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Application of the Multicomponent Method of Assessment of Student's Progress in Physics

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Abstract **The multicomponent method of assessing the progress in physics of students from the Technical University of Gabrovo is discussed in the paper. It is shown that tests papers as a modern form of examining students can successfully be combined with other traditional forms of examination. In that way the teacher can get important feedback on how students understand lectures and laboratory teaching material during the semester and to adjust their work so that they can in time adapt to the necessary level. Thus, students are actively involved in the learning process, which improves the results they show at the final exam. These conclusions are based on the results of the last decade, ever since the method was introduced.**

Keywords**: examination, test, physics, students.**

I INTRODUCTION

In recent years education in the technical universities of Bulgaria has faced new challenges. The possibility for more flexibility of students and teachers and the new means of communication and information has lead to students being more demanding and has also made them more critical towards traditional methods of education and assessment of their knowledge. Moreover, the motivation of the students to do well and to receive good marks has suffered because of the difficult economic situation in the country. Students presume that the education they receive will not help them to get well paid and prestigious jobs; therefore they feel that they waste their time, do not attend classes regularly and are surprised when they do not do well in exams.

II EXPOSITION

What is more, 20 years ago several people applied for one place in the technical university, which led to better selection and competition and desire for better results. Now the situation is totally different.

On the one hand, some of the best high school students go to study abroad, on the other, because of the demographic problems in the country, the total number of students, graduating high schools decreases every year. As a result the number of people applying to study at universities in the country decreases, which leads to fewer requirements towards them, tolerant attitude towards less successful students during the course of their study, as well as allowing students with less serious and organized approach to work to get into university. Such students cannot easily adapt to the academic style of studying. The fact that they can choose whether to attend lectures or not they interpret as a permission not to attend at all; the time they are given to study on their own they use as leisure time.

In the new curricula has been reduced auditorium employment of students at the expense of extracurricular. This is because of the new requirements of ECTS which aims the introduction of the credits in the training of students. For course Physics I credits are 5, including 60 hours auditorium employment (30 hours of lectures and 30 hours laboratory exercises) and 76,4 hours through extracurricular employment. This study was prompted by the growing importance of extracurricular activity in the education of students.

Therefore as a result of all this we, as teachers of the University, introduced the multicomponent method of assessment of our students in physics.

III PRINCIPLE OF THE MULTICOMPONENT METHOD OF ASSESSMENT OF STUDENT'S LEARNING

During the first semester of their study in the university our students study Physics I (which includes Mechanics, Thermodynamics and Statistical Physics, Electricity and Magnetism, Vibrations and Waves).

The method of assessment of students in physics is based on the following three components:

- The knowledge obtained during laboratory seminars;
- Test examination during the semester;
- Written examination at the end of the semester.

Assessment of the students during laboratory exercises.

The laboratory exercises in Physics are relatively self-dependent in the common course of education in Physics. The reasons for this are the specific method of approach and the disrupted sequence of the learning process. The latter appears to be the main difficulty during the laboratory seminar. It would be easier if the theory is taught during lectures first and then followed by laboratory exercises. In the current method of approach, which is to perform the laboratory seminars in different cycles of physical experiments by small groups of students (two or three a group) this requirement cannot be fulfilled for the larger part of the

students. They have to prepare for the particular laboratory experiment by referring to a textbook in Physics or a practical handbook, which makes it more difficult for them. The work during the laboratory exercises requires that the students know the experimental set-ups and connections in the electrical circuits and the constants of various devices as well as their different ranges. They should know how to measure different physical quantities and analyze the experimental results (analytically, in tables and graphically); how to register the measured and indirectly received results together with the errors and to form and improve new habits and abilities. Besides this, they have to be careful and continuously abide by the safety rules, be concentrated and organized and be able to cope with the laboratory problems within the set deadlines.

What makes the assessment during laboratory seminars easy is the comparatively long period of direct contact between teacher and students and the comparatively small number of students in a group (10-15 students). There is constant feedback which the teacher receives every week and helps him/her form a clearer idea of the students' abilities. The teacher routinely tests the students and this routine has been long established (the Department of Physics at the Technical University - Gabrovo was founded in 1963). For example:

-The students are tested before they are given permission to work in the laboratory. They are asked suitable questions, many of which are written on the laboratory tables. They are also tested on how well they know the theory of a given physical problem, connected with the laboratory exercise. They also have to write in advance the first part of their logs for the laboratory exercise where some aspects of the problem have to be defined more precisely;

- The student's involvement during the practical work connected with the particular physical problem is taken into account;

- The students' logbooks at the end of the laboratory exercise are checked, e.g. authenticity of the received results, the data for every problem, presence of gross errors in the measurements, preliminary checks of the calculation and analysis of the measured results received by the students during the current exercise;

- The logbooks of the finished laboratory exercises (this is done during the next lesson after analysis of the laboratory problem) are handed over to the teacher. The teacher checks the calculations, the results together with their errors (absolute and percentage errors) and the correctness of the graphs. The students must present all necessary steps in the calculation of every physical value or error as well as interpret and analyze the received results.

