Information and analytical system for assessing the quality of planning and monitoring of the process of teaching students during the semester

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Abstract. Monitoring the student learning process is the basis of feedback in the management of the quality of specialist training, which determines its relevance and relevance. The aim of the work is to develop a model of continuous monitoring of the quality of student training in the semester in the context of student-teacher interaction. The monitoring is built on the basis of a special mathematical model that allows solving problems of forming the recommended student assessment and assessment of the teacher’s performance discipline implemented in the corresponding information system. Formation of the recommended assessment of a student in a discipline is carried out as an accumulation from individual stages of a discipline based on data grouping methods, work with associative data sets, data convolution, database manipulation. Statistical methods allow to monitor the performance discipline of university teachers on the basis of numerical convolutions, getting it in measurable indicators. Thus, a feedback model in the student-teacher chain was obtained, which is necessary to substantiate management decision-making in the educational process.

1. Introduction
Planning and monitoring the educational process of a university largely determines the quality of training. Further, we will consider one of the aspects of planning the educational process, namely, the evaluation of the educational achievements (performance) of students and the quality of this monitoring on the part of teachers, which is one of the most important tasks of the learning process. The purpose of this work is to develop a mechanism for continuous monitoring of teacher assessment of students during the academic semester based on the active use of information technology. The most effective monitoring mechanism is the point-rating system (Bolotov V.A., Efremova N.F. [1], Ershova O.V. [2]). The attitude of the students themselves to the point-rating system is interesting, in the work of N.G. Dairy. (1998) [3] shows results of aketization that testify to a positive attitude of students, (over 72% positive responses) to the introduction of a point-rating system, which noted such factors as visibility, evidence of assessment, firmly established “rules of the game”. Modern researchers (2017, Shalova S.Yu. [4]) cite data that about 73% of students noted the following advantages of a pointing system: reducing the impact of luck on the exam, increasing knowledge control during the semester (this encourages regular training), transparency of the assessment system, lower stress levels before the exam compared to the traditional system.
At the present stage of development, it is the application of information technologies, in particular, WEB technologies, that allows to ensure information openness and transparency of the rating system, which allows a more objective assessment of the level of students' academic performance and skills. For the practical implementation of this, it is necessary to develop a supporting information system that implements all the necessary communications in the teacher-student scheme and automates mathematical calculations [5]; requirements for such systems in modern conditions are formulated in the works of N. Novikova [6], Anikina O. AT. [7], Bogdana N.V. [eight]. It is obvious that the quality of the introduction of a point-rating system is determined by the quality of its planning by the teacher. Thus, the objective objective becomes the objective control of this planning and the control of the teacher’s performance discipline for its implementation, the algorithm of which is created by the authors on the basis of a graphical representation and is original. The developed information system assesses the quality of the planning of the educational process by the teacher and offers a recommended assessment calculated by the methods of mathematical statistics that takes into account all types of student’s planned work, and also determines the numerical characteristic of the teacher’s work. The models described in the article develop the ideas of the authors presented by them earlier [9].

The practical result of the introduction of an information system that creates a monitoring mechanism for teachers to set grades during the academic semester is to improve the quality of education of students at the university, which was confirmed by experimental use at one of the faculties of the Samara State Technical University [10].

In the study applied the methods of mathematical statistics, grouping big data and data convolution. During the development of the information system, the task of network work of many users was solved, their synchronization and delimitation of user rights. Also, an important task was to choose the optimal strategy for storing large amounts of data based on minimizing their volume while maintaining the necessary access speed.

2. Formulation of the problem
Monitoring the student learning process is one of the most important prerequisites for managing the learning process. At the same time, management of educational processes prevents from going beyond the boundaries of curricula. A large amount of information (Table 1) requires the development of an information system.

It is necessary to monitor the work of the faculty. As an example, consider the work of teachers of one of the faculties of the Samara State Technical University (SamSTU) in the fall semester of the 2018/2019 academic year.

3. Description of research object
In SamGTU, the reference university of the region, it was decided to create a cumulative system of achievement and the development of an appropriate information system.

