching technologies should effectively organize the students' cognitive activities, allow them to fully master all competencies without exception, and leave the university fully prepared to solve the main problems and tasks of ensuring technosphere safety in agriculture.

Currently, both domestic and abroad specialists are concerned by the problems of the training efficiency in labor protection and safety (Bakiko et al., 2017; Lustgarten, 2017; Gallyamova, 2012; Koshechkin et al., 2017; Hillyer, Wesley; Oldfield & Craft-McCormick, 2000; Barnett, 2000). Most of them generally focus on the need to switch to a verbal and digital learning technology combination for students (Gushchin, 2012). For example, since 2010, there has been a double-digit increase in the volume of e-learning in the specialist

training framework in foreign countries. The intensive modernization and digitalization of the economy and agricultural production in Russia requires the modernization of education, the use of the possibilities of digital technologies, and the training of specialists with certain competencies.

DISCUSSION

The efficiency of any training depends on the following components:

- The incentive;
- The efficiency of the developed technologies and teaching materials;
- Effective interaction between teacher and students;
- Feedback efficiency.

The majority of students' incentive to successfully pass the exams must be changed through conversation and constant reminders (especially at the very beginning of studying the "Introduction to the specialty" discipline). Students should understand that not only their personal material well-being and career growth but the life and health of employees and the success of the production will depend on the competencies they have mastered and the ability to apply them in practice. Their personal freedom and the employer's freedom also depend on them if violations in occupational safety and health lead to work accidents.

The pedagogical technologies used by the teachers of the technosphere safety faculties should be developed considering the andragogical approach: it is the university there are adults studying; presenting information "in a school-like manner" does not allow today's students to receive a full-fledged perception of the necessary knowledge and form the required competencies. The base of the andragogical approach to teaching method formation, work programs, and estimation techniques should be the slogan – we teach not for school, but life. And, as noted above, this directly concerns the activities of technosphere safety specialists. Such an approach should be considered as a rule for all studied disciplines, but it is crucial when studying legal, managerial, and organizational issues of technosphere safety, which are usually given in the 3rd and 4th year (thus, to even more matured young adults). These disciplines complete the formation of the competencies and personality of the future technosphere safety specialist (Machles, 2003; Zilberman, 2019).

When creating learning technologies, one should consider the characteristics of a new generation of people – the so-called Generation Z (centennials) (Generation Z (centennials) include people from 1991 to 2001, depending on the technology development level in different countries. Sociologists often choose 1995 as the reference year, i.e., the senior centennials are now 25 years old.). These people were not only "born with gadgets and devices in their hands," but also lived in a family, where all members are actively involved in consumer digitalization: the Internet, phone communications, social networks, etc. The modern generation of students is more different from teachers, even young ones, in terms of thinking style, speed of perception and information processing, and the time of keeping attention on one object. The teaching methods and technologies are still predominantly conservative, designed for previous generations. They are designed for students who knew how to read ordinary book texts and perceive textual information, were able to listen to long texts with concentration, hear and perceive verbal information. These are the Generation X and Generation Y.

The first includes people born in 1963–1981, before the Internet, and the rapid development of technologies that everyone is used to now. This is the last generation, which books, newspapers, and magazines have accustomed to large texts without pictures and illustrations, which can keep their attention to the information received for a long time.

Generation Y – are people born after 1981. This is the first generation deeply involved in digital technology. But they also caught the era before the spread of the Internet: their childhood passed mainly without smartphones and social networks (Kashcheeva, 2019).

Generation Z students receive mostly digital information from early childhood. Mutual communication of young adults occurs only through social networks, messengers, and applications using gadgets and

devices, even when sitting in the same room, at the same table. They shorten texts up to the full transition of information perception through stickers and emoji; the reading of belles-lettres in the traditional "paper" form reduces sharply. The listed features have seriously influenced both the mechanism of perception and assimilation of information, the ability of verbal thought expression and verbal perception.

