

USE OF INFORMATION TECHNOLOGY AND ORTUS IN MATHEMATICAL STUDIES FOR FOREIGN STUDENTS AT RIGA TECHNICAL UNIVERSITY

I. Dzenite, S. Cernajeva, A. Matvejevs

Riga Technical University (LATVIA)

Abstract

In recent years there have been many discussions regarding teaching mathematics in schools and universities, particularly concerning the necessity of encouraging students to focus more on studying mathematics. Since the entrance exam at universities in Latvia was cancelled long ago, the admission to studies at Riga Technical University (RTU) has been based on the results of the School Centralized Examinations (CE), where results are graded from 0% to 100%. Unfortunately, students with very low CE marks on Mathematics (e.g. below 30% or even 20%), may be also admitted to RTU, even though competency in mathematical subjects are required for engineering students. Further to this, many foreign students start studies at RTU with a low level of mathematical knowledge, and the number of foreign students enrolled in studies at RTU is increasing significantly every year. Under such conditions, the work of RTU Professors becomes very challenging.

In order to ensure a high quality study process, each study subject should be aware of the knowledge, skills and competences that it will provide to students, as well as their relevance to a potential future employer's skills requirements. The quality of students' competence depends on the amount of knowledge they have acquired in a discipline, and this includes mathematics. In the study process, students more and more actively use ORTUS, the MOODLE based e-learning platform, the strategic aim of which is to provide sustainable development of e-learning at the University based on a synergy of research, innovation and quality assurance.

In this paper, the authors, Professors of the Department of Engineering Mathematics, analyze in detail the knowledge of foreign students in mathematics at RTU, as well as the use of the latest teaching methods, technical teaching aids and information technology to develop these students' learning skills. Study should provide those versatile and life-long skills and competencies that are useful in different spheres of life, and that develop in the young engineer the professional qualities that help him/her to be competitive in the labour market.

Keywords: Engineering higher education, foreign students, knowledge, skills, competences.

1 INTRODUCTION

RTU is the only Technical University in Latvia that prepares engineering specialists in a wide variety of fields, starting from architecture and technical translation, and ending with energy and mechanical engineering. As one of the leading Latvian universities, RTU is also recognized by international rankings such as QS World University Rankings, Times Higher Education, Eduniversal and others.

The number of foreign students at RTU has been growing significantly over the last few years, increasing by more than ten times in eight years, exceeding 3500 students from 80 countries last year [1]. This significant growth is a result of the purposeful strategy of internationalization and actively attracting these students, which has included the offer of variety and excellence in the quality of study syllabi available in English. This strategy alone has been highly valued by students from Europe, Asia and Latin America. Most foreign students studying at RTU come from India, Uzbekistan, Kazakhstan, France and Germany. Last year, students from Switzerland and Vietnam were admitted to RTU for the first time. However, the most significant increase in students in recent years has come from Sri Lanka, Kazakhstan, China, Germany, Russia and Mexico.

The authors, in their previous publication [2], have analyzed the reasons why foreign students choose to study at RTU: why engineering studies at RTU are becoming so attractive to them, what are the aims, hopes and future plans of these students, and what has been the role of mathematical subjects in making the study of engineering higher education for foreign students at RTU so attractive? Subjects which are prerequisite for engineering study! In [2], the conclusions have been made on the

basis of student surveys and the extensive teaching experience of the Professors of the Department of Engineering Mathematics.

While the art of teaching art has a very long history, today the teaching process is more scientifically planned and organized, and new concepts and ideas are constantly being learned. At the UNESCO Lifelong Learning Memorandum, four basic theses that underpin education in the 21st century have been set out: 1) learning to know, - in order to gain the tools of understanding; 2) learning to do, - in order to be able to interact creatively with the world around us; 3) learning to live together, - in order to participate and interact with people in all spheres of human activity; 4) learning to be, - in order to grow in our personal development [3].

Not the least important task is to be able to learn - to acquire, understand and memorize temporarily any given information and to use it for solving practical problems. Although this would be a task of secondary education, we often encounter the fact that tertiary students have not yet mastered this skill. Learning is an active process that requires a lot of strength from the student, but it depends on what the student is learning and on his/her personal characteristics, on their level of mental development, their needs and motivation, as well as significant environmental influences [4].

Academic staff at RTU invest a lot of time and energy in the development of e-learning, providing access to education in free time and space.

2 METHODOLOGY

Nowadays, computers and other information technologies are entering into everyday life at an increasingly rapid rate, and the field of education is no exception. Information and communication technologies are being used more and more in the field of higher education and training [5]. The environment of both teaching and learning mathematics is also affected by the development of information technology [6]. The use of information and communication technologies is welcomed by students and graduates.

