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EVALUATION OF SCHOOL STUDENTS' COGNITIVE STATUS AND PSYCHO-PEDAGOGICAL OPTIMIZATION OF THEIR COGNITIVE ACTIVITY

The article deals with the issue of effective teaching of students of general secondary education institutions of different types and also its connection with the levels of the development of their cognitive skills (auditory and visual memory, attention, verbal-logical and visual-figurative thinking as well as the quality of mental processes). The relevance of the research is due to the need for diagnostics of the cognitive processes at the early stages of learning, development of the methods of student-centered education and stimulation of the students' cognitive sphere development in the educational process. The purpose of this study is to analyze the psycho-physiological peculiarities of the students' cognitive sphere in conditions of information load of different intensity and development of a complex of psycho-pedagogical means of their cognitive activity stimulation. Among the research methods used is the evaluation of the cognitive status (CS) of schoolchildren by mathematical means using the commonly accepted methods for assessing auditory operational and visual memory, attention, flexibility of thinking, visual-figurative and verbal-logical thinking and strength of the nervous system. The predominance of higher levels of the CS in students of a new type of school with in-depth study of subjects and a large amount of information loading has been discovered. The positive influence of special classes on the development of mental functions has been revealed. A comprehensive psycho-pedagogical approach to stimulation of students' cognitive activity has been proposed in order to increase the effectiveness of their learning by means of game situations at lessons, various visual aids, the use of students' life experiences and specific examples, avoiding monotony, exclusion of numerous reproductive tasks, taking into account individual peculiarities of each student, creation of a friendly environment and positive emotional atmosphere. The obtained results can be used by teachers, psychologists-practitioners while selecting students for special classes with in-depth study of particular subjects for predicting the effectiveness of learning. The proposed complex of cognitive activity stimulation can be taken as the basis by teachers of general secondary schools.

Keywords*: cognitive status, cognitive activity, effectiveness of learning, mental functions.*

Introduction

Under conditions of rapid informatization of education, modern school requires students to have a high level of cognitive abilities and functions for acquiring information on the background of intensification of the educational process. Therefore, for an adequate response of an organism to the information loading with preservation of the high productivity, the compulsory requirement is an active state of the cognitive sphere, which determines the success of the study (Lyashenko, Tumanova, Gnutova, 2017).

The effectiveness of learning skills formation is determined first of all by maturation and degree of preservation of the analyzer systems as well as by the complete mental development of schoolchildren (Lizohub, 2000; Makarenko, 2000-2002). Persistent difficulties in learning may occur in students with normal intelligence and oral speech, full senses of vision and hearing but with malfunctions of some mental processes that are based on the lag of functional maturation of brain structures behind the age norm. These specific disorders are not usually manifested in everyday life, they do not lead to serious intelligence violations but create difficulties in learning and serve as one of the main causes of low academic success.

The problem of effective learning and its connection with students' cognitive activity was the subject of special interest of the scholars of the last century who identified psycho-pedagogical means for raising cognitive activity (Marianenko, 1990), namely, it has been found out that the leading role in cognitive activity is played by the autonomy of thinking and creative search (Kholodnaya, 2002). The researchers also studied the concepts of general life activity that determined human efficiency in different spheres of activity (Lizohub, 2000; Makarenko, 2000-2002). According to modern psychologists, the nature of the person's cognitive activity depends on his/her self-activity and mental experience (Boryshevskyi, 2001; Lyashenko, Tumanova, Gnutova, 2017; Kholodnaya, 2002). In addition, L. Marianenko, after the theoretical study of this problem, came to the conclusion that the development of cognitive activity depended on the for-

mation of learning skills, intellectual abilities and cognitive motivation (Marianenko, 1990).

In the twentieth century, the relevance of the problem of schoolchildren's low cognitive activity initiated the above-mentioned diagnostic and correctional studies, development of special training techniques, opening specialized schools and "remedial classes". Modern general secondary education, in accordance with the Law of Ukraine "On General Secondary Education", represents the purposeful process of systematized knowledge mastering by means of cognitive and practical activity. Consequently, one of the foundations of education and labour activity is the development of the processes of cognitive sphere which together with the properties of the nervous system can determine the cognitive status (CS) of students.

Nowadays, there are no well-developed approaches to the study of this problem and criteria for assessing students' CS that determines the effectiveness of learning. The addressing of this issue will solve such practical tasks as diagnostics of the cognitive processes at the early stages of learning, development of methods of the student-centered teaching and psycho-physiological correction of schoolchildren. The issue of stimulation of both development of schoolchildren's cognitive sphere with underdeveloped cognitive processes and their cognitive activity as a whole in conditions of the educational process remains relevant.

