The preliminaries and introduction of the course "Technical Mathematics", and the examination of the students' workload

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The course Technical Mathematics was introduced during the academic year of 2006/2007 at the College of Dunaújváros. I compare the course with those courses taught at a time period preceding the introduction of the new course. I examine what kind of changes happened in the average grades by contracting several courses and forcing the students to accomplish a similar course curriculum within a shorter time period.

With statistics, I illustrate the success of the course. I examine the syllabus of the course in terms of its achievability, and investigate and analyze the students' workload. With the help of the analysis of the results of the students – the 'learning outcomes' –, I search for solutions and compensations to provide better achievability of the course. At the time of this lecture I can present only a summary of the results of the national survey carried out during the Fall term, I supplement it later with the results themselves, which are connected to the topic of my future Ph.D. thesis.

Using the viewpoint of ECTS, I examine the structure of the syllabus, and propose innovations in methodology.

Keywords: Technical Mathematics, Learning Statistics, examination of students' workload, national survey

1. Introduction

I examine the kind of changes occurred due to the merge of several courses into one, and due to the fact that the students had to complete this course during a shorter time period.

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2. The introduction of the course Technical Mathematics

The course Technical Mathematics was introduced in the academic year 2006/2007. This course is one semester long and it contains those subjects which are thought separately: Probability Theory, Mathematical Methods, Mathematical Statistics. The course is composed of lectures of two hours or two-times-two hours per week (15x2 hour lectures on probability theory and statistics, 4x2 hour lectures on linear algebra), furthermore two-hour practice sessions per week (8x2 hour practice sessions on probability theory, 7x2 hour practice sessions on mathematical statistics, and 12x2 hour computer lab sessions (DF1 2006, DF2 2006, DF3 2006,).

2.1 The aim of the module "Technical Mathematics"

The main aim of the module is that the students are cognizing and acquiring the technical and practical bases of the applied mathematics subjects (linear algebra, probability theory, mathematical statistics) on such level which is indispensable for the investigation of the special subjects.

Through the using of MATLAB conceived as an aim to cognize an up-to-date mathematical software package. By the help and use of it many - related to the fields of linear algebra, analysis, and numerical methods- mathematical exercises should solve.

I won't detail the weekly exchanging and scheduling of the subject cause in 2008 I wrote it down in my gossip which issued in the publication of the Weeks of Science Conference at the College of Dunaújváros (DF4 2008, DF5 2009).

3. Experience

The fulfillment of the course depends on several factors, the course requirement is rather complex. In the next part, I introduce the average grades in the semesters before and after the introduction of the new course structure. I consider the academic year right before the introduction of the new course as the base for the comparisons for the old courses. In the following tables I summarize the distribution of the achieved grades for both semesters from that year.

Table 1. Grade credits of students in Semester 1 of 2005/2006

Semester 1 of year 2005/2006	failed (1)	satisfactory (2)	mean (3)	good (4)	excellent (5)	total number of students
Mathematical Methods	159	138	80	39	24	440
Mathematical Statistics	6	12	12	3	0	33
Probability Theory	126	153	126	95	48	548

Source: own creation

Table 2. Grade credits of students Semester 2 of 2005/2006

Semester 2 of year 2005/2006	failed (1)	satisfactory (2)	mean (3)	good (4)	excellent (5)	total number of students
Mathematical Methods	217	165	74	45	20	521
Mathematical Statistics	13	39	18	6	6	82
Probability Theory	115	172	138	98	60	583

Source: own creation

One can clearly see that the courses were attended by different numbers of students. Thus the courses could be compared only with some difficulties. Therefore, we show the next graphs with the same data, but now in terms of percentage (with respect to the total number of students) for each course.

