E-LEARNING APPROACH IN MATHEMATICAL TRAINING OF FUTURE ECONOMISTS

Dana Országhová
Slovak University of Agriculture in Nitra
Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic
dana.orszaghova@uniag.sk

Abstract: *The inclusion of e-learning methods in education enables teachers to create modern learning resources, to provide support in the self-study of students, and motivate them to acquire knowledge actively. The main objective of this paper is the analysis of possibilities of adopting the e-learning approach in mathematics education. The research sample was focused on students in economic bachelor study program that includes compulsory mathematical subjects. Through the survey, we examined whether students use electronic materials in mathematics study. Via a statistical two sample t-test we evaluated students' exam outcomes in mathematical subjects.*

Keywords: mathematics teaching, e-learning, LMS Moodle, exam outcomes, two-sample t-test.

INTRODUCTION

The university education of new experts in the field of economics and management has undergone various changes and modifications. They reflect the process of transformation of education, which is related to changes in educational content and also to modernization in the forms of education. Results of the development and implementation of information and communication technologies are recognizable at all levels of education: elementary and secondary schools, universities and lifelong learning. The requirements of the current society for the training of professionals are also changing the process of mathematical education.

There are many different factors in the learning process that represent the subjects, means and circumstances of learning. Therefore, education analysis involves the effects of many factors and often brings new observations and findings. The integration of modern educational tools and methods into teaching is a part of the work of the university teacher. The role of teachers is to explore the interaction between traditional and modern teaching methods.

Everyone who comes in contact with school education (teachers, parents, education authorities, etc.) is aware that the learning process is also dependent on the following factors (Průcha, 2005): what students are taught, how many students are in the study group, whether the teacher is an experienced teacher or a novice teacher, whether the learning process is equipped with good textbooks and study materials, and so on. The mentioned factors belong to the input determinants of educational processes that affect the level of the educational process. In a wider sense, the quality of education is also conditioned by another determinant, which is the level of information technologies and the degree of their implementation in the activities of the educational process. The significant features of new media are:

- Transmitting of information by interactive means,
- Double-sided communication,
- Combined information including image, sound and traditional text,
- Multilevel information: user can follow the text in different directions (hypertext),
- Networks, e-mail and multimedia and combine forms of data storage on media,
- Mobile resources and access to study materials "anytime and anywhere".

Study materials in electronic form are created and used at all universities and for all taught subjects included in the study programmes. Some study materials and books are available on the Internet in pdf format, in the form of web pages, or we can study books in electronic form directly through so-called "readers". Pedagogical empirical research and practical experience of educators confirm that students in both the daily and external forms of study are interested in learning with e-learning methods with the use of information technology (IT) (Országhová et al., 2010).

Due to the dynamic development of mobile technologies, the current student is not bound to one place and a specific computer in e-learning form of study. Many educational institutions or providers of distance learning forms are aware of the possibilities of mobile technologies and adapt the form of materials suitable for to the method of M-learning (mobile learning).

The use of Learning Management Systems in higher education has greatly increased and has a strong impact on the educational process from the aspect of both the educator and the educated student (Cerezo et al., 2016). In addition, as it is stated by Alajbeg et al. (2017), the implementation of LMS in the teaching process offers a wide range of benefits: reducing the administrative work of teachers, reducing the possibility of errors in the preparation, execution and evaluation of examinations; eliminating the subjectivity of the teacher during the assessment phase; reducing inappropriate student actions during examinations, etc.

In many studies it is confirmed that one of the main tasks of education should be the increase in student's motivation to learn and motivation factors influencing the student’s learning, include internal motivation of students, teacher’s personality,

suitable educational methods, attractive educational environment and other (Ferenczi Vaňová et al., 2014).

Nowadays, the information and knowledge society requires a modern teacher to master and use available IT resources to form new opportunities for students to realize creative self-study. Activities such as virtual meetings, learning management systems for educational process support, online tutoring, and social media are also part of the teachers' activities (Smyrnova-Trybulska et al., 2017).

1. MATHEMATICS STUDY COURSES IN LMS MOODLE

Implementation of information technology into mathematics teaching brings a number of professional and didactic tasks. The basic scheme of the contemporary university education (Figure 1) integrates IT - supported study with the contact teaching and self - study.

