Use of IT programs and tools for organizing independent studies in mathematics e-environment

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Abstract: In order to improve mathematics study process at Latvia University of Agriculture (LUA) one of the major challenges is ICT integration in the study process. At the Department of Mathematics of LUA has been created a structural scheme of the mathematics study form modules in which in addition to lectures and practical works, more attention is paid to the IT software integration in the learning process, as well as individual works for independent studies. Mathematics study process has been improved with an e-learning environment Moodle, in which there are placed the study materials (including interactive materials). The aim of the research was to investigate the current situation in Department of Mathematics and to improve the students' independent studies using ICT: 1) the development of practical tasks database in e-environment according to mathematical topics and types of solutions; 2) the exploration of Random Assignment Generator options and their adjustment for individual works assignment in mathematics in e-courses; 3) the creation of the solution examples with MathCad (for bachelor level) in mathematics and their accessibility in e-environment. Results of student survey shows that the use of MathCad for solution verification in computer classes and solutions' examples placed in e–environment, allows students to learn mathematics software independently, but for teachers reduce the time for checking students' individual works.

Keywords: students' independent studies, individual works, IT tools, e-studies

Introduction

European higher education reformation known as the Bologna Process comes to a close, its impact on the field of mathematics is significant in many ways. Mathematics degrees and programs are changing across Europe, and in some cases, with serious side effects. On the other hand, there have been considerable increases in the percentage of international students, who tend to major in mathematics and mathematics-related fields, attending European universities (Taylor-Buckner, 2010).

The main research of the ERDF project "Cross-border Network for Adapting Mathematical Competences in the Socio-economic Development (MatNet)" which has been implemented since 2011 till 2013 by the Departments of Mathematics of the Latvia University of Agriculture (LUA) and Siauliai University (SU) in Lithuania was Curriculum development which is based on two pillars: 1) changes in curriculum structure related to learning outcomes and competences and credit-module system; 2) improvement in the organization of study process where the focus is on study forms modules, on integration of ICT in study process and collaborative learning in mathematics (Balciunas, 2011).

The main objective of mathematics of recent years was reviewed to give students the knowledge necessary for better acquisition of technical subjects. But nowadays, besides the applications, students also need the basis of theoretical knowledge in their future work as well as understanding of the available literature and its creative use. Mostly all students spend only one year (engineering students - two years) to acquire the basic course in mathematics. The problem is: how to organize the mathematical education in the first or the second year of studies in such a manner which would be appropriate both for studying technical subjects and for the working life?

The aim of this research was to investigate the current situation at the Department of Mathematics of LUA and to find a way to improve organization of students' independent studies using ICT. Therefore, the emphases are going to be on:

1) the development of practical tasks database in e-environment according to mathematical topics and types of solutions;
2) the exploration of Random Assignment Generator options and their adjustment for individual works assignment in mathematics in e-courses
3) the creation of the solution examples with MathCad in mathematics and their accessibility in e-environment.

Furthermore, it is important to find out students' opinions on the proposed organization of independent studies in e-environment.

Methodology

In order to improve mathematics study process at LUA one of the major challenges is to revise the mathematics study forms and to integrate ICT in the study process.

Structural scheme of the mathematics study form modules in which in addition to lectures and practical works, more attention is paid to the IT software integration in the learning process, as well as individual works for independent studies.

1. Study form modules.

At the Department of Mathematics of LUA has been created a structural scheme of the study modules, where the process is divided into study form modules (Figure 1) has been worked out (Zeidmane**,** Vintere, 2009*)*. The most important in the theme acquisition is supposed THE PROVISION OF INFORMATION which includes previously learned material ("from the background knowledge"), the material from other subjects, necessary for the given theme and new material. For the processing of the given information integration of different forms of study modules (lectures, tasks, ICT environment, and students' individual works) can be used.