Figure 1. The graphs for Semester 1 of year 2005/2006

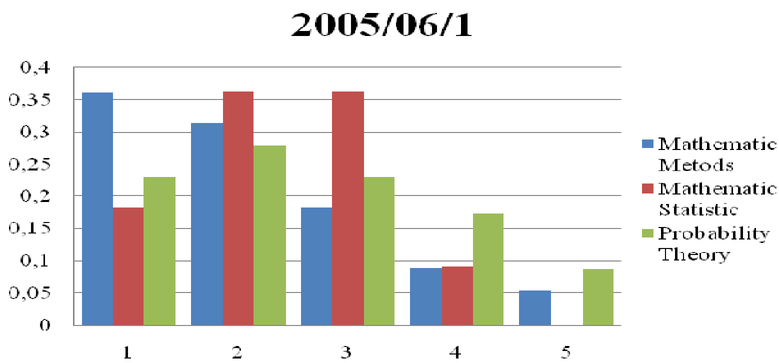

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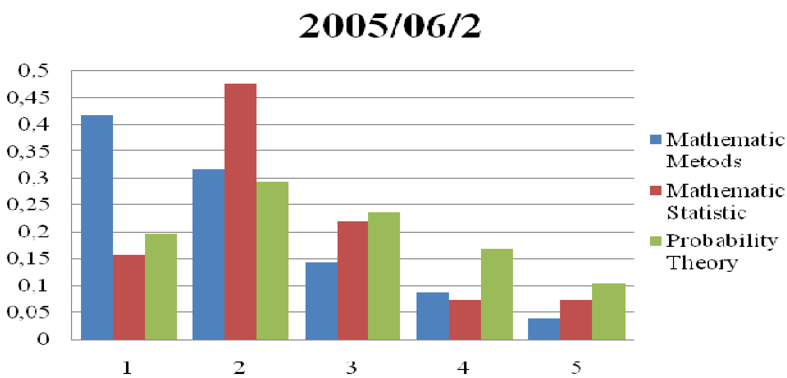
Figure 2. The graphs for Semester 2 of 2005/2006



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3.1 The results of Technical Mathematics

The course requirement is fairly complex, and hence the fulfillment of the course depends on various factors. In the next section I compare the grades of the students obtained since the introduction of the course.

For the course "Technical Mathematics" the five completed semesters give the base for comparison with the predecessor courses:

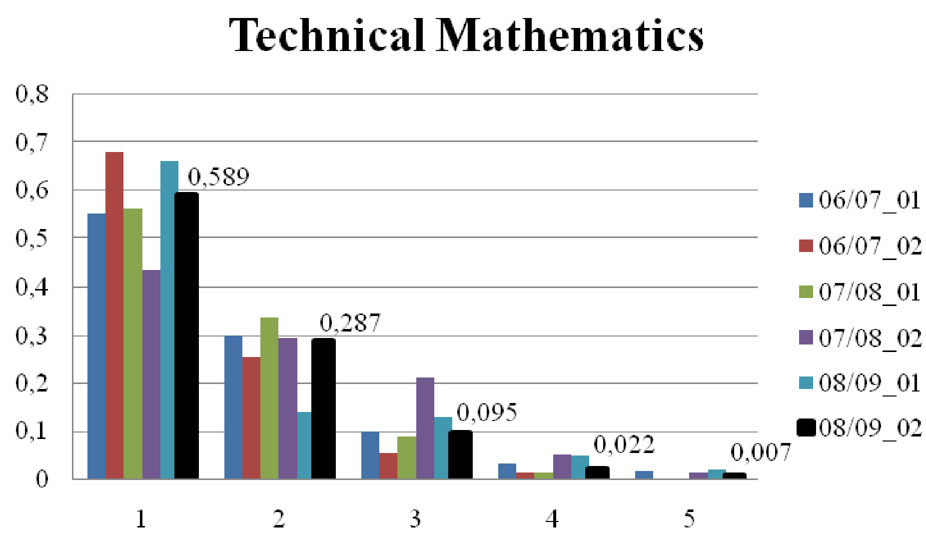
Table 5. Summary of the five completed semesters

	failed (1)	satisfactory (2)	mean (3)	good (4)	excellent (5)	total number of students
Semester 1 2006/07	0,55	0,3	0,1	0,03333	0,016667	60
Semester 2 2006/07	0,68	0,2533	0,0533	0,0133	0	75
Semester 1 2007/08	0,561	0,338	0,0878	0,0135	0	148
Semester 2 2007/08	0,433	0,293	0,21	0,051	0,013	157
Semester 1 2008/09	0,66	0,139	0,129	0,047	0,019	108
Semester 2 2008/09	0,587	0,287	0,095	0,022	0,007	139

Source: own creation

I graphed the data in the following figure to make it easier to compare them to one another.

