

The Criteria of Adaptation of Primary School Pupils to the Academic Load of the Increased Intensity

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ABSTRACT

The relevance of the research problem is due to applying various training programs in the modern education system which are supposed to increase teaching efficiency. In-depth study of some subjects at schools, lyceums and gymnasiums which starts in the elementary school quite often leads to tension and failures of adaptation process in innovative institutions that makes it necessary to work out the criteria of this process. This article deals with studying such criteria as dynamics of intellectual working capacity, physical health and physical fitness of the 1-3rd graders influenced by teaching in classes with in-depth study of a foreign language. The methods of the research of this problem are: the method of proof tests, the health index assessment method, testing of physical qualities that make it possible to define the level of intellectual working capacity, physical health and physical fitness of the 1-3rd graders in their dynamics and interrelation with the intensity of the academic load. The criteria of adaptation of primary school pupils to the academic load of the increased intensity have been worked out in the article. It has been proved that the increase in the academic load increases pupils' intellectual working capacity and has no negative effect on physical fitness of the 1-3rd graders, but it increases their disease incidence that indicates a high physiological cost of organism adaptation to a more intensive academic load. The materials of the article can be useful to elementary school teachers and school psychologists in working out and planning training programs involving in-depth study of subjects.

KEYWORDS

Pupils, intensity of training, intellectual working capacity, physical health, physical fitness

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Introduction

Study of the problem of an academic load impact on the working capacity and functional state of pupils of innovative educational institutions has been one of the important topics in scientific research of teachers, psychologists, physiologists and hygienists in recent years. It's connected with applying in education system various training programs which are supposed to increase

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teaching efficiency. In-depth study of subjects at schools, lyceums and gymnasiums quite often leads to pupils' overload that makes it necessary to study interrelation of the intensity of the teaching load and working capacity and standard of health of pupils in innovative educational institutions (Polenova et.al., 2012; Marushchak and Shemanchuk, 2013; Ryabichenko et al., 2014).

According to some data in literature an insufficient regulation of the academic load a child's organism is subjected to, particularly its increase, influences the pupils' standard of health and their physical growth and development negatively, wherein 30-40% of children experience difficulties while studying at school (Dubrovinskaya, Farber and Armless, 2000). This problem is especially urgent in a primary school (Zaytseva, 2004). At the same time primary school age is characterized by the accelerated processes of mental development in the background of morfo-functional changes of an organism that in many respects defines the subsequent child's growth and development (Kirpichev, 2002).

Despite numerous studies of the adaptation process of pupils of various age groups to the academic load (Grigorieva, 2000; Grebneva et al., 2004; Nazipova, 2002), the issue of the effect of the intensity of training on the change of psycho-physiological state of the body of primary school pupils within the first three years of training is studied insufficiently. In studying the influence of the academic load on a child's organism the effectiveness of adaptation can be evaluated judging by physical development, functional condition of cardiovascular and respiratory systems, the standard of health, and also by the change of pupils' intellectual working capacity. As an indicator of a functional state of pupils' organism and its reaction to intellectual, physical, psycho-emotional load the assessment of heart rate variability has been widely used in recent years (Voronina, Small and Spitsin, 2004). There are also some works studying physical fitness of the 1-3rd graders, and hereby the attention is focused on age and sex peculiarities of development of certain physical qualities. But the possibility of using these indicators as a criterion of adaptation of a pupils' organism to the academic load isn't studied.

The analysis of odd bits of information on the studied problem available in literature allowed to formulate a research hypothesis as follows: applying an integrated approach in studying the influence of intensity of training of the 1-3rd graders on their working capacity, physical health and physical fitness will allow to reveal the most significant criteria of adaptation of primary school pupils to the academic load of the increased intensity.

Materials and Methods

Theoretical and Empirical Methods

For checking the hypothesis, the complex of the various methods complementing each other has been used:

- theoretical: the analysis of literature, regulations, instructive-methodological, work documents and the materials on the research problem, the analysis and synthesis;

- empirical: survey, testing intellectual working capacity by proof samples (Guminsky, 1990), testing of physical qualities, assessment of motivation, level of anxiety, school progress.

The Base of Research

Educational institutions of Kirov were chosen as the base of research: schools No. No. 21, 14, 9, and also the lyceum of Natural Sciences.

