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# The problem of timely training and retraining of workforce and innovative methods of the problem solution

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**Abstract.** The subject of the article is urgent due to fast rates of occurrence of new specialities and the corresponding demand for specialists, on the one hand, and long and inefficient cycle of training of a limited number of specialists with lack or small number of new knowledge possessors. The core of the problem is insufficient quantity of specialists in demand training for a long time, exceeding the time of implemented process cycle change. The objective of the research is to define the problem of timely training and retraining of workforce in educational institutions and offer innovative ways of the problem solution. The tasks of the research are to describe traditional educational processes implemented nowadays and determine the existing deficiencies, to define the problem of timely training and retraining of workforce and offer innovative methods of solving the problem of workforce timely training and retraining. The research is based on such methods as the method of data analysis, method of psychophysical analysis, theory of image identification, probability theory and methods of segmentation analysis. The offered and patented innovative methods contribute to improvement of the quality of training by means of optimal combination of complexity of material studied and psychophysiological parameters of trainees and expansion of teacher's capabilities in efficiency control of training impact. Within the framework of the present article, the objectively existing problem of training and retraining of workforce was stated and innovative methods of its solution that are totally new in the world, technically implementable and applicable in practice were proposed.

## 1. Introduction

Presently, educational science covers a significant number of techniques and methods of organisation and implementation of training as applied to standard situations. The majority of methods and techniques imply availability of teacher's vast experience and talent [1], but even this does not guarantee successful results [2]. The majority of teachers implement training with the use of forms and methods more suitable to an ideal situation [3]. With new technologies occurrence, within the time less than that of training presently set, even outstanding teachers cannot change the situation [4].

The problem is urgent due to the fact that presently everywhere one can see misbalance between the time of introduction of principally new technologies [3] and substantially longer time of training of the corresponding workforce [5]. At that, there is a tendency of increasing this discontinuity [6]. This retards development of all economy branches [7], especially prospective and critical ones [8].



The objective of the research is to set the problem of timely training and retraining of workforce in educational institutions and offer innovative ways of the problem solution.

Research tasks are as follows:

- description of traditional educational processes implemented now and identification of existing deficiencies
- determination of the problem of timely training and retraining of workforce
- systematisation and description of factors having impact on educational processes
- proposition of innovative methods of workforce timely training and retraining problem solution.

## 2. Methods

The research is based on such methods as the method of data analysis, method of psychophysical analysis, theory of image identification, probability theory and methods of segmentation analysis.

## 3. Problem setting

Timely educational process features a number of factors as follows:

- Classrooms are not well equipped with software and hardware for quantitative assessment practically in real time scale providing quantitative evaluation both of individual psychophysiological status of training participants and general parameters of local groups or all the trainees.
- Teachers are preparing the training content and methodical materials without taking into consideration the psychophysiological status of trainees and their readiness as they do not obtain the necessary information due to lack of the corresponding software and hardware [9];
- There are no methods and means of objective, individual testing of trainees for determination of the scope, contents and structure of previously obtained knowledge.
- State-of-the-art, for example, additive processes implemented in industry are not studied in timely manner, as in educational institutions there have been no teachers associated with them for a long time already [10].

Thus, there is a problem of workforce training and retraining in current socio-economic and technological environment.

The objective basis of the problem is fast rate of occurrence of new specialities and related demand for specialists, on the one hand, and long and inefficient cycle of training a limited number of specialists with lack or small number of new knowledge possessors, on the other hand [11].

The core of the problem is insufficient quantity of specialists in demand who are trained for a long time, which exceeds the time of implemented process cycle.

The main cause is mass copying of inefficient teaching processes implemented with experienced, talented professionals available only with a lack of true quantitative data on current psychophysiological status of training participants [13] and on results of previous training [12].

Theory is taught with the use of traditional educational means and methods.

The basic core of traditional education may be presented as follows:

- the data medium contains some volume of structured data  $W_i''$
- the trainees obtain potential capability of learning some data  $W_i^0$  with a change in its structure, and in the simplest case, without a change
- it is supposed that the process of data transfer is carried out without losses and distortions with

a certain speed  $V$  within time  $t = \frac{W_{\Pi}}{V}$ .

Training features a number of allowances and limitations as follows:

- The process of learning for each trainee does not depend on a similar process for the rest of trainees.