Since the 2007/2008 academic year, Riga Technical University has been using the MOODLE based (Modular Object-Oriented Dynamic Learning Environment) e-learning platform, which is called "ORTUS" at RTU. This platform facilitates the study process for students and makes the work of Professors more effective. Every student and all RTU personnel have their own username and password to access ORTUS at any time and in any place which has internet access. ORTUS is an environment containing general information, announcements about the University events, as well as information relevant to every study subject taken by a student. Each study subject in ORTUS has a separate environment, an e-learning course, where students can collaborate with their course-mates, as well as with the lecturer. Students can also find out which topics will be covered in each study subject, and what is required for the successful completion of the subject. ORTUS provides convenient access to electronic study materials, electronic tests and actual course information.

In ORTUS, for every study semester, a new e-learning course is created for each study subject. There is also the facility for any Professor to separate their personal e-course with limited access allowed only for students who have been enrolled to this Professor's lectures, and for the Professor's teaching assistants. The Professors of the Department of Engineering Mathematics are keen on using this opportunity. Although the requirements for mathematical subjects are the same, each Professor has their own style of explaining mathematical topics, and of preparing lectures slides and other additional study materials. In the same way, each Professor expects to receive feedback from students during their examinations. Besides, in the separated e-course, there is no risk of misunderstanding by students regarding the announcement of tests, exams and other course specific information, whether it refers to them or to any other group of students.

Since the 2008/2009 academic year, all academic staff of the Department of Engineering Mathematics (DEM) have been obliged to use ORTUS, in maintaining and completing e-learning courses. Moreover, the leading Professors of DEM have created several "public e-learning courses", which are available for any RTU student and other personnel. These are "Higher Mathematics I" and "Higher Mathematics II" taught in the 1st and 2nd semester, respectively, and "Supplementary Mathematics". These public e-courses are prepared in Latvian. At present, mathematical e-learning courses for foreign students only exist as personal e-courses of the Professors, who are responsible for them. However, due to the growing interest from foreign students in engineering higher education at RTU and, as a result, the rapid increase in the number of foreign students studying at RTU, the DEM is planning to create similar public e-courses in English.

The main problem for students is the large amount of material to be revised. Thus, both the use of visual aids and a positive atmosphere of communication should be successfully organized to stimulate the students' desire to study and to achieve better results. In order to make the revision process easier, great attention has been given to the use of visual materials. Therefore, in Spring 2014, and acting on the recommendation of the RTU Vice Rector for Teaching, the Professors of the Department of Engineering Mathematics created a course of video lectures on Elementary Mathematics, a course which now contains 43 video lectures of between 5-18 minutes in length. This has been a joint project of both the Department of Engineering Mathematics and the RTU Department of Studies and Information Technology Centre, a valuable exercise in cross Departmental cooperation. Technically, colleagues from the RTU Information Technology Centre provided the filming, processing and posting of video lectures on the INTERNET. The lectures are available on the YOUTUBE website under the heading "Basic Elementary Mathematics" [7]. At the moment, this video course is in Latvian, but there are plans to create the same video course in English. Nevertheless, during the temporary absence of such a video course created in English by the Professors of DEM of RTU, foreign students can easily find various video lectures on YouTube given by lecturers from the whole world, which cover all basic mathematical topics and in many languages, not only in English.

In the period from 2005 to 2014, in addition to traditional mathematical tutoring, Latvian students of the Faculty of Computer Science and Information Technology were taught to use the MATHEMATICA software package in its application to mathematical problems [8]. In the last two years, the MATHEMATICA software package was switched to the MATLAB software package. As for our foreign students, they are familiarized with the use of mathematical software study through the lessons of the study subject "Numerical Methods". Currently, both Latvian and foreign students have free access through ORTUS to the latest version of the MATLAB package which can be used in their studies.

As experience shows, students are interested in learning mathematical software that makes it easier for them to understand the algorithm of a given task. For example, many of the students with poor math skills, who can't solve a problem on paper on their own, are surprisingly good at solving it in MATLAB or MATHEMATICA. In addition, in using mathematical software, students can solve time-consuming tasks easily if they don't need to solve it analytically on paper.

One more great opportunity for ORTUS users is the free and instant access to the databases of many world libraries, which is important for scientific work and for personal development.