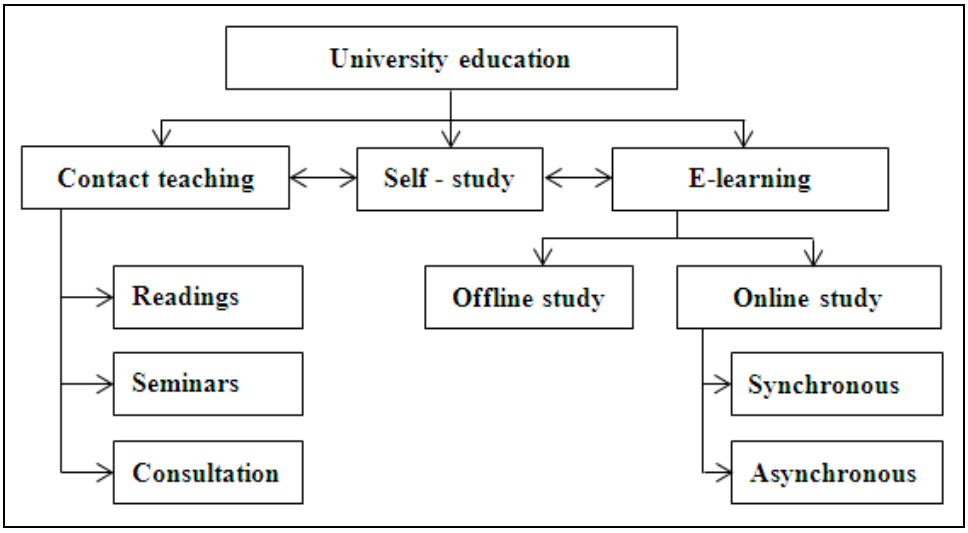

Figure 1. The scheme of university education
Source: Own work

As Turek (1997) states, we can use programmed instruction to implement e-learning, which is based on the following main principles: the principle of small steps, the principle of active response, the principle of immediate fixation, the principle of individualization and the principle of evaluating and improving the programme.

The research work material for this paper was obtained from the teaching of compulsory subjects Mathematics IA and Mathematics IB at the Faculty of Economics and Management (FEM), the Slovak University of Agriculture (SUA) in Nitra. The methodological approach is based on the analysis of lectures,

exercises and exam outcomes, which are presented also in graphic form. Next material was received from the research projects of the Department of Mathematics, which were focused on the implementation of IT tools in education and from conducted survey about usage of electronic study sources by students of the Faculty of Economics and Management.

Teachers from the Department of Mathematics SUA in Nitra created in LMS Moodle electronic courses for mathematical subjects taught in the Slovak language:

- Course "Exercises in Mathematics (Winter Term)" for the study subject Mathematics IA,
- Course "Exercises in Mathematics (Summer Term)" for the study subject Mathematics IB,
- Special course for seminary projects: students get seminar assignments and submit solutions via tools of LMS Moodle.

The content of the next course "Mathematics" (Figure 2) is in line with the study subject Mathematics that is taught in English: Matrices, Systems of Linear Equations, Functions of one real variable, Limit of the function of one real variable, Derivative of the function of one real variable and applications, and Indefinite and definite integrals of the function of one real variable.

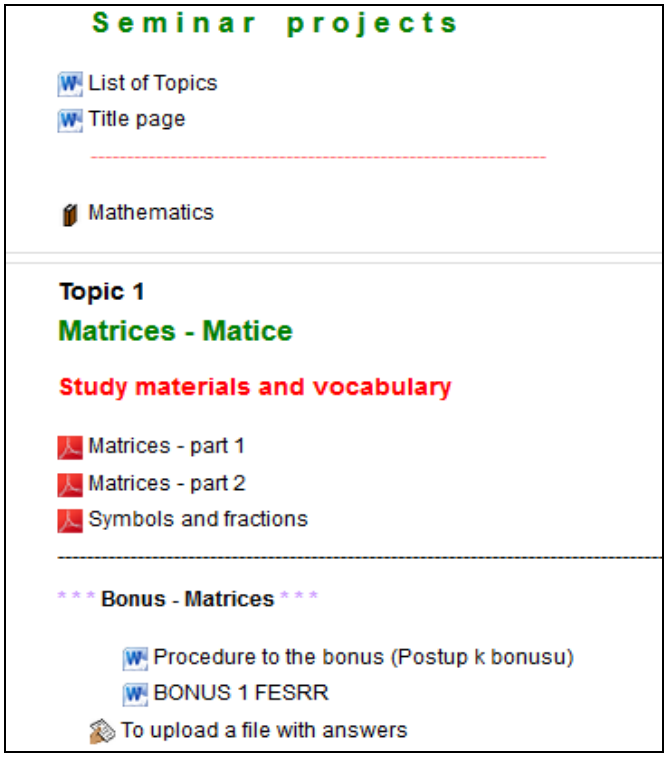

Figure 2. The topic "Matrices" in LMS Moodle course "Mathematics"
Source: Own work

Technically, LMS Moodle provides a user-friendly interface that does not impose special requirements on users, teachers and students. The user applies an Internet browser environment and uses hyperlinks.