- The potential scope of knowledge distribution is substantially larger than that of the knowledge to be gained.
- The scope of teacher's knowledge shall be larger than the summary scope of initial knowledge of the trainees; otherwise, there will be no knowledge transfer (from high concentration to low one).
- Psychophysiological parameters of the trainer and the trainees are not evaluated quantitatively, hence they are not taken into consideration.

It is natural that training situations differ from the ideal model.

Let us consider principally significant factors as follows:

- The potential capability of gaining knowledge may principally differ with the assigned majority of the trainees  $(W_i^n \neq W_j^o)$ ;  $K_o = \frac{W_i^o}{W_j^o} \in (0; \infty)$
- The channels of data reception feature practically discontinuous variability, i.e. the rate of gaining knowledge may substantially change within the time less than the time planned for a session,  $V_j^o = f(t), t < T_s$
- The rates of information obtaining for all the trainees are different in general case, and the options of their change may or may not depend on the status of other trainees.
- The rate of knowledge transfer is not constant and depends on many factors, and, first of all, on psychophysiological status of training participants;
- Each trainee might receive information via “n” channels consequently or simultaneously.
- The consumption rate of the training content depends on many factors, but the most significant ones are: content structure, thesaurus, the structure of previous information and psychophysiological status.
- The trainer status and the trainees' statuses at an assigned moment of time,  $t_i$ , depend on the statuses at the previous moments of time  $t_{i-1}$ , i.e. there is a significant after-effect, which is, besides, individual.

Within a long period of time and up till now, technical equipment of the places of training has not in fact been changed. One cannot seriously accept variations of board size and materials. Even total introduction of multimedia equipment does not substantially influence the results of training, and often, with unskillful usage, may substantially lessen the training efficiency.

At the same time, means and methods of recording and consequential processing of psychophysical parameters have been developed and technically implemented [14], including remote means and methods, but the results received have not been adapted to training [15].

With substantial enlargement of the scope of knowledge, its more complex structure, and practical invariability of anthropological and psychophysiological parameters of potential participants of training, two trends of eliminating controversy are implemented: extension of training time and transition to subspecialty. These are, so to say, “dead end” options, as life duration grows, but with substantially lower rates, and variability of labour market requires not subspecialty, but the basic educational platform providing increase of the quantity of probable options of an employee potential usage.

From the economic point of view, extension of training time leads to increase of training cost and, consequently, efficiency becomes lower. Implementation of subspecialty options with great variability of labour market requires more frequent retraining and thus, additional expenditures.

#### **4. Innovative methods of solution of the problem of workforce training and retraining**

Presently, there exist conditions for real-time and remote implementation of new training technologies based on consideration of the main psychophysiological parameters of training participants.

The educational content can be presented in different forms, but the main channels of receiving information are visual and audio ones.

The training participants (including the trainer and the trainees) might feature a number of psychophysical and biomechanical parameters, most of which are not consciously controlled by man, including the following ones:

- breathing rate
- heart rate and its variability
- temperature of various parts of the body and thermal radiation
- blood pressure
- parameters recorded in EEG
- voice responses
- motor performance of various parts of the body and mimic response
- blood contents
- skin resistance
- parameters featuring eye movement (eye position, motion trajectory and glance fixing duration).

In traditional pedagogy, and furthermore, in up-to-date educational approaches, informational technologies are more and more widely used, neuro-linguistic programming know how is introduced intensely covering representative systems of the trainees and trainers.

As to the nature of dominating modality of data presentation, representative systems are divided into visual one with eyesight dominating, audio one with hearing dominating, and kinesthetic one with motor sensations dominating etc. Through visual organs, visual information arrives at the human brain, which makes about 70% of all the perceived information, that's why the visual representative system is dominating for man.

Object and phenomena perception takes place by means of effect of object and phenomena attributes on human organs of sense perception. Perceptive actions are the main structural units of human perception. While solving the tasks of perception, the trainee carries out a number of actions at perceptive level, such as differentiation, identification, understanding etc. Result of perceptive actions is generation of subjective and adequate reflection of reality or, purposefully, an illusion generated by trainee in his conscience. Thanks to structurally placed perceptive actions undertaken by trainee with teaching material, the trainee can monitor the quality of such material, including its rejection or substantial change.

Receptive actions are actions on receiving information. Receptive actions relate to such actions which are performed by the trainee with information prior to its perception and extracting of the necessary information.

