

**PREPARAÇÃO PROFISSIONAL DE PROFESSORES NOS EUA NA PERSPECTIVA DO PROFISSIONALISMO E DA COMPETÊNCIA****PROFESSIONAL PREPARATION OF TEACHERS IN THE USA FROM THE PERSPECTIVE OF PROFESSIONALISM AND COMPETENCE****ПРОФЕССИОНАЛЬНАЯ ПОДГОТОВКА УЧИТЕЛЕЙ В США С ТОЧКИ ЗРЕНИЯ ПРОФЕССИОНАЛИЗМА И КОМПЕТЕНТНОСТИ**

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**RESUMO**

A relevância deste estudo reside no fato de que os professores modernos das escolas e universidades são limitados pelas estruturas de uma disciplina e, assim, seu crescimento profissional é limitado apenas pela recitação gradual das provisões de um ou outro assunto na escola de ensino superior, não permitindo desenvolvimento de cursos interdisciplinares. Os autores do artigo consideram o problema muito mais profundo e definem que a oportunidade dos professores para aumentar o seu conhecimento profissional é baseada na preparação necessária dos professores, a fim de não apenas permitir que eles ensinem sua própria disciplina, mas também permitir que eles implementem a abordagem interdisciplinar. A novidade do artigo está no fato de que não diz que o professor deve ministrar vários cursos e assim ter a idéia da estrutura de alguma ou outra disciplina. Para os autores do artigo, o principal componente é a necessidade na preparação do professor da ensino superior de ambas as disciplinas técnicas e humanas, o que permite demonstrar com precisão as conexões interdisciplinares no processo de educação. O artigo revela os parâmetros de tal qualificação e apresenta um modelo que permite avaliar até que ponto os professores podem aplicar o conhecimento obtido na prática. A implementação da disposição do artigo no campo da prática pedagógica é vista pelos autores no desenvolvimento dos programas de preparação profissional dos professores, no processo de seu trabalho, e na melhoria de seu conhecimento profissional.

**Palavras-chave:** *professor, competências, oportunidades, estratificação, profissionalismo.*

**ABSTRACT**

The relevance of the study is in the fact that modern school and university teachers are limited by the frameworks of one discipline and thus their professional growth is only limited by the gradual recitation of the provisions of one or another subject in the senior school not allowing them developing interdisciplinary courses. The authors of the paper consider the problem much deeper and define that the teachers' opportunity to increase their professional knowledge is based on the provision of the necessary preparation of teachers in order to not

only let them teach their own discipline but also to let them implement the interdisciplinary approach. The novelty of the paper is in the fact that it does not say that the teacher should give several courses and thus have the idea of the structure of some or other discipline. For the authors of the paper, the main component is the need in the preparation of the senior school teacher of both technical and humanitarian disciplines, which allows precisely demonstrating the interdisciplinary connections in the process of education. The paper reveals the parameters of such qualification and presents the model that allows assessing the extent teachers may apply the obtained knowledge in practice. The implementation of the paper's provision in the field of the pedagogical practice is seen by the authors in the development of the programs of the professional preparation of teachers in the process of their work and further improvement of their professional knowledge.

**Keywords:** *teacher, competences, opportunities, stratification, professionalism.*

## АННОТАЦИЯ

Актуальность работы заключается в том, что современные педагоги и преподаватели в старшей школе ограничены рамками только одного предмета и таким образом их профессиональный рост ограничивается только постепенным изложением положений того или иного предмета в старших классах без возможности разработки междисциплинарных курсов. Авторы статьи рассматривают проблему гораздо глубже и определяют, что возможность для педагога увеличить свои профессиональные знания основаны на положении о необходимости подготовки учителя таким образом, чтобы он мог не только преподавать свой предмет, но также и реализовать мультидисциплинарный подход. Новизна статьи заключается в том, что в ней не сказано о том, что необходимо преподавателю читать несколько курсов и таким образом иметь представления о том, как построена та или иная дисциплины. Авторы статьи определяют главным компонентом необходимость подготовки преподавателя старших классов как технических, так и гуманитарных дисциплин, что позволяет четко показывать межпредметные связи в процессе обучения. В статье раскрыты параметры подобной квалификации и представлена модель, которая позволяет оценить, насколько в процессе реализации своей профессиональной деятельности педагоги могут применять полученные знания на практике. Реализацией в поле педагогической практики положения статьи авторы видят в развитии программ профессиональной подготовки педагогов в процессе их работы и дальнейшего совершенствования профессиональных навыков.

**Ключевые слова:** *учитель, компетенции, возможности, стратификация, профессионализм.*

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## 1. INTRODUCTION

The increase and potential development of the pedagogical excellence for the modern teachers is a rather acute issue because the gradual development of the technologies changes the importance of teacher from the translator of knowledge to the organizer of competences (Wuttke and Seifried, 2017; Sayeski *et al.*, 2019). The teacher should accompany his or her student and form his/her own competences (Salema, 2012; Kuriloff *et al.*, 2019). In this regard, a teacher should give the complete information to the student and contribute to the formation of his/her worldview to the full extent because there is a series of task a student is not able to solve on his/her own. (Pedro *et al.*, 2014). In this regard, the teacher should form the complete worldview for his/her student (Gridina and Andreev, 2016).

Under the conditions of the informatization of society, the leading role is defined by means of the spacious mind of the teacher (Watson, 2001; Ryu *et al.*, 2019). For this purpose, he/she should

precisely understand the way his/her professional competences are implemented. There is no sense in analyzing the way the teacher's preparation (Voss, 2017; Alles *et al.*, 2019). So, the most relevant is the opinion, according to which a teacher should increase his/her pedagogical competencies that may be called institutional in practice (Mrnjajus, 2012; Hahl and Mikulec, 2018). We base our idea on the activity component of professional competences, which essentially defines the pure possibility of implementing the stated process (Korshunov *et al.*, 2016).

## 2. LITERATURE REVIEW

In regard to the activity component of professional competences, it is notable that almost all the scientists connect it with the performance of professional functions and the ability to perform both separate operations in the professional activities and the entire activity in general, which implies the ability of modeling the professional situations, making professional decisions and

bearing the responsibility for them (Santagata and Yeh, 2016; Cervantes-Soon, 2018).

The mentioned approaches to the understanding of the contents of each component of the professional competences made it possible to make them more concrete in our definition of the concept 'senior school teacher's professional activities' (Blömeke, 2008; Bartell *et al.*, 2018). When developing it, we adhered to the structure-functional approach to the definition of professional competences of the future specialist in any branch and thought that the procedure of revealing the component contents of the senior school teacher's professional competencies should include the following measures (Blömeke, 2008; Van Overschelde and López, 2018):

- The analysis of the regulatory requirements to the structure of the activities and duties in order to detect the components of the actions to be performed;

- The definition of the components of preparedness of the teachers to the performance of the stated professional actions;

- The integration of the allocated components of readiness to the professional activities in the form of professional competences.

