

INFORMATION AND EDUCATIONAL ENVIRONMENT FOR MONITORING AND FORMING A CUMULATIVE ASSESSMENT OF A STUDENT'S ACADEMIC WORK IN A SEMESTER

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Abstract. *The article discusses the use of the student's cumulative assessment system of academic progress as a valid element of e-learning in universities. Today, online learning is becoming mainstream. Training on online platforms is convenient and interesting, however, it is not acceptable for all students due to the need to conclude network contracts or lack of regulations on how to recalculate the results of online training at the university, etc. Using the cumulative system becomes the mechanism that solves the issue of e-learning at universities, including using distance learning technologies, without cooperating with the online platforms. The suggested approach is a new one. The purpose of the article is to study the electronic information and educational environment of the university to monitor the students' progress. The recommended assessment means the cumulative assessment, which reflects the consistency of knowledge of the student as a participant in the training process. The recommended assessment is suggested by the information system and is calculated using a mathematical model that considers all types of student work. The assessment becomes the main one and should be considered during an interim assessment. The study of the recommended assessment formation uses the methods of mathematical statistics, data grouping, associative data sets, data verification, database manipulation. The authors also give an optimal strategy for storing large amounts of data based on minimizing their volume while maintaining the necessary access speed.*

Keywords: *information system, monitoring, academic progress, e-learning, education quality.*

Introduction

Evaluation of students' academic performance is one of the most important tasks of the learning process. The purpose of this work is to study the mechanism of formation of the recommended student grade for the discipline on the basis of their work in the semester based on the active use of information technology.

Under the recommended grade, we will understand the grade that is formed on the basis of continuous monitoring of the student's progress (Kozlov & Sheshunova, 2013) and that is cumulative, i.e. demonstrating the systematic learning of the student. In order to introduce the mechanism for the formation of the recommended grade, it is necessary to develop a supporting information system that implements all the necessary communications in the teacher-student scheme and mathematical calculations. The recommended grade is suggested by the information system and is calculated on the basis of a mathematical model that takes into account all types of student's compulsory work (Kozlov, 2010).

The practical result of the introduction of the information system, which creates a mechanism for the formation of the recommended grade, is an increase in the absolute academic performance of students and the quality of their training due to their motivation for systematic and regular activities during the semester, and not against the clock before the exams. Any employer needs employees who will work evenly, regularly and according to a predetermined plan. A student's motivation to work systematically throughout the semester makes it possible to make them such a specialist. In addition, the assessment of a student's training on a regular basis will allow to more accurately and fully assessing the quality of their training (Ershova, 2016). Any point control in the form of an exam or a test does not allow one to assess the completeness of the student's mastery of the entire educational material in a discipline. The proposed cumulative system does not deny the intermediate control, but specifies it, allowing the teacher to make an assessment of the level of student's knowledge throughout the semester.

In the study of the mechanism of formation of the recommended grade, the methods of mathematical statistics, network programming, network security organization and delimitation of user rights, big data grouping, work with associative data sets, data convolution were applied. During the development of the information system, the problem of network operation of many users and their synchronization was solved. Also, an important task of the study was the choice of the optimal strategy for storing large amounts of data based on minimizing their volume while maintaining the necessary access speed.

Goal Setting

University training of specialists is determined by the curriculum and training strategy based on the chosen pedagogical scenarios and organizational learning model. Pedagogical scenarios determine the main types of educational activities of students and teachers (lectures, seminars, independent work, consultations, testing, written examinations, etc.), as well as methods for their remote interaction (specialized website, email, forum, chat, newsgroups, etc.) that are to be implemented as part of the e-learning system. At the Samara State

Technical University, it was decided to create a cumulative academic performance system and develop an appropriate information system (Yusupova, Alontseva, Kozlov, & Kulakova, 2017).

