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Implementation of future agricultural engineers' training technology in the informational and educational environment

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Abstract. The article presents the implementation of future agricultural engineers' training technology in the informational and educational environment. To train future agricultural engineers, it is advisable to form tutorials for the study of each discipline in the conditions of informational and educational environment. Such tutorials are an assistance in mastering both theoretical material and course navigation, where interactive electronic learning tools are presented to perform tasks in the informational and educational environment. Higher education applicants perform such tasks directly in the classroom with the help of gadgets or personal computers. The final grade is formed from the scores obtained in the classroom and the rating of higher education applicants while studying in the informational and educational environment. The outlined approach is able to help in the quality of learning content. The use of interactive audiovisual online tools allows to get acquainted with the theoretical, practical and experimental provisions clearly, it is important for the training of future agricultural engineers. At the end of the experiment, it can be argued that the developed technology increases the level of motivation and self-incentive to work in the informational and educational environment. The application of the presented technology provides an opportunity to combine the educational process in the classroom with learning in the informational and educational environment, forms analytical abilities and competencies in professional activity. The reliability of the obtained results was checked using the λ Kolmogorov-Smirnov criterion. It is determined that when using this technology in the educational process, the indicators in the experimental group increased, which displays the effectiveness of training bachelors in agricultural engineering in the conditions of informational and educational environment.

Keywords: agricultural engineers' training technology, informational and educational environment

1. Introduction

While training of agricultural engineers there is a need for new approaches that are associated with interdisciplinary training and the use of modern technologies [7]. This level of training

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of future agricultural engineers is provided in the informational and educational environment [5]. As learning practices and technological tools change, such learning continues to evolve [9]. In 2018, the emphasis will be on various aspects, starting with how higher education applicants gain access to content, as defined by the idea of a "curriculum" [13, 14]. Online technologies, engineering programs and Internet access facilitate the transition to learning in an informational and educational environment, but immersion in the learning environment goes beyond learning tools [18, 28]. Studying in the conditions of informational and educational environment maintains constant access to the educational process. With the advent of learning in the informational and educational environment, educational systems are changing. Higher education applicants have the opportunity to prepare homework by watching the video that tutor posted online [25]. An option with a greater degree of interaction is possible when using mobile devices during classes [15, 19, 24, 30]. For example, a tutor asks questions and higher education applicants will answer them using mobile devices. It is possible to get direct feedback while studying at home and to interact with higher education applicants during lectures. Organizations around the world recognize that there is a large amount of supporting content that is often available, but it is ignored [16]. Successful use of this content requires a curator who uses specialized knowledge to combine relevant learning tools and pathways for higher education applicants [29]. The use of audiovisual materials increases exponentially during training. Interactive video-based learning offers a much higher level of involvement and learning experience. Mobile applications are useful for creating educational content, as they are optimized for mobile devices. The use of gamification for learning is convenient with the expansion of educational content viewing via mobile devices [2, 3, 33]. Informational and educational environment is a system of available to the user sources of information, methods and means of its appropriation, as well as the conditions of information interaction of the subject with these sources [36]. And studying in an informational and educational environment requires the use of interactive audiovisual online tools such as video lectures, online workshops, educational computer interactive simulators [10, 12, 20, 37], it increases the clarity, effectiveness and feedback during the training of higher education applicants.

Given the above, the aim of the paper is to present an implementation of future agricultural engineers' training technology in the informational and educational environment.

2. Training technology of future agricultural engineers in an informational and educational environment

The learning environment is dynamic and pedagogical activities cannot be reduced to a limited set of mechanically combined procedures [21]. The set of methods used in the research process is represented by: empirical methods – survey, questionnaire, self-assessment, testing, direct and indirect observation of the learning process, pedagogical experiment [26], statistical methods – quantitative processing of indicators and verification of the reliability of the obtained empirical results using the Fisher criterion [17], Kolmogorov-Smirnov criterion [31]. The empirical methods contribute a dynamic tool for developing practice and provide accumulation, fixation, classification and synthesis of feedstock for any particular educational system development [22, 27].