The study of the corresponding scientific approaches to the understanding of the professional competence of a specialist allowed us to define the pedagogical category of 'senior school teacher's professional competence' as an integrated peculiarity of a professional containing of three following interdependent components (Blömeke, 2008; Bastian and Janda, 2018):

- Cognitive, including the knowledge of the profile disciplines and the ability to obtain and replenish them;

- Function-activity, connected with the implementation of professional functions and the ability to perform professional activities, which implies the skill of modeling professional situations, making professional decisions and bearing the responsibility for them;

- Personal, connected with the ability of actualizing personal qualities and opportunities for the performance of the professional duties including responsibility, focus on the goal, persistence, creativity, independence, self-confidence, diligence, focus on effectiveness and quality, ability to the innovative activity and risk, ability to the ongoing professional growth, self-development and self-improvement.

Considering the above-stated, by the

professional competence of a senior school teacher we mean integral characteristics of personal and business qualities of a specialist reflecting the level of knowledge, skills, experience sufficient for the achievement of the goals of his/her professional activities, as well as his/her moral position concluded in the readiness to set the goal and make the decisions necessary for its implementation (Mohamadi and Malekshahi, 2018; Evans and Lee, 2018). At the same time, professional competence is a situational category as it is manifested in a subject in his/her ability to successfully solving professional tasks in various professional situations, so as the conditions necessary for its formation there are situations modeling future professional activities of the student (Whyte, 2015; Kolman, 2018). This choice is caused by the fact that in the process of education, a situation may be considered as a unit of the pedagogical process (Nevalainen and Kimonen, 2013; Winarti, 2018).

In order to conduct the experiment to define the extent of the competence formation, we should define the criterion-level apparatus of the research (Toleubekova and Sarzhanova, 2018; Corcoran and O'Flaherty, 2017). The design of the pedagogical experiment on the introduction of the developed model of the senior school teachers' professional competence required revealing the following issues (Gillmore, 1977; Mundschenk *et al.*, 2017):

- The definition of the ideas' contents and the performance indicators of the professional competence formation as the educational process;

- The analysis of the papers studying the design of the criteria and indicators of the extent of professional competence formation;

- The definition and substantiation of the criteria, indicators, and the senior school teachers' professional competence formation extent when studying the natural and general technical disciplines;

- The development of the ways to define the indicators of each criterion of senior school teachers' professional competence formation extent when studying natural and agrotechnical disciplines.

The study of the experience of the professional competence structure development showed that it consists of the professional knowledge and skills, the experience of their application in practice, and personal characteristics corresponding to the profession (Gillmore, 1977; North and Brookes, 2017). The

stated components are included to the structure model of senior school teachers' professional competence, which will be described in detail in various sources and includes cognitive, activity and personal components (Zenchanka and Zenchanka, 2018; Windschitl and Stroupe, 2017). So, the substantiation of the criteria of the senior school teachers' professional competence formation extent by means of the integration of the natural science and general technical disciplines was our prioritized task (Mohamadi, 2018; Bastian and Marks, 2017).

As a result of the analysis of the scientific literature regarding the issue of diagnostics of the senior school teachers' professional competence formation extent, it was found that there is a problem of in measuring the effectiveness and quality of the educational activities in the educational institutions regarding the formation of the specialists' readiness to the performance of the professional duties (Kedzierska, 2010; Corcoran and O'Flaherty, 2017). The reason of this phenomenon may be seen in the problem of developing the criteria, indicators and the levels of their expression when studying the state of a particular object or the characteristics of the process (Huijbers, 2017; Tracz *et al.*, 2017).

### 3. MATERIALS AND METHODS

In order to define the goals and methods of diagnosing the senior school teachers' professional competence formation extent, we have analyzed the contents of the main definitions, such as 'criterion', 'indicator', 'effectiveness', and 'quality'. As for the concept of 'criterion', it is notable that it is of the Greek origin and means 'the ground for reasoning', i.e. it is a basis for evaluation, definition, and classification of something. Criterion always expresses the essential changes in the object and presents the knowledge of the limit, the completeness of the revealing of its essence in particular expression. Criterion is not an evaluation but it is a tool for the evaluation.

The creation of the methodical recommendations was implied especially for the teacher. The reasonability of their development is connected with the need in the provision of the pedagogical conditions for the senior school teachers' professional competence formation by means of the integration of the natural and general technical disciplines connected with the preparedness of the teacher to introduce the corresponding models to the educational process. Due to these reasons, the contents of this

environment should provide the teachers with the information necessary for the comprehension of the essence of the proposed model and the conditions of its implementation when studying a particular professional discipline. So, we included in this environment the following three units of auxiliary information:

- The theoretical unit implying the acquaintance with the concept of 'professional competence', the structural models of the professional competence formation by means of the integration of the natural and general technical disciplines, pedagogical conditions of implementation of the model that we developed, the contents of each of the concepts, which are key for each condition;

- The diagnostic unit containing the texts of the questionnaires for the diagnostics of the motivation for the educational-cognitive and professional activities for the senior school teachers, the levels of development of their reasoning, the readiness to the activities and adaptation to it, as well as the keys to the processing of the questionnaires. The inclusion of these materials provided an opportunity to facilitate the work of the teacher with the design, management, and control of the results of studying natural and general technical disciplines focused on the formation of their professional competence;

- The control unit presenting as follows: the register of attendance of the lessons and current grades of the retrainees; their workbooks aimed for control works; and the thematic plan for conduction of all kinds of lessons of the discipline.

Besides, the contents of the information presented in the recommendations for the teachers provided them an opportunity of acquiring the theoretical-methodical bases for the organization of the senior school teachers' educational process organization focused on their professional competence formation (Law *et al.*, 2011). Thus, we ensured the preparation of the teachers to the implementation of the model of the senior school teachers' professional competence formation extent by means of professional disciplines (Nikolova *et al.*, 2018). The conduction of the educational experiment with the application of the developed materials and diagnostics of the obtained results provided an opportunity of conducting their analysis and statistical processing.

### 4. RESULTS AND DISCUSSION:

The developed system was approbated in

the following stages:

– 2010-2011 – ascertaining stage – the authors studied the regulatory documents and materials on the organization of the educational process in the educational institutions; they also analyzed the available methodical provision of the educational process in the educational institutions in order to reveal its compliance with the model of the senior school teachers' professional competence formation and the conditions, at which it can give a positive result; the authors studied the readiness to the performance of the professional duties and the solution of the production tasks;

– 2013-2015 – teaching stage – the authors designed the models of the school teachers' professional competence formation substantiated the pedagogical conditions of their implementation in the practice of teaching to the natural and general technical disciplines; the authors elaborated the contents of the components for the model of the senior school teachers' professional competence formation by means of natural and general technical disciplines; the authors developed the methods for implementation of the pedagogical conditions; they also prepared a complex of the pedagogical means necessary for the effective senior school teachers' professional competence formation in the process of studying natural science and general technical disciplines; and analyzed the course and the result of the experiment;

– 2016-2017 – final stage – the authors formed the results of the experimental work, analyzed and generalized the results of the theoretical and experimental research, and formulated the theoretical and practical conclusions.