Experimental Procedure and Its Description

For three academic years we have studied intellectual working capacity of 333 pupils of the 1-3rd grades of schools in Kirov (183 girls and 150 boys). From the total number of surveyed 117 pupils of school No. 21 – 54 pupils (25 boys and 29 girls) of two classes with in-depth study of English (group E) and 63 pupils (33 boys and 30 girls) of two classes with the traditional mode of training (group T) we studied physical development, the standard of health and physical fitness.

The academic load in groups E and T in the 1st grade was 22 h, English lessons in group E were conducted optionally and were included into a general academic load. In the 2nd and 3rd grades the academic load in group E was increased in comparison with group T by 3 h a week at the expense of English and was 27 h (in group T – 24 h).

Intellectual working capacity was studied three times a year – in October, December and April (n=333), within 4 min. the examinees deleted 2 stated letters. At the same time the coefficients of accuracy performance of work and the efficiency of cerebation, volume (in bit) and the speed of processing of visual information (in bit/s) were calculated.

The standard of health was estimated on the basis of the analysis of individual medical records of pupils (form 026/y) by such indicators as existence of chronic diseases, a medical and a sports group, the quantity of students' chronic diseases in a year in the 1, 2 and 3 grades (n=117). Besides the timetable of the 1-3rd grades of groups E and T and its compliance to the dynamics of pupils' working capacity was estimated.

We studied pupils' daily regime, diet, physical activity by questioning in groups E and T in the 3rd grade (n=117). We carried out testing of physical qualities in the 1st and 3rd grades (n=117): force (bending and extension of hands in an emphasis lying: finger-tip push-up, F), general (running 1000 m, R) and strength endurance (deduction of a body in a vis on a crossbeam, V), high-speed and power qualities (a long jump from the place, J; lifting a body from a prone position on a back for 30 s, L), flexibility (inclination from a sitting position, I). On the basis of the obtained data we calculated an overall level of physical condition (in points) according to OLPC formula = $(F+R+V+J+L+I)/6$ (Vavilov, Yarych, and Kakorina, 1997). For the sufficient level of physical fitness we accepted estimates "super", "excellent", "good", "satisfactory".

The results of the research were subjected to statistical processing with the use of Microsoft Excel (in the text they were expressed as $M\pm m$); distinctions were estimated by Student's criterion and considered reliable at $p < 0,05$.

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Results

Dependence of the Intellectual Working Capacity of the 1-3rd Graders on the Intensity of the Academic Load

On the basis of more than 10000 slice assignments carried out by 333 pupils of the 1-3rd grades it has been ascertained that irrespective of the intensity of the academic load annually by the end of an academic year there is a reliable increase of pupils' intellectual working capacity. Particularly, the annual gain of the volume of the processed visual information, according to the results of measuring in April (at the 1st lesson) in the 1st grade was 17,8% of the values received in October, in the 2nd – 25,1%, and in the 3rd – 22,9%. Judging by the ratio of the indicators registered at the 1st and 4th lessons, pupils' intellectual working capacity is the most stable in the 2nd quarter of the 1st and 2nd grades. For example, in the 4th quarter by the end of a school day the volume of the processed visual information (Q) of the pupils decreases in the 1st grade (from 209,5±4,0 bits to 197,1±3,9 * bit), in the 2nd grade (from 283,1±5,1 bits to 265,6±5,5 * bit) and the 3rd grade (from 356,5±8,7 bits to 338,3±7,9 * bit; here and below in the text * points out the existence of reliable distinctions, $p < 0,05$). Big stability of intellectual working capacity in the 2nd quarter can be seen as a manifestation of a stable phase of adaptation to the academic load.

