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Original Article

Extracurricular swimming as a targeted process for developing key physical qualities in students for professional success

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Abstract:
The development of physical qualities relevant to professional activities is a key aspect of student physical education. **Purpose:** The purpose of this study is to design and evaluate an experimental swimming training program for University of Siberia students performed as part of extracurricular activities with a focus on improving both basic and specialized physical qualities. **Materials and methods:** The study involved 60 male students in their 1st–3rd years, enrolled in the Prospecting and Exploration of Mineral Deposits program. Participants were divided into two groups: a control group (CG, n = 30) and an implementation group (IG, n = 30). All students followed the standard curriculum for the Physical Education course. In both groups, standard methods and approaches to physical education were applied. Additionally, students in the IG participated in extra training sessions beyond regular school hours, following the specially designed experimental "Swimming" program. Training sessions for both groups were performed twice a week as part of the mandatory academic curriculum, while the IG had an additional session once a week as part of extracurricular activities. Students' general, specialized, and swimming-specific physical fitness were assessed twice in both groups. **Results:** Analysis of the findings revealed significantly higher performance indicators, as well as improved physical and swimming fitness, among students in the IG compared to those in the CG. **Conclusions:** The test results of the proposed program confirm its effectiveness in developing swimming competence, which is essential for developing professionally relevant motor skills in students—future specialists in the mining industry. The developed program for enhancing these critical motor skills can also be implemented in other educational institutions.
Key Words: Swimming Competence, Physical Fitness, Physical Qualities, Extracurricular Activities

Introduction

Numerous researchers highlight the importance of physical education in higher education institutions and its role in promoting health and development among future professionals (Wu et al., 2024; Marsigliante et al., 2024; Vorozheikin et al., 2020). Aquatic-based physical activity is recognized as a key component of physical education (Görner et al., 2020; Ganchar et al., 2022; Freitas et al., 2025), offering an effective and economical approach to preventing hypokinesia, enhancing physical health, and improving the body's adaptive capacities across diverse population groups (Sigmundsson, 2021; Marzouki et al., 2022; Boraczyński et al., 2025). In this context, swimming instruction is integrated into recreational sports programs on college campuses in the United States (Anderson & Ramos, 2018). Health-improving swimming techniques are widely used and have proven effective in correcting scoliosis in children (Baccouch et al., 2024; Metalnikov et al., 2024). The benefits of swimming for the cardiovascular and respiratory systems are well-documented. As a form of cyclic physical activity, swimming enhances cardiorespiratory endurance, increases left ventricular systolic output, and improves hemodynamic parameters (Bocharin et al., 2023) as well as respiratory function (Tan et al., 2023). These physiological adaptations begin to appear as early as childhood (Ferreira et al., 2024).

The study by D. Badau and A. Badau (2024) demonstrates that physical exercises in an aquatic environment significantly enhance motor skills, improve psychological function, and promote swift recovery and

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rehabilitation after illness. Notably, sea swimming is particularly effective in improving young people's mental health (Taylor et al., 2025).

Educational institutions continue to report the limited effectiveness of traditional physical education classes (Osipov et al., 2016: Kolpakova, 2018). Consequently, specialists and researchers are developing innovative methods to enhance their impact (Bliznevsky et al., 2016; Stojanović et al., 2023; Zhou et al., 2025). The integration of fitness technologies into students' physical education programs has been well-documented, demonstrating significant effectiveness in improving both physical and functional fitness in young men and women (Rebryna et al., 2024; Romanova et al., 2023).

A high level of swimming competence is essential for military personnel and professionals in various fields (Needham-Beck et al., 2024). In this context, swimming is a crucial component of professional physical training, without which certain service activities become challenging. One such sector is the mining industry, particularly mineral exploration, where miners and geologists frequently work in harsh natural and climatic conditions, often involving aquatic environments. Therefore, strong swimming skills are a vital professional asset for these specialists. It is widely recognized that the workplace of a mining industry specialist can serve as a platform for promoting health and physical activity (Bezzina et al., 2024). In university education, greater emphasis should be placed on professional and applied physical training. For mining faculty students, swimming is one such essential component. However, the use of swimming technologies for future mining industry specialists remains insufficiently explored in the scientific literature. We believe that enhancing the professional and applied physical training of mining students through swimming will contribute to their overall physical fitness and well-being, which will contribute to the performance of professional actions at a higher level.

