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**CHANGE OF MENTAL AND PHYSICAL EFFICIENCY OF STUDENTS IN THE  
EXPERIMENTAL PROGRAM IN PHYSICAL EDUCATION USING THE  
TECHNOLOGY OF MUTUAL INSTRUCTION**

ZMIANY W SPRAWNOŚCI PSYCHICZNEJ I FIZYCZNEJ UCZNIÓW,  
W EKSPERYMENTALNYM PROGRAMIE WYCHOWANIA FIZYCZNEGO Z  
WYKORZYSTANIEM TECHNIKI WZAJEMNEGO INSTRUKTAŻU

**Abstract**

The paper experimentally proves the effectiveness of physical education program using technology of mutual instruction on indicators of mental and physical performance of students. Stages and main principles of the program have been highlighted. The results of formative experiment have been presented as well. During the pedagogical experiment, a significant increase has been noticed in physical and mental performance of students in the experimental group and there was a growth of percentage of students with above average and high efficiency level.

**Keywords**

Mental efficiency, physical efficiency, physical education, mutual instruction, students.

**Streszczenie**

Artykuł doświadczalnie dowodzi skuteczności programu, w zakresie edukacji fizycznej przy użyciu techniki wzajemnego instruktazu, na wskaźniki sprawności psychicznej i fizycznej uczniów. Wyróżnione zostały etapy i główne zasady programu. Zaprezentowano także wyniki eksperymentu kształtującego. Podczas eksperymentu pedagogicznego, został zauważony znaczący wzrost w fizycznych i psychicznych wynikach uczniów w grupie eksperymentalnej. Stwierdzono też wzrost odsetka uczniów z wynikami powyżej średniej i wysokim poziomem sprawności.

**Słowa kluczowe**

Sprawność umysłowa, sprawność fizyczna, wychowanie fizyczne, wzajemny instruktaz, uczniowie.

## **Problem setting. Analysis of research literature**

A human being in a present-day world feels a strong negative impact of social, natural, daily, and many other factors that need to take special measures for the protection and enhancement of physical and mental health [1, 5]. One of the most important indicators of professional training and functional state is physical and mental efficiency. Under the circumstance of significant letdown of the physical health of modern students in the last decades, the issue of the formation of optimal mental and physical efficiency during studying in universities become especially important.

It has been found out that [5] the level of psychomotor development of the human body is in direct correlation with the level of development of basic motor properties. At the same time, the problem of finding ways to improve mental and physical efficiency of students by means of motor activity is not sufficiently studied. Literature data are scattered, research materials are fragmentary. These factors made it necessary to hold research in this direction.

**The research aim** – to test the effectiveness of program of physical education using technology of mutual instruction of students on their mental and physical efficiency.

### **The research methods:**

- Theoretical – analysis of psychological and pedagogical literature;
- Empirical – stephometry (determination of physical efficiency of students viewing Harvard step test), methods of diagnostics (efficacy of processing of tables by Schulte-Platonov), pedagogical observation of the process of physical education of students, pedagogical experiment;
- Statistical – arithmetic average, standard deviation, Student's t-criterion.

### **Organization of research**

We carried out pedagogical experiment at the Lviv National University by the name of I. Franko. The study lasted from September 2011 to June 2012. The study involved 127 people, respectively divided into two experimental (EG) (boys, n = 31 girls, n = 33) and 2 control groups (CG) (boys, n = 32 girls, n = 31). At the beginning of the experiment groups were equal viewing all indicators. Students of the control group were involved in physical education according to traditional program in physical education, and in experimental group – according to the program we developed using the technology of mutual instruction of students.

The point of the experimental program using technology of mutual instruction was to create a climate of cooperation and interaction between students in the subgroups. Subject-to-subject interaction of students was made up in accordance with the objectives of physical education classes. The process of applying technology of mutual instruction of students in physical education was divided into the following stages:

- **introductory** – acquaintance with a new form of educational process; announcement of targets, selection of educational material, a clear division of work, roles, responsibilities;

- **preparatory** – diagnostics of psychophysical state level, creating a comfortable interpersonal relationships between participants, forming abilities of dialogue

communication, help each other to solve problems, find the necessary information. These skills were perfected in the process of both practical and methodical physical education classes;

- **main** – formation of ability to learn, being both a student and a teacher, creating responsibility for their actions and deeds; assimilation of information on the proposed topics, the use of active, game and competitive methods of solving problems, creative choice of processing character of materials, constant self-control and mutual control;
- **evaluation and adjustment** – the record of learning outcomes, analysis of the results and identifying of drawbacks, making adjustments and recommendations.