Aim and Tasks

The aim of the research is to study psycho-physiological and psychological peculiarities of the students' cognitive sphere in conditions of the information loading of different intensity. In order to achieve the research aim the following tasks should be solved: 1) to develop a complex of psycho-pedagogical means of stimulation of students' cognitive activity; 2) to assess the impact of the proposed measures on the effectiveness of their learning.

Research Methods

The study involved 264 students aged from 12 to 15 of Sumy gymnasium who formed the main group (MG) and 255 pupils of the corresponding age of secondary schools in Sumy who constituted the comparison group (CG). The effectiveness of the student's learning was assessed by calculating the arithmetic mean of all subjects. The following processes were analyzed for the establishment of the CS: auditory and visual memory, attention, flexibility of thinking, visual-figurative thinking, verbal-logical (conceptual) thinking.

The auditory memory was examined using H. Khilova's methodology in modification for students of the general secondary education institutions. The volume of visual memory and attention were assessed by means of M. Makarenko's test (Makarenko, 2000-2002). The conceptual thinking of the respondents was analyzed according to the well-known "Analogy test". Diagnostics of individual peculiarities of thinking of each student, one of the qualities of the thinking process – its flexibility, was carried out with the help of the "Anagrams" test according to the generally accepted psychological method. The analysis of visual-figurative thinking was conducted using progressive matrices of Raven and allowed to assess the students' ability to represent situations and their changes as well as the ability to reproduce the versatility of various factual characteristics of the subject. In addition, the nervous system strength (NSS) as an indicator of the intensity of brain function was estimated with the maximum rate of movement of the wrist in time. For diagnostics of the SNS the technique "tapping test", proposed by E. Ilyin, was used. The strength of the nervous system was examined by the type of working capacity curves (Makarenko, 2006), and individuals with strong (group 4), medium (group 3), middle weak (group 2) and weak (group 1) types of the nervous system were identified.

In order to perform the quantitative assessment of interdependence between the studied indicators, a correlation analysis according to the Pearson criterion was used. Mean values and average error were calculated in accordance with generally accepted methods. The statistical analysis has been conducted using the Statistica application package for Windows v.10.0. Statistical processing of the data obtained was carried out by calculating the mean (M), relative values (P) and their error (m) by generally accepted methods, the significance of the differences in the mean values were estimated according to Student's t-test.

Research Results

According to the obtained data, the learning effectiveness in general is significantly higher in the MG as compared to the CG (8.60±0.12 and 6.15±0.14 – in boys, ($p<0.01$) and 9.48±0.1 and 7.55±0.2 ($p<0.01$) – in girls, respectively) that can be explained by high motivation for learning and selection of students to classes with specialized training. Moreover, learning effectiveness prevails in girls of both educational establishments that can be explained by the best indicators of the cognitive abilities development.

The distribution according to the levels of performance showed that among the students of the MG there were no students with the low level (1-3 points out of 12) as well as low percentage of the students of gymnasium who had 4-6 points (2 level). The effectiveness of learning in 69.8% of students of the MG is considered to be sufficient (7-9 points) and 25.5 % of the respondents have a high level which is a result of the educational process of a new type of school. The opposite results of academic performance are obtained from the students of the CG most of whom (54.5%) have 4-6 points, which corresponds to the average level of learning effectiveness.

In order to explain the results, we should assess the levels of cognitive abilities of students in both education institutions (Table 1).

Table 1.

***Indicators of the Levels of Cognitive Processes Development of the Students of the MG and the CG** (M±m)*

Indicators	The MG		The CG	
	Boys, *n=136*	Girls, *n=128*	Boys, *n=138*	Girls, *n=117*
Auditory span, %	84.32±2.27	90.87±1.27	83.96±1.71	90.19±1.62
Visual span, points	8.2±0.13*	8.2±0.15	7.84±0.13*	7.84±0.18
Attention span, points	3.5±0.19*	3.4±0.19	2.1±0.15*	3±0.28
Verbal-logical thinking, points	3.99±0.12*	4.14±0.14**	2.7±0.13*	3.68±0.17**
Visual-figurative thinking, points	2.9±0.14*	3.33±0.15	2.4±0.16*	3.3±0.21
Flexibility of thinking, points	4.05±0.13*	4.27±0.14**	2.93±0.13*	3.45±0.18**

Note: * – the probable differences between the boys of the main group and the comparison group (p <0.01-0.05);** – probable differences between girls of the main group and the comparison group (p <0.01-0.05).

As indicated in the table, in general, cognitive functions, especially mental processes, are better developed in girls than in boys. Probably, this peculiarity enables girls to use different ways of perception and thinking successfully, to adapt to a learning environment that is provided with high flexibility of thinking, and to have higher performance in comparison with boys.