The aim of this study is to develop and test an experimental swimming physical training program for mining faculty students, implemented as part of extracurricular activities to enhance both basic and specialized physical qualities.

Materials and methods

The study was performed at a technical university in Russia, involving 60 male students from the University of Siberia. Participants were divided into two groups: a control group (CG, n = 30) and an implementation group (IG, n = 30). Both groups followed the traditional physical training program, while the IG additionally participated in the experimental "Swimming" program as part of their extracurricular activities. Both groups attended classes twice a week for 90 min as part of their mandatory academic curriculum, while the IG had an additional weekly session as an extracurricular activity. At the start of the study, all students provided voluntary written consent to participate, and the experiment was performed in accordance with the 2008 Helsinki Declaration. Researchers from various universities in Russia, Kazakhstan, and Kyrgyzstan participated in the study. Key components of the professionally essential qualities for Mining Faculty students include well-developed fundamental and specialized physical qualities such as high levels of endurance, strength, speed, agility, coordination, and flexibility.

Taking this into account, an experimental program was designed, consisting of 10 h of lectures and 40 h of practical sessions. The program aimed to develop professional competencies, particularly the ability to maintain an adequate level of physical fitness (Table 1).

Table 1. Educational thematic plan for the experimental "Swimming" program

No.	Item section	Lectures	Practical classes	Independent work	Total hours
1.	Historical overview and current state of swimming. Scientific and theoretical foundations of swimming. Types of swimming	2		16	18
2.	Water exercises: – mastering lower limb movements during swimming; – teaching proper breathing techniques while swimming; – mastering coordination of arms, legs, and breathing	2	10	16	28
3.	Methods for teaching sports swimming techniques	2	10	16	28
4.	Methods for teaching applied swimming	2	10	16	28
5.	Organization of work and holding of swimming competitions	2	10	16	28
	Total	10	40	80	130

We identified organizational, pedagogical, and methodological conditions for implementing the experimental program, incorporating a range of diagnostic tools to assess students' physical and swimming fitness, as well as their overall performance. The developed swimming program aims to improve professional–specific physical qualities and psychophysical resilience. It uses a diverse set of exercises both on land and in water to achieve these objectives. The selection of swimming training equipment was based on the principle that developing special physical qualities was most effective when combining exercises on land and in water. The

program incorporates specialized equipment, including a swimming board, fins, paddles, resistance bands, breathing tubes, a ball, a ring, a floating anchor, and various other training devices.

To assess overall physical fitness, the following tests were performed: 100 m sprint (s), 1000 m run (m/s), 3000 m run (m/s), pull-ups on a high bar (repetitions), and forward bend while standing on a gymnastic bench (cm). Special physical fitness was evaluated using the following tests: Romberg test (static balance) (s), standing long jump (cm), push-ups in a prone position (repetitions), body hold while hanging on a horizontal bar (s), and a 10 × 10 m shuttle run (s).

General swimming fitness was assessed through a 100 m freestyle swim (m/s) and the 12 min swimming distance test (K. Cooper test, 12 m swimming) (m).

Special swimming fitness was measured using a 50 m swim (m/s) and a buoyancy test (gliding distance) (m). The digital data were analyzed using statistical methods, including the calculation of the arithmetic mean, its error, and sigma. The reliability of differences was assessed using Student's t-test. A difference in indicator values was considered statistically significant if $p < 0.05$.

Results

Table 2 presents the initial and final results of the general physical fitness indicators for students in both experimental groups.