Totally the experiment involved 603 students: 228 – in the control groups, and 375 – in the experimental groups. The first group with the introduced integration model No.1 involved 120 retrainees; the second one with the introduced integration model No. 2 – 127 retrainees; the third group with the introduced integration model No.3 involved 128 retrainees. The effectiveness of the experimental education was defined by the indicators of the formation extent of the components of the subject competences (from physics and general technical disciplines), as well as professional competence in general. At the same time, the hypothesis of the research concluded in the supposition that the integrative approach to teaching physics and general technical disciplines had a positive effect on the

extent of the students' digestion of both disciplines, which in its turn increased the professional competence formation extent in general (Wuttke and Seifried, 2017; Kenshimov *et al.*, 2017). As it was almost impossible to select control and experimental groups with the same distribution of retrainees by the formation extent of each type of competences at the beginning of the teaching experiment, we judged about the model of integration of physics and general technical disciplines by the changes taken place in the distributions and as a result of the introduction of the relevant integrative approaches. The distributions of the retrainees by the professional competence formation extent were calculated as average measured (Siek-Piskozub and Jankowska, 2013).

The effectiveness criteria for the introduction of the model of the senior school teachers' professional competence formation in the process of studying natural science and general technical disciplines were chosen theoretical, practical personal with the following indicators: theoretical – success in the digestion of the physical concepts; knowledge of the algorithm for solving the main tasks, knowledge of the requirements to the profession; practical – ability to set and solve tasks; ability to set and solve tasks of problematic and professional contents and the time of their performance; personal – motivation, responsibility and self-reflection (ability to self-control and self-esteem) (Nikolova *et al.*, 2018; Kirillov *et al.*, 2015).

To conduct the research, we developed four models of implementation of the process of the senior school teachers' professional competence formation by means of the integration of natural and technical disciplines. We highlighted three experimental groups, which were educated according to the following models – experimental No.1 (according to model No. 1), experimental No. 2 (according to model No. 2) and experimental No. 3 (according to model No. 3). Also, we separated a control group for comparison.

The distribution according to the groups was implemented based on the comparison of the retrainees' academic performance results in discipline 'Physics', which is basic for the general technical disciplines of the experiment and significantly affects the results of their digestion. Considering the fact that we may deem equal such distributions of the retrainees by the level of effectiveness, the lack of differences in which is proved statistically, the definition of the groups for the experimental and control samplings was implemented based on the comparative

assessment of the results of the retrainees' academic performance in physics (comprehensive course) with the subsequent statistical testing of the reliability of the existing differences. Despite the fact, the results of the academic achievements are assessed by the 5 points system, the adherence to the levels of effectiveness is defined as follows (Table 1).

The processing of the examination records in physics (comprehensive course) of the retrainees provided an opportunity to obtain their distributions by the levels presented in Table 2. From the analysis of Table 2 data, one may see the inconsistency in the distribution of the retrainees by the experimental groups. There are the following reasons for this: the experiment was being conducted during five years, and each year the number of the academic groups studying the experimental specialty was limited (4-5 group in a course); the transfer of the retrainees from one academic group to another is technically impossible (due to the complexity of the personnel accounting); the number of teachers that might be involved in the experiment, was on the one hand limited by the lack of the physics teachers' technical awareness for teaching, and on the other hand, the lack of the teachers' readiness to teach the natural science disciplines to the retrainees – physics; the overload of the involved teachers (teaching different specialties in different groups) limited the variation of their pedagogical load etc.

Thus, we decided to pay special attention to the groups with low-quality indicators of initial preparation (inlet results) and teach them according to the model, which, to our mind, should provide the best result – experimental group No.3. In this case, a more significant result will be the comparison of the change in the indicators in the levels of the retrainees' achievement as part of each group and the dynamics of these changes.

The comparison of the academic performance of the retrainees of the control and experimental groups No.1 and No.2 provides the ground for the conclusion that their distributions by the levels of the achievements in physics may be deemed as almost the same. For the statistical substantiation of the lack of differences between the control and experimental samplings, we will use the Pearson's chi-square test ( $\chi^2$ ) and will calculate its value according to formula (1). The value of the statistics of the  $\chi^2$  criterion at the comparison of the frequencies distribution of the retrainees from the control and experimental groups will be denoted as T.

$$T_1 = \frac{1}{n_1 n_2} \sum_{i=1}^3 \frac{(n_1 Q_{1i} - n_2 Q_{2i})^2}{Q_{1i} + Q_{2i}} \quad (\text{Eq. 1})$$

where  $n_1$  and  $n_2$  – volumes of the control and experimental samplings;  $Q_{11}, Q_{12}, Q_{13}$  – the number of the objects from the control sampling entering the category of the state of the investigated property (in our case, the groups of retrainees with high, medium and low levels of academic performance in physics);  $Q_{21}, Q_{22}, Q_{23}$  – the number of the objects from the experimental sampling entering the category of the state of the investigated property (in our case, the group of retrainees with high, medium and low levels of academic performance in physics).

Let us introduce the designations corresponding to those used in the formula for the calculation of the  $T_{\text{ex}}$  statistics and make necessary calculations. Putting the values of the corresponding variables to the formula (1), we will obtain the value of  $T_{\text{ex}}$  for each experimental group inserted into Table 3.

We find the critical value of the  $T_{\text{kr}}$  criterion according to our data. It is equal to  $T_{\text{kr}}=5.99$  (for the level of significance 0.05, for the pedagogical studies it is considered allowable, and the number of the freedom extents  $v = C - 1$ , which in our case is equal to  $v = 3 - 1 = 2$ ). Using the rule of decision-making, we will compare the average measured value of the  $\chi^2$  criterion calculated for the data of our experiment ( $T_{\text{ex}}$ ) and table ( $T_{\text{kr}}$ ) ( $3.4 < 5.99$ ). The result of the comparison provides the grounds to conclude that the differences in the distribution of the retrainees from the control and experimental sampling by the grades in physics are statistically not reliable. Using the rule of decision-making, we will compare the values of the  $\chi^2$  criterion calculated for the data of our experiment ( $T_{\text{ex}}$ ) and table ( $T_{\text{kr}}$ ) – for each model in comparison with the control groups, the inequality  $T_{\text{ex}} < T_{\text{kr}}$  was just. Thus, the result of the comparison provides the grounds to conclude that the differences in the distributions of the retrainees from the control and experimental sampling by the grades in physics are not statistically reliable for the models No.1 and No.2.

