ERGONOMIC PRINCPLES TO DESIGN LEARNING WORKPLACE

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INTRODUCTION

Ergonomics of XXI century has changed its requirements to products and environment of activity, because the object and tools of activity changed from material to mental ones. As a result a human, as well as student and teacher/lecturer, have to organize their workplace not only in material environment (that needed to meet a human physical conditions), but in virtual one (more requirements to psychic and mental conditions). People faced problems to satisfy both physical and mental external and internal conditions of activity. Special attention should be paid to young people: schoolchildren and students. Human abilities for cognitive performance are not stable over time span (years, months, weeks, days, minutes) that impacts on a human mental performance efficiency.

As Joseph S. Renzulli 18 th World Conference 2009 [1], it is necessary to review the objectives and role of education gifted children and talented youth in a rapidly changing world and in the educational system, so that today's children and teens have come to the digital world. Study in the electronic environment is becoming more and more popular and common way of education. And most kids are spending more and more time each day, creating, consuming, reproducing and sharing digital materials to other members of the educational process. Classroom activities, homework and transportation of study materials have increased the ergonomic risks to students. However, widespread education has not been informing students, teachers or parents about these risks. New approaches to the ergonomics and technology of education are needed to reduce the risks and ensure children are not denied the opportunity to become productive members of the next generation [2].

The current challenges of education correspond opportunities and modern trends of using electronic learning (e-learning). The concept of context-based knowledge foresees that an individual student's knowledge construction should take place in a context that is similar to the context in which this knowledge should be applied in the future including cross-cultural collaborative community [3].

At the same time, we know that human potential cognitive activity may vary from day to day depending on external and internal factors those affect his/her performance. As a result such changes can affect the person's ability to adapt to the specific learning environment to perceive and represent new information in order

to use it, the acquisition of knowledge and skills to prevent its inefficiency [4]. The specifics of learning work consists in that informative processes that are more involved than energetical ones, and conceptual model of learning work is a result of psychophysiological adaptation to this activity.

METHODOLOGICAL BACKGROUND

As highlighted V.A. Bodrov [5], adaptation is manifested not only in the passive and adaptive way, but also actively converting relations with the environment. Adaptation refers to a system and a human psyche response to prolonged and repeated impact of internal and external environment associated with the restructuring mechanisms ensuring homeostatic regulation of functional activity. In this context, adaptation to activity (including education and training) can be considered as professional homeostasis that occurs (formed) as a result of educational, training and production processes. Adaptation is revealed as:

• Deployment of functional *responses* of human action on factors that can disrupt the constant internal environment.

• *State* that the new structure of the integration of functional systems.

• *Result* of internal changes within a certain time interval in the form of relatively stable indicators of physiological parameters.

Human activity is accompanied by creation and maintenance of functional systems that :

- activate dominant brain structures,
- activate corresponding activity of one or another physiological system,
- are quite stable for particular type of the human work.

Learning activity consists in discrete comparison of information obtained from outside with the mental (conceptual) model of the discipline and education process.

In such a context:

- Conceptual model can be considered as an information stratum of professional work (learning).
- Physiological chain „afferent inputs – activity acceptor – physiological control – effectors - act" is an energetic stratum.

The goal of education (training) is <u>to form the conceptual model</u> for a student professional (!) activity, i.e. creation of „information contour" that exists and is maintained in active state when student controls the process of goal-aided activity [6].

This contour embraces:

- afferent inputs,
- decision making block,
- activity acceptor,
- act program,
- as well as the object of activity (information model).

Especially it is important in e-learning when human abilities could be used more effective [7].

Human activity should be evaluated accounting such "human views":

(1) Constraint. If a system requires a human interface, then the system must be designed to accommodate the human as a passive and as an active element, creating sub-system for safety both for and from a human.

(2) Functions. Provide a justification for the allocation of tasks and functions between the humans and machines depending on a human current status and capability.

(3) Role. Describes the roles that have been defined for the human interacting with the system and their possible changes over mission time (f.e., from simple executor to leader and/or commander) accounting his competencies, ability for tasks generation, leadership etc.

(4) Human network. Team performance impacts, re-allocation, dependencies and communication.

