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MONITORING OF INTELLECT DEVELOPMENT OF MATH HIGH SCHOOLS' STUDENTS

Abstract. *The article discusses challenges related to measurement and use indices of adolescent intelligence. It is proposed technique and computer tool to monitor schoolchildren of mathematic classes' abilities. Experimental research confirmed data obtained in the author's research earlier that highlighted significant increase of intelligence indices after 8th and 10th grade. But, in contrast with general (averaged) data for all types of school profile, it was revealed that intelligence of mathematical class' students increases quickly in 9th grade and a little be slow in 10th, but is higher than in general schools. The results indicated that refinement of the mechanisms of intelligence development require longitudinal studies and expansion of the base of educational institutions in order to increase the effectiveness of personality-oriented learning. Some fruitful results in understanding of the intellect changes in micro-age intervals at high school could be expected in relationship of intellect personality features, namely as regards the style of thinking and features of properties of the central nervous system, as well as accounting learning workload. Experimental results in this research were compared with previous ones obtained with the tool's prototype (averaged data is captured by more than 3,500 schoolchildren).*

Key words: *intelligence, measurement, experimentation, computer tools.*

The problem setting. As was stated at the world economic forum in 2017: "the Ingenuity and creativity in our collective disposal to provide us the means not only to solve the great challenges of our time, but also, critically, to build future, more meaningful and human centric "[1]. Currently, the needs of a rapidly changing world and the education system should take into account that today's children and teenagers born in the digital world [2], and this has led to new requirements for professionally important skills of the person. At the same time, new technologies developed over the past decade, more and more people-oriented, there are new problems that give kids more opportunities to realize their potential and to support lifelong learning [3].

Today's world needs well-educated, ready to work and capable people for scientific and research activities. These human needs are increasingly concerned enterprises, government and public life. Selection of students for research activities, training and preparation for scientific competitions should be provided at early stages in school using all available resources [4]. By far the most actively developed tools provide children access to educational resources, a cloud-based [5] or included in synthetic learning environment [6]. The question of human abilities and willingness to performance is focus of researchers over a long period. First of all, there are problems with human intelligence [7]. But despite the large number of studies of intelligence in General, not many studies deal age aspects of its development. According to many experts, this can be explained by the difficulties of reliable techniques of measuring intelligence, especially in its dynamics [8].

Analysis of actual studies. Recognized that the world market need a workforce with new competencies, which are based on all components of intelligence [9-11], including social and cultural [6]. Appropriate orientation of teachers is associated with the current trend in the transformation of education on STEM (science, technology, engineering and mathematics) with emphasis on mathematics and ICT (information and communication technologies), which have a significant impact on the formation of the human component of national intellectual capital [3] and on cognitive share of many kinds of mental work, especially in critical and emerging areas. At the

same time, it must be emphasized that, despite the successful results of studying structural and functional characteristics of intelligence [12] and the dynamics of its formation [13], including in adolescence [14], some problems of reliability and comparability of these findings is due to the difficulties of the phenomenon of intelligence and its measurement [15; 16]. The measurement task can be solved by excluding differences in the method of test characteristics, measurement of intelligence and in data processing. In this way was obtained some results [17], but they need to confirm in other school groups and also in terms of expanding the methodological possibilities for monitoring skills of youth.

The article's goal is to develop a technique and a tool for monitoring intelligence of adolescence and to compare the results of the test work and school mathematics in General.

Presentation of main material. Efficiency of psychophysiological research methods increases significantly in case of not using the "test battery", and psychodiagnostic system. To solve this problem was developed and approved computer system (and its online version) for psychophysiological studies of sensory and cognitive activity of man in the research laboratory and real conditions, as well as schools. The experiments included results of psychological tests on the subjects on the computer in accordance with the methodology developed and approved for personnel selection [18]. They were used in the tests follows: test modified A. Amthauer on the structure of intelligence, skills assessment in the areas of mental activity; associated with the color Lusher test (paired selection), assessment of stress level, willingness to test the psychological qualities of balance; a modified technique, Hilchenko-Makarenko, control and evaluation of functional mobility of nervous processes; the Indicator of type Myers-Briggs (MBTI).

They observed 3596 school pupils from 7 to 11 academic years (K7 K11...), including 453 student front of the Lyceum.

According to the method used, they were measured for each student (primary data) and calculated estimates. Index was calculated of the level of development of verbal intelligence (VI) and the index of development of non-verbal intelligence. In addition, the calculated integral index (II) the development of intelligence, which translated into a recognized scale IQ.