Observations show that for the most part, students of the new generation find it difficult to perceive traditional textbook texts; they read mainly diagonally or move their gaze along the text in the resemblance of "F" letter when the first lines are captured during reading, and then the amplitude of the gaze movement narrows, covering even smaller, left part of the text (Kashcheeva, 2019; Uvarov et al., 2019). As a result, the meaning is caught instantly and does not remain in memory.

The teacher cannot help but consider these features; otherwise, the learning process becomes formal: the teacher seems to be teaching, fairly presenting the material provided by FSES and work programs, but the students' consciousness does not perceive this material or perceives it only partially. This is also confirmed by occasional tests of the retained knowledge of students.

The current generation of students is also distinguished because it is difficult for them to concentrate and hold attention on an object for more than 8 seconds – it is the so-called "goldfish" level. The previous generation could hold attention for about 12 seconds. For a teacher, these new changes should become the key to form a new approach to teaching technology, didactic materials, and methods of assessing the gained knowledge. To keep students' attention, texts should be as easy as possible and divided into small parts (paragraphs and sections), and, if possible, supplemented with images, infographics. Moreover, we must consider one more feature: the students' transmission and perception of information can occur with emoji, stickers, and other visual signs (as thousands of years ago when transmitting information with cave paintings). That is, their thinking today is more based on visual rather than the verbal perception of information. The teacher should use it to increase efficiency in conveying new knowledge to students and increasing their assimilation level.

As psychologists note, attention concentration is more successful when we use different transmission channels and perceptions of information: visual, verbal, and tactile. (Kashcheeva, 2019; Uvarov et al., 2019). Moreover, the teacher should use the following effects: (1) the "Zeigarnik effect" – the effect when interrupted information may be recalled faster, and (2) the "Serial-position effect," which is a tendency of a person to recall the first and last items in a series best. But if at the beginning of classes (approximately the first 10-20 minutes) the student only starts to draw into work, then the most important part should be presented in the next 30-40 minutes, i.e., at the beginning of the first class. Then, at the end of the second class, the teacher can use the same method and interview the students, formulating the questions so that they themselves repeat the most important information for assimilation. In this case, replacing the source (a teacher with a student) will revive the perception of tired students and will effectively use the "serial-position effect."

When training specialists of the 20.03.01 direction, teachers should consider that they will have to (often – from the very first day at work) obligatory conduct almost all types of employees' training on technosphere safety, starting with introductory briefings on labor protection, fire safety, protection from natural and human-made emergencies. Bachelor students should know how to present the essential information for safe work convincingly, and that could save life and health. This means that students themselves must acquire knowledge and skills sufficient for the independent development of programs and modern teaching methods. The training programs for specialists in the "Safety of technological processes and production" provide such disciplines as "Pedagogy" and "Psychology." However, the focus of these disciplines does not consider the specifics of future teaching work in labor protection specialists' activities.

Considering the above-mentioned problems of verbal presentation due to the long-term habit of digital communication, students should speak as often as possible in the classroom to help them to master and use the specific terminology of technosphere safety. For the same purpose, it is necessary to organize thematic seminars, scientific conferences, colloquiums, and public defense of term papers and projects from the first year of study.

Much of the above suggests that there is a need not only to change the approach of teaching new generations. There is clearly a need for the digital transformation of education following the trend towards

the digital transformation of the economy and agriculture. This is not distance education, which began to be actively used during the self-isolation period. This is the possibility of enhancing the combination of the collective (group) educational process in the classroom using the capabilities of modern computer technologies with the individualization of education when each student gets an opportunity for additional independent creative work with remote control and correction by the teacher. To be ready for life in the digital economy, each student must not only accumulate knowledge, develop the ability to learn, and master other competencies of the 21st century but also get satisfaction from this complicated work. In this case, the traditional organization of the educational process turns out to be insufficient and must be replaced by a personalized, effective organization of the educational process. The progress in microprocessor technology makes it widely available today. And their combination with artificial intelligence technologies promises to transform traditional educational and methodological materials into visual and "tangible." It will fully implement all steps of the gradual formation of knowledge and competencies during the direct dialogue with students (Uvarov et al., 2019). For the modern student, gamification can become one of the effective technologies of the learning process, as it makes it possible to immerse in real production situations and forces students to seek the right management decisions in an understandable and interesting system. However, the creation of such programs is an expensive process and is possible, for example, by pooling the financial efforts of a group of specialized universities.