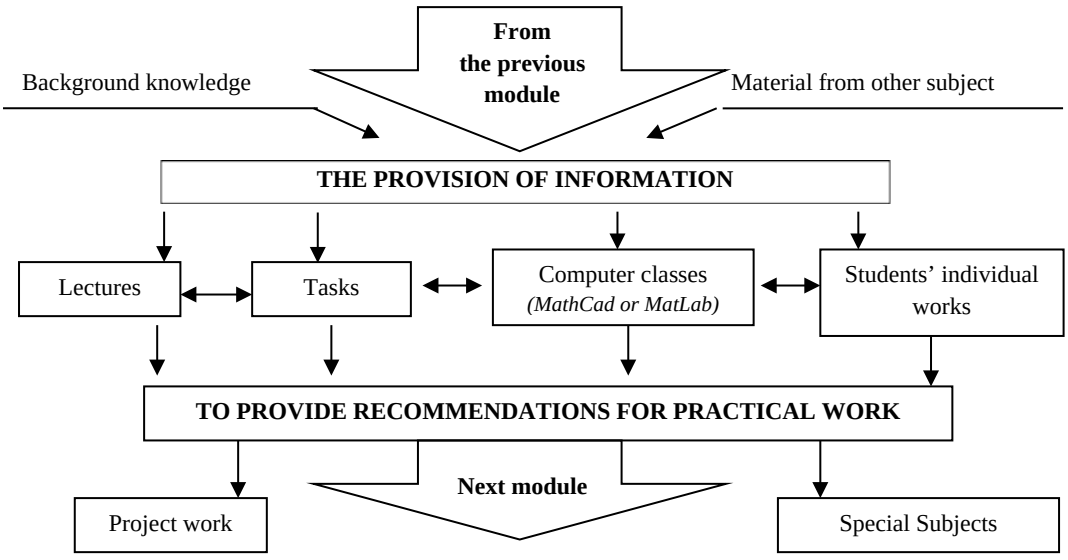

Figure 1. Structural scheme of study form modules

2. Integration of ICT in study process of mathematics

Based on the recent demands of labour market and increasingly rapid entry of IT into our lives it is necessary to review the mathematics learning process and content. The compromise should be found in the study process of Mathematics between:

- the acquisition of the fundamental knowledge;
- acquisition of know-how application of knowledge;
- the use of IT software in the calculations.

Integration of ICT in the study process has two aspects: using e- environment and using IT software. E-learning is one of modern approaches in educations field. The introduction of e-studies in the higher educational establishments does not mean only the creation of data basis which provides access to materials. It also requires the organization of new teaching forms as well as a new way of assessing the acquired level of knowledge. E-learning gives opportunity to follow up every student, his/her abilities, requirements and deliver to him/her only the information he/she wants. In fact, combined teaching is used in the studies – work in the lecture-room is combined with the work on e-learning website (Zeidmane, Paulins, 2012). The education support services must be completed: e-studies take place online, they are accessible in computers using standard software, the student interacts not only with the material but also with the lecturers and other students and the focus is on the wide education vision (Rosenberg, 2001). E-studies are also defined as the usage of the technologies for the selection, development, registration, provision, management, teaching and the support. Thus, e-studies are the process where the person learns on his/her own by using technologies.

The rapid changes in computer technology led to computer algebra systems like MathCad, Matlab, Mathematica and Maple which are used for education of future engineers. Therefore it is very important to integrate any of IT software in mathematics study process. LUA has experience in integration of IT in the study process of mathematics. The acquisition of software MathCad is integrated in the study process accounting for 0.5 of contact lessons per week (Computer classes) (Figure 2).

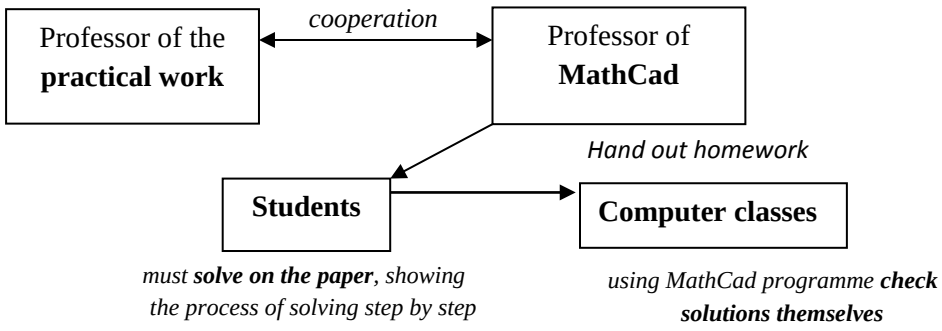

Figure 2. Integration of program MathCad in the mathematics study process at LUA

Professor of the MathCad cooperating with the professor of the practical work, hand out individual work to students. Students must solve practical tasks in mathematics on the paper, showing the process of solving step by step. One or two weeks later in the computer classes' students check solutions themselves using MathCad programme. The results are very positive because: 1) students enjoy comparing the results of their individual tasks with the results obtained with MathCad , the motivation to solve more mathematic problems is ~~in~~ increasing and students are interested in solving several variants; 2) professor spend less time for checking individual works; 3) the final tests show the improved scores.