It is presented the training technology of future agricultural engineers in an informational and educational environment (figure 1). Training of bachelors in agricultural engineering provides not only classical forms of studying in the classroom, but also is supplemented by preparation for lectures, practical classes, laboratory works, seminars, support of higher education applicants by independent work and practice. When studying the cycle of disciplines of the initial level (1-2 years of study) preparation for lectures is accompanied by interactive content of informational and educational environment such as audiovisual lectures, webinars and online glossary [6]. Preparation for practical classes in the informational and educational environment involves working with online glossaries, watching videos, solving engineering problems in workshops, working with presentations. Preparing bachelors in agricultural engineering for laboratory classes may include video instructions on execution, calculation parts, working with a glossary, and viewing presentations. Preparation for seminars in the informational and educational environment can include work with online glossary and video instructions. Independent work includes webinars and interactive content of informational and educational environment. Online support should be provided through chats and thematic forums.

When studying the cycle of bachelor's degree disciplines (3-4 years) in the informational and educational environment, preparation for lectures is carried out with the help of interactive multimedia lectures. Preparation for practical classes in the informational and educational environment includes round tables in thematic forums, online practical classes, interactive tasks, educational computer interactive simulators. It is expedient to apply interactive tasks, educational computer interactive simulators to laboratory classes in the process of preparation of bachelors in agricultural engineering. The preparation of higher education applicants in specialty "Agricultural Engineering" for seminars may include presentations, interactive tasks, video conferences and thematic chat conferences [8]. Independent work in the informational and educational environment is based on interactive multimedia lectures, practical tasks, educational computer interactive simulators and research projects. The internship is provided by video conference, thematic chat conferences, online support [1]. It is necessary to monitor the results of bachelors in agricultural engineering and to study the acquisition degree of professional competencies [23].

According to the proposed technology was developed a number of tutorials on disciplines for the training of future agricultural engineers in the informational and educational environment (disciplines "Mechanics of Materials and Constructions", "Theory of Mechanisms and Machines", "Engineering and Computer Graphics"), the work of which was tested with higher education applicants in "Agricultural Engineering".

The essence of tutorials for training higher education applicants in the informational and educational environment is that they can work both independently at home and in the classroom. Theoretical material, prototypes of practical works and questions for tests and exams are presented for work in the classroom. In the informational and educational environment, a wide range of tools is presented, namely: multimedia presentations for practical work, interactive laboratory work, audiovisual lectures, educational computer interactive simulators, online glossaries, forums, webinar recordings, etc.

When attending classes, higher education applicants receive points for attendance, as well as for working in the informational and educational environment. Higher education applicants are acquainted in advance with the theoretical material. Then in the classroom, they begin the