Visual components of information presentation of teaching materials are as follows: screens, light projectors, PC displays, letter-digital and graphic images, animation effects, colour, light intensity etc. The elements of visual information carriers have psychological effect on trainees, and the time for understanding the teaching material information from visual information carriers substantially effect the total level of teaching and academic progress.

Beside the leading visual system, trainees receive information via other channels, as a rule, parallel in time. First of all, they get it with the use of hearing sense. Acoustic channel of information transfer is implemented with the use of a trainee's vocal apparatus, means of gaining, correction and transfer of audio information.

The total level of academic progress depends on many characteristics of teaching material presentation, firstly, on the following:

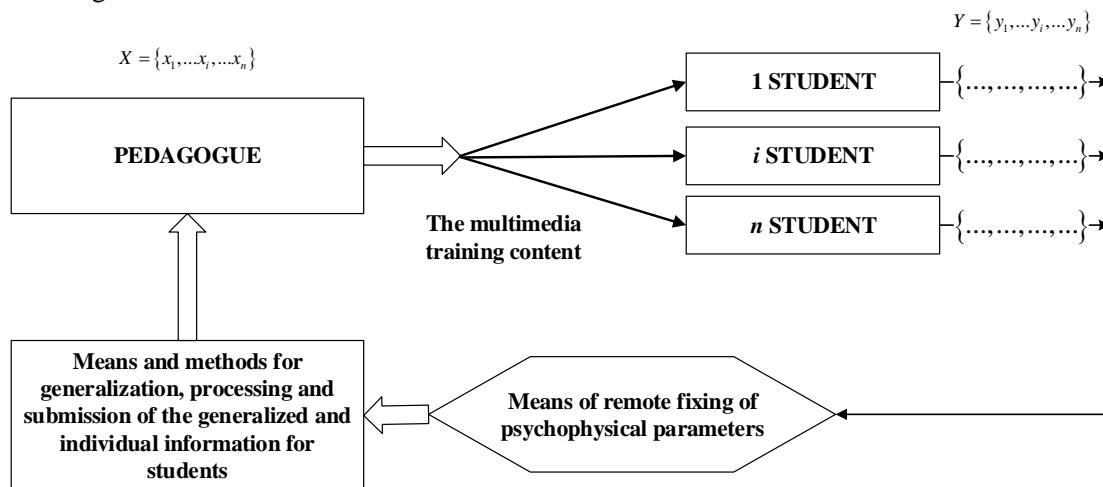
- total scope
- presentation rate of training content
- parameters reflecting complexity of structure of the training content
- the number of key words
- complexity and logic of key notion interrelation
- visual illustrations complexity level

- a set o colours of graphical images and their intensity
- sound level, rate and legibility.

Presently, a new trend, psychophysics, is being intensely developed. According to [16], psychophysics is a science studying relations between stimuli and sense responses.

Thus, psychophysics is a science studying interaction between objectively measured physical processes and subjective mental experience.

The generalised diagram of pedagogical process taking into account parameters of effect and remote element wise recording of trainee's responses at the level of consciously uncontrolled psychophysiological parameters and its presentation in generalised and individual form to trainees is given in figure 1.



**Figure 1.** Generalised diagram of pedagogical process.

Practically, “black box” exploring concept is being implemented on the basis of analysis of input and output parameters,  $Y$ .

The concept of “efficiency” is, as a rule, the ratio of costs and the result received. According to the part relating to pedagogy, increase of economic efficiency might be described as improvement of the result with unchangeable expenses or maintaining the existing result at expense reduction. For example, if one and the same programme is understood by the trainees in one group within 2 academic hours, and within 4 hours in another group, it is evident that more efficient training process has been implemented in the first group.