ERGONOMIC PRINCIPLES TO DESIGN LEARNING PROCESS

Accounting featured of human activity in digital age and possible ways of ergonomics development, ergonomic tasks to be solved in area of education and training could be defined as follows:

- Design the information habitat (working, learning, everyday, recreation, general use) as a working tool and as an environment at one time (design aspect).
- Flexible adaptability of the information habitat depending on a human individual abilities and current functional state (exploitation aspect).
- Assessment, prediction and correction of a human functional state and fitness-for-duty (serviceability aspect, for a *human* as an object of activity).

Thereafter, principles of ergonomic design for workplace of students/teachers could be defined in this way:

1. *Subject-oriented design of workplace*. Human (student/teacher) is a system-created factor when designing workplace. He/she plays the central role in the system human-technique-environment (THE).

2. *Adequate learning tools and means*. Tools and means for learning activity should meet requirements of not only didactics, but *abilities* and *needs* of a subject.

3. *Student-friendly learning environment*. "Environment" is understood as : nature (physical, biological etc.), material objects, organization, information, psychological and didactic ones. It should correspond a student abilities, opportunities, needs etc.

4. *Activity developing*. Real development of a human, his/her abilities formation are not effective without professional activity. Just it combines human, tools and environment.

5. *Effectiveness as a goal of learning process*. HTE is a system that maintains learning activity.

6. *Safety of a student mental and physical health*. About 70% of school children in Japan and China have disorders by 14 years and increases to school graduating (S.Saito, 2009). Student 's safety (health) deviation should be satisfied .

7. *Comfort of a student's learning process*. This is very important, because motivation, readiness-to-act and health depend on comfort of learning process' subjects.

These ergonomic principles to design learning process including workplace were delivered to practitioners (school authorities) and their effectiveness was checked in field experimentation.

METHOD

There were developed methodic and software tools to measure cognitive abilities of school children and students under pressure of physical factors and learning process on their health and learning efficacy.

That impact was planned to be studied in conditions of traditional learning workplace (including common computer chairs) and optimized conditions (time management, orthopedic chairs as well as special ergonomic chairs produced by Kulik System Ltd., Kiev, Ukraine).

WE strongly believe that effectiveness of research psychophysiological technique considerably rises in case of usage not of a set of tests, but of a psychodiagnostic system. Experiments included psychological tests performance by subjects at the computer display and simultaneous measurement of physiological parameters. They were used tests as follows: short memory, perceptual (searching of missed numeral), cognitive (logic-combinatorial). In all tests we registered time of each task performance in milliseconds, correct (expected) and really entered answers. To account subjective aspect of psychological measurement, we used a subjective state assessment of the examinees by means of the reduced variant of the test "General_state - Activity – Mood" (GsAM) at beginning and ending of test session (the indices of mood **mood**, serviceability **FfD**, attention **atten**, anxiety **anxiety** prior to the beginning (index "0") estimated and upon finishing the tests performance).

They were was measured as indices of physiological "cost" of activity and human state a heart rate **HR** and blood pressure (systolic **BPs**, diastolic **BPd**) by means of the cardio-monitor "Solveig". The indices **HR**, **BPs** and **BPd** we registered during 5 min prior to the tests beginning (index "0") and 5 min after finishing (relaxation).

The data on influence of solar activity on a human health and some physiological systems are known, however results of study of cognitive activity associating with heliophysic parameters are not known in the scientific literature to date. In our preliminary pilot researches the precise connection between effectiveness of operator activity and parameters of a solar wind (SW) was revealed. With the purpose to study this phenomenon we registered indices of proton component of a solar wind - velocity **SWsp** (km/s) and density **SWden** (proton/см^3) on the data from Internet site NASA [9], as well as parameters of the geomagnetic field (GMF) - planetary index **Ks** and index of "equivalent amplitude" **A**.

RESULTS AND DISCUSSION

More than 3500 school children were studied at the first stage of experiment when schoolchildren with high abilities to research work were selected. The method developed and its application regards day-to-day fitness-for-learning were analyzed by result of study of 20 intellectually gifted school boys' cognitive abilities on a month day-to-day basis. Subjects participated in day-to-day monitoring of performance the series of cognitive tasks.