Table 2. Final testing results of the general physical fitness level of students in both experimental groups, M ± m

No	Test	CG, n = 30		IG, n = 30	
		At the beginning	After the intervention	At the beginning	After the intervention
1.	100 m run, s	17.0 ±1.53	15.3 ± 1.06	16.7±0.86	14.2 ± 0.93*
2.	1000 m run, m/s	7:54 ±2.85	4:24 ±2.42	7:45 ±2.70	3:38 ± 2.16
3.	3000 m run, m/s	17:65 ±2.95	14:12 ± 2.26	17:83±2.17	12:42 ± 2.32*
4.	Pull-ups on the horizontal bar, repetitions	19.0 ± 0.54	23.0 ± 0.76*	18.5±0.44	25.0 ± 0.78*
5.	Forward bend while standing on a gymnastics bench, cm	10.6 ± 2.18	12.2 ± 2.18	9.9±1.85	14.4 ± 2.24*

*Note: * The difference in differences is significant at the end of the study compared to the beginning, $p < 0.05$.*

At the beginning of the study, the general physical fitness indicators for young men in both experimental groups did not differ significantly, $p > 0.05$, allowing the experiment to proceed.

At the end of the study, changes were observed in the general physical fitness indicators of students in both experimental groups. At this stage, significant differences were noted between the CG and the IG in terms of their general physical fitness indicators. In the CG, a significant improvement was observed in one motor test (No. 4), whereas in the IG, the values for four out of five control exercises showed a significant increase ($p < 0.05$). The dynamics of the improvement in general physical fitness indicators at the end of the study are shown in Figure 1.

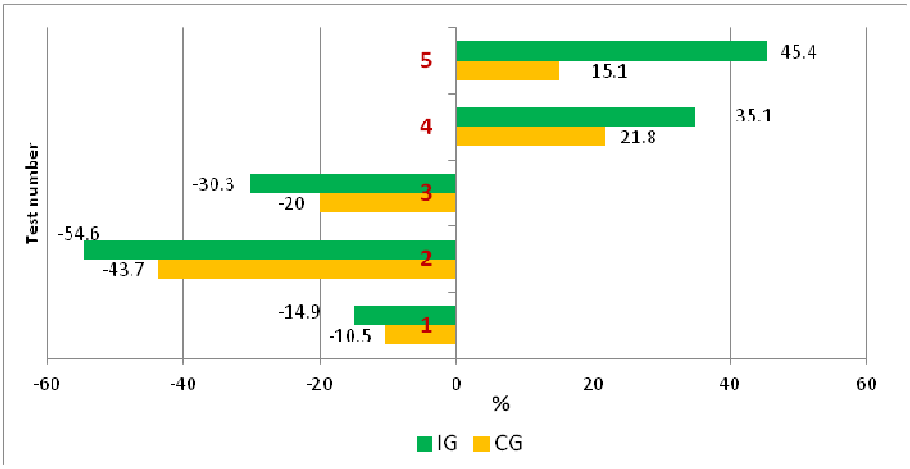

Fig. 1. Dynamics of the increase in indicators of general physical fitness in students at the end of the experiment

The increase in performance across all motor tests was greater in the young men of the IG compared to those in the CG (Figure 1). This suggests that the experimental extracurricular swimming training methodology had a more positive impact on overall physical fitness than the traditional student physical education program. Additionally, the implementation of the experimental methodology in IG students led to a significant improvement in special physical fitness indicators (Table 3).

Table 3. Results of the final testing of the level of special physical fitness of students in both experimental groups, M ± m

No	Test	CG, n = 30		IG, n = 30	
		At the beginning	After the intervention	At the beginning	After the intervention
1.	Romberg test, s	30.5 ± 2.12	37.2 ± 2.24*	32.4 ± 2.14	48.6 ± 3.16*
2.	Standing long jump, cm	227.5 ±5.18	247.3 ± 6.35*	228.2 ±5.22	258.4 ±8.97*
3.	Push-ups, repetitions	52.0 ± 1.26	54.0 ± 1.23	56.0 ±1.76	68.0 ±3.14*
4.	Hanging body hold on the horizontal bar, s	41.8 ± 1.94	44.6 ± 2.14	44.6 ± 2.42	59.2 ± 2.85*
5.	Shuttle run 10 × 10 m, s	24.4 ± 2.08	22.8 ± 2.22	24.2 ± 2.36	19.2 ± 2.14*

*Note: * The difference in differences is statistically significant at the end of the study compared to the beginning, $p < 0.05$.*

At the beginning of the study, both experimental groups had a comparable level of special physical fitness ($p > 0.05$). However, by the end of the observation period, the most significant improvements were observed in the IG. Students in this group demonstrated a significant increase in all motor test indicators compared to their baseline values ($p < 0.05$). In contrast, students in the CG showed a significant improvement in only two tests (Nos. 1 and 2). The progression of special physical fitness indicators at the end of the study is shown in Figure 2.