Results and discussion

1. Investigation of experience in preparing and assigning the individual tasks in mathematics at LUA

Investigating the current situation at the LUA Department of Mathematics can be concluded that in all mathematics courses individual works are being assigned for students. Even more, individual works are one of the conditions to pass the mathematics course. As in every mathematics course there are 5-6 individual works (depending of the course credit points), that consists of several tasks and every students has its own variant, then all LUA mathematics teachers spend a lot of time every year to prepare individual works.

There are many practices of preparation of individual works among LUA mathematics teachers. The most popular individual work preparation types are:

- To use ready individual works with many variants from textbooks.
- To make their own individual work compilations from different literature sources.
- To create a new individual work tasks every year.

There also are different practices in the way how individual works are handed out to students:

- If individual works are stored electronically (as Microsoft Word, Portable Document Format - pdf document), then group of individual works file usually is sent to students over e-mail.
- If individual works are prepared on a paper then one copy of individual work is handed out to a whole group of students (everyone should write down their individual work task).
- Some teachers prepare and hand out individual work for every student in paper form.
- In resent time approximately 50 variants about each topic is created and placed in mathematics e-courses and each student have his own variant.

These experiences have a lot of weaknesses.

Concerning to preparation of individual works:

- Teachers spend a lot of time on updating, changing and creating new individual work every year.
- Using ready individual works from textbooks or even their individual work compilation every year, a plagiarism issue can arise among students –individual work that is handed in is solved in previous years by other students.

Concerning to ways of hand out:

- If individual work is sent to student e-mail, then very often students argue that somehow they have not received these teacher e-mails. All variants of individual work tasks are available for all students that also can enable a plagiarism issue.
- If one individual work copy is being handed out for a group then usually students have excuses for not writing down his individual work or even losing their copy. Writing down their tasks, students make mistakes.
- Preparing an individual copy for every student, teachers spent a lot of time for writing, copying and handing out a copy for every student. And if student has missed this lecture, when individual work is handed out, then student gets no individual work.

2. Development of individual tasks database in e- environment

One of the results of the ERDF project "Cross-border network for adapting mathematical competences in the socio-economic development (MatNet)" was preparation of recommendations for improvements of mathematics study programs. According to these recommendations, group of teachers from Departments of Mathematics of LUA and SU developed database of practical mathematical tasks from all topics of mathematics. Teachers divided mathematical tasks according to the different methods of solving and different levels of difficulty. Such a database was created in the Department of Mathematics at LUA for three levels of Mathematics courses- engineering level, pre- engineering level and mathematics for social sciences.

3. Possibilities of Random Assignment Generator

Summarizing challenges and everyday practice in mathematics individual work assignments at LUA, authors concluded that there should be created a system for individual work assignment, corresponding to certain requirements: 1) unique variants of individual work should be assigned for every student without spending a lot of time; 2) easy individual work assignment process for teachers and students; 3) improved mathematics teacher work efficiency.

Individual work assignment system called Random Assignment Generator (RAG) was created as Course Management System Moodle Quiz activity with certain choice of question types and options together with specially established and categorized individual work database (question bank). (Moodle: Learning Management System, 2013).

Moodle Open Source Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE) (Moodle: Learning Management System,

2013) was chosen for the implementation of the RAG, as it met all the requirements. LUA actively uses Moodle in study process because LUA encourage blended learning approach in study process, blending full-time studies with e-learning and new system development for individual work assignments would be ineffective in many ways – cost, time and usability. The Quiz activity module allows teacher to design and build quizzes consisting of a large variety of Question types, including multiple choice, true – false, and short answer questions. These questions are kept in the Question bank and can be re-used in different quizzes.