Summing up the obtained results, we have the ground to state that the selected groups of the control and experimental samplings are equal according to the theoretical criteria. The selection of the control and experimental groups of the retrainees by the grades in physics was insufficient for the definition of the further shifts in the practical and experimental criteria of the senior school

teachers' professional competence formation extent. So, we studied the states of development of the indicators of practical and personal criteria among the retrainees at the beginning of the academic year, when they start studying the methods for teaching natural science and general technical disciplines. In general, the distributions of the retrainees by the formation extent of the physical component of the senior school teachers' professional competence at the beginning of the experiment are presented in Table 4.

During the experiment, we compared the results of the final control of the retrainees' knowledge studied according to three models in the experimental groups and control groups. The inlet data of the experiment, as it was noted above, were chosen the results of the knowledge in physics (comprehensive course) for the assessment of the effectiveness of forming the physical component of professional competence; while the general technical component of professional competence was based on the knowledge of the general course of physics. The initial data was as follows: for the physical component of professional competence – the knowledge in physics after its study, while for the general technical component of professional competence – the knowledge of the technological bases as general technical discipline upon the completion of its study. Thus, the distributions of the retrainees by the formation extent of the general technical component of the senior school teachers' professional competence at the beginning of the experiment are presented in Table 5.

In the course of the experiment, we conducted the inlet, intermediate, and final assessments of the education results of the retrainees by the theoretical, practical, and personal criteria. The number of the models for the conduction of the research, the experimental groups, and their inconsistency, the number of criteria for their assessments and comparison complicate the statistical calculations of the experimental data. So, we compared the experimental results according to the changes in the formation extent of the professional competence's component according to each criterion. For the theoretical of the professional competence's criterion of the physical component of the change in the levels for each group are presented in table 6-9.

The comparison of the percent values of the theoretical criterion indicators for the experimental and control samplings allowed establishing the nature of the changes happening

in the distribution of the retrainees resulted from the introduction of the developed models of school teachers' professional competence formation and pedagogical conditions of its implementation. They speak about the following:

– The digestion of the basic physical concepts appeared to be better among the retrainees from experimental groups No.1 and No.2 (26% and 27% retrainees respectively obtained a high level of knowledge), but the highest value in the indicators of high level was observed among the retrainees from experimental group No.3 (6.3%), while the lowest one – in experimental groups No.2 (1.2%), compared with the control group, though it is incorrect to consider the obtained results as reassuring (57.8% of the retrainees from experimental groups No.3 revealed a low level of knowledge in the wordings and definitions of the main concepts and rules);

– The main concepts were better digested by the students from experimental groups No.1 and No.2 (38.3% and 36.3% retrainees respectively obtained high level of knowledge), at the same time, the increment in the indicators of high level had higher value among the retrainees from experimental group No.3 (18.8%), while the lowest one – in the control group (7.9%);

– The best knowledge of the ways of actions (composition and solution of the tasks, the performance of laboratory works, composition and defense of the reports) is shown by the representatives of the groups studied according to the experimental method. This is evidenced by the increase in the number of the retrainees with high (26.8%, 26.8% and 23.4% versus 23.2%) and medium (60%, 55.1% and 56.3% versus 49.6%) levels in the experimental groups compared with the control one for the physical component of the professional competence; as well as the increase in the number of retrainees with high (29.2%, 29.1% and 21.9% versus 23.7%) and medium (54.28%, 56.7% and 54.7% versus 51.8%) levels in the experimental groups compared with the control one for the initial technical component of professional competence. Though it is notable that experimental group No.3, which in the beginning of the experiment had 16.4% of high level of the general technical knowledge (versus 22.8% in the control group), showed 54.7% of the medium level of knowledge of the ways of action at the completion stage (versus 51.8% in the control group), though the high indicator has the following values (21.9% in experimental group No.3 versus 23.7% in the control group);

– The differences in the distributions of the

retrainees by the knowledge of the regulatory requirements to the profession have appeared to be peculiar only for a quarter of the retrainees. It is predominantly related to the retrainees with high and low levels of digestion of the regulatory knowledge. This may be explained by the fact that they start studying professional disciplines, the contents of which implies the acquaintance of the senior school teachers with the regulatory requirements to this profession, and the duties. The differences in the distribution of the retrainees from the experimental and control groups according to the theoretical criteria are statistically reliable, which is evidenced by the nature of the changes: the increase in the number of retrainees with high and medium levels of formation extent of the cognitive (physical and general technical) component of the senior school teachers' professional competence (physical component – the increase by 6.3% in the experimental groups No. 3 versus the 2.7% retrainees increment in the control groups of high level; general technical component – the increase by 18.8% in experimental group No.3 versus the 7.9% retrainees increment in the control groups of high level) and the decrease in the number of the retrainees with low level of knowledge (physical component – decrease by 19% of the retrainees in the experimental groups versus 6% of the retrainees in the control groups; general technical component – the decrease by 34% of the retrainees in the experimental groups versus 6% of the retrainees in the control groups).

The above-stated calculation data may be presented in the form of diagrams in Figure 1 and Figure 2 – the distribution of the retrainees by the formation extent of the indicators of physical and general technical components of professional competence in the beginning and at the end of the experiment. The comparison of the survey results of the retrainees from the control and experimental groups provided the grounds to suppose that positive changes took place in the distribution by the levels of each indicator of personal criterion. The most significant are the changes in the motivation of the retrainees to the education and distinct manifestation of the sense of responsibility. It is supported by the following facts:

– The decrease in the number of retrainees with low level of motivation in the experimental groups compared with the control one (4.8%) by 10% (in experimental group No.1) and by 14% (in experimental group No.3) and the decrease in the number of retrainees with low level of responsibility for making their own decisions in the experimental groups by 12.5% (No.1) and by

17.2% (No.3) compared with the control one (6.1%);

– The increase in the number of retrainees with high level of motivation in the experimental groups compared with the control one by 6.3%, as well as the increase in the number of retrainees with high levels of self-reflection and distinct manifestation of sense of responsibility for making their own decisions by 7% in the experimental groups compared with the control one;

– The increase in the number of retrainees with high (by 4.7%) and medium (на 6%) levels of the personal criterion in general in the experimental groups compared with the control one.

The differences in the distribution of the retrainees from the experimental and control groups by the formation extent of personal criterion among senior school teachers' professional competence are statistically reliable. The definition of the average values of the retrainees' distributions by the formation extent of the theoretical, practical and criterion provided the grounds to compare the changes they have undergone under the influence of the suggested methods of studying one of the special disciplines. The generalizing table that reflects them we present in the form of comparative diagrams – in Figure 3 and Figure 4.

As seen from the diagrams, the statistically significant changes took place in all the criteria of retrainees' professional competence formation extent, which evidences about the effectiveness of the developed model of senior school teachers' professional competence formation in the process of studying special disciplines and pedagogical conditions of its implementation. The proposed data shows the positive changes taken place in the groups of senior school teachers resulted from the introduction of three integration models of natural and general technical disciplines (basics of hydromechanics). It is supported by the data of Table 10 based on the comparison of the results of the teaching experiment.

