MAKING HIGHER MATHEMATICS ACCESSIBLE: EXPERIENCE FROM RIGA TECHNICAL UNIVERSITY

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Abstract

Riga Technical University is the only technical university in Latvia and the first technical university in the Baltic countries with long lasting traditions, advanced teaching methods and around 15 000 students from Latvia and abroad. Number of high school graduates in Latvia is decreasing every year as well as their interest in STEM subjects during high school. As a result the university is facing insufficient level of student knowledge in mathematics which is one of core subjects in engineering sciences. This aspect leads to high dropout rate during the first year of studies. In order to overcome these problems we have analyzed data regarding student high school leaving exam marks and first semester math grades and decided upon a plan for helping weakest students to catch up with Higher Mathematics courses. Actions we are taking include conducting simple video lectures which are available online for free and compensative courses right before first semester in topics which are found to be most challenging for students in previous teaching experience. The paper covers educational data analytics, teaching strategies and lessons learned from evaluation of the results in Riga Technical University.

Keywords: Teaching Mathematics, Educational Data Mining, MOOCs.

1 INTRODUCTION

As stated in the Riga Technical University (RTU) Strategy, the vision of RTU until 2020 is to become the leading University of science and innovation in the Baltic States. In order to achieve it, the strategy defines three objectives of the University – high quality study process, excellence in research and sustainable innovation and commercialization activities [1]. Half of nearly 15 000 students at RTU are funded by state. Quality study process defines a goal of “Prestigious, internationally recognised high quality studies that train internationally competitive, analytical and creative specialists”. These specialists rely on strong foundations which in egineering sciences are put by mathematics. In practice, core courses in Higher Mathematics are one of the stumbling blocks in the first year of studies for many students.

In this paper we are investigating aspects which determine and influence student command of higher mathematics and describe actions being taken to deal with difficulties we are facing.

2 SITUATION AWARENESS

According to latest Eropean Cimmission’s Euryduce report [2], mathematics takes up around 15 per cent of total secondary education instruction time in most countries. It is rarely the subject taking the largest share of total instruction time. In about half of the countries studied, the lowest proportion of total instruction time is allocated to sciences. Therefore it comes as no surprise that difficulties with higher mathematics courses are neither new in educational institutions around Europe nor in RTU. One of the reasons being stated as the primary for many students not being successful in the mathematics is that they “do not actually do the problems. As a population, they generally do not spend enough time with the material, and this is why they fail at a very high rate [3]”. Besides that we are facing very diverse proficiency of math between those school-leavers which undertake studies at RTU. Every secondary school leaver in Latvia is obligated to take centralized exam (CE) in math which serves as one of university entrance exams as well. Results of CE range from five (minimum score to pass) to 100 per cents. RTU entrant CE results in the last intake are showing normal distribution (see Fig. 1) with the mode 60 per cent.