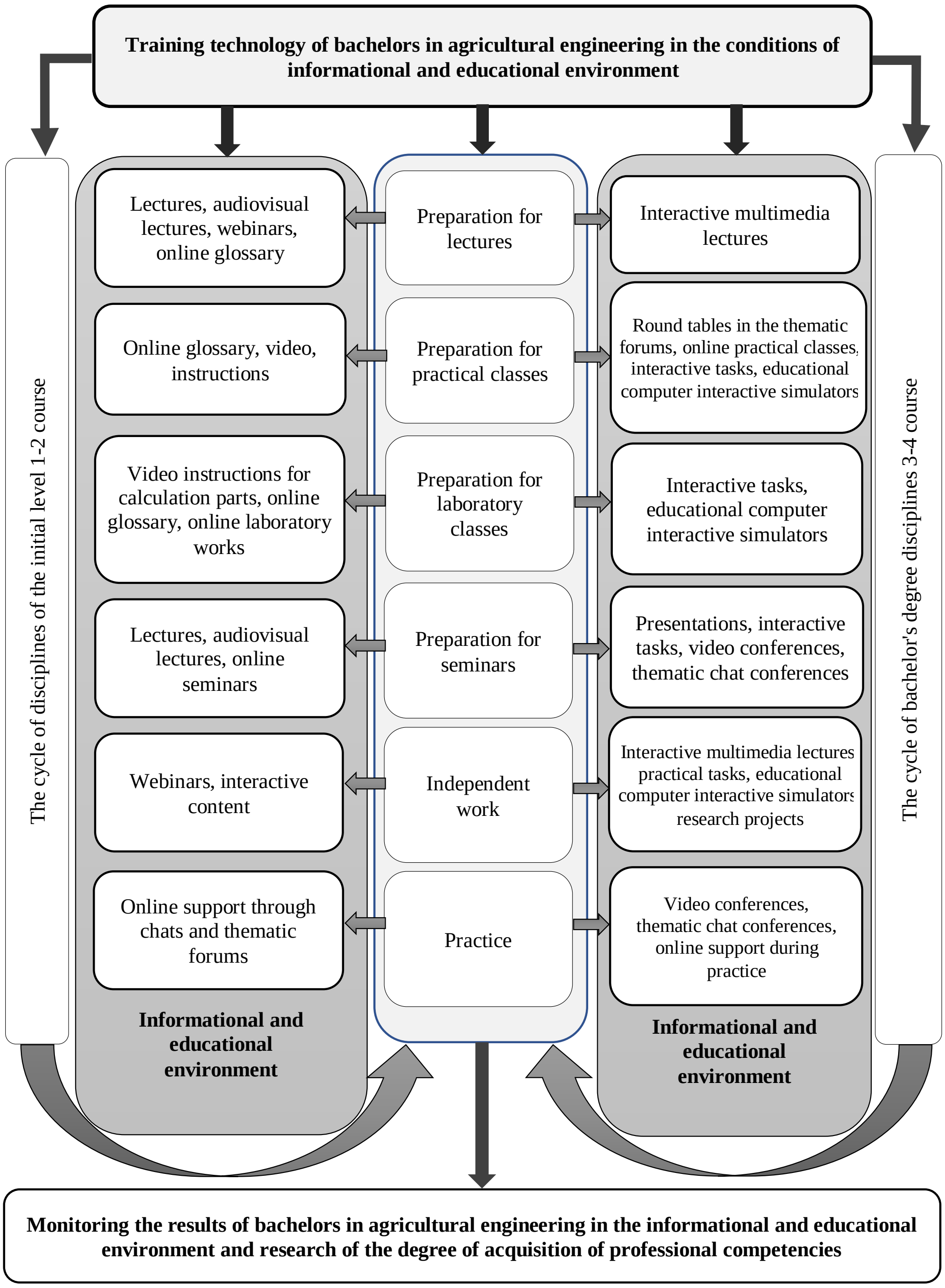

Figure 1: Future agricultural engineers' training technology in the informational and educational environment

practical implementation of tasks that are presented in the tutorial using QR-codes [34, 38, 39]. Higher education applicants, with the help of applications for reading QR-codes enter the appropriate section of the course and begin to perform tasks using a PC or mobile phone, using presented interactive audiovisual online tools, such as: multimedia presentations for practical work, interactive laboratory work, lectures with audiovisual support, educational computer interactive simulators, etc. Audiovisual lectures include the use of images, video clips, which improves the quality of perception of educational information, and provide control of knowledge at the end of each informational block. Interactive multimedia lectures allow the use of dynamic interactive elements and may have links to external hypertext pages from the Internet, which improving the professional competence of higher education applicants [35]. Online practical classes in the informational and educational environment play a leading role in the formation of skills and application of acquired knowledge. Video instructions for practical tasks contain explanations on the use of special engineering programs required for the calculation and design of technical facilities, which is important for agricultural engineering education. Conducting video conferences and thematic chat conferences with further discussion of problematic issues increases the level of assimilation of the results obtained by bachelors in the field of agriculture during the internship. Educational computer interactive simulators have a wide range of applications, can be used to demonstrate a process or mechanism, and can be complex simulators of technological processes and equipment. The educational computer interactive simulator in the informational and educational environment can be considered as a training complex, a system of modelling, a set of computer and physical models based on the performance of a specific educational task. The higher education applicant performs certain operations and receives a response from the computer system of the informational and educational environment for self-analysis. Educational computer interactive simulators in the training of bachelors in agricultural engineering can be divided into three groups: test, graphic and gamified. The test training simulators are based on engineering test tasks that help to master the rules, methods, laws, theorems and other content in the field of agricultural engineering. Graphic training simulators include such training tasks, which are based on work with engineering and graphic images and the execution of drawings of parts in an informational and educational environment. Gamified training simulators basically have a game task, performing which develops professional agricultural engineering competencies. These include acquaintance with the parts and devices that are the basis of agricultural engineering, the principles of training in the operation of complex agricultural machinery; skills of installation, assembly of systems, and also at search of malfunctions and repair of agricultural machinery.

For each participant of the course it is possible to trace statistical data, on their basis the applicant of higher education receives semester points: monitoring of points for the executed tasks in the informational and educational environment, answers in the conditions of thematic forums and chat- conferences, points for mastering theoretical content, practical tasks, educational computer interactive simulators. After completing the task with the help of device, the informational and educational environment forms an assessment for higher education applicants and statistical indicators of the task for the tutor. Thus, for higher education applicants a rating is formed during training in the informational and educational environment, which affects the final assessment. The tutor controls the time of certain tasks and limits the number of attempts [4].

