Multiparameter Control of Schoolchildren's Mastery of the Basic Educational Program

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Abstract. Based on the requirements of the educational standards, groups of parameters were revealed, according to which educational achievements should be monitored. It includes assimilation of theoretical material, the performance of tasks and exercises, the performance of laboratory and practical work, the intersubject skills, personal development, health. Information systems (IS) used in educational practice have a problem of insufficient quality in terms of functional completeness, namely, they provide control only for half of the required groups of parameters. Increase in functional completeness of IS can lead to significant increase in size of the data which are stored in system. Consequently, the processing time of monitoring results also increases, which reduces the productivity of IS. The article considers the problem of improving the quality of the functioning of the information system of multiparametric control of schoolchildren's educational achievements. Within the framework of the subject domain modeling, using the principles of such general scientific methods of research as structural and morphological analysis, a model of the object structure of schoolchildren's educational achievements has been created. It has the form of a morphological hierarchical tree and includes more than 80 educational results to be collected, stored and processed. The analysis of the time of formation of a report with a multiparametrical mark of the schoolchildren was carried out. The conclusion is drawn that in scales of the subject of the state temporal time delays will have unacceptable value. The method of increase in system performance is applied, namely - the denormalization used for optimization of the diagram of data storage. Results of an experiment according to productivity of the developed information system showed efficiency of the applied method.

1. Introduction
Many researches are devoted to improvement of the existing instruments of control of basic educational program. At the theoretical level – it is N.O. Verbitskaya [1], M.M. Potashnik [2], E.A. Yamburg works [3], D. Sh. The sailor [4], V. P. Bespalko [5], V. I. Zvonnikova [6], J.D. Bransford [7], L. S. Fuchs [8], on experimental – development of new control devices: intelligent control systems of knowledge and abilities [9], systems of adaptive testing [10], expert systems of the analysis of knowledge [11]. It is possible to distinguish from the foreign systems devoted to control of educational achievements "Cito Monitoring and Evaluation System" [12], "WebPhysics project" [13], "PLATO® Pathways Learning Management System" [14], "to Praxis II Physics: Content Knowledge (0265) Exam Flashcard Study System" 15], "Illinois Certification Testing System" [16], "Georgia Online Assessment System" [17], "AIMSweb® Benchmark and progress monitoring system" [18].
The analysis of the information systems existing in Russia showed that there is a problem of their insufficient functional completeness [19]. The functional completeness of information systems which is one of indicators of their quality is understood as the number of the automated functions [20]. Five of the most widespread systems ("NetSchool", "KnowledgeCT", "Monitoring", "Porcupine", "MS School") provide control only on a half of the required groups of parameters.

Before us there was a task to find scientific approach to exarticulation of educational achievements of schoolchildren which need to be controlled, and to their representation in this or that look suitable for automation of control and design of an information system. Considering that controlled parameters there will be about one hundred, and functioning of an information system of multiparametrical control is supposed at the level of the region of the country, there is a requirement to system without time lags to perform the functions.

2. Problem of quality of functioning of an information system
Increase in functional completeness of an information system due to implementation of requirements imposed to system can lead to decline in quality of its functioning, one of indicators of which is productivity, namely to growth of number of entries in the database and increase in time of their processing to unacceptable for participants control - estimated activity of value. Understand time between presentation to the system of entrance data and emergence of the relevant output information as productivity of an information system [21]. In our work - this time of formation of multiparametrical assessment. Therefore prior to the beginning of a designing process of an information system ways of increase in its productivity are analysed. The most correct approach will be initial optimization of structure of the database even prior to development of application programs. Time spent for optimization of structure of the database will reduce costs for development and debugging of a program code [22].

3. Modeling of subject domain
From the point of view of structural modeling of subject domain the model of object structure of a subject of the automated control is constructed. This model is developed with application of one of parts of a morphological method of a research – the morphological analysis. All significant classification signs of results of development by pupils of the educational program are marked out. 1. Subject results (studying of a subject matter on the example of "Physics" according to the educational standard is directed to their achievement). 2. All-educational results (intersubject concepts and universal educational actions). 3. Personal results (components of structure of the personality according to K.K. Platonov). 4. Results of education (behavior).