They provide the grounds to conclude that the slightest changes in the distribution of the retrainees by the formation extent of the physical and general technical components of professional competence took place in the control groups: the number of retrainees with low formation extent of physical component of professional competence decreased by 2.9%, and by 3.1% – with low and medium formation extent of general technical component of professional competence. It caused the increase in the number of retrainees with



medium (by 1%) and high (by 1.9%) formation extent of the physical component of professional competence and 3.1% increase in the number of the retrainees with high formation extent of the general technical component of professional competence.

## 5. CONCLUSION:

The study of the condition for the implementation of the integrative approach to the education of the senior school teachers of natural and general technical disciplines provided the grounds to state that despite the relevance of the problem, there is a series of drawbacks in the educational-upbringing process, which do not allow ensuring proper fundamental and technical preparation of the retrainees to the professional activities. In the course of the ascertaining experiment, it was found that the course of physics serves the basis for the digestion of the general technical and professional knowledge and is one of the most difficult courses. It is supported by the results of the control works and the answers of the retrainees at the examinations. The teachers of the special disciplines also note that the majority of the retrainees are not aware of the significance of the physical knowledge and skills for the acquisition of the profession, which shows the imperfection of the existing methods for teaching physics and professional disciplines.

The conduction of the teaching experiment proved the effectiveness of the suggested models of integration of natural science (physics) and general technical disciplines by all the indicators. The biggest changes in the distribution of the retrainees by the extent of formation of the physical and general technical components of professional competence took place in the groups, where the third integration model was introduced:

– the number of the retrainees with the low physical competence formation extent decreased by 18.5%, and thus the number of retrainees with a medium level increased by 9.9%, while the number of retrainees with the high level of the general technical component of the professional competence formation extent increased by 8.6%;

– the number of the retrainees with the low general technical competence formation extent decreased by 17.4%, and thus the number of retrainees with a medium level increased by 7.6% while the number of retrainees with the high level of the general technical component of the professional competence formation extent increased by 9.8%.

The differences in the distribution of the retrainees in the groups with the introduced integration models No.1 and No.2 are almost the same; however, they change due to the number of the retrainees with different physical and general technical competences formation extent.

The obtained results prove the positive dynamics of the increase in the formation extent of the studied indicators in the experimental groups compared with the control ones, which may be considered as a proof of the effectiveness of the introduced models and pedagogical conditions of the senior school teachers' professional competence formation extent. Based on the above-stated one may consider the hypothesis as proved and the goal of the research as achieved.

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**Table 1.** The correspondence of the grades to the levels of academic achievements

Kind of Educational Institution	Level of Initial Knowledge		
	High	Medium	Low
College	Grade – 5	Grade – 4	Grade – 3

**Table 2.** Distribution of the retrainees from the experimental and control groups at the beginning of the experiment (by the levels of achievement in physics)

Kind of Group	Number of Students by the Levels						Total
	Low		Medium		High		
	fact.	%	fact.	%	fact.	%	
Control	91	39.9	97	42.5	40	17.5	228
Experimental No.1	27	22.5	68	56.7	25	20.8	120
Experimental No.2	42	33.1	58	45.7	27	21.3	127
Experimental No.3	85	66.4	36	28.1	7	5.5	128
Total	245	40.6	259	43.0	99	16.4	603

**Table 3.** Value of the  $\chi^2_{ex}$  criterion statistics at the comparison of the distribution of the retrainees from the control and experimental samplings by the levels of academic achievements in physics at the beginning of the experiment

Model Name	Value of the $\chi^2$ Criterion's Statistics				Conclusion
	Kind of Sampling	$T_{ex}$	$T_{kr}$		
Model No. 1	control	6.8	5.99		$T_{ex} < T_{kr}$
	experimental				
Model No. 2	control	1.8	5.99		$T_{ex} < T_{kr}$
	experimental				
Model No. 3	control	15.3	5.99		$T_{ex} > T_{kr}$
	experimental				
Mean Value		3.4	5.99		$T_{ex} < T_{kr}$

**Table 4.** Distribution of the retrainees by the formation extent of the physical component of the senior school teachers' professional competence at the beginning of the experiment

Criteria	Groups	Formation Extent for each Criterion					
		Low		Medium		High	
		people	%	people	%	people	%
Theoretical readiness	Control	95	41.7	98	43.0	35	15.4
	Experimental-1	33	27.5	65	54.2	22	18.3
	Experimental-2	46	36.2	56	44.1	25	19.7
	Experimental-3	93	72.7	31	24.2	4	3.1
Practical readiness	Control	69	30.3	110	48.2	49	21.5
	Experimental-1	24	20.0	68	56.7	28	23.3
	Experimental-2	27	21.3	68	53.5	32	25.2
	Experimental-3	56	43.8	57	44.5	15	11.7
Personal	Control	35	15.4	129	56.6	64	28.1
	Experimental-1	20	16.7	67	55.8	33	27.5
	Experimental-2	22	17.3	68	53.5	37	29.1
	Experimental-3	43	33.6	60	46.9	25	19.5
Average Measured	Control	66	29.1	112	49.3	49	21.6
	Experimental-1	26	21.4	67	55.6	28	23.1
	Experimental-2	32	24.9	64	50.4	31	24.7
	Experimental-3	64	50.0	49	38.5	15	11.5

**Table 5.** Distributions of the retrainees by the formation extent of the general technical component of the senior school teachers' professional competence at the beginning of the experiment

Criteria	Groups	Formation Extent for each Criterion					
		Low		Medium		High	
		people	%	people	%	people	%
Theoretical readiness	Control	91	39.9	97	42.5	40	17.5
	Experimental-1	27	22.5	68	56.7	25	20.8
	Experimental-2	42	33.1	58	45.7	27	21.3
	Experimental-3	82	64.1	37	28.9	9	7.0
Practical readiness	Control	64	28.1	112	49.1	52	22.8
	Experimental-1	18	15.0	71	59.2	31	25.8
	Experimental-2	23	18.1	70	55.1	34	26.8
	Experimental-3	45	35.2	62	48.4	21	16.4
Personal	Control	28	12.3	132	58.1	67	29.5
	Experimental-1	15	12.5	69	57.5	36	30.0
	Experimental-2	18	14.2	71	55.9	38	29.9
	Experimental-3	35	27.3	64	50.0	29	22.7
Average Measured	Control	61	26.8	114	49.9	53	23.3
	Experimental-1	20	16.7	69	57.8	31	25.6
	Experimental-2	28	21.8	66	52.2	33	26.0
	Experimental-3	54	42.2	54	42.4	20	15.4