Figure 3. The graphs for the last five semesters



Source: own creation

The 'total number of students' column shows that in the first academic year the course was taken only by a small number of students. The reason for this is that in that academic year only B.Sc. students were allowed to take the course. In year

2007/2008 not only B.Sc. students could take it, but all others who were not able to fulfill the course requirements for at least one of the predecessor courses (Probability Theory, Mathematical Methods and Mathematical Statistics). The following rule was introduced: Those who could not pass in the predecessor courses may pass by passing in the new course. In this way, the number of students taking the course increased dramatically.

Despite the large increase in the number of students, the improvement in the quality of the grades is clearly visible. The number of students with grade 'failed' decreased, the number of the other grades increased. This increased number thanked to two things – on the one part the semester repeaters are increase the number – the another part is that those students who are in the conventional training should take up this subject instead of the older subjects which they don't completed.

Taking into account the fluctuation of the number of students, we can observe a slight decline in the number of students who passed, but after reaching a balance state, we can immediately see an improvement. According to the structure of the subject they could easier completed the curricular. In the last two semesters again there has been a decline. From what I can see the cause of it is that the students are "accommodate" to the new requirements and as they see to complete the subject easier than expend less time to learn it. Analyzing the dispersion of the marks we can see that the highest was 0,26 in the first semester, the lowest dispersion we got from the II. Semester of 2007/2008 which was 0,15. In the last semester which I investigated (I. semester in 2008/2009) I counted 0,22. This value gave exactly the average of dispersions. The data for the last semester are highlighted in the graph. We can notice that it is close to the mean values of the number of grades in the previous semesters. Fortunately, even though minimally, but the ratio of students getting 'failed' has decreased. The number of students getting 'satisfactory' has more than doubled, but, unfortunately, there has been a significant decrease in the number of better grades.

Among the causes of this decline, a major problem is that the students bring less and less knowledge from high schools. There are more and more students in higher education, and thus their level of knowledge varies on a large scale. We can do nothing else but get adapted to this new situation and shape and re-form the course syllabus so as to be able to transfer the required knowledge to the students. We have to take into consideration that some parts are omissible from the curricular or not and/or maybe we teach it according to the base of the actual theme. The students know less but this knowledge is certain.

4. The attempts made to improve performance

In the first semester of the academic year 2009/2010 we made a try with a new syllabus. We did not reduce the course material, but re-distributed the topics among the practice lessons and the laboratory exercises. We started the practice lessons with probability theory as before, but from the 9th week we continued with linear algebra, and mathematical statistics was transferred to the labs. Due to the change, we did not need computers on the practice lessons.

We decreased also the number of quizzes. There were three quizzes in practice lessons (on weeks 4, 9, and 14), and two quizzes in labs (on weeks 7 and 14); each for 20 marks. Hopefully students can achieve better results after this step (DF5 2009).

3.1. The future

Unfortunately, the lack of knowledge brought from high schools should be taken into consideration. It is therefore necessary to assess the knowledge of first-year students. This is necessary not only because of the course "Technical Mathematics", but also for the prerequisite courses Calculus I and Calculus II.

3.1.1. National survey

Due to the initiative of the Budapest University of Technology, this year was the first one in which a standardized assessment test has been written on a national level.

The objectives of the 2009 test:

- To examine the knowledge of the students entering higher education, and determine if it satisfies the requirements of their chosen degree programs.
- To investigate whether the recruitment score provides sufficient information on the student's knowledge?
- To verify our former conclusions, and support them with further empirical data.[2]

Execution of the examination:

The students wrote a sixty minute test during registration week; that is, at a time when the higher education institute had not yet "interfered" with their training. We at the College of Dunaújváros could have the test been written on September, 3rd with 500 first year students. The thing that the people preparing the test had in mind during their work was to examine the knowledge of the students important for higher education and necessary for the students' successful advancement. The test mapped especially the knowledge learnt in and brought from high school.

The questions were chosen centrally, and a solution with detailed instructions for markers was also enclosed to make marking as uniform as possible. Each institution itself organized the test and its marking, following the central instructions. Our

[2] http://members.iif.hu/rad8012/index_elemei/kriterium.htm

fellow instructors recorded the results in a centrally prepared Excel sheet, and sent it back for process. Peer comments on the results of a centrally prepared and recorded in an Excel table, they were sent back for processing.