## Results of research

At the beginning of the experiment between indicators of mental efficiency in CG and EG, both in the girls and boys have not been found probable differences. After the experiment positive changes have been revealed in students in EG ( $p < 0.05$ ). In particular, we have found that the effectiveness of work (average number of processing 5 tables) in surveyed students at the beginning of the experiment in EG was at a satisfactory level as the average time of processing of each table was within  $51,85 \pm 18,95$  sec (Table 1).

Table 1. Changes of mental efficiency indices of boys according to Schulte-Platonov tables

Indices		EG		p	CG		p	P C and E At the end
		At the beginning	At the end		At the beginning	At the end		
Time filling tables Schulte (sec)	1 <sup>st</sup>	55,23 ±28,89	38,94 ±11,49	< 0,05	52,66 ±21,64	51,47 ±30,56	> 0,05	< 0,05
	2 <sup>nd</sup>	46,06 ±15,71	41,26 ±8,08	> 0,05	46,81 ±15,06	45,47 ±15,72	< 0,05	> 0,05
	3 <sup>rd</sup>	48,52 ±26,31	42,97 ±12,84	> 0,05	52,26 ±25,83	49,72 ±26,97	< 0,01	> 0,05
	4 <sup>th</sup>	55,81 ±20,00	40,88 ±7,61	< 0,001	53,63 ±20,77	52,69 ±20,73	> 0,05	< 0,01
	5 <sup>th</sup>	53,65 ±20,46	44,06 ±13,10	< 0,05	52,41 ±19,47	49,50 ±20,60	< 0,01	> 0,05
Effectiveness of tables processing		51,85 ±18,95	41,89 ±8,40	< 0,05	51,61 ±17,61	49,77 ±19,22	< 0,05	< 0,05
Speed of working-over		1,05 ±0,25	0,93 ±0,18	≤ 0,01	1,02 ±0,25	1,01 ±0,29	> 0,05	> 0,05
Psychic stability		1,09 ±0,20	0,99 ±0,13	< 0,05	1,04 ±0,17	1,07±0,17	> 0,05	< 0,05

Upon completion of the program of physical education classes in subgroups using mutual instruction a positive growth of indices has been seen ( $p < 0.05$ ), as the average result of processing of 5 tables was  $41,89 \pm 8,40$  sec, which corresponds to a sufficient level. At the end of the experiment the boys in CG also showed an increase of effectiveness in processing of tables ( $p < 0,05$ ). However, between EG and CG groups after the completion of the pedagogical experiment were reported reliable differences; boys in EG by 7.88 sec faster processed tables than boys in CG ( $p < 0,05$ ). The girls in EG influenced by technology of mutual instruction also showed an improvement of the distribution of space and the amount of attention (9.26 sec at  $p < 0.001$ ) in CG - significant increases were not observed ( $p > 0.05$ ). Thus, at the end of the experiment the difference between the rates of girls in CG and EG was 8.51 sec ( $p < 0.001$ ). The reliability of differences in terms of the distribution of space and attention emphasizes higher efficiency of the author's program, compared with the traditional one.

Degree of working-over (ratio of processing time of the 1<sup>st</sup> table to the average processing time of all tables) at the beginning of the experiment in girls and boys in EG and CG was low ( $> 1.0$ ). In boys in EG results during the experiment increased by 0.12 sec ( $p \leq 0,01$ ), in CG – no increase was identified. The girls in EG set a reliable improvement in degree of working-over as growth rate was 0.1 sec ( $p < 0.01$ ). The girls in CG remained with stable results ( $p > 0.05$ ) (Table 2). Growth of results of working in boys and girls in the experiment confirms higher efficiency of technology of mutual instruction.

Table 2. Changes of mental efficiency indices of girls according to Schulte-Platonov tables

