

Organization and content efficiency substantiation of a strengthened professional and applied physical training course for railway higher educational institution students

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Purpose: to experimentally substantiate the effectiveness of the application of the experimental program for physical education with an intensified course of professional-applied physical training (PAPT) for students of I–II courses of railway specialties.

Material & Methods: analysis and generalization of literary sources, pedagogical experiment, pedagogical testing, physiological and psycho-physiological methods, methods of mathematical statistics.

Result: obtained data after the introduction of the experimental program on physical education with an intensified course of professional-applied physical training, students of railway universities.

Conclusion: analysis and generalization of the literature sources found the absence of a scientifically based program of PAPT for students of higher education institutions of the railway profile. The introduction in the educational process of physical education of the experimental program on physical education with the strengthened course of the PAPT showed an increase in the level of physical, professionally applied physical and psycho-physiological readiness of students.

Keywords: professional-applied physical training, railway engineers, physical training, experimental program, students, psycho-physiological preparedness.

Introduction

Uncontrollable development of scientific and technological progress, global changes in the political, economic and social spheres fundamentally change the perception of the quality process for the training of the future specialist, requires fundamentally new approaches to the entire system of physical education, especially in the process of professional-applied physical training (PAPT).

In modern conditions of reforming the system of the educational process in higher educational institutions of Ukraine, many domestic researchers note the relevance of substantiating the content and organization of programs for professional-applied physical training, taking into account the requirements of a particular profession and the search for new technologies for their implementation.

Successful functioning of such a strategically important complex as rail transport is largely determined by the human factor. High demands placed on modern railroad specialists every year increasingly illuminate the contradictions between the need for Ukrzaliznytsia in highly qualified, harmoniously developed specialists and the traditional system of physical education in the university, does not take into account the specific nature of future professional activity and does not provide this need in full; between the rapid development of the railway industry and the needs for specialists, capable of prolonged professional longevity and inadequate elaboration of the content of existing programs for physical education in the conceptual plan; between the requirements for physical, psychophysical and mental preparedness of modern specialists of the railway industry and the available level of training

graduates of higher educational institutions. So, it is obvious that the existing system of physical education needs to be improved and the search for new, more effective forms of its organization in higher educational institutions [2; 4; 7].

Problem of optimization and improvement of professional-applied physical training of future specialists of various specialties is devoted to a considerable number of scientific works [1; 2; 5; 8]. This is not an accident, because a modern specialist should differ not only in the quality of professional training, but also have a high level of physical development and functional state of the body. So, the programs of professionally-applied physical training for students of high schools of energy specialties [9], machine-building industry [3], students studying on the profile of radio engineering [8] and others. However, it should be noted that the issues of professionally-applied physical training have not been adequately covered in the literature, in particular, with reference to the specifics of the railway industry. Do not disclose the features of profiled training, taking into account the professional orientation of the work process of electrical engineers of the railway transport, organizational and methodological foundations of the construction of technology of professionally-applied physical training are not developed taking into account the structure and functioning of the universities of railway transport. Such training of railway engineers is practically not carried out either during study at the university, or during the further production activity. Main reason for this is the lack of a scientifically based system presentation of professional-applied training of future railway specialists and the technology of practical implementation of this training in specialized educational institutions, Ukrzaliznytsia and other industrial enterprises.

In the scientific literature [2, 3, 4] it is proved that the level of physical preparedness of workers in the railway industry does not meet modern requirements on a number of criteria. Weak physical fitness is the reason for the low level of efficiency of specialists, rapid fatigue, psychological breakdowns, which leads to a large number of production errors in railway transport. In addition, as A. I. Davidenko [2] notes, the professional activities of railway specialists are carried out under conditions of exposure to harmful factors of the production environment: noise, vibration, dust, unfavorable microclimate, heavy physical labor, neuro-emotional tension and inefficient nutrition. Such working conditions provoke the emergence of many occupational diseases. Thus, among the most common diseases among railway workers are: respiratory diseases, peripheral nervous and musculoskeletal systems, circulatory system, digestive organs, occupational deafness, diseases and injuries of the musculoskeletal system, poisoning. Scientists [2, 7] note that workers in the railway industry have a reduced level of psycho-physiological and psychophysical preparedness, a high incidence rate, an early professional aging, is the cause of many accidents and incidents.