On the assumption that typological properties of the higher nervous activity determine formation of the psycho-physiological qualities and create conditions for the implementation of the corresponding functions (Makarenko, 2002), it is necessary to compare the indicators of the NSS and development of the cognitive abilities. The obtained results have not revealed the dependence of the cognitive functions development on the NSS. Among the students whose NSS belongs to the strong type (group 4), there are more representatives of the CG whose cognitive abilities are worse developed. Most students, of both the MG and CG, have the capacity of the medium and middle weak type of the nervous system. Based on the fact that high capacity of the nervous system stimulates development of higher mental functions (Lizohub, 2000; Makarenko, 2000, 2002), one can make assumptions about the ambiguous effect of the NSS on the development of most cognitive processes in different age periods as the study involved students aged 12-15.

All of the above mentioned had become the basis for determining the integral index of CS of the students in order to conduct a comparative analysis between schoolchildren of both groups. The evaluation of CS of the students was carried out according to all investigated qualities using the mathematical formula:

$$CS = \frac{\sum_{i=1}^{n} X_i}{n},$$

in which: X – the indicator of cognitive ability development (in points);

n – the number of indicators determined during the study.

The obtained indicators of cognitive abilities of each student were processed using the proposed formula and grouped by the following gradation: CS<1.8 – low level – I; 1.8≤PS≤2.4 – medium level – II; PS>2.4 – high level – III.

As indicated in table 2, the students who are classified into a low CS group have significantly worse indicators (p<0.01) of all cognitive functions as compared to the groups of students of medium and high level of the CS (table 2).

Table 2.

***Indicators of Development of the Cognitive Processes of Students with Different Levels of the CS** (M±m)*

Indicators	The MG			The CG		
	low *n=39*	medium *n=129*	high *n=96*	low *n=68*	medium *n=132*	high *n=55*
Auditory memory span, %	68.46±5.67	85.02±1.96	94.83±1.09	76.43±3.99	91.60±1.10	95.17±1.37
Visual memory span, points	6.6±0.44	8.0±0.13	8.66±0.07	6.82±0.2	7.90±0.12	8.41±0.16
Attention span, points	1.8±0.25*	2.8±0.16	4.7±0.15	1.29±0.12**	2.33±0.15	3.90±0.31
Verbal-logical thinking, points	2.8±0.26	3.68±0.10	4.92±0.13	2.04±0.18	3.05±0.12	4.41±0.16
Visual-figurative thinking, points	3.15±0.34	3.9±0.10	4.86±0.14	2.36±0.16	2.97±0.14	4.28±0.18
Flexibility of thinking, points	2.6±0.38	2.85±0.13	3.81±0.15	1.82±0.19**	2.58±0.15	4.62±0.22

Note: * – the probable differences between the students of groups of low and high levels of cognitive processes MG (p <0.01);
** – the probable differences between the students of groups of low and high levels of cognitive processes of CG (p <0.01).

In addition, in the course of the study, it was determined that 10.7% of the students of the MG and 22.3% of the students of the CG had the low level of CS; in the range of the average values the results are 51.9% and 53.4% of students of the MG and the CG respectively; the status of 37.4% of the gymnasium students and 24.3% of schoolchildren is characterized by the highest indicators.

The obtained data indicate that the students with a high level of the CS have better learning effectiveness in comparison with the students who had lower CS indicators. This fact is confirmed by direct correlations, which are calculated between the average performance score, reflecting the effectiveness of learning, and indicators of cognitive abilities: auditory memory span ($r=0.36$; $p<0.05$), visual memory span ($r=0.35$; $p<0.05$), attention span ($r=0.35$; $p<0.05$), levels of conceptual thinking ($r=0.43$, $p<0.01$), flexibility of thinking ($r=0.36$; $p<0.05$) and visual-figurative thinking ($r=0.34$; $p<0.05$).

The obtained results have confirmed the fact that there is a close correlation relationship between the modern students' academic success (effectiveness of learning) and the levels of development of their cognitive sphere that creates the need for active implementation of the psycho-pedagogical means and methods of stimulation of the cognitive abilities and functions development as well as increasing students' cognitive activity in general, especially in conditions of excessive information loading.

We suggest a comprehensive program of psycho-pedagogical stimulation of the modern students' cognitive activity, the algorithm of which is represented in Table 3.

Thus, the guidelines for teachers for stimulating students' cognitive activity during the process of study are as follows: to use game situations and different kinds of visual aids at the lesson; to rely on students' life observations and concrete examples; to avoid the monotony of lessons and exclude numerous reproductive tasks; to take into account individual peculiarities of each student; to change the style of communication with students at the lesson and adjust them to the perception of material; to ensure evoking positive emotions to learning activities and to create a friendly environment and positive emotional atmosphere.

Table 3.