Indices		EG		P	CG		P	P <sub>EG - CG end</sub>
		At the beginning	At the end		At the beginning	At the end		
Time filling tables Schulte (sec)	1 <sup>st</sup>	54,70 $\pm 14,70$	<b>40,30</b> $\pm 8,46$	$< 0,001$	54,45 $\pm 15,13$	<b>55,81</b> $\pm 20,27$	$> 0,05$	$< 0,01$
	2 <sup>nd</sup>	47,30 $\pm 9,29$	<b>42,12</b> $\pm 8,33$	$< 0,01$	48,98 $\pm 14,25$	<b>46,48</b> $\pm 14,48$	$> 0,05$	$> 0,05$
	3 <sup>rd</sup>	48,82 $\pm 11,93$	<b>42,24</b> $\pm 8,70$	$< 0,001$	47,97 $\pm 11,15$	<b>45,39</b> $\pm 11,31$	$> 0,05$	$> 0,05$
	4 <sup>th</sup>	53,48 $\pm 9,72$	<b>40,15</b> $\pm 6,63$	$< 0,001$	52,32 $\pm 15,27$	<b>54,77</b> $\pm 15,55$	$> 0,05$	$< 0,001$
	5 <sup>th</sup>	49,52 $\pm 11,20$	<b>42,70</b> $\pm 10,06$	$< 0,001$	46,81 $\pm 10,66$	<b>47,61</b> $\pm 11,38$	$> 0,05$	$> 0,05$
Effectiveness of processing		50,76 $\pm 8,52$	<b>41,50</b> $\pm 6,55$	$< 0,001$	50,09 $\pm 9,78$	<b>50,01</b> $\pm 11,05$	$> 0,05$	$< 0,001$
Speed of working-over		1,07 $\pm 0,18$	<b>0,97</b> $\pm 0,15$	$< 0,01$	1,09 $\pm 0,25$	<b>1,10</b> $\pm 0,23$	$> 0,05$	$< 0,01$
Psychic stability		1,06 $\pm 0,11$	<b>0,97</b> $\pm 0,10$	$< 0,001$	1,03 $\pm 0,16$	<b>1,09</b> $\pm 0,17$	$> 0,05$	$< 0,01$

Average numbers of psychic stability (the ratio of processing time of the 4<sup>th</sup> table to the processing time of the 5<sup>th</sup> table of Schulte-Platonov) at the beginning of the experiment in the EG of boys indicated a low level of psychic stability of students. After the experiment result in EG increased ( $p < 0.05$ ), and in CG – worsened, but statistically, these changes were not confirmed ( $p > 0,05$ ). The girls in EG during the

experiment showed a statistically significant increase in psychic stability thanks to the use of technology of mutual instruction in subgroups with rational distribution of functions and tasks. So, at the end of the experiment the girls' results in EG improved ( $p < 0,001$ ), and in CG – revealed worse results, but the differences were not statistically confirmed ( $p > 0.05$ ).

Positive growth of indices of mental efficiency allows us to conclude that physical education classes in an atmosphere of cooperation and mutual instruction improves the efficiency of physical education.

At the beginning of the experiment in CG and EG of girls and boys were not observed intergroup differences in physical efficiency indices ( $p > 0.05$ ). After implementation of the program of physical education using technology of mutual instruction in the level of physical efficiency of male and female students were found significant differences (Table 3). In boys in EG the growth of physical efficiency was 3.9 arbitrary units. ( $p < 0,001$ ), while in CG – there was no significant change ( $p > 0.05$ ). At the beginning of the experiment there were only 12.5% of boys with a higher than average level of physical efficiency, and no boys with high level. At the end of the pedagogical experiment was set an increase in the number of students 29.0% with a higher than average level of physical efficiency than 16.5% and 9.7% of boys reported a high level of physical efficiency.

Instead, the boys in CG after the experiment did not show a reliable increase in preparedness level ( $p > 0,05$ ). Differences between the groups after the pedagogical experiment again emphasize higher effectiveness of mutual instruction of youth in the process of physical education.

Analysis of the dynamics of the physical efficiency of girls in EG shows positive growth, which is 3.7 arbitrary units. ( $p < 0,01$ ), whereas in CG – changes after the experiment were not detected ( $p > 0.05$ ). It is worth noting that at the beginning of the experiment 27.0% of the girls in EG had level of physical efficiency below average, the bulk – 69.7% had an average level of physical efficiency and only 3.0% of girls – a higher than average level of overall physical efficiency (Fig. 2).