Researches of scientists [5, 7] show that the production activity of workers in the railway industry is more than 60% dependent on the human factor and up to 50% on the quality of psycho-physiological and psychophysical preparedness of specialists. R. T. Rayevsky [6] determined that for the development and improvement of sensory, volitional and mental qualities, specially selected means of applied orientation. Due to their purposeful impact, the optimum level of functioning and reliability of all organs and systems.

In order to substantiate the need for PAPT railway specialists, it is necessary to consider the specific features and requirements for employees of this industry. Thus, V. A. Sadovsky [7] notes that the general requirements include: professional psychophysical readiness, mental abilities, sensory, motor, physical, volitional, organizational skills and abilities of railroad specialists. High labor productivity largely depends on individual abilities for mental and physical labor, the level of endurance and restorability of an organism, efficiency, etc.

Scientists [2, 4, 5, 7] note that the physical reliability and readiness of railway specialists is effectively achieved through the special, professionally directed use of PAPT tools and methods.

The scientific works indicate that the formation of professionally important physical qualities and skills in future specialists, the increase in the body's resistance to the adverse effects of the external and industrial environment is most effectively achieved in the process of specially directed use of methods and means of physical education.

At present, the issue of the professionally applied physical training of railroad specialists, in particular, electrical engineers of railway transport, has not been practically investigated. Significant requirements that professional activity impose on the physical, psychophysical and mental training of modern railroad specialists, high social importance of their work activity make it especially relevant to develop and introduce in the process of physical education in universities a strengthened course of the PAPT, with the aim of acquiring, by future specialists, the professionally required level of professional physical and psycho-physiological readiness for railway en-

gineers.

Current situation determines the relevance of the scientific substantiation of the content and organization of professionally-applied physical training and their introduction into the educational process of future electrical engineers of the railway transport.

Purpose of the study: to experimentally substantiate the effectiveness of the application of the experimental program for physical education with an intensified course of professionally-applied physical training (PAPT) for students of I–II courses of railway specialties.

Material and Methods of the research

In the course of the research, the following methods were used: analysis and generalization of literary sources, pedagogical experiment, pedagogical testing, physiological and psycho-physiological methods, and methods of mathematical statistics.

In order to test the effectiveness of the organization and content of the experimental program for physical education with a strengthened PAPT course for students, future electrical engineers of railway transport, a pedagogical experiment was conducted. In the experiment, 50 students (young men) took part, of which an experimental (25 people) and control (25 people) group of first year students of the Ukrainian State University of Railway Transport. Classes of students of both groups were held under the same conditions: two-time classes per week for 90 minutes. Structures of the sports base of UkrSURT and the necessary sports equipment were used. All studies in the experimental group were carried out by the author of the work, in the control group – by teachers of the Department of Physical Education and Sports in accordance with the curriculum for physical education for higher educational institutions of Ukraine III–IV levels of accreditation.

Results of the research and their discussion

At the beginning of the experiment, both groups (experimental and control) did not have significant differences in all studied parameters.

It was revealed that the data of the initial level of anthropometric and psycho-physiological indices of physical and psycho-physical development as a whole corresponded to the average age norms. Level of physical and professionally-applied physical preparedness is low.

An analysis of the results of the initial study made it possible to conclude that it is necessary to introduce a strengthened course of PAPT in the physical education of railway higher education institutions in order to reach future physicists with a high level of physical and psycho-physiological readiness that are important for the further successful work.

In the developed experimental program, a wide application of exercises aimed at increasing the overall physical preparedness and performance in conjunction with a large arsenal of PAPT, most effective for this professional activity, as well as the introduction of methods for optimizing occupations, which allowed to increase the intensity and motor density of occupations, not exceeding the limits of the hours allocated

by the program. means of GPP and PAPT were distributed as follows: exercises aimed at increasing physical performance and development of physical qualities – 40%, on development of strength qualities – 25%, speed-strength endurance – 15%, exercises aimed at improving attention functions and kinesthetic sensibility – 10%, general and special working capacity – 10%.

Pedagogical experiment was designed for two years. Results of testing conducted at the end of the second year of the study showed that the students of the experimental group had significant positive changes in their physical preparedness for almost all indicators. Thus, the results in pull-ups increased by 75,5%, by 49,9% – arm-pumping exercises, by 61,9% – in the bent suspension, by 36,5% - in the rise of the trunk in squat and 57% – in the angled position from the squat position. Indices of endurance (run on 3000 m) among the students of the experimental group improved by 19,2%, agility by 9,6%, speed-strength qualities by 9,7% (standing long jump) and by 5,3% – speed (running on 100 m).