Another possibility for ORTUS is the ability to obtain feedback from students in the form of a survey. The RTU Study Department, in cooperation with the Information Technology Service, has implemented the Student Questionnaire System by conducting regular student surveys at least once a semester on the quality of mathematics study content and on the quality of teaching staff work. Using ORTUS, each student receives a questionnaire for each study course completed during the semester. In order to improve mathematical studies at RTU and to facilitate the understanding of mathematics for students, several Professors of the Department of Engineering Mathematics have created and conducted several surveys with questions specific to mathematical subjects. The results of these surveys have already been taken into account regarding teaching mathematical subjects at RTU, and have also been presented at several conferences and published in full text (see [9], [10]).

Online questionnaires are one of the newest and most modern methods of conducting research. It is also one of the most widely used research methods. Defining the questionnaire correctly and accurately, and selecting a sufficiently large number of respondents, can provide an objective assessment of the particular question or subject of interest.

3 RESULTS

The above-mentioned surveys were given to the foreign students from the Faculty of Mechanical Engineering, Transport and Aeronautics, Faculty of Power and Electrical Engineering, Faculty of Material Science and Applied Chemistry, and the Faculty of Computer Science and Information Technology. The most interesting results of the surveys are presented below in Fig. 1 - Fig. 4.

In Fig. 1, one can see that 44.1 % of the surveyed students use ORTUS almost every day because the platform has an interactive and user-friendly navigation system that makes it easier to work with. ORTUS provides an e-learning environment, a system consisting of virtual classes and session planning. It also collects information on study, household, IT support and document management services that foreign students need every day.

How often do you use e-resources from ORTUS in your studies at RTU?

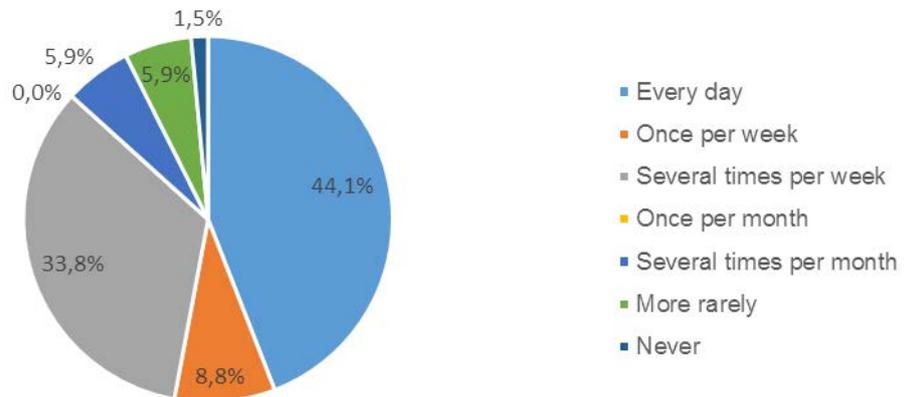


Figure 1. The frequency of use of ORTUS e-resources by RTU foreign students.

Which e-resources from ORTUS do you use?

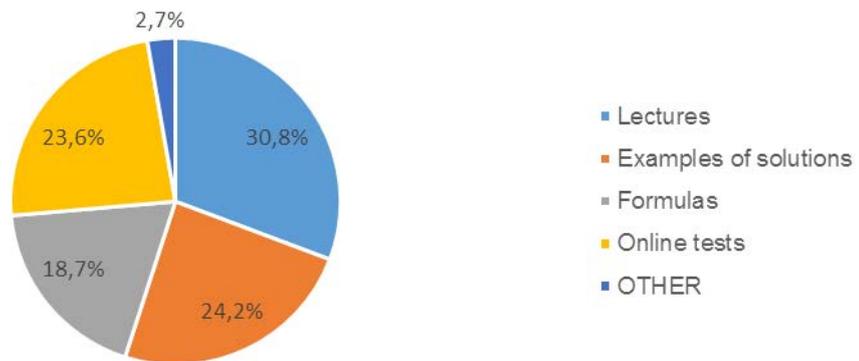


Figure 2. The ORTUS e-resources most used by RTU foreign students.

Which mathematical software packages do you use in your engineering studies at RTU?