While investigating the dependence of intellectual working capacity of the 1-3rd graders on the intensity of the academic load we compared this indicator among the pupils of two groups – E and T. It was stated before that there were certain distinctions between these groups. In group E, in particular, there were more pupils having high educational motivation in comparison with group T in the 1st (50,0±6,8 * % against 32,0±5,9%) and in the 3rd (48,7±6,8 * % against 24,1±5,4%) grades. A level of anxiety didn't depend on the intensity of training – for example, 32,0±6,4% of the pupils studying in group E and 41,7±6,2 – in group T had high interpersonal anxiety in the 1st class, and 17,4±5,2% of the pupils studying in group E and 27,7±5,6% in group T had a high educational anxiety characteristic of the 3rd class. Pupils' progress in learning in the 1st and 3rd grades didn't depend on intensity of training; in the 2nd grade the pupils' progress in learning was higher in group E – 94,0±3,2%*of the pupils of this group (in comparison with 79,5±5,1% in group T) had an average (3,6-4,5 points) and high (4,6-5,0 points) progress in learning. Groups E and T didn't differ in duration of a night dream – it was in group E in the 1st, 2nd and 3rd grades respectively 10,1±0,2 h, 9,0±0,2 h and 8,8±0,3 h (in comparison with 10,0±0,2 h, 9,3±0,2 h and 9,5±0,2 h in group T). On the other hand, in group E there were more children who were engaged in sports sections – it is characteristic of the 1st (56,8±6,7 * % against 37,0±6,1% in group T) and the 2nd (52,9±6,8 * % against 34,8±6,0%) grades. In the 3rd grade the number of pupils of the groups E and T who were engaged in sports sections didn't differ (57,1±6,4% and 58,7±6,2%). It was confirmed by the level of physical activity of third-graders in both groups (2,75±0,15 h – in group E and 2,85±0,23 h – in group T). It was below the norm equal to 3,5-4,0 h (Sukharev, 1991). The pupils of group E differed from the pupils of group T in higher educational motivation and a wider range of physical activity due to going in for sports in sports sections that probably increases the efficiency of adaptation to the intensive academic load.

The analysis of the results of fulfilling Anfimov's test (tab. 1) has shown that for all three years of training pupils of group E have had higher working capacity judging by the volume (P) and the speed of processing information (SPI). So, P at the end of the 1st grade at the 1st lesson in group E is $204,4 \pm 6,1$ * bit and in group T – $180,6 \pm 7,4$ bit, and at the end of the 3rd grade – respectively $393,7 \pm 14,7$ * bit and $335,0 \pm 10,9$ bit. The pupils of group E didn't differ from the pupils of group T in performance accuracy.

This research has also shown that in the 1st, 2nd (October) and 3 grades the change of pupils' intellectual working capacity during a school day and a school week, as a rule, doesn't depend on the intensity of the academic load, i.e. it decreases in both groups by the end of a school day or a school week. However even against the background of fatigue working capacity remains higher in group E than in group T. So, in the 3rd grade (October) the volume of the processed visual information in group E was $307,6 \pm 9,3$ bit at the beginning of a week, and $277,3 \pm 8,3$ bit at the end of the week; for group T these values were equal respectively to $273,8 \pm 8,3$ * bit and $233,5 \pm 12,3$ bit.

Table 1. Indicators of intellectual working capacity of the 1-3rd graders during a school day and an academic year depending on the intensity of training

Indicators	Group	October		December		April	
		1-st lesson	4-th lesson	1-st lesson	4-th lesson	1-st lesson	4-th lesson
1-st grade							
P, bit	E	173,1+8,1	186,2+6,6	207,3+5,9	216,8+6,7*	204,4+6,1*	195,7+6,5*
	T	153,9+6,8	169,0+6,9	193,3+7,1	187,1+7,8	180,6+7,4	162,9+7,1
SPI, bit/s	E	0,68+0,03	0,69+0,03	0,80+0,02	0,78+0,03*	0,81+0,02*	0,70+0,02* ¹
	T	0,60+0,03	0,62+0,02	0,74+0,03	0,66+0,03	0,71+0,03	0,57+0,02 ¹
2-nd grade							
P, bit	E	237,4+7,5	204,9+7,4 ¹	221,4+6,6	254,4+9,3* ¹	316,4+9,6*	270,1+11,2 ¹
	T	223,6+9,2	201,7+7,8	206,3+7,2	215,4+9,4	284,1+13,4	280,7+12,0
SPI, bit/s	E	0,94+0,03	0,77+0,03 ¹	0,86+0,03	1,02+0,03* ¹	1,27+0,04*	1,03+0,04 ¹
	T	0,88+0,04	0,75+0,03 ¹	0,80+0,03	0,86+0,03	1,11+0,05	1,09+0,05
3-rd grade							
P, bit	E	307,6+9,3*	301,4+10,7*	344,7+11,2*	293,9+10,6* ¹	393,7+14,7*	363,5+15,1*
	T	273,8+8,3	256,5+9,5	302,6+11,1	259,6+10,9 ¹	335,0+10,9	314,3+14,0
SPI, bit/s	E	1,19+0,03*	1,09+0,03	1,33+0,04*	1,04+0,04 ¹	1,50+0,04*	1,34+0,05 ¹
	T	1,08+0,04	1,00+0,04	1,19+0,05	1,00+0,07 ¹	1,34+0,04	1,20+0,06 ¹

