

Refresher Course in Mathematics—Two-Year Experience

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Abstract: In autumn 2013 and 2014, there was a refresher course in mathematics, necessary for learning Higher Mathematics at Estonian University of Life Sciences. It was a new opportunity to see whether this kind of course has any positive impact on the grades of Higher Mathematics. In the beginning of the semester Forest Management students took a common diagnostic test in mathematics and 30 of them who got the lowest scores (less than 5 points of 15) had to enrol in the course. This course was worth three ECTS, and ran in two different years with two different approaches. After the course students had to take the test one more time. This time the average test score was higher in both years. Students were asked to give some feedback. We give some remarks about the feedback and provide a comparison with last year's results in compulsory Higher Mathematics course.

Key words: Teaching mathematics, feedback of teaching, refresher course.

1. Introduction

Having participated in many conferences over the years, we have heard complaints about incoming students' low Mathematics level, and it is getting worse. This statement is true for our university as well. It seems that the number of students who are not motivated to learn Maths has increased. Students, doing different degrees, have very different Maths level.

Several universities offer Maths Refresher courses in order to revise high school Maths and to even out students' Maths level. In some universities (e.g., Utah State University), this refresher course costs some extra money to students and no credit can be earned, whereas in others (e.g., Tallinn University of Technology), it is included in the curricula and students can earn credits. Vrije Universiteit (VU) in Amsterdam offers a one-week Maths Refresher course for MSc Economics students. On the Internet, we can find many computer-based self-study courses. However, there has

not been an academic study on the effectiveness of Maths Refresher courses at university.

Every year new students who have some compulsory mathematics courses in Estonian University of Life Sciences have to take an international test in mathematics [1]. The test was composed in collaboration with Latvian, Lithuanian and Swedish Agricultural Universities. This test has been used in our university since year 2000. Comparing the test scores between different specialities showed that for many years the Forest Management students have had the lowest scores [2-3]. In their curricula there is one compulsory Higher Mathematics course (that counts for 4 ECTS) and the results of its exams have not been very good. To see some improvements of Forest Management students' results, we had an idea to start a refresher course in mathematics. In this article we analyse the results of 2013 and 2014 refresher course.

2. Feedback and Results

In 2013, there were 52 and in 2014 there were 53 Forest Management students who took the test. In both

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years 30 students with the lowest score (less than 5 points out of 15) had to enrol in a course that gives 3 ECTS. There were students who were interested in the course and asked if they could participate even if their test score was higher than 5 points. We allowed them to participate in the course, but after some lessons, they left it. Some students left the university altogether during the first month, some dropped this course only. Finally, 22 students completed this course in 2013 and 21 students in 2014.

The course was held in September 2013: on Tuesdays and Wednesdays for two academic hours per day, on Thursdays and Fridays for three academic hours per day, starting at 2 pm each day. The course had two teachers. One teacher was experienced and the other one was, in fact, a third year student in our university. We involved a student in the teaching process with a hope that it will bring more casual atmosphere to the classroom and that students would feel free to ask questions and to have no fear against the studying process.

Based on the feedback of year 2013 teachers, we decided to change the course set-up in 2014. It seemed, in 2013, that the students were tired at the end of the course; they did not work as much as was expected from them. In 2014, we decided to run Maths Refresher course and Higher Mathematics course in parallel. As usually there are no classes during the first academic week, we used that week to hold 9 hours of Maths Refresher and 4 hours of Higher Mathematics. From the second academic week onwards, there were 5 hours of Maths Refresher. For Higher Mathematics, the number of contact hours did not change. Therefore, Maths Refresher finished by the end of week 8.

At the end of the course, we asked for students' feedback. In 2013 many of them pointed out that they liked the intensity of the course, and thus, they did not forget important formulae for next day lectures. However, in 2014, students liked having classes

running in parallel because in Maths Refresher they learnt the basics of the topic that was covered more thoroughly in Higher Mathematics the same week. Therefore, it was noted that Higher Mathematics was easier to follow thanks to the refresher course.

They also liked the friendly atmosphere in classes and some of them even replied that they liked studying mathematics. The feedback was similar in both years. Most students replied that they spent 0.5-2 hours per day doing the exercises but there were also students who spent 5 hours or more doing the mathematics homework. Four students replied that they did not do their homework at all. Students were pleased with the teachers; the general opinion was that they did a good job explaining the formulae. Friendliness and keeping up student's motivation were two of the positive aspects of the teachers. Only negative aspect mentioned in year 2013 was that sometimes one of the teachers tended to hurry with explanations. The students were able to ask for one to one consultation from the teacher. In 2013, 8 students used this opportunity, but in 2014, the students preferred asking from course mates, who understood the topic in hand, to asking from the teacher.