Quantitative Characteristics

The information system for forming the cumulative assessment of students' academic achievements was developed and introduced into pilot use as part of the bachelor and specialist programs in the 2016/17 academic year for the first-year students of the Faculty of Mechanical Engineering, Metallurgy and Transport; in the 2017/18 academic year for the first-year students; in the 2018/19 academic year for the first and second-year students. Quantitative characteristics of the volume of implementation are shown in Table 1 and Figure 1.

Table 1 *Quantitative characteristics of the implementation volume*

Academic year	Increase of the number of faculties	Increase of the number of students groups	Increase of the number of students	Increase of the number of departments	Increase of the number of subjects
2016/17	1	14	238	11	17
2017/18	15	120	2401	32	41
2018/19	15	213	4935	59	158

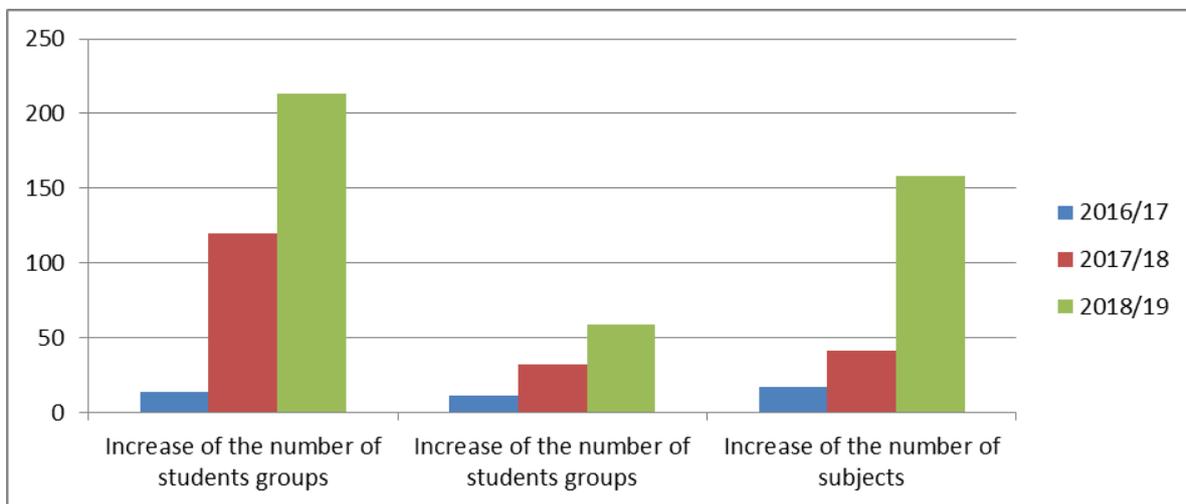


Figure 1 *Quantitative characteristics of the implementation volume*

As follows from the data presented, the coverage of students and academic disciplines monotonously increases, which indicates the relevance of the work and its essential character (Yusupova, Gubanov, & Kozlov, 2017).

Formation of Expected Estimates and Mathematical Formulas

The cumulative assessment of a student is formed as a normalized (in percent) sum of student's grades by stages (topics) of mastering academic disciplines. To implement the cumulative approach to the assessment of knowledge, it is proposed to highlight logically completed blocks - stages in the academic discipline, formulate requirements for their level of mastering, estimate the weight of each block in points and make a recommended schedule of reporting, thus creating a trajectory for teaching students in the discipline (Aleksanova & Kozlov, 2016). Often, the concept of a control point is used. 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 grade in the future, and not to simply controlling the level of mastering the discipline on a 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 working program of the discipline (module).

The developed information system is characterized by the flexibility to evaluate and take into account this assessment in the formation of the cumulative recommended assessment (Table 2).

Table 2 Assessment types of the stages in studying the discipline

No.	Type of evaluation phase	Features of assessment
1	Simple assessment	Setting the maximum possible score
2	Assessment with a minimum passing score	Setting the maximum possible score and the minimum score, up to which the stage is considered undeveloped
3	Optional assessment	Setting the maximum possible score
4	Assessment through testing	Setting the maximum possible score and assigning a computer test for assessment

Each stage has a reporting date. The valuation approach is used when forming a cumulative assessment.