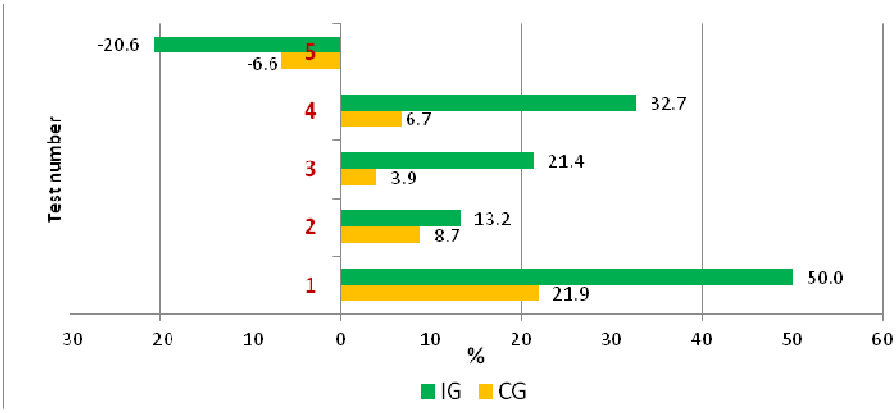

Fig. 2. Dynamics of the increase in indicators of special physical fitness in students at the end of the experiment

At the end of the experiment, the increase in special physical fitness indicators among IG students was greater than in the CG, highlighting the positive impact of the proposed methodology on the development of professionally significant motor qualities. Of both scientific and practical interest is the study of the experimental methodology's effect on the development and improvement of students' swimming competence (Table 4).

Table 4. Results of the final testing of swimming fitness in students from both experimental groups, M ± m

No.	Test	CG, n = 30		IG, n = 30	
		At the beginning	After the intervention	At the beginning	After the intervention
General swimming physical fitness					
1.	Freestyle swimming 100 m, m/s	2:45±0.34	2:13 ± 0.19	2:43±0.32	1:49 ± 0.06*
2.	Distance of 12-min swimming (Cooper test, 12 m swimming), m	478.3 ±31.87	516.4 ± 42.36	483.2±31.6	672.3 ± 64.28*
Special swimming physical fitness					
3.	Swimming 50 m, m/s		0:45.12 ± 0.06	0:46.5±0.08	0:42.01 ±0.03*
4.	Buoyancy test (gliding), m	12.5 ±0.56	13.2 ± 0.64	12.8 ±0.65	15.6 ± 0.87*

*Note: * The difference in differences is statistically significant at the end of the study compared to the beginning, $p < 0.05$.*

At the beginning of the experiment, the indicators of general and special swimming physical fitness were nearly identical for young men in both experimental groups ($p > 0.05$). By the end of the study, improvements in these indicators were observed in both groups. However, a significant increase in the values of all swimming test indicators was found only in the IG ($p < 0.05$). The dynamics of the improvement in general and special swimming physical fitness indicators at the end of the study are shown in Figure 3.

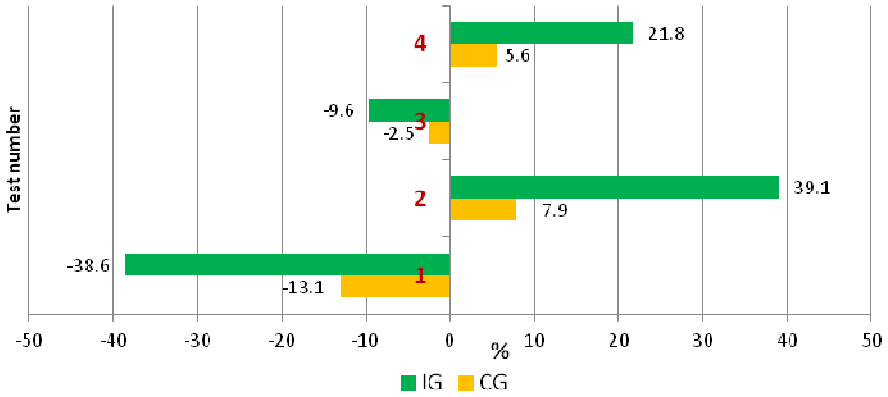

Fig. 3. Dynamics of the increase in indicators in students' swimming fitness tests at the end of the experiment