The topics that were covered in the refresher course can be seen in Table 1. As part of the feedback questionnaire the students marked the topics that had not been clear at school and that they had liked at school. Also, they were asked to mark the topics that became clearer after the refresher course. In Table 1, you can find relative frequencies for each corresponding topic. We can see that topics, such as sequences, logarithms, exponential functions and trigonometric functions, are the ones that had remained unclear at school, and were marked most often in both years. It is not surprising that these subjects were found difficult at school, but interestingly these topics were marked likeable at the same time, especially in 2013. It is good to learn from the feedback that the same topics

were much clearer after the refresher course. We can see that all the topics covered were better understood after the refresher course in 2014.

In Estonia, high school finishes with five exams and at least three of them are state exams. In 2013, students could choose all the exams, except the Estonian language state exam. Only three students from the refresher course had taken a state exam in mathematics before coming to university in 2013. In 2014, there was a big change in the organisation of state exams. Estonian, Maths and English state exams were compulsory for all the high school graduates. They could choose only two additional exams. Thus, the number of students who had taken a state exam in mathematics grew to 13 in 2014. The high school mathematics' grades of the refresher course students were "3" ("satisfying") for 13 students and "4" ("good")

for 9 students, in 2013. The corresponding numbers in 2014 were 13 and 8.

One might think that Maths test results were better in 2014 because more students had taken Maths state exam in previous spring. Unfortunately, based on two different year's test results of all Forest Management students, it cannot be concluded like that. The average test result in 2013 was 5.7 (52 students) and in 2014 6.1 (53 students). These results do not differ much from each other (according to the t-test, these averages are equal, $p = 0.4$).

The final grades of the refresher course can be seen from Table 2. Most of the students got grade "D" or "E" in 2013. The results for 2014 were a bit better, equal number of students got grade "B" and "C". However, grade "D" was also quite commonly received. Two students got the best grade "A" in 2013 and one student in 2014.

Table 1 Topics taught in the refresher course in mathematics.

Topic	Did not understand at school		Liked at school		Understand better after the course	
	2013	2014	2013	2014	2013	2014
Fractions	0.07	0.08	0.07	0.5	0.07	0.67
Algebraic operations	0.14	0.08	0.14	0.33	0.14	0.75
Tangent line	0.11	0.08	0.07	0.25	0.11	0.5
Sequences	0.36	0.58	0.25	0.42	0.36	0.67
Logarithms	0.68	0.42	0.50	0	0.61	0.58
Exponential functions	0.54	0.42	0.36	0.17	0.50	0.5
Trigonometric functions	0.61	0.33	0.32	0.25	0.54	0.5
Inequalities	0.18	0.08	0.04	0.33	0.07	0.75
Percentage	0.21	0.25	0.14	0.33	0.18	0.83
Functions. Graphs	0.32	0.17	0.11	0.33	0.21	0.67
Limit of function	0.14	0.25	0.00	0.25	0.04	0.75
Derivative of function	0.18	0	0.04	0.17	0.04	0.75
Investigation of function	0.32	0.17	0.14	0.5	0.18	0.83

At the end of the course, the students retook the test and the average test score increased in both years (see Table 3). Although we can see an improvement, we still have to point out that at the beginning of the course the students had just come from almost

three-month-long summer break and they had probably forgotten many formulae.

After completing the compulsory Higher Mathematics course, we compared its grades between the students who took the refresher course

and who did not take it (see Figure 1 for the proportions). Many students took the refresher course but did not take the final exam (43% in 2013 and 30% in 2014). It shows that students have fear against mathematics and the basic competence in mathematics is still poor. Amongst the students who did not participate in the refresher course the number of students who did not take the exam, is lower in 2013, but greater in 2014. Unfortunately, the number of students who did not take the exam is relatively big in both years and this tendency is a real problem. There is no difference between these two years' average grade in Higher Mathematics (t-test: $p = 0.37$) but in 2014 grades "A" and "B" have been obtained as well (by 4% of the students, in each case). Most common grades are "C", "D" and "E" in both years (see Figure1).