In addition to various ways of assessing the stages of studying the discipline, the information system provides for the possibility of individualization as applied to the students (Kozlov, 2010). So, stages can be assigned to:

- the whole group of students;
- individual students;
- the whole group, except for individual students.

Mathematically, the process of accumulating points by a student is their accumulation (Zhuravleva & Kozlov, 2017).

$$M = \frac{\sum_i B_i K_i^{\text{вкл}} (1 - K_i^{\text{искл}}) K_i^{\text{дата}}}{\sum_i B_i^{\text{max}} K_i^{\text{вкл}} (1 - K_i^{\text{искл}}) (1 - K_i^{\text{бонус}}) K_i^{\text{дата}}}$$

where M – cumulative student score for the discipline; i – control point number; B_i – student score for the i –stage; B_i^{max} – maximum possible score for the i –stage; $K_i^{\text{вкл}}$ – the sign (1, if $i \in I^{\text{вкл}} \cup I$), that the i –stage should be mastered by the student; $K_i^{\text{искл}}$ – the sign (1, if $i \in I^{\text{искл}}$), that the i –stage should not be mastered by a student; $K_i^{\text{бонус}}$ – the sign (1, if yes), that the i –stage is a bonus; $K_i^{\text{дата}}$ – the sign (1, if yes), that the i –stage must be mastered at the current time; $I^{\text{вкл}}$, $I^{\text{искл}}$ – sets of stages, assigned and not assigned to be studied by a student; I – set of all stages in the discipline.

Thus, the proposed method gives at each time point a normalized value characterizing the student’s cumulative score, taking into account the individualization of the educational trajectory (Kozlov, 2010). However, to recommend a grade, it is necessary to pass the stages with the set minimum score or no “fines” ($\text{III} = 0$) for their failure.

$$\text{III} = \sum_i \text{III}_i K_i^{\text{вкл}} (1 - K_i^{\text{искл}}) K_i^{\text{дата}}$$

where III_i – the sign that the i –stage is mastered at an insufficient level (1, if $\text{III}_i < B_i^{\text{min}}$, B_i^{min} – passing grade).

In the future, the recommended grade is formed on a standard scale:

- > 90% is excellent;
- > 75% is good;
- > 50% satisfactory;
- in all other cases—unsatisfactory.

Description of the Information System

To implement the proposed methodology for the formation of a student’s assessment, an information system has been developed that allows the above-described algorithm to be implemented in combination with elements of interactive distance work using a student-teacher scheme (Anikina, Gushchina, & Panyukova, 2017). First, let us consider the capabilities of the information system on the part of the teacher. Figure 2 shows a summary of the discipline. Each discipline in the student group is given one line, which shows the integral characteristics: the percentage of students who have grades, the percentage of completion by stages, the distribution of marks, the date of actualization, and the number of days since that moment.

Faculty disciplines and groups

Update data 28.11.2018 Cathedra - Professor - Discipline -
 Degree - Speciality - Specialist's program -
 Department - Group -
 Course -
 Show Save faculty discipline changes

Subjects																			
N	Subject	Term	Points	Department	Group	Students	Profile	Cathedra	Professors	Date of last att.	Days since last att.	% comp. Rating	% comp. Control Point	A	B	C	D	Without rating	Not rated
1	Operation systems	1	7	EM	yy-1	9	Educational management	EM	yyPetrov@EM	2018.11.22	84	100	55	0	0	4	0	0	0

Figure 2 Summary information for the teacher

Figure 3 shows detailed information on the group (Aleksanova & Kozlov, 2015). It demonstrates the main types of control stages. For the Module Test stage, the student has attached a file with the completed test and thus, this stage is evaluated on a remote basis, the Conference stage is a bonus one and is not taken into account when calculating the maximum possible score, but is taken into account when calculating the points scored by the student and therefore only increases the score.