The test consisted of 12 multiple-choice questions, two exercises about formulas and three computational problems.

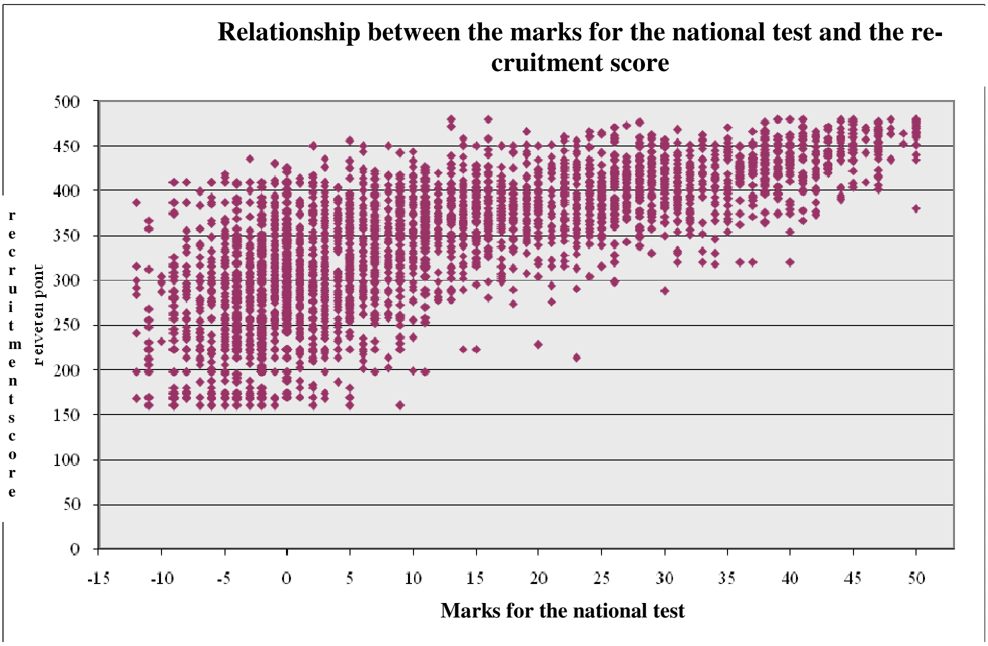
A very high percentage of students dealt only with the multiple-choice questions. They did not touch the two exercises requiring the knowledge of formulas, or used only basic formulas and did not care that they used the formulas with data different from those given in the exercises.

The third part contained the computational problems. Only ten percent of the students dealt with the last part. Even among those who made an attempt, only a few got maximum marks for them, many listed only the data gathered from the text, and made no real work.

In general, we could find numerous types of errors in the solutions.

In Figure 4, a diagram containing more than 3000 data is shown. Note how much the marks of this test and the students' recruitment scores are unrelated. I made a correlation calculation from the data where it was 0,723. One can see from the correlation coefficient that there is a correlation between the results of the qualifying examination and test but it isn't a strong connection.From the fact that someone had a high recruitment score does not follow that they got good marks on this test. Unfortunately, it seems that, among those with recruitment score between 300 and 400, we can find all the kinds of marks from the lowest to the highest. A question is raising that the process of the marticulation or perhaps the measuring isn't good. The Cronbach alpha of the measuring was calculated by the authors (Katalin Radnóti) which was 0,88 and this is a real good value. This confirms that hypotesis that the process of matriculation have to revise.

Figure 4. The summarized data of the national test



Source: Radnóti (2010)

Unfortunately, now we know what we have only suspected: that the knowledge of students coming from high school is less and less. My hope is that, due to this test, we become more aware of the knowledge of the students, and by using our experience we can make the syllabus and our teaching methods better.