In the informational and educational environment, higher education applicants have the opportunity to acquire competencies that are attached to the tasks. As a result of taking the course, the applicant of higher education acquires the indicator of competencies acquisition, as a result of taking the course according to the curriculum during the term, acquires the indicator of competencies according to the curriculum template. On the basis of the received points and the acquired competences, on each applicant of higher education it is possible to form a rating in the conditions of the informational and educational environment.

3. Results

The main purpose of the experiment was to test the future agricultural engineers' training technology in the informational and educational environment. The experimental procedure included the following steps:

- selection of control and experimental groups (homogeneous);
- development of methodological tools for assessing the criteria and indicators of the current level of knowledge, skills, abilities of bachelors in agricultural engineering, reflecting the readiness level of the higher education applicants for professional activity;
- determination and ascertainment of the bachelors' readiness formation level for professional activity in the conditions of informational and educational environment;
- introduction of future agricultural engineers' professional training technology in the conditions of informational and educational environment;
- comparison of indicators of bachelors' readiness level for professional activity after the introduction of author's developments;
- generalization and conclusion about the efficiency of the proposed author's developments, which are characterized by the relationship of dependent and independent variables (methods and results in fixed conditions, etc.).

The purpose and objectives of the study determined the objectives of the pedagogical experiment and to justify the efficiency of the developed technology of training bachelors in agricultural engineering to professional activity in the informational and educational environment through practical implementation.

The control group used traditional tools to perform the tasks, and the experimental ones used interactive audiovisual online tools of the informational and educational environment. The obtained data were redistributed into two equal groups according to the corresponding number of initial score. To verify the homogeneity of the distribution into control and experimental groups, we used ϕ^* – Fisher's criterion. According to Fisher's criterion the groups are distributed uniformly. Numerical indicators for determining the bachelors' readiness levels for professional activity in the informational and educational environment was checked by testing, questionnaires, comprehensive tests, educational results.

The results of the bachelors' readiness levels for professional activity in the informational and educational environment in the experimental and control groups at the beginning of the experiment of the λ Kolmogorov-Smirnov criterion are presented in

Table 1 examining the levels of readiness for professional activity of bachelors in agricultural engineering in the informational and educational environment at the beginning of the experiment, it should be noted that the percentages between the experimental and control groups differed only in hundredths.

Table 1
Calculation of the λ Kolmogorov-Smirnov criterion for comparison the readiness level for professional activity in the informational and educational environment at the beginning of the experiment

Level	Empirical frequencies		Empirical particles		Accumulated empirical particles		Difference
	$f_{experimental}$ (number of respondents)	$f_{control}$ (number of respondents)	$f_{experimental}$ %	$f_{control}$ %	N_i	N_i^*	$d = \|N_i - N_i^*\|$
High	8	7	1.23	1.08	0.01	0.01	0.00
Sufficient	27	26	4.14	4.01	0.04	0.04	0.00
Average	126	128	19.32	19.72	0.19	0.20	0.01
Initial	491	488	75.31	75.19	0.75	0.75	0.00
Total	652	649	100	100			

We will form statistical hypotheses to test the level of readiness of bachelors in agricultural engineering for professional activity in the informational and educational environment.

H_0: the number of bachelors in agricultural engineering, in which the level of readiness for professional activity in the informational and educational environment in the experimental group is not higher than in the control.

H_1: the number of bachelors in agricultural engineering, in which the level of readiness for professional activity in the informational and educational environment in the experimental group is higher than in the control one.

We will check the reliability of the obtained results with the help of the Kolmogorov-Smirnov criterion λ with the help of the calculation table [11, 32] (table 1).

Determine $d_{max} = 0.01$ and the level at which this value falls, and calculate the value of λ by the formula:

$$\lambda_{empirical} = d_{max}\sqrt{\frac{f_{experimental} \cdot f_{control}}{f_{experimental} + f_{control}}} = 0.168298687, \lambda_{critical} = \begin{cases} \lambda_{0.05} = 1.36 \\ \lambda_{0.01} = 1.63 \end{cases}$$

Thus, $\lambda_{empirical} < \lambda_{critical}$, H_1 – deviates, hypothesis H_0 is preserved. The number of bachelors in agricultural engineering, in which the readiness level for professional activity in the informational and educational environment to the formative stage in the experimental group is not higher than in the control one.