Note: group E, n = 54; group T, n = 63;

* - distinctions with group T are reliable, $p < 0,05$; 1 - distinctions with the 1st lesson are reliable, $p < 0,05$.

Dependence of the Standard of Health on the Intensity of the Academic Load

It has been shown that the pupils of group E had the index of health authentically lower in the 2nd and 3rd classes, than pupils in group T, – respectively $41,6 \pm 6,3$ * % against $59,2 \pm 6,2$ % and $33,3 \pm 6,0$ * % against $59,2 \pm 6,2$ %. According to other indicators characterizing the standard of children's health, distinctions between groups E and T had a doubtful character. For example, the number of children with the second group of health in the 1st grade in group E

reached $82,8 \pm 5,1\%$, and in group T – $80,3 \pm 5,0\%$; by the third grade these values were respectively $77,4 \pm 5,7\%$ and $77,8 \pm 5,2\%$. In general, the submitted data indicate that the increase of the intensity of the academic load (3 h a week longer in the 2nd and 3rd grades) reduces the standard of health, i.e. increases the physiological cost of adaptation to the learning activity.

The Influence of the Academic Load on the Pupils' Physical Fitness in the 1-3rd Classes

It has been ascertained that the increase of the academic load hasn't influenced negatively pupils' physical fitness, including the indicators characterizing force (finger-tip push-up), the general (running 1000 m) and power (deduction of a body in a vis on a crossbeam) endurance, high-speed and power qualities (a long jump from the place, lifting of a body from a prone position on a back) and flexibility (inclination from a sitting position), and also the overall level of physical condition (OLPC). So, it has turned out that $94,2 \pm 3,2\%$ of children in group E and $90,5 \pm 3,7\%$ of children in group T in the first grade, and respectively 100% and $95,3 \pm 2,7\%$ of children in the 3rd grade – have a sufficient level of physical fitness.

In analyzing the indicators of physical fitness we succeeded in revealing a number of important regularities. The boys of Kirov schools lag behind the age norms developed in general for Russia (Vavilov, Yarych and Kakorina, 1997) in such indicators as flexibility, force of muscles of hands (the 1st grade) and high-speed and power qualities and flexibility (the 3rd grade), but advance these norms in such indicators as force of muscles of an abdominal tension (the 1st and 3rd grades), power endurance (the 3rd grade). The girls of Kirov schools lag behind the age norms in such indicators as force of muscles of hands (the 1st grade), high-speed and power qualities (the 1st and 3rd grades), but advance these norms in such indicators as the force of muscles of an abdominal tension (the 1st and 3rd grades). We have revealed distinctions of physical fitness in connection with pupils' regular going in for sports in sports sections which according to our data contribute to the rapid development of high-speed and power qualities, power endurance and flexibility.

Discussion and Conclusion

In studying the influence of the academic load on the child's organism the effectiveness of adaptation can be estimated on physical development, a functional condition of cardiovascular and respiratory systems, a standard of health and the change of pupils' intellectual working capacity. Study of intellectual working capacity as a criterion of adaptation of pupils to the academic load is one of the important issues in a number of research of physiologists and teachers. So,

N.N. Chasanova (2007), while studying characteristics of the level and dynamics of pupils' intellectual working capacity in the 3rd and 4th grades of a rural school in the conditions of the federal experimental program of training, showed that the optimal physical activity amid a moderate intellectual loading in the structure of four years' primary education allows to level the influence of intellectual and static loads on the children's organism, facilitates their adaptation and maintains working capacity and health at a high level. M.I. Stepanova et al. (2012) studied the dynamics of intellectual working capacity for

an efficiency assessment of various educational technologies which are supposed to decrease a tiresome influence of the educational load of pupils.