During the self-isolation period, the author worked out a mechanism for working with students by combining group and personal training through Whatsapp and Zoom programs and generated online feedback. Such digitalization of education increases the labor intensity and intensity of the teacher's work but allows working with students in their usual digital environment and increases their engagement and satisfaction with the educational process. This is a long and time-consuming process, which requires a developed digital environment and a willingness of the teaching staff to change. Surveys showed that students are ready for such changes, but they also need direct classroom communication with the teacher. It is important to make this classroom communication interesting and comprehensible for modern generations of students.

CONCLUSION

The requirements of legislative documents on the transition to a risk-based approach and "zero injury" concept in the system of ensuring technosphere safety, real problems of current agricultural production, and the introduction of professional standard 40.054 indicate the need to increase the number of places for training labor protection specialists in agricultural universities in Russia. Only on the base of serious staffing is it possible to create or improve effective labor protection management in agriculture.

Noticeably, changed cognitive abilities of new generations of students put forward corresponding requirements for teaching technologies and training programs for technosphere safety specialists. Training programs should pay more attention to legal, organizational, and managerial aspects, as well as to issues of psychology and pedagogy.

Moreover, to a full-fledged specialist training in labor protection and safety, the time allotted in a bachelor's degree is clearly not enough to master some basic disciplines that should be the predecessors of the disciplines studied (for example, "Safety of hoisting-and-transport machines and pressure vessels," "Reliability of technical systems and technogenic risk"). There is also not enough time to develop the skills provided by the educational standard, namely:

- Basic technological processes and modes of production, equipment, and principles of its operation, raw materials and materials used in the production process, etc.;
- Probability theory for mastering the theory of reliability and risks, the resistance of materials, machine parts and hoisting-and-transport machines and mechanisms, heat engineering and thermodynamics, etc.;
- Basic engineering disciplines for the meaningful development of the discipline "Safety of hoisting-and-transport machines and pressure vessels," "Safety of gas facilities";

- Drawing and descriptive geometry.

First, due to production necessity, a labor protection specialist should be able to interpret drawings and other design and construction documents, calculate collective and individual risks, etc. This cannot be done without appropriate basic training. At the same time, to expand the profile of a labor protection specialist who is delegated authority in almost all areas of technosphere safety, they need to be trained as specialists, whose competencies should integrate a large body of knowledge in various disciplines and practical methods for solving technosphere safety problems in the industrial environment of current diversified agriculture farms. Master's degrees do not correct basic engineering education gaps due to the completely different goals of this level of education. Therefore, it is advisable to return from a bachelor's degree to a specialist degree when training specialists. Many teachers and specialists noted the relevance of such change (Bakiko et al., 2017; Koshechkin et al., 2017; Lustgarten, 2017).

Second, the educational processes do not fully consider the transition to a risk-based approach of labor protection and health, the introduction of professional standards, and several new state standards. Therefore, it is necessary to revise all adopted standards and existing OS programs. The new programs should be based on appropriate educational and professional standards, considering the agricultural sector's specifics. Future specialists should have practice and internships at workplaces with labor protection in the conditions of real enterprises.

Third, it is necessary to create a system of "technosphere safety" training for the teaching staff, who deeply know the problems of labor protection in agriculture, considering the specifics of its branches. This can be done by increasing the quotas for admission to masters and postgraduate degrees of such specialists who have passed the vestibule school. Postgraduate studies with the subsequent thesis defense and obtaining an academic degree are the base for the creation of scientific and pedagogical personnel potential and the key to effective training of future specialists.

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