Table 2 Final grades in the Refresher Course in Mathematics.

Grade	No. of students	
	2013	2014
A "excellent"	2	1
B "very good"	1	7
C "good"	2	7
D "satisfactory"	7	6
E "sufficient"	6	3
F "insufficient"	4	0
Did not attend	0	1

Table 3 Test results at the beginning of the Refresher course and at the end of the course.

2013		2014	
Test 1	Test 2	Test 1	Test 2
4.05	5.91	4.2	7.3

We also compared the students' grades in other subjects they had that semester (see Figure 2 and Figure3 for proportions). The students showed best

results in economics and land-surveying. It points out that in mathematics many students failed to attend the final exam. Also in land-survey the number of students who did not go to exam is high, but still the students who took the exam did it well. However, the maths exam was not done the worst, it was the dendrology exam. It can be concluded that we do not need to worry about students' mathematical skills, only, but their general knowledge is quite minimal.

In Figure 4, there is a comparison with last years' grades in compulsory Higher Mathematics course. The final grade proportions show that, in 2013, there were many "D-s", whereas in 2011, the most common grade was "E". There are very few excellent grades in all these years (in fact, there are not any "A-s" at all, in 2013). Only in 2011, there were about 15% less students, who did not attend the final exam, than in other years. We cannot say that the results of Higher Mathematics course were much better after offering the opportunity to take the refresher course.

The analysis shows that the refresher course has had a positive impact on the results. When before the most common grades were "E" and "F", then now these are "C", "D" and "E" (see Figure 4).

However, as the magnitude of refresher course's impact is relatively small, one might ask whether there is any use to continue with the course in its present set-up. A disadvantage of the current course is that it can be offered to only one speciality because of clashes in different degrees' timetables and lack of teaching staff. Therefore, a solution to the problem would be an intensive two-week Maths course one week before the academic year starts. During the first week, students do not have any other courses and they should be able to concentrate on Maths only. Although some courses start during the second week of the refresher course, we can easily find some spare time for Maths classes. Only before this course was optional for Forest Management students, then this new course would be

for all students from different specialities who want to improve their Maths skills.

3. Conclusions

From the feedback, we can conclude that students were pleased with the course; they liked the friendly atmosphere and studying mathematics. Overall, the

feedback was good and students thought that this course was necessary. At the end of the course, the students retook the test and the average test score increased in both years. However, the positive influence of the Maths Refresher course on Higher Mathematics' grades is not so apparent.

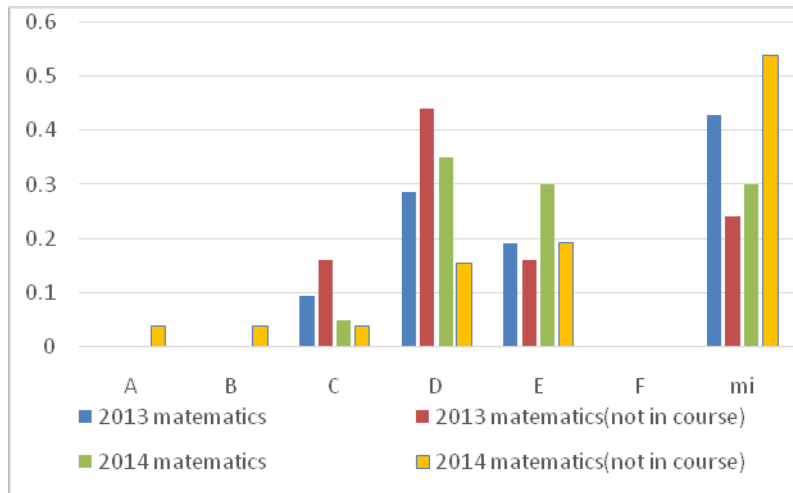


Fig. 1 Comparison of final grades between two groups in 2013 and 2014—students who attended the refresher course and students who did not. Note: In this figure “mi” stands for “not present in exam”.