Discipline: Operation systems
 Lecturer: yyPetrov, EM
 yy-1, 990399-259 Educational management
 Study period: 01.11.2018 - 23.01.2019
 Auditorium hour: Lec-36, Lab-36, Monitoring: Ex, Term 1

Date updated (ГГГГ-ММ-ДД)	Mark	Outs. hour	Accumulated points	Delete Edit		Delete Edit		Delete Edit		Delete Edit		Delete Edit		Delete Edit		
				28.11.2018	28.11.2018	17.11.2018	17.11.2018	15.11.2018	15.11.2018	13.11.2018	13.11.2018	11.11.2018	11.11.2018	09.11.2018	09.11.2018	
28.11.2018				Practical work marks 10 / 4		New marks 10		New marks 5		Test marks 10 / 6		New marks 25 TEST		Conference marks 10		New marks 10
1. Student 1			21 / 65	3		10				8 report.		0				
2. Student 2	D		15 / 60	5				2		8						
3. Student 3	D		15 / 60	5				3		7						
4. Student 4	D		23 / 70	5		6		5		7						
5. Student 5			12 / 60	2				4		6						
6. Student 6			14 / 60	3				5		6						
7. Student 7			12 / 60	4				3		5						
8. Student 8			15 / 60	7				3		5						
9. Student 9	D		20 / 60	7 report.				2		10		1				

Figure 3 Information on the stages of mastering the discipline (teacher)

Ideally, the stages of studying the discipline should be determined in advance, but in practice, it is often necessary to dynamically adjust the educational trajectory (Kozlov & Sheshunova, 2013). Figure 4 shows the dialogue for creating or adjusting a discipline stage.

New

Close
Create

Date , , days

Full name:

Maximum score:

Passing score:

Bonus control point:

Control in the form of testing

▾

▾

Perform a task from the manuals on page 34 for options.

	For ALL	Individually	Besides
1. Student 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Student 2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Student 3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Student 4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Student 5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Student 6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Student 7	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Student 8	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 4 Creation and adjustment of the stage of mastering the discipline (teacher)

Figure 5 shows a fragment of the student-teacher dialogue necessary to ensure interactivity in the application of distance learning elements.

New message
Update

yyPetrov (22.11.2018 13:24:27): Good morning.

yyPetrov (22.11.2018 13:24:55): Tomorrow will be a test

yyPetrov (22.11.2018 16:14:21): You can also submit a practice report.

Student 1 (22.11.2018 16:18:17): Can i also submit a lab report?

yyPetrov (27.11.2018 11:19:37): Of course, If we have time

Student 1 (27.11.2017 11:20:28): Thank you

Figure 5 Student-teacher messaging (teacher)

Figure 6 demonstrates the capabilities of the content delivery information system. Content here is understood as theoretical material, tasks for independent work and methodological guidance necessary for remote work with the course. The information system keeps records of the use of these materials by students. This feature is an element of distance learning.

Choose File
No file chosen

[Collection of tasks](#)

[Methodical instructions](#)

Save changes

When studying the discipline, special attention should be paid to the following questions.

Figure 6 Content delivery (teacher)

On the student side, there are similar opportunities for monitoring the progress and the possibility of interaction with the teacher. Figure 7 shows the student's summary information for one semester. Here you can see information about the timeline for studying the discipline, the number of discipline hours, control, accumulated points, the recommended grade and the date of the last certification. Figure 7 shows that the Simple stage is assessed using the ON-Line test (No. 293), the result of which is scaled from a 100-point scale to a 25-point scale (stage weight). According to the test results, the statistical characteristics of the test base are calculated, which can be used by the teacher for the iterative refinement of the test base.