Average values of physiological parameters testers for testing days indicate the individual character of their dynamics as in the initial state (immediately after school) and after the test activity (Table 1). Comparison of changes in the nature of physiological parameters as a reaction to stress (cognitive tests are simple and conform to the logical skills of Grade 10 pupils of secondary school), indicates that even these activities can serve as a functional test of the occurrence of fatigue, which was found in previous studies (Fig.1).

Table 1

Average values of physiological parameters

Subject	BPs1	BPs2	BPd1	BPd2	HR1	HR2
SVV	123,83	125,18	71,67	73,09	75,5	81,27
SMR	131,80	130,60	81,47	77,87	90,73	92,53
SMM	134,27	131,36	81,93	73,64	94,6	89,14
SBK	116,93	110,54	71,57	71,08	66	67,38
MOR	128,36	123,1	72,73	76,40	73,45	83,90
RYI	114,17	109,33	84,50	119,80	72,00	69,80

Note: **BPs[1]** and **BPs[2]** - blood pressure, systole, before and after the test, mm Hg, **BPd[1]** and **BPd[2]** - accordingly, blood pressure, diastole, mm Hg, **HR1, HR2** - heart rate, to and after testing.

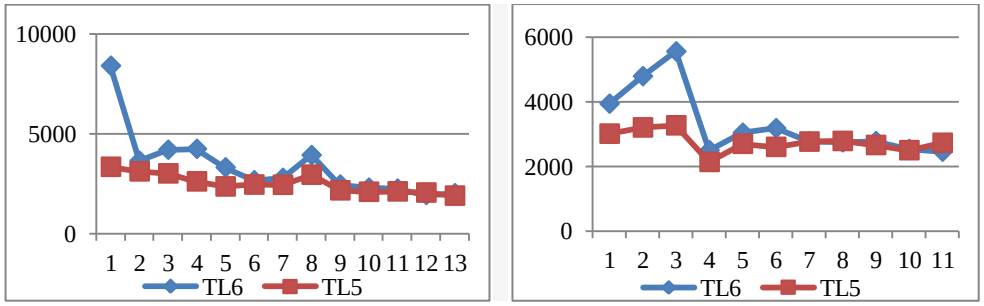

Fig. 1. Daily dynamic run-time tests of two subjects. On the axis: *abscissas* - days of test performance, *ordinate* - the average task time performance in tests T6 and T5, ms.

It was significant increased in heart rate in the first of the testers, while, as in other myocardial activity is, on average, unchanged. This subjective assessment of mood under the influence of the test after the end is more stable comparing to the original state (just after the last lesson). Thus, different tendencies of objective performance changes, self-assessment and physiological changes in time, under learning and external factors impact need to be accounting as the comprehensive approach in education process to increase its efficiency and to reduce negative its negative impact on students' health

They were confirmed data regards the high self-descriptiveness of fluctuation structure of test tasks performance in relation to the physiological "cost" of performance and subjective assessment of mood and capacity. It was revealed impact of learning process impact on subjective and objective state of school children over work(learning) day: raising heart disturbance (including extra-systoles), blood pressure deviation from the norm, subjective decrement after school hours activity etc. Ergonomic problems and possible solutions to avoid those abnormalities are topic for discussion.

FUTURE WORK

More research needs to be conducted in order to develop and to standardize learning conditions including workplace environment (physical conditions, posture,

physical relaxation, mental and physical workload allocation and optimization). Special orthopedic chairs (produced by Kulik System Ltd. for children of different age) usage to solve above mentioned tasks is provided currently at one school in longitude experimentation.

CONCLUSIONS

Human activity is accompanied by creation and maintenance of functional systems that could be described by the conceptual model of learning activities, including motivation and memory associated with the model objects is a necessary condition for updating functional systems activity.

The special ergonomic principles for learning workspace design should be accounted to avoid possible negative impact of learning environment on students.

Unbalanced paths and thus the strain of regulatory mechanisms of student adaptation to learning activity may be the cause of functional impairment and eventually the case of violations of health student. They arise especially clear after classes (school time) when deviate changes in a student's psychophysiological state become significant.

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