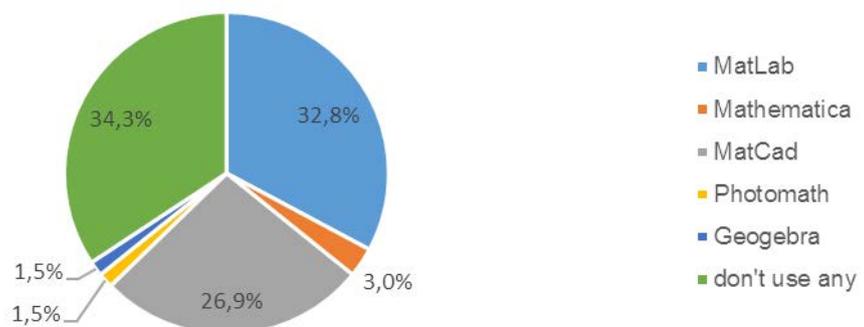


Figure 3. The use of mathematical software packages by RTU foreign students.

RTU Professors of mathematical subjects offer students a variety of opportunities to be prepared for tests and exams independently. The homework, examples of tasks solutions, lectures and online tests are available in ORTUS at any time. It appears that foreign students are actively using this opportunity as well (see Fig. 2). As it can be seen from Fig. 3, foreign students also appreciate and actively use different mathematical software in their studies at RTU. In particular, the MATLAB package is used by 1/3 of the surveyed students as it is a free feature for ORTUS users. The ORTUS e-learning platform provides support to all young people who want to study abroad. The surveys' results show that 89.2 % of the surveyed foreign students consider ORTUS helpful in their studies at RTU.

Other logical questions to ask students studying at RTU are: why have they chosen engineering as their higher education study; whether they are aware that Mathematics is important as a tool for study subjects in engineering education; what did they do to have the knowledge of mathematics at a good level, and if that level can simplify and facilitate their study process at RTU in engineering. This part of the surveys is the most interesting, since the surveyed foreign students express their opinions, show their thinking and tell us about their goals. Their answers are shown in Table 1.

Table 1. Reasons for choosing engineering studies by RTU foreign students.

Why have you chosen ENGINEERING studies?
- Because I want to use my own creativity to develop something useful for humanity, like the internet.
- Because of my interest in computing. At the moment I don't know very much, but one day I would like to be an expert in this field
- I am interested in the syllabus subjects
- I have chosen Computer Science Engineering because I want to become a good Developer
- I have a dream to become a professional Electrical Engineer
- Because I am interested in practical skills
- I think that my way of thinking is much more appropriate for this kind of study
- I love programming (coding, e.g.) & want to become a programmer.
- I have had an interest in engineering since my early age
- I chose chemical engineering because I like chemistry, mostly organic chemistry
- Because I like to work with biochemistry
- Because of the subjects I like, for example, Computer Systems, Maths
- It's been a dream of mine to be a programmer in the graphics field so I have chosen this as my first step
- I want to become a computer engineer and I want to open my own company
- It has a future and I am interested
- Has always been my passion, I feel free while working on a project
- Because I like a competitive work field and I really enjoy making new creative technologies
- Because the future is dependent on Engineering
- I have chosen Computer Systems due to my interest in coding
- I see myself working somewhere with a high salary in about 5 years with Engineering
- I have been interested in Engineering from my childhood
- My ambition is to become a pilot, but nowadays pilot jobs require a degree to join airlines. As to engineering, I am interested in learning about petroleans, so I chose chemical engineering.
- I love computers
- Because I want to be a software engineer
- My goal is to be a computer and IT specialist to make the world a better place

With regard to the question about the students' attitude to Mathematics, the majority of the foreign students (76.9 %) liked Mathematics at school/college. Moreover, about 2/3 of the surveyed students took lessons to develop a deeper understanding of Mathematics during their school/college studies (see Fig. 4). These lessons were given by either private teachers, or offered by the school/college at additional times. This shows that while these students were still at school/college, they clearly saw their future in engineering and purposely worked for it.