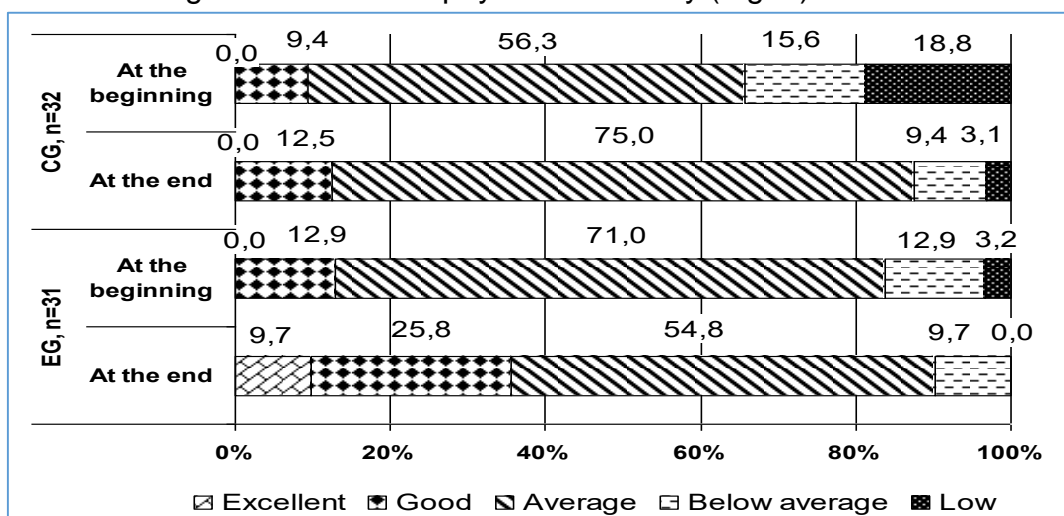


Fig. 1. Evaluation of physical efficiency by Harvard step test in boys

Table 3. Physical efficiency by Harvard step test

Boys				
Indices	CG		EG	
	At the beginning	At the end	At the beginning	At the end
Index	75,03	7,21	9,61	t 1-2 0,09
Sigma	73,03	8,16	11,17	t 2-3 0,86
Coefficient of variation, %	72,72	8,39	11,54	t 1-3 <b>0,05</b>
At the end P <sub>EG and CG</sub> < <b>0,05</b>				
Girls				
Index	64,04	64,89	64,18	69,94
Sigma	6,74	6,30	5,52	6,87
Coefficient of variation, %	10,52	9,71	8,59	9,82
Level of significance	> 0,05		< 0,01	
	At the end P <sub>EG and CG</sub> < <b>0,05</b>			

After the implementation in the process of physical education technology of mutual instruction in subgroups of the percentage of female students with higher than average level rose to 6.1%, and excellent level of physical efficiency was found in 3.0% of girls and the number of female students with below average level decreased by 3 times and respectively constituted 18.2%. As for the physical efficiency of girls in CG at the beginning of the experiment there were most of the students (61.3%) had an average level of physical efficiency, only 6.5% – with good level. After the experiment, changes almost were not observed in girls in CG ( $p > 0,05$ ).

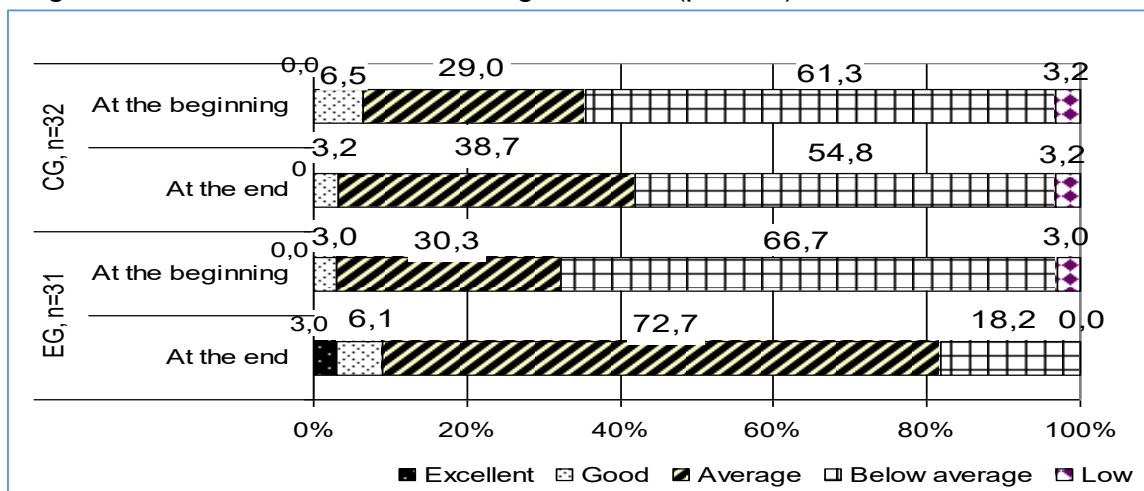


Fig. 2 Evaluation of physical efficiency by Harvard step test in girls

The results of experiment confirm the high effectiveness of the program of physical education using the technology of mutual instruction.

**Conclusions.** The tendency to increase the distribution of space and the amount of attention of girls and boys in EG under the influence of physical education program using the technology of mutual instruction. Growth of index of processing effectiveness of the tables by Schulte-Platonov was 9.26 sec ( $p < 0.001$ ). Boys in EG processed tables by 7.88 sec faster than boys in CG ( $p < 0,05$ ).

Growth of physical efficiency indices of boys in EG was 3.9 arbitrary units. ( $p < 0,001$ ). After the implementation in the process of physical education the technology of mutual instruction in subgroups, a number of students with higher than average level increased by 16.5% in boys and 3.1% in girls. After completion of pedagogical experiment there were 9.7% of boys and 3% of girls with an excellent level of physical efficiency, while at the beginning of the experiment there was not a single student with high level of efficiency. In the course of pedagogical experiment the number of female students with level below the average dropped by 3 times.

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