At the same time, despite the available data on the process of adaptation of pupils of various age groups, the issue of the influence of the intensity of training on the change of a psychophysiological state of children's organism within the first years of training at school is studied insufficiently. So, T. I. Ryabichenko et al. (2014) carried out a comparative analysis of the health of teenagers being trained in educational institutions with increased and usual level of the academic load which has shown that the pupils in the group with an increased load have a higher level of social, personal, psychological and mental health. M.A. Polenova et al. (2012) studied the dynamics of intellectual working capacity of the second graders and concluded a hygienic expediency of an integrated approach contributing to the optimization of teaching and learning activities. Its health saving efficiency is shown in the decrease of a negative impact of the increased educational load on teenagers' organism, reduction of the "the physiological cost" of training and preservation of organism functional reserves.

The results received by us are coordinated with the data of other researchers (Chasanova et al., 2004) confirming a more apparent increase in the intellectual working capacity of pupils of innovative forms of training. We can explain this fact by a higher speed of increase in the information field and the existence of the expressed dominant in the course of intensive training. The mentioned authors think that the increase of intellectual working capacity appears in the 5th grade, i.e. at a later stage of innovative training. But it probably can occur earlier, particularly, as our research has shown, at the end of the 1st year of training. At the same time, it is possible to assert that the growth of an evident fatigue of the pupils of innovative forms of training isn't an obligatory component of a child's activity at the end of a school day or a week as it is noted in literature (Khimich and Bulekbayeva, 2000).

It is well-known that in-depth study of subjects causes a considerable psychic tension in pupils, at the same time a dream duration, a range of physical activity and the time of staying in the fresh air are greatly reduced (Marushchak and Shemanchuk, 2013). Presented in the article data on pupils' incidence indicate that the increase of the intensity of the academic load (3 h a week longer in the 2nd and 3rd grades) reduces the standard of health, i.e. increases the physiological cost of adaptation to learning activity. At the same time pupils' physical fitness, as the results of our research show, doesn't depend on the intensity of the academic load. It's defined by the extension in the range of physical activity due to regular going in for sports in sports sections that was also noted by other authors (Zaytseva, 2004; Lebedeva, 2004).

Thus, the influence of the intensity of the academic load is demonstrated in the increase of pupils' intellectual working capacity in the 1-3rd grades, but causes tension in the mechanisms of cardiac function regulation and decrease in the standard of pupils' health (the 2nd and 3rd grades) that indicates a big physiological cost of adaptation. It confirms the need of the physiologist - hygienic maintenance of educational process during intensive programs of training and an expediency of further study of this problem. The integrated approach and monitoring research give a possibility of introducing amendments in the process of child's training and upbringing in due time and on a scientific basis.

The increase in the academic load (in-depth study of a foreign language in the 1-3rd grades) increases students' intellectual working capacity (judging by the increase in the volume and speed of processing of visual information), it doesn't influence negatively students' physical working capacity and physical readiness of pupils of the 1-3rd grades, but it increases their disease incidence that testifies a high physiological cost of adaptation of a child's organism to a more intensive academic load.

Physical fitness of the 1-3rd graders is defined by the conditions of rationally organized physical activity. Regular athletic training in sports sections increase girls' and boys' rates of development of high-speed and power qualities, power endurance and flexibility, contributing greatly to their harmonious development.

All in all, theoretically the results of the research extend the conception of the dependence of intellectual working capacity of the 1-3rd graders and their standard of physical health on the intensity of training and allow us to consider these indicators as the criteria of adaptation primary school pupils to the academic load.

Implications and Recommendations

The revealed facts are of practical interest to physiologists, psychologists, school teachers, pupils' parents as they characterize the mode of in-depth study of some subjects at a primary school as a functional-adequate one providing a rational organization of a teaching and learning process and pupils' physical activity taking into account pupils' individual peculiarities.

The complex assessment of individual peculiarities of intellectual working capacity and adaptation of primary school pupils to the academic load can serve as a physiological-hygienic maintenance of innovative educational programs for optimizing teaching and learning process, health protection and improvement of functional organism reserves.

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No potential conflict of interest was reported by the authors.

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