All this gives the teacher the possibility to give an objective mark to every student for his or her work during the laboratory seminar. Besides this, when the students know in advance that their work during the laboratory seminars will be taken into account in the final exam, they get additional motivation to work better during the laboratory lessons.

Test examination during the semester

Teaching Physics requires feedback during the semester – during lectures as well as in the laboratory exercises. This can be done with the contemporary form of written examination – the tests.

In the beginning of the semester it is appropriate to give students an introductory test. From this information the teacher can get an idea about the level of the student awareness in Physics depending on what they have learned in the high school. Usually the students come from different schools (ordinary high schools, mathematics, language or technical schools) where Physics syllabi differ. Besides this the capabilities of the students applying for technical universities are different. Depending on the received results, the teacher can work individually with the students, who have serious problems. Consultation hours are very appropriate for this individual work (4 hours weekly at the Technical university of Gabrovo). The teacher can discuss problem areas with the students and give them assignments.

Thematic tests during the semester, done on completion of each part of Physics are appropriate as well. For example, for the students from the Faculty of Electrical Engineering and Electronics, these are Mechanics, Thermodynamics and Molecule Physics, Electricity and Magnetism. They are also given a test based on the laboratory seminar at the end of the semester. When at the beginning of the semester the timetable for the tests is drawn and the students know that their performance at the tests will be taken into account in the final examination, they are additionally motivated to take Physics more seriously and work harder. One needs to take into account the system for assessing the results of the tests, developed by the teachers from the department [1] and that the subjective factor in the assessment of the tests is reduced to a minimum.

These examinations are very useful for the students, because in that way students participate more actively in the educational process. They prepare for the tests and have the opportunity to use their lecture notes and textbooks, some of which are written by the teachers at the Department of Physics [2-5]. They also use handbooks with tests in Physics [6-10]. Using these handbooks students get an idea about how well they will do at the test since they can combine questions and their answers, included in the handbooks.

The examination consists of sets of tests with 15 questions each and each question has 5 answers. Every student has a different set of questions. These sets of tests include the lecture material from the Physics curriculum. The students are given 2 minutes for every question, which is 30 minutes for the whole test. During the last laboratory seminar students are given another test, which includes all the material studied during laboratory seminars.

So, the students are given 4 tests in total and the 4 marks from these tests are used for the average grade in Physics at the final examination.

Written examination at the end of the semester

The preparation of the students for the final examination is made easier since the great part of the taught material is learned during the semester thanks to the practical laboratory examinations and tests on lecture and laboratory material.

The most important in the written examination is memorizing and reproduction of the studied material. Students have to interpret and explain the physical phenomena and processes, to understand the Physics laws and their consequences and to explain the connections between the physical values. As a whole, students should have a comparatively full picture of the world.

At the final examination the students draw a piece of paper with two topics from the conspectus, which they receive during the first lecture in Physics. The topics have to be answered in writing and when necessary the students are asked additional questions afterwards. The student's written work is marked.

The final mark for the subject is calculated in the following way:

$$c = k_1 x + k_2 y + k_3 z, \qquad (1)$$

where k_1, k_2 and k_3 are coefficients, c is the final mark on the subject, x – the mark from the laboratory practicum, y – the average mark from the 4 tests, z – the mark from the written examination.

IV RESULTS

The marks the students from the Faculty of Electrical Engineering and Electronics received during the academic years 2009/10, 2010/11, 2011/12 and 2012/2013 at the Physics I examinations are given in Table 1. The values of the coefficients are: $k_1 = 0{,}3$; $k_2 = 0{,}3$ and $k_3 = 0{,}4$. The comparatively big values of k_1, and k_2 correspond to the important role of the experiment and tests during the semester in the teaching of Physics at a technical university. The formula for the final mark in the subject is explained to the students during the first lecture when the conspectus is given, as already mentioned above. In that way every student can their own strategy for achieving of better results.

We have to mention that the results, shown in column II (for the 2009/10 academic year) are received when the old system was practiced. Then the students were examined only at the final exam. The results shown in columns III, IV and V were received when the application of the multicomponent method of assessment of the students was practiced.

As an example, the distribution of the scores of the students from the group № 7 from the exam on Physics I for the academic years 2009/10 and 2011/12 are shown on the figures 1 and 2, respectively. In the academic year 2009/10 the evaluations are 21 % "poor" and 16 % "Very Good "and" Excellent". During the academic year 2011/12 all students have successfully passed the exam such as 39 % of them have evaluations "Very Good "and" Excellent". There is increase of the success with more than half unit (4,17 for 2011/12 and 3,54 for 2009/10).

Year Group №	2009/10	2010/11	2011/12	2012/13
1	2,92	3,44	3,57	3,61
2	2,75	3,25	3,35	3,48
3	3,20	3,50	3,46	3,73
4	3,12	3,50	3,43	3,67
5	3,60	4,00	4,10	4,14
6	3,25	3,78	3,83	3,91
7	3,54	4,25	4,17	4,19
8	3,16	3,71	3,90	4,05
9	3,68	4,14	4,05	4,00
10	3,32	3,42	3,75	3,81

Table 1. The average scores of the students in Physics I. Degree courses: (1,2) – Automation, information and control systems, group (a,b); (3,4) - Electronics, group (ab,);(5,6) – Power engineering and electrical equipment, group (a,b); (7,8) – Computer systems and technologies, group (a,b); (9,10) – Communication equipment and technologies, group (a,b)

In this way we are able to compare the results for the same group of students (taught during the same academic year in different subjects), as well as for different groups of students (taught during two subsequent academic years in the same subject).