The information system for forming the cumulative (cumulative) evaluation of students' academic achievements was developed and introduced into pilot use as part of training bachelors and specialists in the 2016/17 academic year as a first year student of the Faculty of Mechanical Engineering, Metallurgy and Transport, and in the 2017/18 academic year as a first year SamSTU, in 2018/19, on the first and second courses of SamSTU. Quantitative characteristics of the implementation volume are shown in Table 1 and Figure 1.
Table 1. Quantitive characteristics of the volume of implementation.

| Year     | Faculty | Number of groups | Number of students | Number of departments | Number of disciplines |
|----------|---------|------------------|--------------------|-----------------------|-----------------------|
| 2016/17  | 1       | 14               | 238                | 11                    | 17                    |
| 2017/18  | 15      | 120              | 2401               | 32                    | 41                    |
| 2018/19  | 15      | 213              | 4935               | 59                    | 158                   |

As follows from the data presented, the coverage of students and academic disciplines monotonously increases, which indicates the relevance of the work and its relevance.

4. Assessment of students
The recommended grade for a student in a discipline is calculated based on a cumulative grade. The cumulative assessment of the student is a standardized value (in percent) and is formed as the ratio of the sum of the student's grades by stages (themes) of the development of academic disciplines to the maximum possible sum of these assessments. To implement a cumulative (cumulative) approach to assessing knowledge, it is proposed to highlight logically completed blocks and stages in an academic discipline, formulate requirements for their level of mastering, estimate the weight of each block in points, and make up the student’s recommended timeline for their delivery by discipline. Often, the notion of a control point is used to designate blocks (stages) of a discipline. The difference between the mastering stage and the control point is the linking of the stage to the logic of studying the discipline and the possibility of adjusting the assessment in the future, and not to simply controlling the level of mastering the discipline on a strictly specific date. This does not require an additional effort from the teacher, since all the work necessary for this should already be carried out by the teacher when drawing up the work program of the discipline (module).
A feature of the developed information system is the flexibility to evaluate the individual stages and to take this assessment into account when forming the cumulative recommended rating (table 2). Individualization is ensured by the fact that individual stages can be assigned to students individually, and not the whole group. To solve the problem of simultaneous work of several teachers in one group, it was proposed to create common stages (for all teachers and the whole group) and special (individual for individual students and, accordingly, teachers).

### Table 2. Types of evaluating the stages of studying discipline.

| Type of evaluating the stage          | Estimation features                                           |
|---------------------------------------|---------------------------------------------------------------|
| Simple assessment                     | Setting the maximum possible score                            |
| Assessment with a minimum passing score | Setting the maximum possible score and the minimum score, up to which the stage is considered undeveloped |
| optional assessment                   | Adding the highest possible score, but this value does not go to the denominator in the calculations |
| Evaluation through testing            | Setting the maximum possible score and assigning a computer test for assessment |

Mathematically student cumulative score is determined by the formula.

\[
M = \frac{\sum_i B_i K_i^b (1 - K_i^l) K_i^d}{\sum_i B_i^{max} K_i (1 - K_i^l) (1 - K_i^s) K_i^d}
\]

(1)

Where:

- \(M\) – student’s cumulative score for the discipline;
- \(i\) – number of control point;
- \(B_i\) – student’s score on \(i\) – stage;
- \(B_i^{max}\) – the maximum possible score (weight) for the \(i\) – stage;
- \(K_i^b\) – sign (1, if \(i \in I^b \cup I\)), that \(i\) – stage must be mastered by a student;
- \(K_i^l\) – sign (1, if \(i \in I^l\)), that \(i\) – stage should not be mastered by the student;
- \(K_i^s\) – sign (1, if yes), that \(i\) – stage is bonus;
- \(K_i^d\) – sign (1, if yes), that \(i\) – stage should be mastered at the current time;
- \(I^b, I^l\) – sets of stages, assigned and not assigned for studying by a student;
- \(I\) – the set of all stages in the discipline.

Thus, the proposed method gives for each time point a normalized value characterizing the student’s cumulative score, taking into account the individualization of the educational trajectory. However, to recommend an assessment, it is necessary to pass the stages for which a minimum score or no “fines” \((W = 0)\) for their failure is given.

\[
W = \sum_i W_i K_i^b (1 - K_i^l) K_i^d
\]

(2)

Where: \(W_i\) – the sign that the \(i\) – stage is mastered at an insufficient level \((1, if W_i < B_i^{min}, B_i^{min} – passing grade point)\).
In the future, the recommended rating is formed on a standard scale:

> 90% is excellent;

> 75% is good;

> 50% satisfactory;

in all other cases - unsatisfactory.