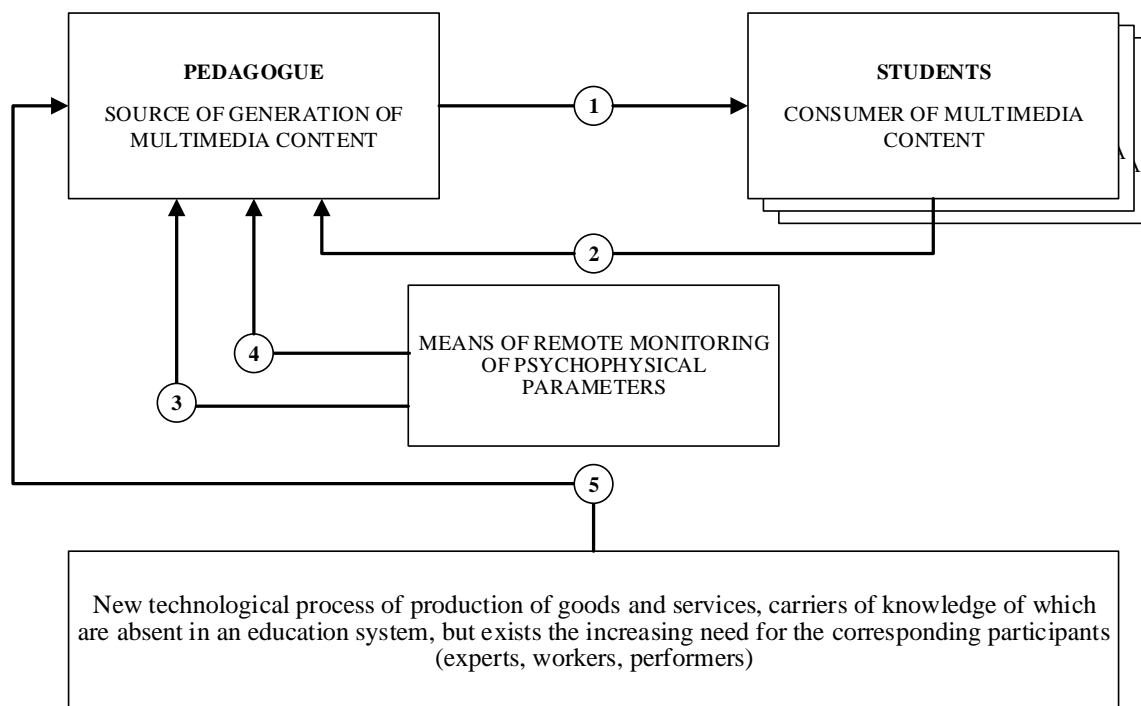
The direct profit of a university is to reduce time of training, increase its efficiency, improve quality and results, and also to cut short irrational spending of intellectual labour of the trainees.

Thus, the aim is trainees' understanding of the assigned information (teaching material) scope within minimal time.

Reduction of the time of understanding the teaching material by trainees contributes to increase of the productivity of pedagogical labour, and, consequently, leads to reduction of training load, decrease of labour costs.

The authors of the article prepared and offer innovative methods developing psychophysics and pedagogy on the basis of state-of-the-art technologies. The methods are aimed at increase of efficiency of training and, as a consequence, economic efficiency both of organisations implementing educational process and organisations manufacturing goods and services, and finally, the Russian Federation economy.

The composition and structure of methods developed are given in figure 2 taking into account the part and place in the generalised diagram of generation, transfer and consumption both of useful and harmful multimedia data content.



**Figure 2.** Part and place of developed methods in educational process.

At that, graphical presentation corresponds to the following patented methods:

- 1) Method of providing protection of automated systems (RF Patent No. 2477881 dated 24.11.2011) [17];
- 2) Method of diagnostics of intellectual potency of trainees (a group of trainees) and consequential correction of training effect (RF Patent No. 2523132 dated 10.11.2011) [18];
- 3) Correction method of time distribution for presentation of visual training information (RF Patent No. 2644329 dated 19.04.2017) [19];
- 4) Correction method of contents and scope of information of teaching material (RF Patent No. 2649289 dated 01.06.2017) [20];
- 5) Correction method of biomechanical parameters of team rowing technique (RF Patent No. 2630436 dated 29.04.2016) [21].

## 5. Conclusions

Firstly, the problem of timely training and retraining of workforce objectively exists, and it is extremely urgent for all the sectors of economy.

Secondly, traditional educational processes have substantial disadvantages, which hinder achievement of required levels of efficiency of educational activity of institutes that causes necessity of rectification.

Thirdly, the developed and patented innovative methods contribute to improvement of the quality of training by means of optimal combination of complexity of material studied and psychophysiological parameters of trainees and expansion of teacher's capabilities in monitoring the efficiency of training impact.

Thus, within the framework of the present article, the objectively existing problem of training and retraining of workforce was determined, and innovative methods of its solution that are new in the world, technically implementable and applicable in practice were proposed. This means that the goal set has been achieved and the tasks have been solved.

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