One of the important components of testing the effectiveness of the experimental program was testing of professionally important physical, psychophysical and mental qualities and abilities of future electrical engineers of railway transport. Results of a two-year experiment prove that an experimental program has been developed that has positively influenced the development of such professionally important physical qualities as kinesthetic sensuality, strength, strength endurance of the back muscles and coordinated movements. Thus, the increase in the parameters of the kinesthetic sensibility of the leading brush was $10,76 \pm 0,19$ kg ($p < 0,05$), that is 26,8%; indicators of strength – $31,2 \pm 0,7$ kg ($p < 0,05$), That corresponds to 33.8%; indicators coordinated movements (test

Kopilova "Ten eights") – $2,53 \pm 0,16$ s ($p < 0,05$), i.e. 23,9%; static endurance performance (retention time 50 % weight of the maximum) – $20,72 \pm 0,73$ s ($p < 0,05$), that is 33,4% (Table 1).

Positively influenced of experiment program and on professionally important for railroad specialists attention functions. Thus, the indicators of volume, distribution and switching of attention (Gorbov's method) in the students of the experimental group improved $115,08 \pm 4,57$ c.u. ($p < 0,05$), equal to 57,1%; results of attention selectivity (Munsterberg's method) increased by $10,32 \pm 0,38$ c.u. ($p < 0,05$), which was 70,9%; indicators of the stability of attention (the technique of "confused lines") improved by $10,64 \pm 0,16$ c.u. ($p < 0,05$), which corresponded to 79%. Analysis of voluntary attention (the technique of "Arranging numbers") showed that they increased by $4,52 \pm 0,28$ c.u., that is, by 22,2%, and attention-level indicators (Bourdon's technique) improved by $220,57 \pm 31,57$ c.u. ($p < 0,05$), i.e. 137,8% (Table 2).

After applying the experimental program, the students of the experimental group decreased the time of a simple reaction to light by 49,4 ms ($p < 0,05$) (15,6%) and the time of a simple reaction to sound at 38,32 ms ($p < 0,05$) (9,5%); time of a complex reaction to the presence of a sign decreased by $220,44 \pm 0,25$ ms ($p < 0,05$), which was 22,2%, and the time of a complex reaction for the absence of a sign was $168,48 \pm 2,56$ ms ($p < 0,05$), i.e. 17%. The parameters of the muscular sensitivity of the leading brush without visual control in the students of the experimental group improved after two years of training on $4,80 \pm 0,17$ kg ($p < 0,05$). Positive changes were observed in the parameters of the muscular sensitivity of the leading brush with visual control. After two years of classes, they decreased by $5,56 \pm 0,21$ kg ($p < 0,05$) (Table 3).

Table 1
Dynamics of indices of professionally applied physical readiness of the students of the experimental group, n=25

Normative indicators	Research stage	$\bar{X} \pm m$	Probability evaluation	
			t	p
Brush dynamometry, kg	before	$40,12 \pm 0,65$	13,50	<0,05
	after	$50,88 \pm 0,46$		
Dead lift dynamometry, kg	before	$92,4 \pm 3,37$	7,26	<0,05
	after	$123,6 \pm 2,67$		
Ten eights (test Kopilova), s	before	$10,59 \pm 0,19$	13,31	<0,05
	after	$8,06 \pm 0,03$		
Retention time 50 % weight of the max, on the dead lift dynamometry, s	before	$62,92 \pm 2,47$	6,87	<0,05
	after	$83,64 \pm 1,74$		

Table 2
Dynamics of indicators of professionally important attention functions of students of the experimental group

Normative indicators	Research stage	$\bar{X} \pm m$	Probability evaluation	
			t	p
Volume, distribution and switching of attention, c.u. Gorbov's table	before	$358,64 \pm 6,11$	32,52	<0,05
	after	$153,72 \pm 1,54$		
Attention selectivity, c.u. Munsterberg's test	before	$14,56 \pm 0,45$	22,81	<0,05
	after	$24,88 \pm 0,07$		
Stability of attention, c.u. technique of "Confused lines"	before	$13,48 \pm 0,43$	20,81	<0,05
	after	$24,12 \pm 0,27$		
Voluntary attention, c.u. technique of "Arranging numbers"	before	$20,36 \pm 0,35$	12,84	<0,05
	after	$24,88 \pm 0,07$		
Attention, c.u. Bourdon's technique	before	$160,11 \pm 6,56$	5,70	<0,05
	after	$380,68 \pm 38,13$		