The structural method of scientific research is at the same time applied to reveal the results of control which are characterized by hierarchical subordination (Fig. 1).

4. Optimization of the scheme of data storage
The analysis of time of formation by an information system of multiparametrical assessment of achievements of the pupil showed that formation time the system of multiparametrical assessment depends on search time in tables of the database of records about results of each of control stages. Provided that the information system will function in region scales, time of formation of multiparametrical assessment will be considerable (Table 1). However, if to enter additional tables into the database, then time has to be reduced. For example, if along with the magazine of results of the stage-by-stage solution of tasks to keep the magazine of results of the solution of tasks, then time of formation of multiparametrical assessment decreases seven times as the solution of a task includes performance of seven stages.

The analysis [23], [24] showed that the intended introduction of redundancy to the scheme of data for increase in productivity of system called by a denormalization is one of effective methods of increase in productivity of information systems. Excess or additional storages contain results of preprocessing of data. Their introduction, on the one hand, increases time of preprocessing of results of con-
trol, but, with another, considerably reduces time of formation of multiparametrical assessment that is especially relevant on big arrays of data.

The model of object structure of educational achievements of the pupil represents a morphological and hierarchical tree, includes more than 80 results of education which are subject to control. Further modeling allowed to receive magazines of control to a stage of modeling of structure of the database.

5. Experiment
Realization in an information system of seven subsystems of control, such as, the subsystem of control of digestion of theoretical material, ability to solve problems, to perform laboratory works, creative abilities, development of all-educational skills, personal development, behavior and health, allowed to increase functional completeness of an information system to 87.5% that is 37.5% more, than at the existing systems. Introduction of the created system in educational process at school allowed to increase proficiency studying as 13% [25].

Time spent for formation of multiparametrical assessment on the basis of the database with the optimized structure is 4 times less, than with the database without optimization (Table 1). Conditions and the detailed results of an experiment are described in [25].

The received results coincide with results of researches of other authors. For example, in a research "A hierarchical denormalization: possibilities of optimization of the scheme of data storage" M. Zaker, S. Phn-Anmuaisal, Su-Cheng Haw is shown that use of a method of a denormalization improved system response time on specialized inquiries by 10 times [26].
Table 1. Final results of an experiment.

| Parameter                          | Selection on one class | Selection on one school | Selection on to schools of the city | Selection on schools of the region |
|-----------------------------------|------------------------|-------------------------|------------------------------------|------------------------------------|
| Number of pupils                  | 20                     | 800                     | 16000                              | 412 800                            |
| Number of entries in the database | 6800                   | 272 000                 | 5,44 m.                            | 139,3 million                      |
| Time $t_1$, s                     | 0,005/0,004            | 0,053/0,0408            | 1,678/0,561                        | 3,302/1,293                        |
| Time $t_2$, s                     | 0,001/0,001            | 0,069/0,0031            | 1,382/0,052                        | 4,861/0,324                        |
| Time $t_3$, s                     | 0,001/0,001            | 0,001/0,0028            | 0,018/0,047                        | 0,097/0,111                        |
| Time $t_4$, s                     | 0,001/0,001            | 0,002/0,002             | 0,04/0,045                         | 0,175/0,207                        |
| Total                             | 0,008/0,007            | 0,125/0,0487            | 3,118/0,705                        | 8,435/1,935                        |
| Data processing time on all pupils| 0,16/0,14 s            | 100/39 s                | 13,8/3,1 hour                      | 40,1/9,2 day                       |

6. Conclusions

By means of such methods of scientific research as morphological and structural, parameters of control of educational achievements of schoolchildren are revealed and are presented in the form of a morphological and hierarchical tree. As a result of such modeling tables of the database of an information system multiparametrical control of educational results of schoolchildren are received. When functioning system at the level of the region the database contains a huge number of data. That the system generated multiparametrical estimates of schoolchildren without temporary delays, the problem of increase in its productivity at the expense of a database denormalization is solved. Additional tables contain already processed, intermediate data, but their addition allowed to accelerate work of system several times. Thus, the created information system allows to generate for each schoolchildren multiparametrical assessment which contains full, detailed information on his achievements on 80 parameters and individual recommendations for it. The pedagogical experiment showed efficiency of the offered tool.

7. References

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