It is acknowledged that the priorities of education in the twenty-first century needs to be built for the formation of key competencies for learning throughout life, which are "a combination of knowledge, skills and attitudes appropriate to the context. They are particularly necessary for personal satisfaction and development, social inclusion, active citizenship and employment ". One of the core competencies is "mathematical competence and basic competences in science and technology". This is due to high performance decision-making, creative analytical thinking (based primarily on abstract and logical abilities), fast search and information processing, effective communication, team work.

In earlier studies, individual psychological peculiarities of the transformation process of structure of intellectual abilities of talented adolescents, depending on age (microinterval: from K7 to K11) profile / "directions of differentiation" of learning (physico-mathematical, chemical and biological, humanitarian, economic, etc.) and gender [17]. The results were obtained by screening the observation of students of natural Sciences No. 145.

To explore the General and specific features of adolescent intelligence, they compared microintervals the dynamics of the General intellect (Fig.1) and its verbal and nonverbal components (Fig.2) in accordance with all observation data (without geographical, gender and profile) and the data received in schools mathematics (high schools 157, Kyiv). Data were collected using the method of screening as in previous studies. You know and you know that the maximum of mental efficiency is achieved when optimal motivation and neuro-emotional tension in accordance with the law of Yerkes-Dodson. To ensure the correct set of monitoring data the initial state of the survey tested the performance of the test Lusher and controlled by the results of the least ME. The latter figure was chosen based on preliminary empirical results that were clear from the features and requirements education: memory is one of the most important skills to learn and may not be less than 11. Smaller values imply an inappropriate level of motivation which should be excluded from the dataset, and also due to the high stress or low readiness to perform.

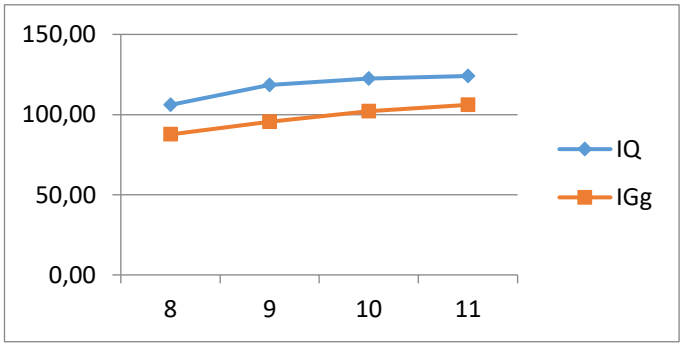

Figure 1. *Average math IQ (IQ) and total (IQg) schools in K8 ... K11*

The above results confirmed the data known about the steady increase in the level of development of intelligence with the promotion of the verbal component in their Teens. At the same time, the differential analysis of the individual components of intelligence indicates heterochronies of this process with different accelerations in grades 10-11.

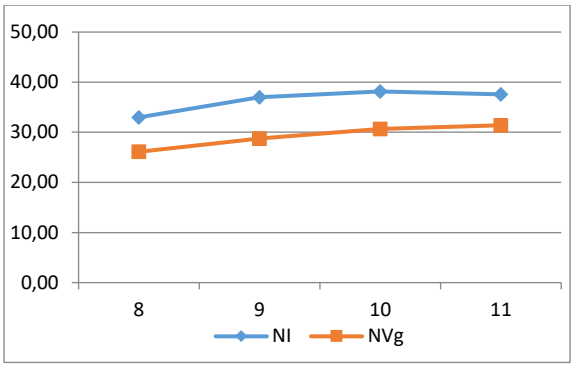

Figure 2a: *Average nonverbal intelligence in mathematics (NI) and total (NIg) schools in K8 ... K11 (raw data)*

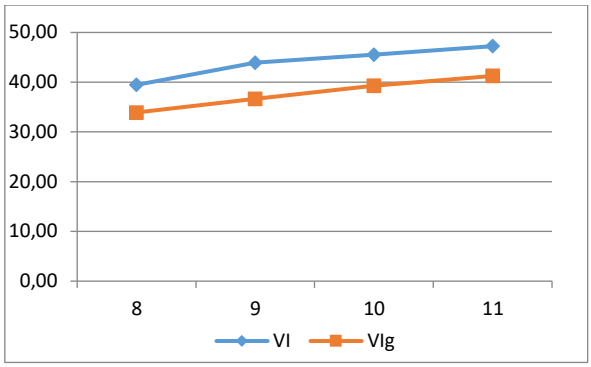

Figure 2b: *Average verbal intelligence mathematical profile (VI) and total (VIg) schools in K8 ... K11 (raw data)*

A higher level of intelligence among the students of the Lyceum can be explained by the fact that students in mathematical high school were selected according to their prior abilities. It must be emphasized that their indexes were higher in non-verbal (often called "mathematical and technical"), and verbal components of intelligence.