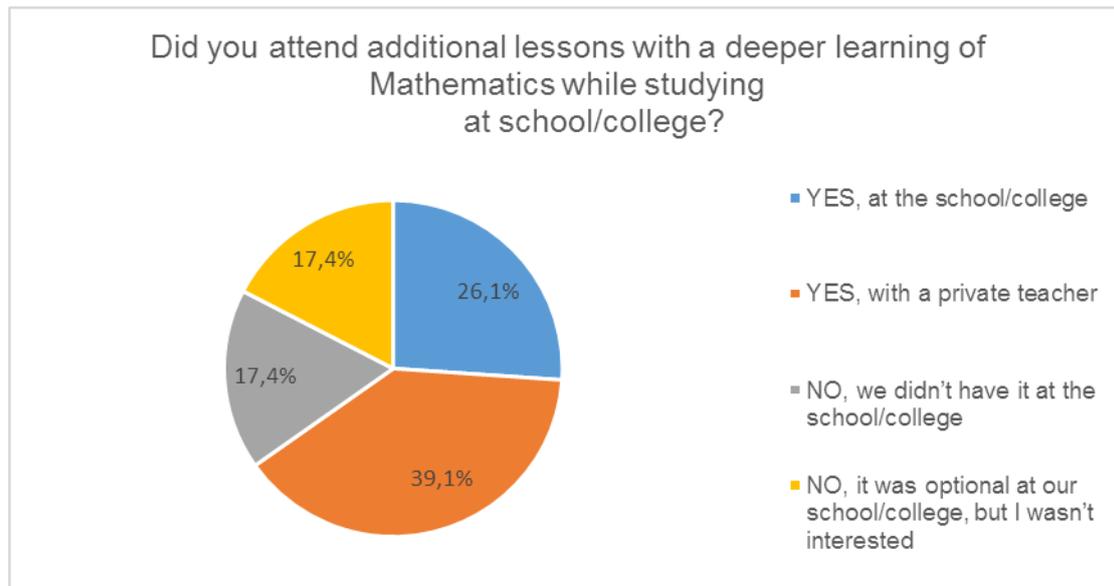


Figure 4. Attendance of additional lessons on Mathematics at school/college by foreign students.

4 CONCLUSIONS

In any field of science, the amount of information is increasing so rapidly, that universities can no longer give their students the amount of knowledge, skills and abilities that they will need throughout their working life. Thus, modern education should develop learning skills, stimulate the creative use of knowledge and promote cognitive development. At present, qualitative higher education is impossible without wide use of technical teaching aids and information technology.

This study looks at different target groups, but the vast majority of respondents say that they prefer group learning in collaboration with group members. However, regardless of the learner's desire for a variety of interactive collaboration methods, lectures and presentations are the dominant forms of learning. Moreover, on planning the education process for foreign students, the psychological particularity of the age of these students should be taken into account, so that the planning and the education process itself should be guided by the students' needs and their motivation to study.

REFERENCES

- [1] RTU website, news, October 2019. Retrieved from <https://www.rtu.lv/en/university/for-mass-media/news/open/rtu-information-and-study-centres-have-been-opened-in-india-and-sri-lanka>.
- [2] I. Dzenite, S. Cernajeva, A. Matvejevs, "Attractiveness of engineering higher education study at RTU for foreign students", *Proceedings of the 19th Conference on Applied Mathematics (APLIMAT 2020)*, Slovak University of Technology in Bratislava, Faculty of Mechanical Engineering, February 2020 (accepted for publishing).
- [3] J. Delors, "Learning: The Treasure Within", *Report to UNESCO of the International Commission on Education for the Twenty-first Century*. UNESCO Publishing, 1998.
- [4] J.W. Keefe, J.M. Jenkins, *Instruction and the Learning Environment*, NY: Eye on Education, Inc., 1997.
- [5] A. Crampton, T. Vanniasinkam, N. Milic, "Vodcasts! How to unsuccessfully implement a new online tool", *Interaction in Communication Technologies and Virtual Learning Environments: Human Factors*, pp. 118-128, 2010.
- [6] P. Galbraith, C. Haines, "Disentangling the nexus: Attitudes to mathematics and technology in a computer learning environment", *Educational Studies in Mathematics*, vol. 36 (3), pp. 275-290, 1998.
- [7] YouTube, RTU eMācības, 2014. Retrieved from http://www.youtube.com/results?search_query=rtu.emacibas.lv

- [8] I. Volodko, S. Čerņajeva, "Use of mathematical program packages for improving and modernizing teaching mathematics in the Faculty of Computer Science and Information Technologies in Riga Technical University", *Proceedings of the 16th International Scientific Conference - Engineering for Rural Development (ERDev 2017)*, Latvia University of Agriculture, Faculty of Engineering, vol.16, pp.242-247, 2017.
- [9] I. Dzenite, S. Čerņajeva, A. Matvejevs, "The role of RTU students' survey in ensuring the quality of mathematics studies", *Proceedings of the 17th Conference on Applied Mathematics (APLIMAT 2018)*, Slovak University of Technology in Bratislava, Faculty of Mechanical Engineering, pp. 316-325, 2018.
- [10] I. Dzenite, S. Čerņajeva, A. Matvejevs, "The influence of students' survey on teaching mathematical subjects at Riga Technical University", *Proceedings of the 17th International Scientific Conference – Engineering for Rural Development (ERDev 2018)*, Latvia University of Agriculture, Faculty of Engineering, vol.17, pp. 1049-1054, 2018.