For RAG authors used Moodle Question bank, where all individual work mathematical tasks are categorized by mathematics topic and solution type. For example, category – Applications of Integrals and subcategories –Area of Plane Region, Volume of Rotation, Length of a Curve etc. (Figure 3). For input of mathematics tasks is chosen Moodle Question type Essay and TeX language. TeX is a typesetting system, popular for typeset mathematical formulae (Knuth, 1984). Random question option is chosen to create Quiz activity for student individual work with unique variants.

Figure 3. Screenshot of student individual work using Random Assignment Generator

RAG implementation into mathematics study process, is a solution for previously listed individual work assignment problems:

- Individual work is accessible for students in Moodle system at any time.
- Individual work tasks are generated randomly for every student.
- Mathematics tasks are easy to create in Moodle, because Moodle supports TeX language.
- Tasks are easy to use, easy to add to e-course and easy to update and change in the Moodle environment. Teachers can quickly add new tasks to the individual work.
- Individual works are easy to import and export from one Moodle e-course to another.
- Teacher gets access to individual work variant that student receives in Moodle.
- RAG allows creating different groups of tasks, so that all teachers can share their individual work compilations.
- Students can generate additional individual work variants and practice more when learning for exam or mid-semester tests.

4. Step by step examples of practical mathematics problem solutions with MathCad

Nowadays IT software is used for calculations and problem solving. It means that students need skills to use IT software as well as knowledge of mathematics, to understand software operations. As mentioned above it is very important to integrate any of IT software in mathematics study process. For bachelor level studies software MathCad is used because at LUA there are only 0.5 computer classes hours per week, this program is easy for students to acquire and with graphical interface (Maxfield, 2009). Although basics of MathCad are acquired in the beginning of classes, solution process of different tasks of each mathematics topic have its own specifics. Examples of practical mathematical problem solutions in MathCad step by step are created and made available to the students through an e-environment. Students can solve tasks in the MathCad independently or with teacher assistance coming to computer classes.

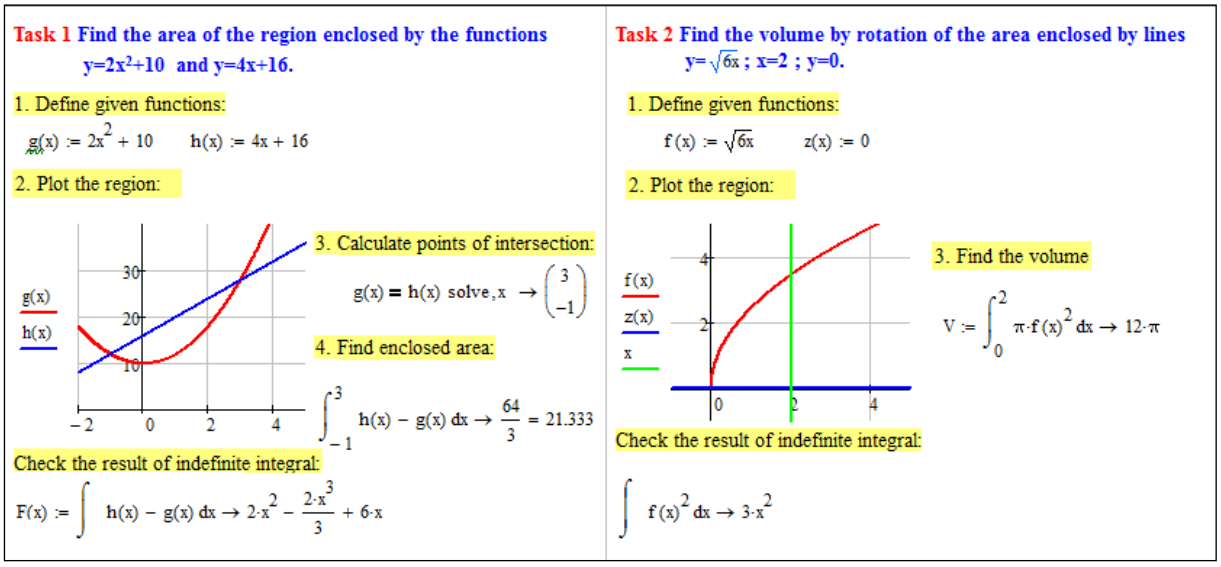

Figure 4. Example of students' individual work about topic "Applications of integral" using RAG.