**5. Quality of planning and evaluation of efficiency of lecturers’ work.**

A numerical indicator of the teacher’s performance in the cumulative point-rating system will be the total deviation of the grades from the planned dates, related to the number of days in the semester. Table 3 presents the initial information to determine this value. In the second column of the table, the actual dates of grading of the stages of studying the discipline are shown, and in the third column, the planned ones. For clarity, the table shows the real dates for one of the disciplines of the fall semester of SamSTU. The teacher has scheduled for the semester 8 stages of the discipline, the beginning of the semester is 01/09/2018, the end of the semester is 31.12.2018 year.

**Table 3.** Planned and actual date of grading.

| № Control Point (CP) | Date of issue CP (actual) | Number of the day since the beginning of the semester (actual) | Date of issue CP (planned) | Number of the day since the beginning of the semester (planned) |
|----------------------|---------------------------|------------------------------------------------------------|-----------------------------|-------------------------------------------------------------|
| 1                    | 27.09.2018                | 26                                                         | 16.09.2018                  | 15                                                          |
| 2                    | 20.10.2018                | 49                                                         | 01.10.2018                  | 30                                                          |
| 3                    | 02.11.2018                | 62                                                         | 16.10.2018                  | 45                                                          |
| 4                    | 18.11.2018                | 78                                                         | 31.10.2018                  | 61                                                          |
| 5                    | 18.12.2018                | 108                                                        | 15.11.2018                  | 76                                                          |
| 6                    | 18.12.2018                | 108                                                        | 30.11.2018                  | 91                                                          |
| 7                    | 28.12.2018                | 118                                                        | 15.12.2018                  | 106                                                         |
| 8                    | 28.12.2018                | 118                                                        | 31.12.2018                  | 121                                                         |
Figure 2. Dynamics of the work of the teacher in the information system

Obviously, the deviation from the ideal model is the area between the schedules of the rating plan and the actual dates. In general, this value is calculated by the following formula:

\[
D = \int_0^n |F(x) - P(x)| dx
\]  

(3)

Where:

n — number of days in a semester;

F(x) — actual rating function;

P(x) — planned rating function;

Since in our case the step is 1 day, then (3) can be converted:

\[
D = \sum_{i=1}^n \int_0^1 |F_i(x) - P_i(x)| dx
\]  

(4)

Where:

n — number of days in a semester;

F(x) — actual rating function;

P(x) — planned rating function;

i — number of the day.

Additionally, the monitoring system automatically measures a number of other characteristics of the course of the educational process. A fragment of the characteristics defined on real data is presented in table 4. The data are presented in the context of student groups.

Table 4. Some statistical characteristics of monitoring the educational process.
Under the percentage of students’ interest (the last column of the table), the percentage of students in the group who visited their personal office in the information system last week is taken. An important criterion is the lifetime of the results – the number of days elapsed since the last update of the data by the teacher (the penultimate column). The remaining columns are shown in traditional characteristics.

This report is available within the information system in five sections:
– student groups;
– faculties;
– disciplines in general for all groups;
– disciplines in a separate group;
– departments.

6. The discussion of the results
Obviously, the rating model will be most appropriate when \(D \to 0\). In addition, from Table 3 and Figure 2, it follows that the actual grading is uneven. The 12/18/2018 and 12/28/2018 were exposed on 2 KT. This is permissible, but it is clear that in the period from 11/15/2018 to 12/15/2018, according to the plan, it is worth setting up three CT. In fact, we get two CT, one of which is double. These graphics can be made not only for specific teachers, but also for departments, specialties, faculties.

7. Conclusions
Thus, the information-analytical system for monitoring the process of student learning is necessary for the regulation of the work of students and teachers. Using such systems, you can optimize the work of departments, faculties, institutes and universities in general. Information systems of this type are able to optimize the management of the educational process and raise education to a qualitatively new level by increasing the motivation of participants in the educational process (students and teachers) to systematic work during the semester and significantly increase the transparency of intermediate certification of students. Thus, there appear adequate and valid parameters for assessing the work of teachers, thanks to which it is possible and necessary to form a motivational basis for the faculty of universities.

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