Algorithm of the Program of Psycho-Pedagogical Stimulation of Schoolchildren's Cognitive Activity

Structural element of the program		Purpose
1	Organization of students' research work, solving creative problems; variety of independent tasks	Stimulation of cognitive processes
2	Exceeding the limits of training activities	Gradual increase in learning and extracurricular activities
3	Creation of a situation of the cognitive dispute	Attracting attention to the problem under discussion, formation of judgments, beliefs, assessments; stimulation of cognitive activity in general
4	Stories about the use in modern conditions of some predictions of science fiction writers, demonstration of interesting experiments	Increasing interest in learning
5	Selection of appropriate tasks at the stage of stimulation of cognitive activity	Creating a situation of success
6	Maintaining a positive microclimate	Reducing feelings of uncertainty, anxiety and worry
7	Using cognitive games during the educational process: travel games, quizzes	Stimulating interest in learning
8	The technique of surprise: the paradox of the experiment, the unusual fact that is presented, the magnitude of numbers	Evoking deep emotional experiences
9	Artistry, brightness, emotional language of the teacher	Creating emotional experiences
10	Heuristic conversation: dialogue, exchange of thoughts, system of focused questions	Directing and maintaining of cognitive activity, activation of memory, thinking

Conclusions

Thus, as it has been found out, the effectiveness of learning depends mainly on the level of development of the cognitive abilities, which in combination analyze students' cognitive status and allow them to predict effectiveness of their performance. The positive influence of introduction of special classes (with in-depth study of different subjects) on the development of mental functions, which was observed in the gymnasium students, has also been revealed. The proposed method of assessment of the cognitive status will allow designing curriculum and methodological provision of educational establishments in accordance with the age and individual-typological characteristics of schoolchildren. The cognitive status is a reflection of the children's potential; it allows them to create models of personality development

that are the basis for introduction of the student-centered pedagogical technologies. The estimation of the CS of each student will contribute to the formation of values and versatile development of the personality on the basis of his/her abilities, serving as one of the objectives of the concept of general secondary education.

Implementation of the program of psycho-pedagogical stimulation of students' cognitive activity in the educational process of general secondary education institutions will increase the efficiency of learning and cognitive activity in general.

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ОЦІНКА ПІЗНАВАЛЬНОГО СТАТУСУ УЧНІВ ТА ПСИХОЛОГО-ПЕДАГОГІЧНА ОПТИМІЗАЦІЯ ЇХНЬОЇ ПІЗНАВАЛЬНОЇ АКТИВНОСТІ

У статті розглядається проблема успішності навчання учнів закладів загальної середньої освіти різного типу, а також її зв'язок з рівнями розвитку пізнавальних властивостей (слухової і зорової пам'яті, уваги, словесно-логічного і наочно-образного мислення, а також якості розумових процесів). Актуальність проблеми визначена необхідністю діагностики пізнавальних процесів на ранніх етапах навчання, розробки методів особистісно зорієнтовної освіти, а також стимуляції розвитку пізнавальної сфери школярів в умовах навчально-виховного процесу. Метою дослідження є вивчення психофізіологічних особливостей пізнавальної сфери учнів в умовах інформаційних навантажень різної інтенсивності, а також розробка комплексу психолого-педагогічних засобів стимуляції пізнавальної активності школярів. Серед методів дослідження обрано оцінку пізнавального статусу (ПС) школярів математичним шляхом з використанням загальноприйнятих методик оцінки слухової оперативної та зорової пам'яті, уваги, гнучкості мислення, наочно-образного та словесно-логічного мислення, сили нервової системи. У результаті дослідження було встановлено переважання вищих рівнів ПС в учнів школи нового типу з поглибленим вивченням навчальних предметів і великим обсягом інформаційного навантаження, а також виявлено позитивний вплив упровадження профільних класів на розвиток психічних функцій. Запропоновано комплексний психолого-педагогічний підхід до стимуляції пізнавальної активності школярів з метою підвищення ефективності їхньої навчальної діяльності, що ґрунтується на використанні ігрових ситуацій на уроці, різноманітності, наочності, використанні життєвого досвіду школярів та конкретних прикладів, уникненні одноманітності, виключенні численних завдань репродуктивного характеру, врахуванні індивідуальних особливостей кожного учня, забезпеченні доброзичливої обстановки та позитивної емоційної атмосфери. Отримані результати можуть бути використані під час відбору школярів у профільні класи з поглибленим вивченням певних предметів для прогнозування ефективності навчання. Запропонований комплекс стимуляції пізнавальної активності може бути взятий за основу вчителями-предметниками та класоводами закладів загальної середньої освіти.

Ключові слова: пізнавальний статус, пізнавальна активність, ефективність навчання, психічні функції.

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