Student 1, yy-1, EM, 1 course baccalaureate - 990399 - EM - Educational management												
N	Cathedra	Lecturer	Discipline	Control points	Last certification	Hours skipped	Accumulated points	Mark	Term	Monitoring	Classroom hours	Study period
1	EM	yyIvanov@EM	Mathematics	0		0	0 out of 0	-	1	Ex	Lec-18, Pr-18	01.11.2018 23.01.2019
2	EM	yyIvanov@EM	Physics	6	2019.02.03	0	40 out of 67	-	1	Ex	Lec-36, Pr-18	01.11.2018 23.02.2019
3	EM	yySidorov@EM	Chemistry	1	2019.02.10	0	3 out of 10	-	1	Of	Lec-36	01.11.2018 23.02.2019
4	EM	yyPetrov@EM	Operation systems	7	2018.11.22	0	21 out of 65	-	1	Ex	Lec-36, Lab-36	01.11.2018 23.01.2019

Figure 7 Summary information (student)

Clicking on the link in the Control Points column will show detailed information on the stages of mastering the discipline (Figure 8).

Student 1 Discipline: Operation systems Lecturer: yyPetrov@EM, EM yy-1, 990399-259 Educational management Study period: 01.11.2018 - 23.01.2019 Auditorium hours: Lec-36, Lab-36, Monitoring: Ex, Term: 1									
Date	Control point	Content checkpoint	Max. score	Min. score	TEST	Your score	My files		
15.10.2018	Practical work		10	4	-	3	Choose File	No file chosen	
16.11.2018	New		10	-	-	10	Choose File	No file chosen	
17.11.2018	New		5	-	-		Choose File	No file chosen	
23.11.2018	Test		10	6	-	8	Choose File	No file chosen	
18.11.2018	New		25	-	293	0	Choose File	No file chosen	
21.11.2018	Conference		10	-	-		Choose File	No file chosen	
19.11.2018	New		10	-	-		Choose File	No file chosen	
TOTAL			65	failed	1	21			

Figure 8 Information on the stages of mastering the discipline (student)

Figure 9 shows an interface for messaging and accessing learning materials by the student.

Collection of tasks, Methodical instructions,	<div style="border: 1px solid gray; padding: 2px;"> New message Update <p>yyPetrov (22.11.2018 13:24:27): Good morning.</p> <p>yyPetrov (22.11.2018 13:24:55): Tomorrow will be a test</p> <p>yyPetrov (22.11.2018 16:14:21): You can also submit a practice report.</p> <p>I'm (22.11.2018 16:18:17): Can i also submit a lab report?</p> <p>yyPetrov (27.11.2018 11:19:37): Of course, If we have time</p> <p>I'm (27.11.2017 11:20:28): Thank you</p> </div>
<p>When studying the discipline, special attention should be paid to the following questions.</p>	

Figure 9 Content and student-teacher messaging (student)

Results of the Research Work

As a result of the pilot introduction of the cumulative system in the fall of 2016 among the first-year students of the Faculty of Mechanical Engineering, Metallurgy and Transport, the absolute academic performance increased from 27% (fall 2015) to 50% (fall 2016) (Yusupova & Kozlov, 2017). Next, it was possible to ensure the high dynamics of the implementation of the proposed system in the educational process (Table 1). The information system itself is developed in the C ++ programming language using the Qt cross-platform framework and the PostgreSQL database management system distributed under the PostgreSQL License (based on BSD and MIT licenses), and has the following advantages:

- 1) flexibility - the ability to do both full and partial distance courses; variable control and evaluation part;
- 2) transparent monitoring of the educational process in the semester;
- 3) lack of dependence on external developers;
- 4) all components are cross-platform and free.

Conclusions

In conclusion, it should be noted that the continuation of the project will increase the transparency of the educational process, reduce the likelihood of a conflict of interest, protect both the teacher and the student from possible unfounded mutual claims, and therefore ensure further development of the positive image of the Samara State Technical University in the Samara Region.

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