The results of the readiness levels for professional activity of bachelors in agricultural engineering in the informational and educational environment in the experimental and control groups at the end of the experiment are presented in table (table 2). At a high level, the percentage in the experimental groups exceeds by 12% the control. In the experimental group at a sufficient level the percentage is higher than in the control one by almost 30%. At the average level in the control group the indicator is higher than in the experimental group by 18%. At the

Table 2
Calculation of the λ Kolmogorov-Smirnov criterion for comparison the readiness formation level for professional activity in conditions of the informational and educational environment at the end of the formative stage of the experiment

Level	Empirical frequencies		Empirical particles		Accumulated empirical particles		Difference
	$f_{experimental}$ (number of respondents)	$f_{control}$ (number of respondents)	$f_{experimental}$ %	$f_{control}$ %	N_i	N_i^*	$d = \|N_i - N_i^*\|$
High	134	54	20.55	8.32	0.21	0.08	0.12
Sufficient	296	109	45.40	16.80	0.45	0.17	0.29
Average	157	279	24.08	42.98	0.24	0.43	0.19
Initial	65	207	9.97	31.90	0.10	0.32	0.22
Total	652	649	100	100			

initial level in the experimental group, the figure does not exceed 10%, which is 21% less than in the control one.

We will form statistical hypotheses to test the level of readiness of bachelors in agricultural engineering for professional activity in the informational and educational environment.

H_0: the number of bachelors in agricultural engineering, in which the level of readiness for professional activity in the informational and educational environment to the formative stage in the experimental group is not higher than in the control one.

H_1: the number of bachelors in agricultural engineering, in which the level of readiness for professional activity in the informational and educational environment to the formative stage in the experimental group is higher than in the control.

We will check the reliability of the obtained results with the help of the Kolmogorov-Smirnov criterion λ with the help of the calculation table (table 2).

Determine $d_{max} = 0.29$ and the level at which this value falls, and calculate the value of λ by the formula:

$$\lambda_{empirical} = d_{max}\sqrt{\frac{f_{experimental} \cdot f_{control}}{f_{experimental} + f_{control}}} = 4.880661923, \lambda_{critical} = \begin{cases} \lambda_{0.05} = 1.36 \\ \lambda_{0.01} = 1.63 \end{cases}$$

Thus, $\lambda_{empirical} > \lambda_{critical}$, H_0 – deviates, hypothesis H_1 is preserved. The number of bachelors in agricultural engineering, in which the level of readiness for professional activity in the informational and educational environment to the formative stage in the experimental group is higher than in the control.

It is presented in the form of bar histograms a comparison of bachelors' readiness levels for professional activity in agricultural engineering in the informational and educational environment in the experimental and control groups at the beginning (figure 2) and at the end (figure 3) of the experiment.

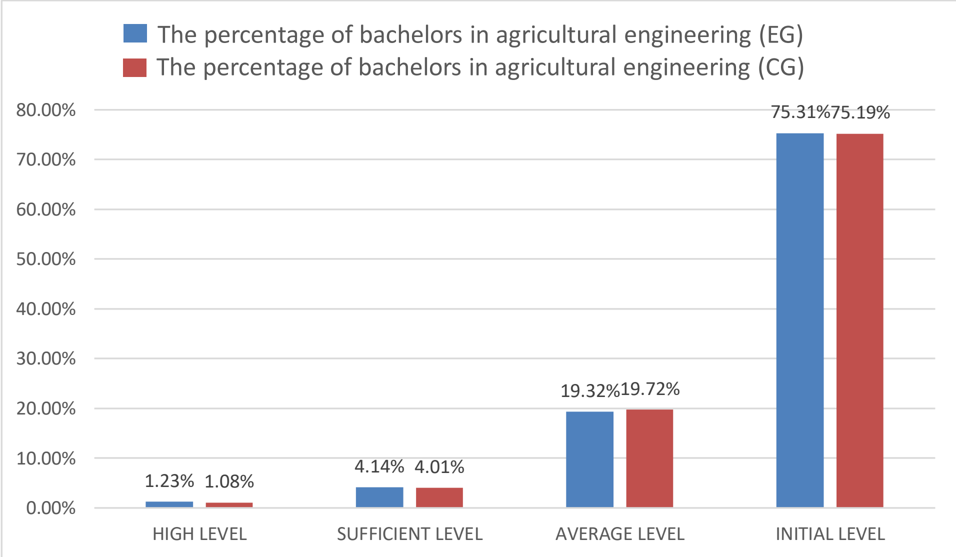

Figure 2: Comparison of the readiness levels for professional activity of bachelors in agricultural engineering in the informational and educational environment in the experimental and control groups at the beginning of the experiment