**Table 6.** Comparison of the retrainees' academic performance level in physics (Ph) and general technical disciplines (GT) at the initial and final stages of the research for the experimental group No.1

Component	Number of the Course Participants by Levels																		Total
	Low						Medium						High						
	inlet		outlet		$\Delta$		inlet		outlet		$\Delta$		inlet		outlet		$\Delta$		
	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	
P h	3	27.	2	20.	-8	-	6	54.	6	57.	4	3.3	2	18.	2	21.	4	3.4	12 0
	3	5	5	8		7	5	2	9	5		2	3	6	7	4			
G T	2	22.	2	21.	-1	0.	6	56.	4	40.	2	-	2	20.	4	38.	2	17.	12 0
	7	5	6	7		8	8	7	8	0	2	16.	5	8	6	3	1	5	

**Table 7.** Comparison of the retrainees' academic performance level in physics (Ph) and general technical disciplines (GT) at the initial and final stages of the research for the experimental group No.2

Component	Number of the course participants by levels																		Total
	Low						Medium						High						
	inlet		outlet		$\Delta$		inlet		outlet		$\Delta$		inlet		outlet		$\Delta$		
	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	
P h	4	36.	4	33.	-4	-	5	44.	5	45.	2	1.	2	19.	2	21.	2	1.	12 7
	6	2	2	0		3.2	6	1	8	7	6	5	7	7	3	6	7		

P h	4	33.	2	19.	-	-	5	45.	5	44.	-2	-	2	21.	4	36.	1	15	12
	2	1	5	7	1	13.	8	7	6	1		1.	7	3	6	3	9	7	
					7	4						6							

**Table 8.** Comparison of the retrainees' academic performance level in physics (Ph) and general technical disciplines (GT) at the initial and final stages of the research for the experimental group No.3

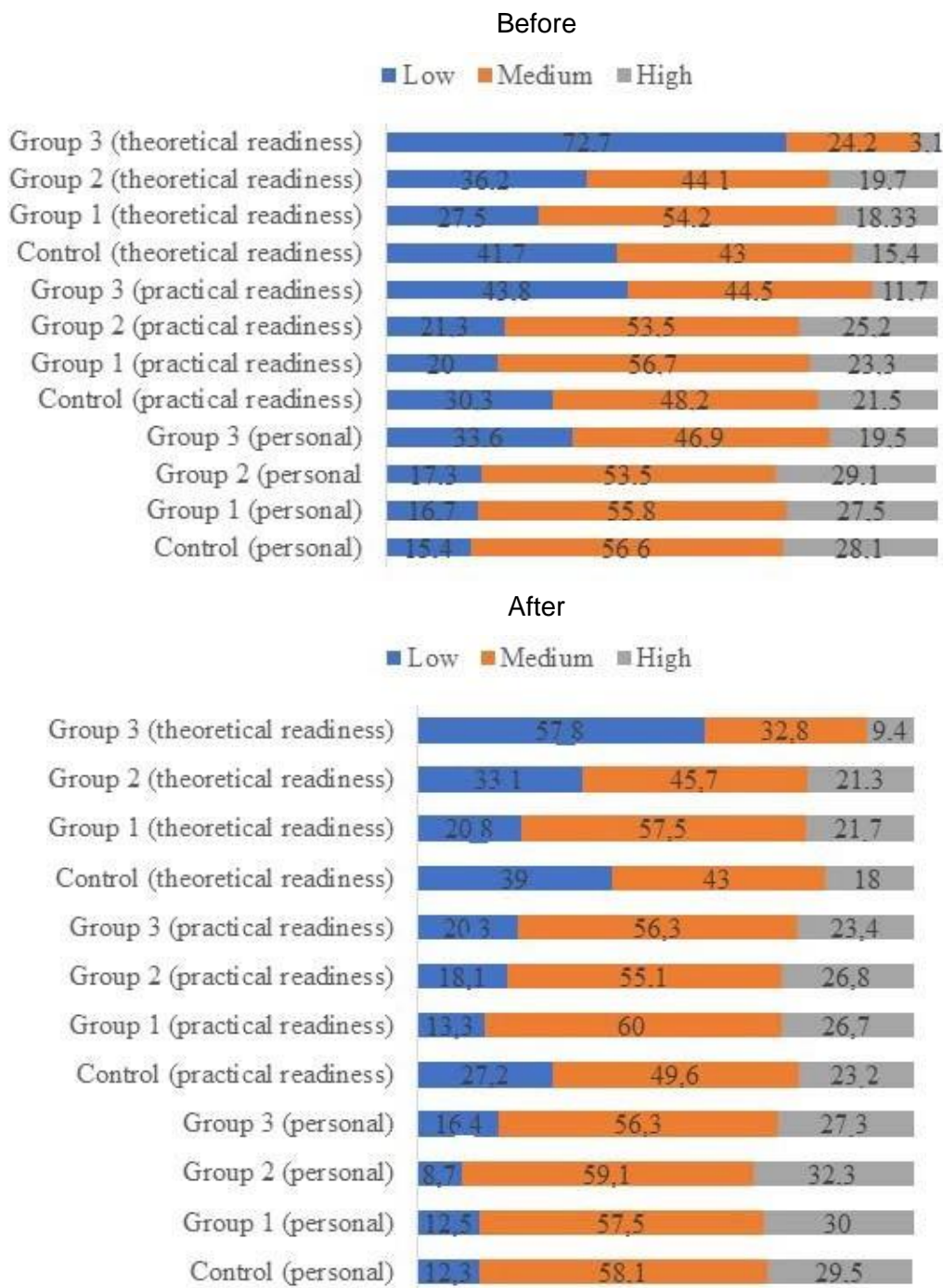
Component	Number of the Course Participants by Levels																		Total
	Low						Medium						High						
	inlet		outlet		Δ		inlet		outlet		Δ		inlet		outlet		Δ		
	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	
P h	9	72.	7	57.	-	-	3	24.	4	32.	1	8.	4	3.	1	9.4	8	6.3	12
	3	7	4	8	1	14.	1	2	2	8	1	6	4	1	2				8
					9	9													
G T	8	64.	4	37.	-	-	3	28.	4	36.	1	7.	9	7.	3	25.	2	18.	12
	2	1	8	5	3	26.	7	9	7	7	0	8		0	3	8	4	8	8
					4	6													

**Table 9.** Comparison of the retrainees' academic performance level in physics (Ph) and general technical disciplines (GT) at the initial and final stages of the research for the control group