Screening method of the review gives an overall look at a static situation, but does not allow to analyze the real changes in intelligence of students. To study such dynamics, the analysis was conducted in connection with the monitoring of changes in the level of intelligence of teenagers Lyceum 157 in the next two school years. Namely, it was checked the results of the test of intelligence of students K8 ... K11 in the school years 2011-2012 and 2012-2013, the K8 Students in the 2011-2012 academic year switched to K9 K9 to K10 and K10 to K11, respectively.

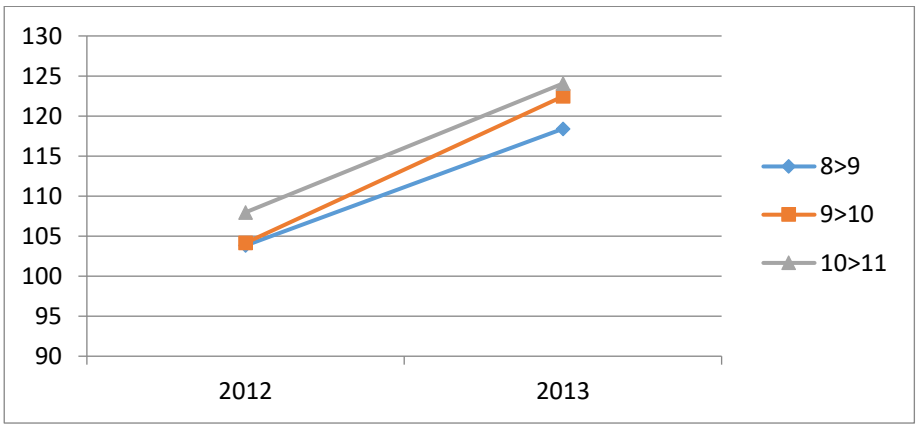

Figure 3. *Average IQ of students in mathematics two consecutive years, when they moved to the next class (from 8 to 9, 9 to 10 and from 10 to 11)*

The graph shows that the greatest acceleration of the development of intelligence demonstrated by K9 students compared to K8. This result is not consistent with the previous study, the General trend (the highest increase was detected from K8 to K9 [17]). It can be assumed that the selection of children with high mathematical abilities and appropriate training in the 8 th grade provide not only good mathematical skills but also the development of higher intelligence at an earlier age than the average population.

Conclusions. According to the research results we can draw the following conclusions.

1. It was found that the most significant changes in the level of intelligence occurred between 9 and 10 academic years at schools of mathematical profiles

2. The results showed that improving the mechanisms of intellectual development requires long-term research and broadening the base of educational institutions with the aim of increasing the effectiveness of training, based on personality.

3. Some fruitful results in understanding the changes in intelligence in the micro age intervals in high school could be expected in relation to the personality characteristics of intelligence, namely in relation to thinking style and features of the properties of the Central nervous system, and also accounting for teaching load [19].

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МОНІТОРИНГ РОЗВИТКУ ІНТЕЛЕКТУ СТАРШОКЛАСНИКІВ МАТЕМАТИЧНИХ ШКІЛ

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***Анотація**. У статті розглядаються проблеми, пов'язані з показниками вимірювання та використання інтелекту підлітків. Запропоновано методику та комп'ютерний інструментарій для моніторингу математичних здібностей старшокласників. Експериментальні дослідження підтвердили дані, отримані в авторському дослідженні раніше, а саме - значне зростання показників інтелекту після 8-го і 10-го класів. Але, на відміну від загальних (усереднених) даних для всіх типів шкільного профілю, було виявлено, що інтелект учнів класів математичного профілю швидко зростає у 9-му класі та трохи сповільнюється у 10-му, але є вищим, ніж у загальноосвітніх школах. Результати показали, що вдосконалення механізмів розвитку інтелекту потребує продовження досліджень та розширення бази обстеження навчальних закладів з метою підвищення ефективності навчання, орієнтованого на особистість. Деякі плідні результати у розумінні інтелекту на мікро-вікових інтервалах у старшій школі можна очікувати у співвідношенні особливостей показників особистості та інтелекту, а саме по відношенню до стиля мислення та особливостей властивостей центральної нервової системи, а також урахування навчального навантаження. Експериментальні результати в цьому дослідженні порівнювалися з попередніми, отриманими за допомогою прототипу інструмента (усереднені дані отримані за результатами обстеження більш ніж 3500 школярів України).*

***Ключові слова:** інтелект, вимірювання, експеримент, комп'ютерний інструментарій.*