The increase in indicators across all swimming fitness tests was significantly greater for IG students compared to the results of young men in the CG. Overall, the improvement in general, special, and swimming physical fitness was more pronounced for IG students than for those in the CG. This demonstrates the higher effectiveness of the proposed experimental program in enhancing professionally significant physical qualities compared to the traditional physical training program for students.

Discussion

Physical education of students in higher education institutions is aimed not only at improving the health of young people (Wu et al., 2024; Marsigliante et al., 2024), but also at improving their physical qualities that are necessary in future professional activities (Anderson, & Ramos, 2018).

Experts in the field of physical education have found that the necessary components of professionally important motor qualities in students of the mining faculty are well-developed physical qualities and skills, which include a high level of development of general endurance, strength and speed, agility, coordination and flexibility (Bezzina et al., 2024). Developed professionally important motor qualities can significantly improve not only the level of health of a young person, labor productivity, but also prevent the occurrence of industrial injuries. Many researchers have proven the positive role of swimming in preventing the negative impact of low physical activity on human health and strengthening the adaptive properties of the body (Marzouki et al., 2022; Boraczyński et al., 2025). The use of swimming to improve professional motor skills in students, future specialists in the mining industry, is of scientific and practical interest. For this purpose, we developed and tested the extracurricular program "Swimming" for students of the mining faculty.

The experimental study revealed some features of the formation of the level of professional motor skills in students of the implementation group compared to the result obtained in the control group, where the traditional curriculum was used. During the boundary testing of general and special physical fitness of students, a significantly higher positive result was established in the control exercises in the implementation group compared to the control group. Our data on the control testing of general and special physical fitness are consistent with the results of observations by other authors who used swimming as a means of physical education of students (Bocharin et al., 2023; Tan et al., 2023; Badau, & Badau, 2024). We agree with the opinion of these authors that swimming refers to physical activity of a cyclic nature, which increases cardiorespiratory endurance, systolic blood ejection, improves hemodynamic parameters and the respiratory system of the body. This leads to the formation of endurance, which is an important motor quality in many professions. We found that the values of the increase in general and special physical fitness indicators in IG students at the end of the experiment were greater than the result in the control group, which indicates a positive result of using the proposed methodology for improving professionally significant motor qualities.

According to our data, it was established that the results of testing swimming physical fitness were significantly higher in the motor tests of students in the implementation group compared to the values of the indicators in young men in the control group. In the implementation group, there was a significantly higher

increase in the value of the indicator in 100 m freestyle swimming and an increase in physical performance. This is evidenced by the result of the increase in the value of the indicator in the K. Cooper test (swimming for 12 minutes), which was significantly higher than the result of this test in young men in the control group.

The use of the experimental program "Swimming" in the physical fitness of students of the Mining Faculty showed a significant positive result. Approximately the same positive effect was obtained by other authors when using swimming in the physical education of students (Bocharin et al., 2024). According to the authors, an important positive result of using swimming in the educational process of physical education was an increase in the interest and motivation of students for regular independent physical activity and adherence to the basics of a healthy lifestyle. In our opinion, the proposed program using swimming as a targeted process of developing professionally significant motor skills in students of the Mining Faculty can be used in other educational institutions

Conclusions

The analysis of the experimental study results demonstrated the higher effectiveness of the proposed pilot program in developing swimming competence and the organizational and pedagogical conditions for its implementation among Mining Faculty students compared to the traditional program. This is supported by significant differences in the performance, physical, and swimming fitness levels of students—future specialists in the mining industry—when compared to the CG. A significant increase in all performance indicators, physical fitness, and swimming fitness was observed in the young men in the IG. Therefore, we believe that the section on professional and applied physical training in the physical education program for students—future specialists in the mining industry—should be revised.

Conflicts of interest. The authors declare no conflict of interest.

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