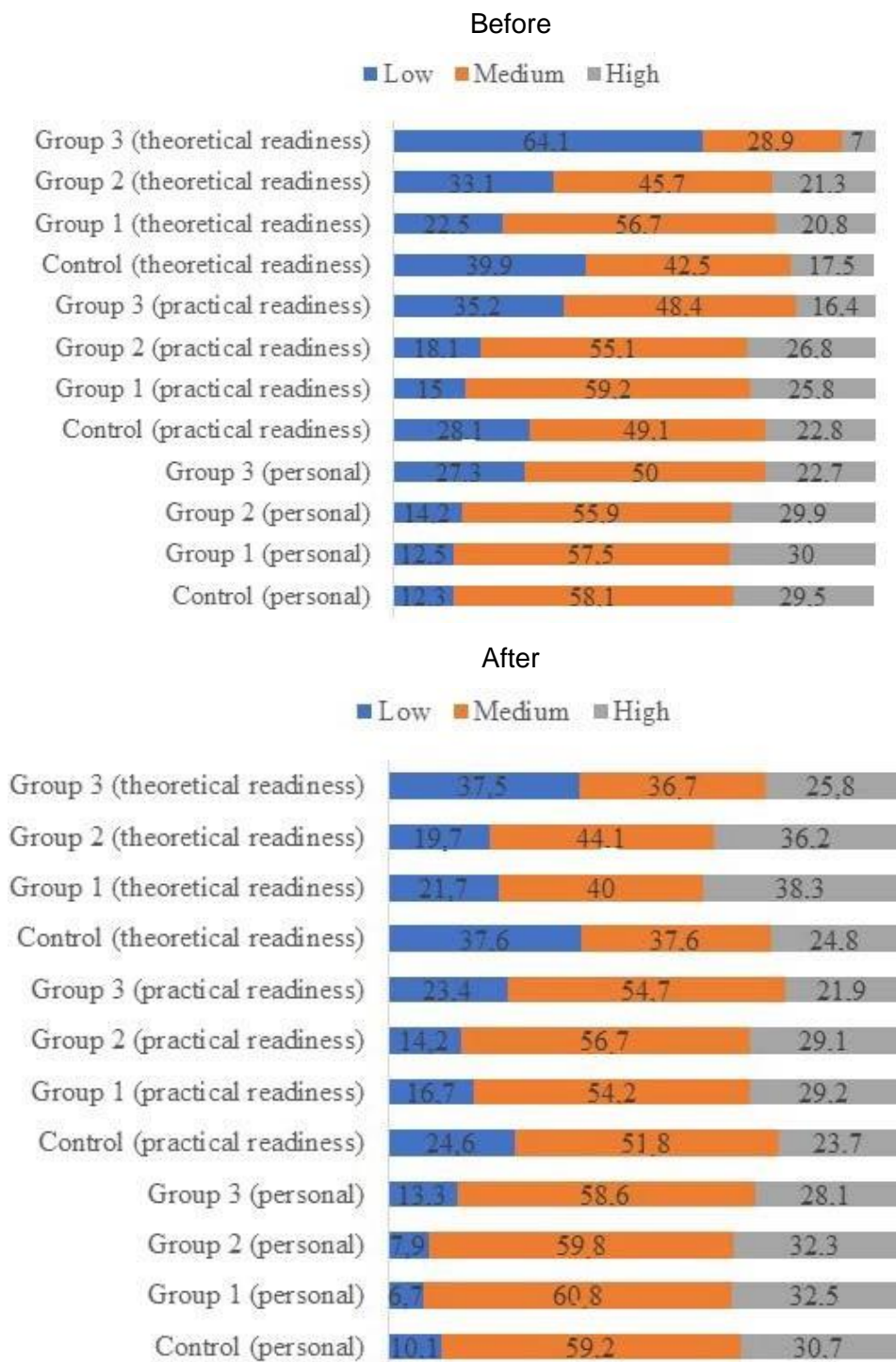
Component	Number of the Course Participants by Levels																		Total
	Low						Medium						High						
	inlet		outlet		Δ		inlet		outlet		Δ		inlet		outlet		Δ		
	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%	
P h	9	41.	8	39.	-6	-	9	43.	9	43.	0	0	3	15.	4	18.	6	2.	22
	5	7	9	0		2.	8	0	8	0			5	4	1	1		7	8
					7														
G T	9	39.	8	37.	-6	-	9	42.	8	37.	-	-	4	17.	5	25.	1	7.	22
	1	9	5	3		2.	7	5	5	3	1	5.	4	5	8	4	8	9	8
					6						2	3							

**Table 10.** Changes in the distribution of the retrainees from the control and experimental groups by the formation extent of physical and general technical components of the senior school teachers' professional competence resulted from the introduction of three integration models

Group	Qualitative Changes in the Formation Extent of Physical Component of the Course Participants' Professional Competence resulted from the Teaching Experiment (people. / %)						Qualitative Changes in the Formation Extent of General Technical Component of the Course Participants' Professional Competence resulted from the Teaching Experiment (people. / %)					
	Low		Medium		High		Low		Medium		High	
	fact	%	fact	%	fact	%	fact	%	fact	%	fact	%
Group No.3	-24	(-18.5)	+13	(9.9)	+11	(8.6)	-22	(-17.4)	10	(7.6)	12	(9.8)
Group No.2	-7	(-5)	+4	(2.9)	+3	(2.1)	-10	(-7.9)	2	(1.3)	8	(6.6)
Group No.1	-7	(-5.8)	+3	(2.8)	+4	(3)	-2	(-1.7)	-7	(-6.1)	9	(7.8)
Control Group	-6	(-2.9)	+2	(1)	+4	(1.9)	-6	(-2.7)	-1	(-0.4)	7	(3.1)