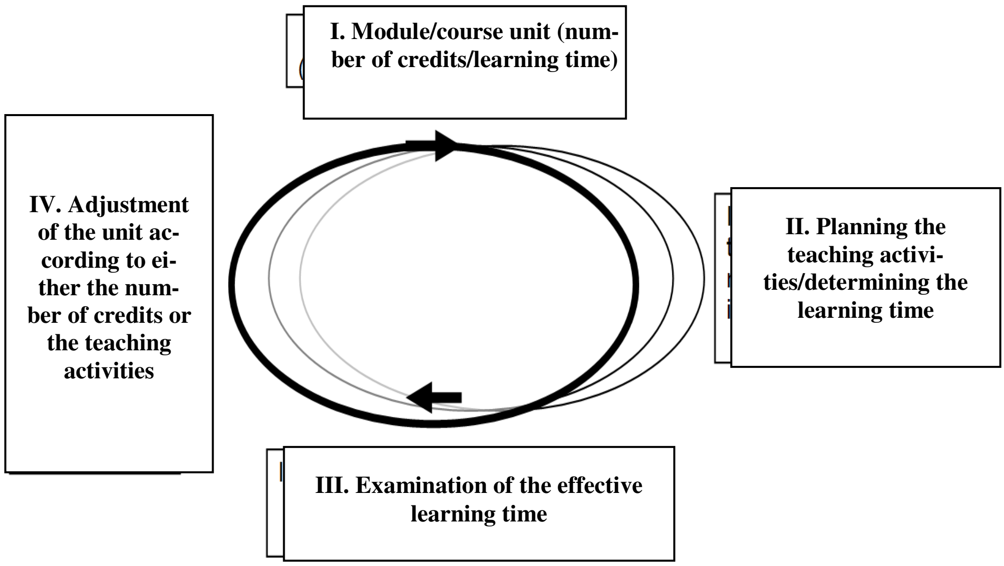
In the Engineering Mathematics course, the practice lessons and labs allow us to avoid the frontal – instructor centered – teaching methods, and to bring forward practice oriented – student centered, knowledge-based – methods supporting individual work.

In the future, we intend to strengthen the changes that we have already started, with the involvement of students. Within the framework of quality assurance, we already surveyed the students at the end of each semester. We asked for their opinion of the course and the instructors. We would like to make a questionnaire in which we can measure also the success of the course. Among the types of questions, there would be ones aimed at the required goals of the training, at gaining skills, and at the time necessary for acquiring these skills.

With this questionnaire, we would get better feedback on how effectively we teach. We could make it more effective with reorganizing the quizzes. Quizzes and tests provide information on the knowledge of the students, but there are skills that must be acquired till the end of the semester. With the questionnaire, the students could put it into words more accurately with which part of the course material they have more problems, and to what would we need to devote more time.

We cannot neglect to determine the students' workload. In the future, this should be taken into account and should be reviewed constantly. A circular investigation should be started, which I represent in the following figure.

Figure 5. Determining the load and task of the students



Source: Kadocsa (2004)

With this method, we receive a constant feedback from the students, by means of which we can redistribute the course material so as to make it more achievable for the students.

The results of the national test surveying the students should be assessed not only by us, instructors. The experts and politicians, who develop the recruitment system and determine the recruitment scores, should also draw the conclusions. Unfortunately, in many cases we should draw the conclusion that the scores achieved by the students do not reflect their real knowledge.

5. Summary

We should continue the trend that started in the country and at our College. We should take into account the students' knowledge and learning skills, and form the syllabus accordingly. We should consider what and how we teach in order to make it easier for the students to acquire the necessary knowledge. We should transfer 'usable' knowledge: one that makes it easier to learn the material of the special courses of their own profession.

References

DF1, Valószínűségszámítás Tantárgyi program (MA-004) 2006: Dunaújvárosi Főiskola Matematika Intézet

DF2, Matematikai statisztika Tantárgyi program (TE-005) 2006: Dunaújvárosi Főiskola Matematika Intézet

DF3, Matematikai módszerek Tantárgyi program (TE-007) 2006: Dunaújvárosi Főiskola Matematika Intézet;

DF4, Műszaki matematika Tantárgyi program (MA-009) 2008: Dunaújvárosi Főiskola Matematika Intézet.

DF5, Műszaki matematika Tantárgyi program (MA-009) 2009: Dunaújvárosi Főiskola Matematika Intézet.

Kadocsa, L. 2004: A kreditalapú moduláris rendszere, mint a curriculumfejlesztés új minősége III. Felsőoktatási Kreditfórum, Dunaújváros 2004 jún. 3-4.

Radnóti, K. 2010: magánközlemények