At a high level at the end of the experiment we have an increase of almost 20%, while in the control groups it is 7%. At a sufficient level at the end of the experiment, a rate of 5% was recorded in the experimental groups, which makes it possible to claim an increase of more than 40%, while in the control groups the increase is 12%. At the average level in the experimental groups, the increase is 5%, in the control it is more than 20%. At the initial level, at the end of the experiment in the experimental groups, the indicators decreased by almost 65%, while in the control groups only by 45%.

4. Conclusions

The implementation of future agricultural engineers' training technology in the informational and educational environment involves the integration of studying in the classroom and in the virtual space. To train bachelors in Agricultural Engineering, it is advisable to form electronic interactive tutorials for the study disciplines in the conditions of informational and educational environment. The final grade is formed from the scores obtained in the classroom and the rating of higher education applicants while studying in the informational and educational environment. The use of interactive audiovisual tools allows to get acquainted with the theoretical, practical and experimental provisions clearly, all this is important for the training of bachelors in Agricultural Engineering.

Thus, the main purpose of the experiment is to test the readiness of bachelors in agricultural engineering for professional activity in the informational and educational environment. The procedure of conducting experimental work included selection of control and experimental groups, development of methodical tools, definition and statement of readiness formation

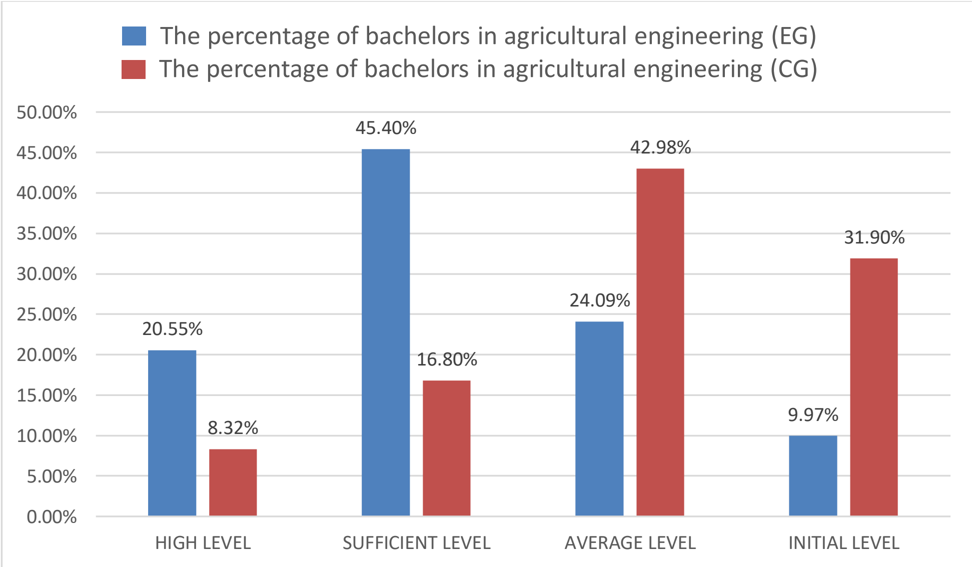

Figure 3: Comparison of the readiness levels for professional activity of bachelors in agricultural engineering in the informational and educational environment in the experimental and control groups at the end of the experiment

level to professional activity in the conditions of informational and educational environment, introduction of technology, comparison of formation levels after introduction of author's developments. Through practical implementation it is necessary to substantiate the efficiency of the developed technology. The reliability of the obtained results was checked using the λ Kolmogorov-Smirnov criterion.

Upon completion of the formative experiment, it can be argued that the future agricultural engineers' training technology in the informational and educational environment is effective. The developed technology of bachelors in agricultural engineering preparation increases the level of motivation and self-incentive to work in the informational and educational environment. The outlined technology provides an opportunity to combine the educational process in the audience of the bachelor in agricultural engineering with learning in the informational and educational environment, forms analytical skills and professional competencies.

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