Table 3

Dynamics of indices of the professionally applied preparedness of the students of the experimental group

Normative indicators	Research stage	$\bar{X} \pm m$	Probability evaluation	
			t	p
Time of a simple reaction, ms	before	316,16 \pm 3,24	13,18	<0,05
	after	266,76 \pm 1,88		
Time of a simple reaction to sound, ms	before	405,04 \pm 6,37	5,41	<0,05
	after	366,72 \pm 3,11		
Time of a complex reaction to the presence of a sign (mean response time for the presence of a sign), ms	before	994,72 \pm 10,17	15,52	<0,05
	after	774,28 \pm 9,92		
Time of a complex reaction for the absence of a sign (mean response time for the absence of a sign), ms	before	991,16 \pm 9,14	14,96	<0,05
	after	822,68 \pm 6,58		
Muscular sensitivity of the leading brush without visual control, kg	before	32,64 \pm 0,78	3,91	<0,05
	after	27,84 \pm 0,95		
Muscular sensitivity of the leading brush with visual control, mg	before	30,52 \pm 0,80	5,57	<0,05
	after	24,96 \pm 0,59		

Testing of the properties of the nervous system at the end of the experiment showed a significant increase in the functional stability of the nervous system, which was reflected in the improvement of the parameters of the tapping test ($p < 0,05$). After two years of application of the experimental improvement program, $1,2 \pm 0,03$ Hz, i.e. 20,7% (Fig. 1).

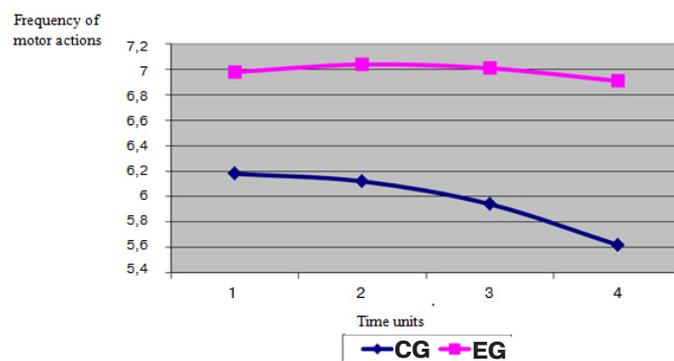


Fig. 1. Dynamics of indicators of the tapping test of the experimental group students after the experiment

Dynamics of indicators tapping test indicates the stabilization of movements per unit time students in the experimental group, both after the first and after the second year of implementation of the pilot program.

Analyzing the state of mental working capacity for simple but monotonous work (E. Krepelin's technique), it is necessary to note the positive dynamics that took place during two years of studies among students of the experimental group. The study of quantitative indicators revealed that the final values for two years amounted to 3,5%, which was $4,6 \pm 0,2$ correct answers. In addition, the students of the experimental group significantly reduced the number of errors in the test, the time spent on the test was improved, and the efficiency factor. So, after two years of lessons on the experimental program, the

number of errors decreased by $4,6 \pm 0,2$ errors, was 92%, the time spent on the test was reduced by $66,0 \pm 6,02$ s, that is, by 25,9 %, and the coefficient of efficiency increased by $0,04 \pm 0,005$ c.u., which equals 4,2%.

Thus, the analysis of the results of the pedagogical study of physical, vocational and psycho-physiological preparedness revealed a positive dynamics of practically all indicators in the students of the experimental group, which is a confirmation of the positive impact of specially selected exercises of the experimental program on physical education with the strengthened course of PAPT on the level of professionally necessary psychophysical and psycho-physiological qualities and abilities of students, future electrical engineers of railway transport.

Conclusions

1. Analysis and generalization of the literature sources revealed the absence of a scientifically grounded program of PAPT for students of higher education institutions of the railway profile.
2. Analysis of the results of the study indicates an increase in the level of physical, professionally applied physical and psycho-physiological readiness of students, is the result of the introduction of an experimental program for physical education with a strengthened course of PAPT.