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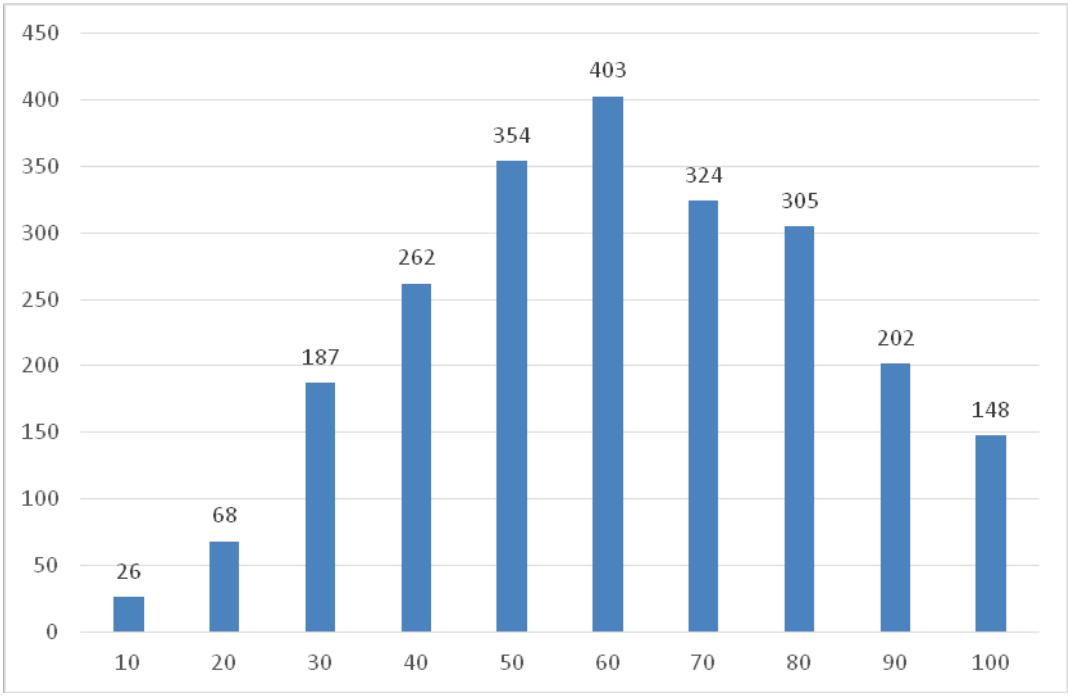

Fig. 1. Distribution of CE math grades (per cents) and number of students in the summer intake 2014

For six consecutive study years (starting from study year 2008/2009 up date) lecturers of higher mathematics courses during the first class have been running the test. The aim of this test is to examine math proficiency with five5 elementary tasks based on topics from primary and secondary school. Student should earn at least mark “4” to pass the test. Overall results of this test can be seen in Fig. 2.

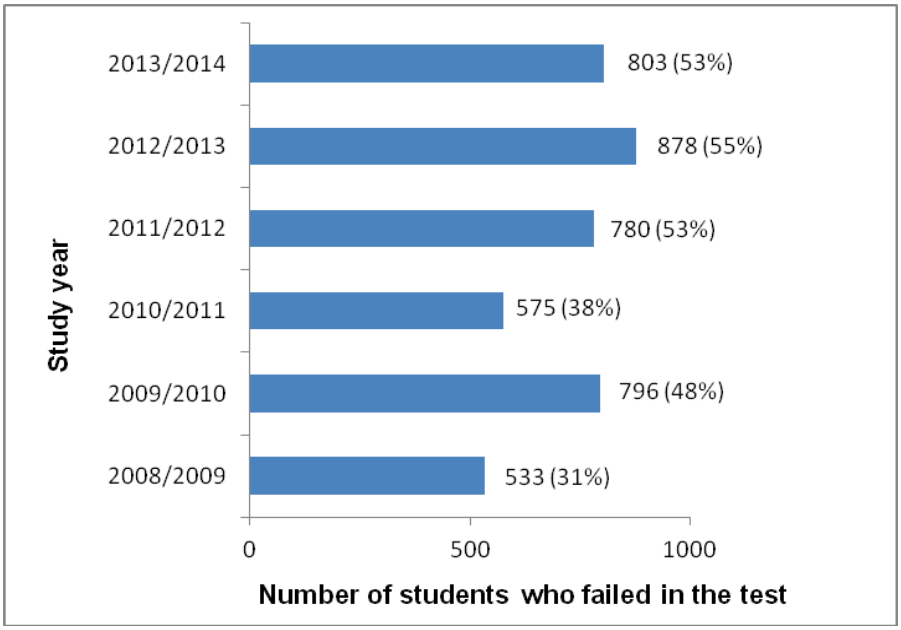

Fig. 2. Number of first grade students failing the introductory test over last 6 years

These results emphasize that there is a wide gap between evaluation in school leaving exams and the actual knowledge being shown on first math classes in the university. However, this is the reality we are facing.

With respect to learning and teaching support, RTU has electronic study portal ORTUS in place. It provides e-study environment and serves as information exchange platform for all university.