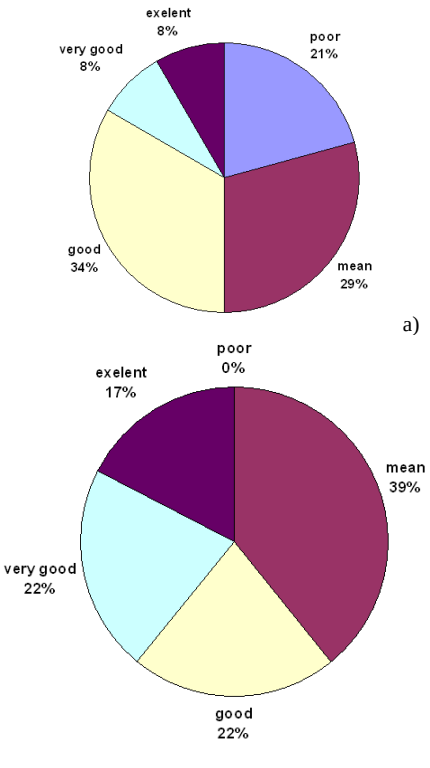

Figure1. Distribution of the scores of the students from the group № 7 from the exam on Physics I: a) for the academic year 2009/10: b) for the academic year 2011/12

Table 1 shows that the average scores of the students is significantly improved with the use of the multicomponent method - for 2009/10, 2010/11, 2011/12 and 2012/13 academic years. Our opinion is that this is due mainly to the better work of the students during the semester which helps them to build up better habits for work with the textbooks as well as to form their own strategy for better learning.

According to our study, the proposed multicomponent method for assessing the progress of students showed the following positive effects on the learning process in the discipline physics:

- Obtained a direct connection of the learning process with the credit system ECTS.
- Strengthened the role of feedback lector-students such as it acquires dimension, both in the auditorium employment and extracurricular one.
- Globally is evaluated as knowledge of students in terms of content and level of the individual modules (elements), which build the discipline physics (laboratory practicum, tests, homework, assignments, etc.).
- Allows fast response and take concrete decisions from methodological point of view.
- Expanded opportunities for individual assessment and consultation with lagging.
- Provides information to the administrative authorities of management such as group leaders to assess the state of progress of each student more during the semester, thus helps make the right management decisions.
- Is an important step towards creating the students' habits and skills for independent work and self-estimation.
- Provides opportunity to integrate specific methodological emphases and visions in university educational platform MOODLE.

V CONCLUSIONS

The implementation of the multicomponent method for assessment of the students' performance enables them to achieve more as a result of their work during the semester. This leads to improved learning of the studied material, as well as to a better quality of the educational process.

This method of assessment of the students at TU Gabrovo leads to a greater among of work for teachers and students during the semester. But there is the moral satisfaction of both sides because of the improved opportunities for achieving better results. Remains the moral satisfaction from both sides, due possibility of achieving good exam results, to refine and optimize academic work in physics discipline, which leads to enhancing the quality of education in technical universities.

VI REFERENCES

[1] Angelov N., D. Demireva, L. Lazov (2003), *Thematic test for checking the learning on physics of the students in high technical schools during the semester*, Karlsruhe, Referate des 32 Symposiums der Internationalen Gesellschaft fur Ingenieurpadagogik (pp.454 – 457),.

[2] Lazov L., N. Petrov, B. Laemmel (2002), *Physics 1: Mechanics, Special theory of relativity (second edition)*, Gabrovo, Publisher „Alma Mater International".

[3] Mihailova V. (2011), Basics of *physics, Part I and II 2*; Sofia, Publisher „Siela".

[4] Maksimov M. (2003), Basics of *physics, Part I*; Sofia, Publisher „Bulvest 2000".

[5] Lazov L., (2006), *Physics 3: Electricity and magnetism*, Gabrovo, Publisher „Alma Mater International".

[6] Angelov N., L.Lazov, P.Stoyanova (2002), *Test questions on Physics: Vibrations and waves, Optics, Quantum Mechanics*; Gabrovo, Publisher „Alma Mater International".

[7] Angelov N., L.Lazov, P.Stoyanova (2003), *Test questions on Physics: Mechanics. Special theory of relativity, Thermodynamics and Molecular Physics, Electricity and Magnetism*; Gabrovo, Publisher „Alma Mater International".

[8] Angelov N. (2004), *Test questions on Physics: Laboratory practicum. Entry level*, Gabrovo, Publisher „Vasil Aprilov".

[9] Angelov N. (2007), *Test tasks on Physics, Part I*, Gabrovo, Publisher „EX-PRESS".

[10] Angelov N. (2008), *Test tasks on Physics, Part II*, Gabrovo, Publisher „EX-PRESS".