For example, one of the individual works is about the mathematics topic – application of integrals. In most LUA mathematics study courses are included applications of definite integral such as calculation area of plane region, volume of rotation region, length of a curve. Practical tasks discussed in RAG example (Figure 3) can be solved with MathCad step by step (Figure 4). In both tasks – area of plane region and volume of rotation, solutions starts with definition of given functions, then students can plot the graphs of the given functions to better understand how the region looks and then follows the calculation using area or volume regularities. Correct answer in MathCad can be obtained directly with the MathCad function definite integral or step by step – indefinite integral and then calculation of boundaries.

To ascertain the students' view on provided support in the e-environment for independent studies, 234 students of LUA engineering specialties were surveyed. Relating to the assignment of the individual works in e – environment, then 83.2% of students are satisfied with this new practice, because they don't need to write down practical tasks anymore and they are accessible anywhere where is available Internet and computer, tablet or smartphone. Still, 10.3% of surveyed students are neutral or not sure, but 6.5% don't support this practice (Figure 5). Most on the neutral and dissatisfied students noted that they don't have necessary technologies at their home place or dormitories, and that they have problems using the technologies and e-environment.

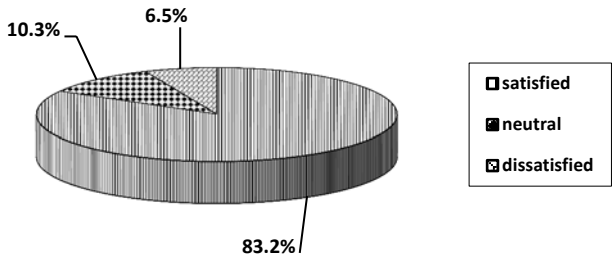

Figure 5. Students'opinion about assignment of the individual work in e-environment

Relating to opportunities to learn mathematical problem solving in MathCad independently, the survey results show that 7.1% answered that they were able to find a solution to the task of Mathcad before computer classes, 12.2% - were able to find a solution to the task of MathCad before computer classes only with help of other colleagues, 46.8% - were able to solve some of the tasks in MathCad before computer classes depending on the difficulty of mathematical topic and 33.9% - were not able to solve the MathCad before computer classes. (Figure 6).

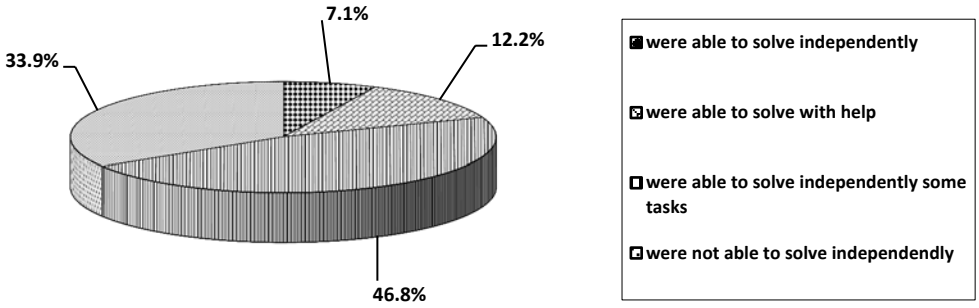

Figure 6. Students'ability to solve practical mathematical tasks in MathCad independently before computer classes.

Student survey showed that often the task solution examples in Mathcad helped to solve the independent work step by step, because 1) the results were comparable 2) solution process of the example in MathCad is similar with the practical task solution on paper.

Conclusions

- Investigating the current situation in the Department of Mathematics at LUA can be concluded that there are many practices of preparation of individual works and in way how the individual works handed out to students. These experiences have a lot of weaknesses: if teachers updating, changing and creating new individual works every year, they spend much time; if is using ready individual works from textbooks the individual works compilation every year, a plagiarism issue can arise among students.
- Solution of this problem at first was creation of common database of practical tasks in mathematics and the second applying the program for generation different variants. Some adjustment of Moodle system should be made in addition, that would allow creating test question without an answer window. Student input is not necessary for higher mathematics tasks, as the right answer is as important, as the solution - chain of logical judgments.
- IT program Random Assignment Generator provides different variants of individual works on specific topics for each student that are not repeated year after year in the mathematics courses. E-environment usage solves the hand out problem.
- Many students agree that the creation of the solution examples with MathCad in mathematics and their accessibility in e-environment support the acquisition of MathCad independently and give solution of individual works step by step.

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