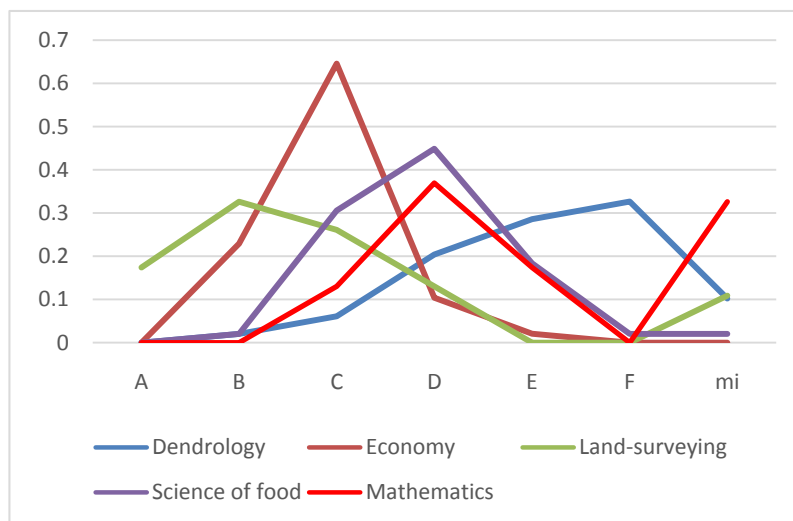


Fig. 2 Comparison of final grades with other subjects in one semester in 2013.

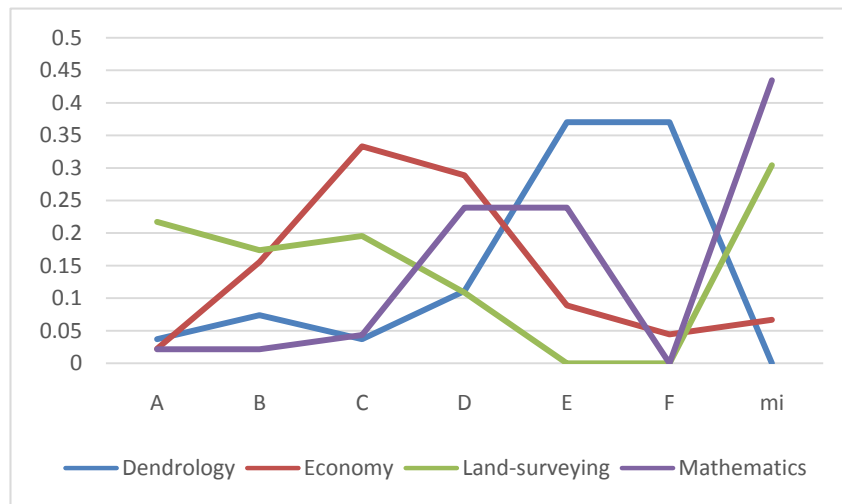


Fig. 3 Comparison of final grades in 2014 with other subjects in one semester.

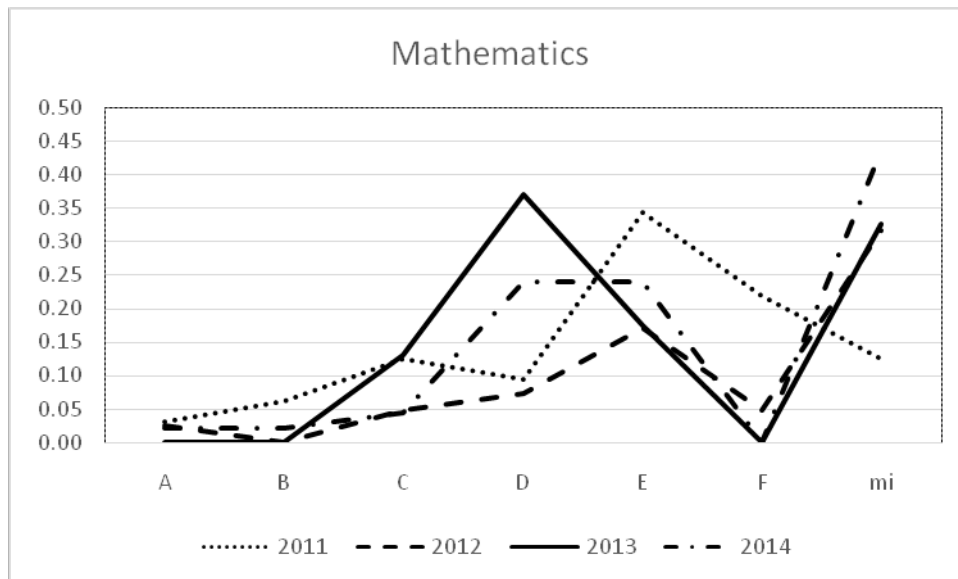


Fig. 4 Comparison of final grades in Higher Mathematics course in 2011-2014.

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