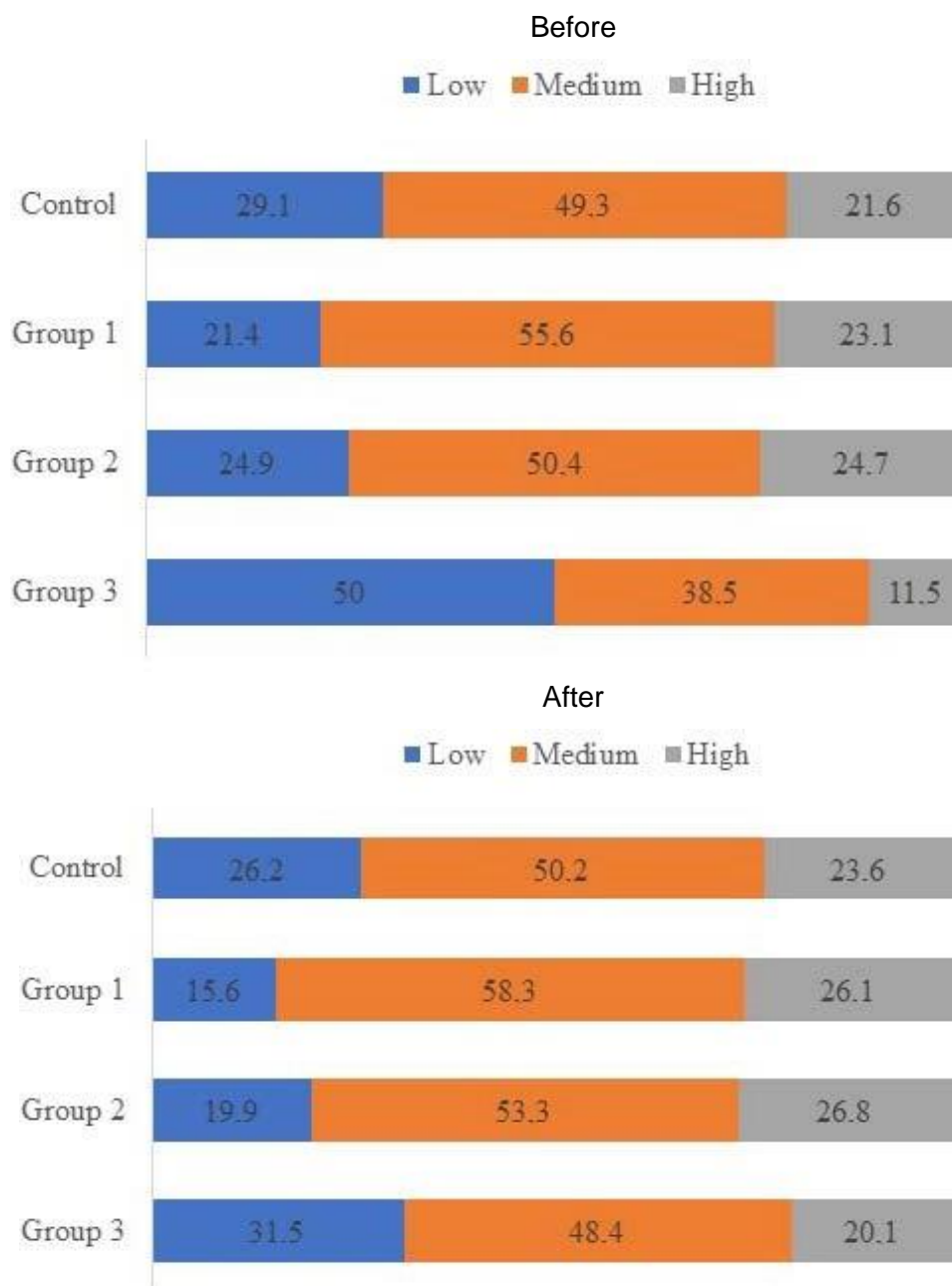


**Figure 1.** Distribution of the retrainees from the control and experimental groups by the formation extent of the indicators of physical component of professional competence at the beginning and at the end of the experiment

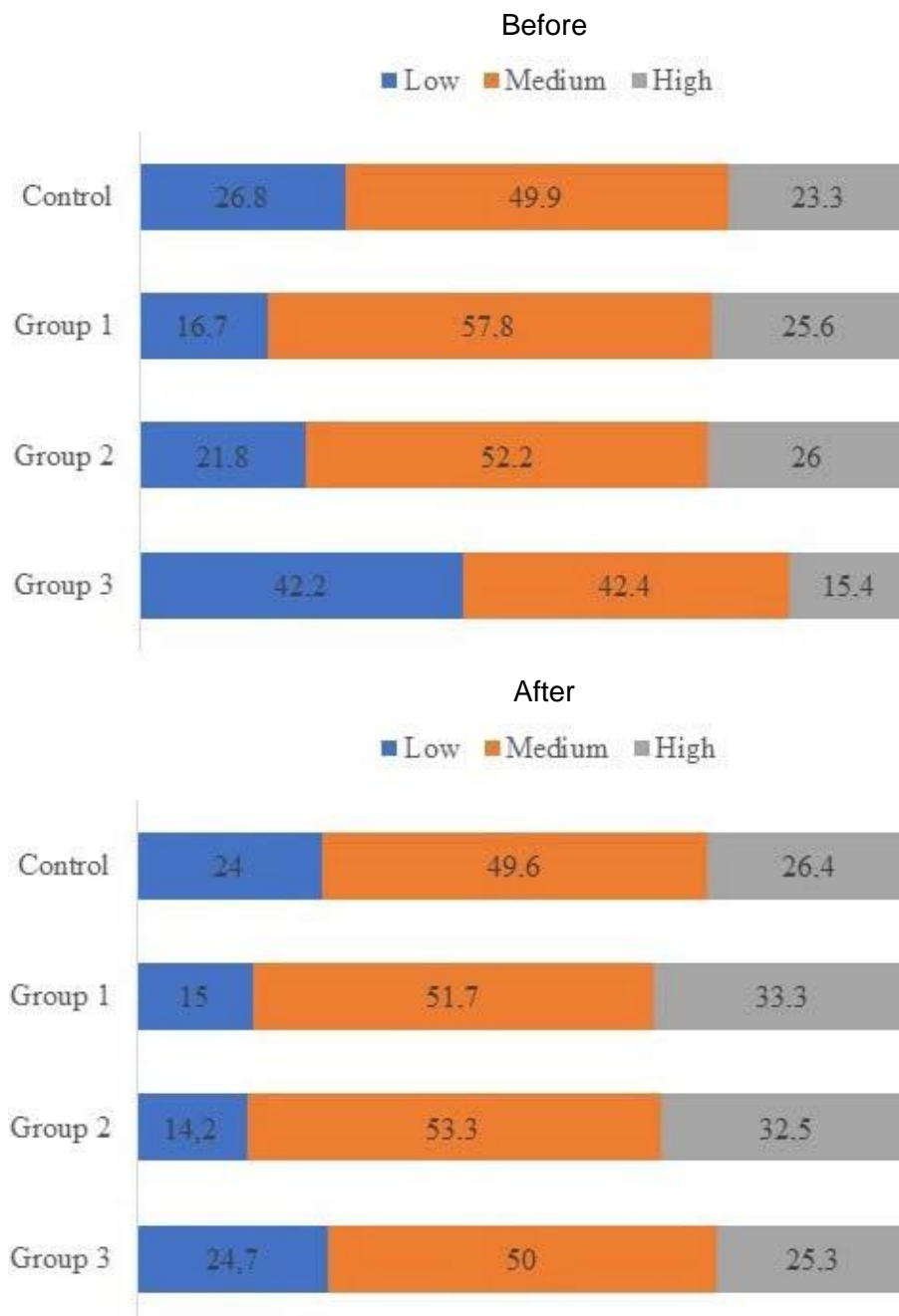


**Figure 2.** Distribution of the retrainees from the control and experimental groups by the formation extent of the indicators of general technical component of professional competence at the beginning and at the end of the experiment





**Figure 3.** Distribution of the retrainees from the control and experimental groups by the formation extent of the indicators of physical component of professional competence at the beginning and at the end of the experiment



**Figure 4.** Distribution of the retrainees from the control and experimental groups by the formation extent of the indicators of general technical component of professional competence at the beginning and at the end of the experiment