Prospects for further research. In subsequent studies, it is planned to make a comparative analysis of the dynamics of the group's indices, which was dealt with according to the author's program with an intensified course of professionally-applied physical training with the indicators of a group of students who were involved in the curriculum for physical education for higher educational institutions of Ukraine III-IV levels of accreditation.

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References

1. Vaseltsova, I.A. (2004), *Sistema professionalno-prikladnoy fizicheskoy podgotovki studentov zheleznodorozhnogo VUZa: avtoref. dis. na*

- soiskanie uch. stepeni kand. ped. nauk: spets. 13.00.08. «Teor. i metod. prof. obrazovaniya»*, [System of professionally-applied physical training of students of the railway university: PhD thesis abstract], Samarskiy gosudarstvennyy tekhnicheskii universitet, Samara, 19 p. (in Russ.)
2. Davidenko, A.I. (2006), *Organizatsiya i sodержanie professionalno-prikladnoy fizicheskoy podgotovki studentov tekhnicheskikh VUZov: avtoref. dis. na soiskanie uch. stepeni kand. ped. nauk: spets. 13.00.04. «Teor. i metod. fiz. vosp., sport. trenirovki, ozdorov. i adapt. fiz. kul'tury»* [Organization and maintenance of the professionally-applied physical training of students of technical universities: PhD thesis abstract], Moscow, 21 p. (in Russ.)
3. Yezhkov, V.S. (2003), *Professionalno-prikladnaya fizicheskaya podgotovka studentov mashinostroitelnykh spetsialnostey: avtoref. dis. na soiskanie uch. stepeni kand. ped. nauk: spets. 13.00.04. «Teor. i metod. fiz. vosp., sport. trenirovki, ozdorov. i adapt. fiz. kul'tury»* [Professionally-applied physical training of students of machine-building specialties: PhD thesis abstract], Kolomna, 26 p. (in Russ.)
4. Yefremova, A.Ia. (2012), "Determination of the level of physical preparedness of future specialists of electricians of railway transport", *Slobozans'kij naukovо-sportivnij visnik*, No. 2(29), pp. 15-18. (in Ukr.)
5. Yefremova, A.Ia., Shesterova, L.Ie. (2013), "Investigation of the specifics of the professional activity of electrical engineers of railway transport", *Slobozans'kij naukovо-sportivnij visnik*, No. 4(37), pp. 25-29. (in Ukr.)
6. Raevskiy, R.T. Khalaydzhi, S.V., Kanishevskiy, S.M. (2007), "Professional-applied physical training as an alternative to the basic physical education of future specialists in the energy complex", *Novi tekhnologii navchannia: Nauk.-metod. zb.*, Vol. 49, pp. 16-20. (in Russ.)
7. Sadovskiy, V.A. (2004), *Differentsirovannaya metodika obucheniya professionalno-prikladnoy fizicheskoy kul'ture studentov zheleznodorozhnogo transporta: Uchebnoe posobie* [Differentiated Methodology for Teaching Professional-Applied Physical Culture of Railway Transport Students: Textbook], Izd-vo DVGUPS, Khabarovsk. (in Russ.)
8. Rymyk, R.V. (2006), *Profesiino-prykladna fizychna pidhotovka uchniv profesiino-tekhnichnykh uchylshch za profilem radiotekhnika: avtoref. dys. na zdobuttia nauk. stupenia kand. nauk z fiz. vykhovannia i sportu: spets. 24.00.02 «Fizychna kul'tura, fizychnе vykhovannia riznykh hrup naselennia»* [Professional-Applied Physical Training of Students of Vocational Schools under the Profile of Radio Engineering: PhD thesis abstract], LSIPC, Lviv, 23 p. (in Ukr.)
9. Khalaidzhi, S.V. (2006), *Profesiino-prykladna fizychna pidhotovka studentiv enerhetychnykh spetsialnostei: avtoref. dys. na zdobuttia nauk. stupenia kand. nauk z fiz. vykhovannia i sportu: spets. 24.00.02 «Fizychna kul'tura, fizychnе vykhovannia riznykh hrup naselennia»* [Professional-Applied Physical Training of Students in Energy Specialties: PhD thesis abstract], LSIPC, Lviv, 15 p. (in Ukr.)

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