3 SOLUTIONS

This section describes educational data analysis and consecutive actions being taken to improve student success in higher mathematics courses in 2014.

3.1 Analysis of entrance marks versus 1st semester grades (year 2013)

Due to its practical significance numerous researches have been devoted to educational data mining and prediction of student dropout [4-8]. It is a challenging task with no universal answers since there is large amount of variance across indicators. However, mathematics related subjects are found to have impact on dropout rates [7,8].

In order to get better insights of correlation between CE exams and first semester math results in RTU the latest available intake has been analysed. We have data set consisting of 2181 entries describing student mark in CE math, his mark in first semester higher mathematics exam first attempt, last attempt and number of attempts. Correlation analysis shows no correlation between CE and the mark in first semester higher mathematics exam.

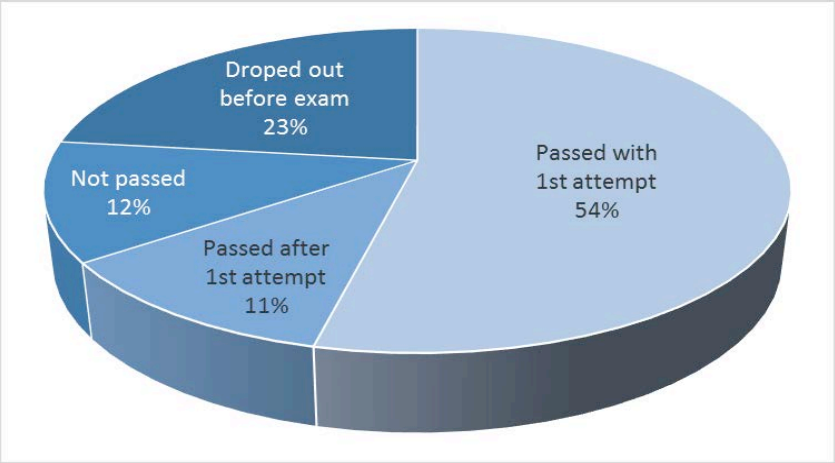

Fig. 3. Percentage of 2013/2014 summer intake results in higher mathematics in first exam session

Only 54 per cent on students who started the studies passed the exam in higher mathematics with first try. After allowed number of attempts at least “4” scored 65 per cent of entrants. We found out that 23 per cent of student did not even enter first exam session having been dropped out for different reasons. Since the number is significant, these reasons need to be investigated in more detail, although they are out of current research scope. Other nine per cent of students dropped out in first study year after passing the math exam.

3.2 Video lectures

One aspect which makes it complicated to help weak students is their unwillingness to make extra effort and fear to be highlighted between others. For this reason additional math course assigned to those first grade students who showed lowest grades in test was not successful. Majority of students not attended these classes.

This year we took another move and, following the trend set by massive open online courses (MOOCs) and small private online courses (SPOCs), prepared short (two to 18 minutes long) comprehensible video lectures covering those topics of elementary mathematics which are essential for mastering higher mathematics and published them in YouTube channel [9]. Up to date channel contains 45 videos arranged in meaningful playlists. There are several benefits of creating customized video lectures in virtual environment. First, students are not obligated to attend additional on-site lectures during semester therefore none feels penalized. Second, this way lectures are available for free to all interested persons – either school pupils or students on their first year or later. Anyone can watch as many times, wherever or whenever needed. Third, lecturers have to prepare this topic only once; it is time and cost effective. Certainly, it cannot substitute full-time lectures, solely serve as complementary self-preparing material for topics mostly on pre-university level.

Insights from analytics show that videos have been watched for around 3200 times with estimated 8500 minutes watched. One should take into account the videos are made in Latvian especially for local students therefore their dissemination due to the language is limited. Fig. 4 depicts RTU e-course video access over time.

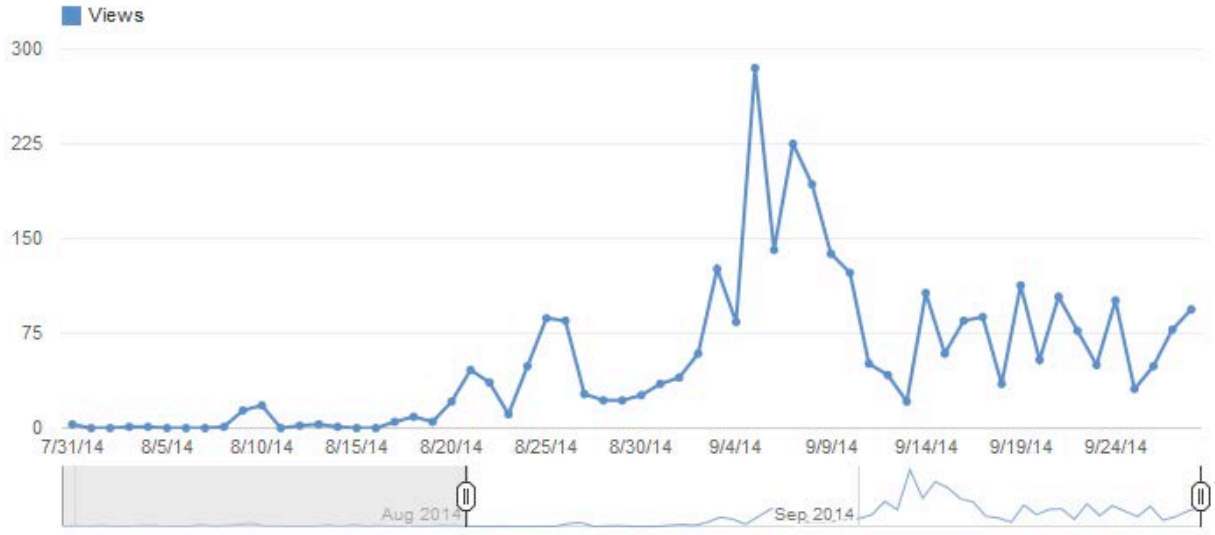

Fig. 4. Number of RTU e-course video views during August – September 2014

Following the access statistics shown there is a visible growth of RTU e-course video usage after announcement to the first grade students had been sent in the first dates of September. After the first big rush the usage remains around 75 hits the day.

3.3 Intensive courses in summer

Beside online video lectures we arranged intensive 20 hour traditional onsite math courses just before the study year (one week in August). Our scope was the entrants of engineering study programmes which have received less than 30 per cent math CE rate in order to increase their readiness for higher mathematics courses afterwards. We sent out invitation e-mails to 200 youngsters of which 48 applied to the university-paid courses and only 28 arrived in practice.

Those who attended expressed their satisfaction with the courses and ability to repeat math and fill the gaps in their knowledge. We will keep track of study results for those who attended the course compared with those who do not. However, the first indications after semester's first test results are not promising and indicate that one week courses are not enough to adjust to university level mathematics after years of insufficient training in secondary school.

4 LESSONS LEARNED

Our experience in RTU shows that highly diverse level of math knowledge between university entrants is an issue we cannot ignore. Additional course for weakest students during semester is found to be ineffective. Intensive course for catching up before semester is an option value of which is to be evaluated. Feedback from course participants shows satisfaction with course content and form. Students mention that repeating forgotten math topics are valuable, especially for those who have not learned math during last year. We could take into consideration the fact that part of entrants come from professional schools where math is not included in last school year. In addition, other entrants are having a break between secondary school and university studies. Therefore, practice of math is even more important for those students.

Specially adapted MOOCs and SPOCs in math are perspective direction [10] which does not make student feel abused as in case of additional face to face courses. Apart from modern technology involvement traditional higher mathematics lectures, labs and practical classes are not to extinct, on the contrary, they have to be continuously improved and adapted to the present needs. One of the key factors is lecturers and their willingness to work hand in hand with students and facilitate their

success. Modern technologies are tools which can help in this road, e.g. by automating tests so that teachers can spend their efforts in personal consultations instead of checking student assignments.

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