2. APPLICATION OF ELECTRONIC LEARNING SOURCES

2.1 Survey about information and study sources for students

The Department of Mathematics SUA in Nitra has been using LMS Moodle in mathematics teaching for several years. Tools of LMS Moodle are effective for teachers who can realize the blended learning in mathematics. Electronic support in a mathematical study can be applied during lectures, seminars and individual study and elaboration of seminary projects. Special activities were created in this system, and during the semester students could earn bonus points for work in LMS Moodle counted in the final evaluation.

The most effective common used tools in the creation of the electronic courses for mathematics are:

- Resources (File, Folder, Page and URL),

- Activities (Assignment, Questionnaire, Quiz and Upload a single file).

During the academic years 2015/2016 and 2016/2017, we have conducted a survey among students of the study program Business Economics, which was focused on the usage of electronic learning resources. The survey was realized in the summer semester of each academic year, when students master the LMS Moodle tools from the winter semester and have information about educational materials. The main objective of the survey was to find out the extent of use of available study materials in electronic form in LMS Moodle, especially during the preparation of students for the mid-term test and for the exam. The survey included 143 students of the first year of the Business Economics study program; we received 78 answers in 2016 and 65 answers in the 2017. The distribution of the research sample by gender was as follows: men 29 % and women 71%. The responses were processed using descriptive statistics and the final results are presented in the graphical form.

2.2 Analysis of the survey outputs

In this part we present the evaluation of three selected questions of the survey.

Question no. 1:

Please, indicate which school information sources/systems are you using?

- E-mail to the teacher,

- E-mail to students,

- LMS Moodle,

- Web page of the faculty,

- University information system (UIS).

Students could indicate all the options they use. The obtained results are demonstrated in Figure 3. University information system is used almost by all students (98% in 2017 and 96% in 2016). This information source is followed by faculty web page (more than one half of students). The usage of LMS Moodle was declared by 39% of students in 2017 and 45% in 2016; in general we can say that less than half of the students of this research sample. This value is followed by mail communication between classmates and teachers. Electronic math communication via mail is difficult because mathematical formulas require special editors and browsers. Students write simple text in the mailbox, and the most they ask for organizational teaching matters.

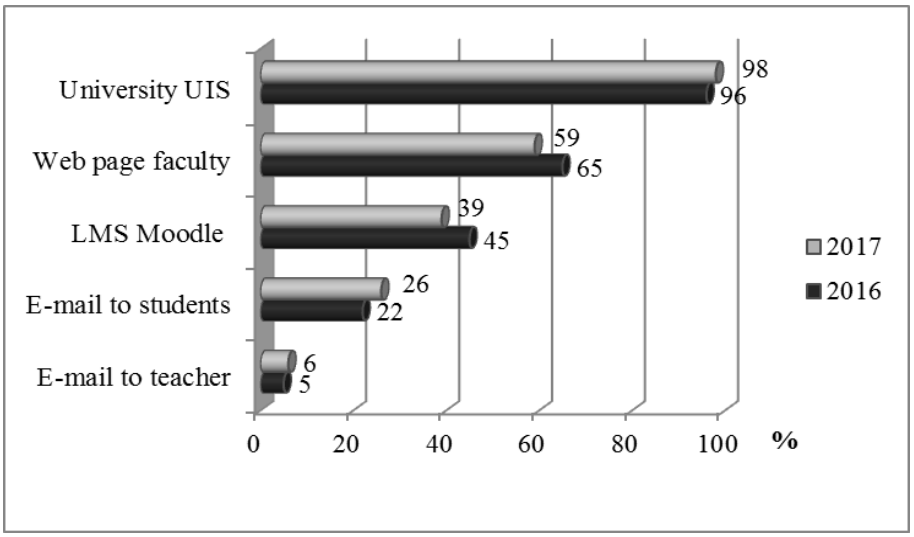

Figure 3. Usage of information sources/systems by students

Source: Own work

Question no. 2:

Please, state how often do you use math's study materials in LMS Moodle in individual activities?

- During the semester: a) often, b) rarely, c) never,

- In preparation for the exam: a) often, b) rarely, c) never,

- When developing a seminar project: a) often, b) rarely, c) never.

The responses to the second question (Figure 4) show that during the semester students did not use very often the study material in the LMS Moodle, only a part of the students mentioned this activity (15%). Only one fifth of the students (22%) actively use the LMS Moodle system to develop a seminar project. In the study for the exam, educational materials in LMS Moodle are used approximately by one

third of the students (29%). More than half of the students said they did not use LMS Moodle during the semester (52%). We can conclude from these answers that it is necessary to create more mandatory activities in the LMS Moodle system during the semester (e.g. individual study assignments) that will be evaluated by teacher and the student will acquire so-called bonus points for the interim evaluation.

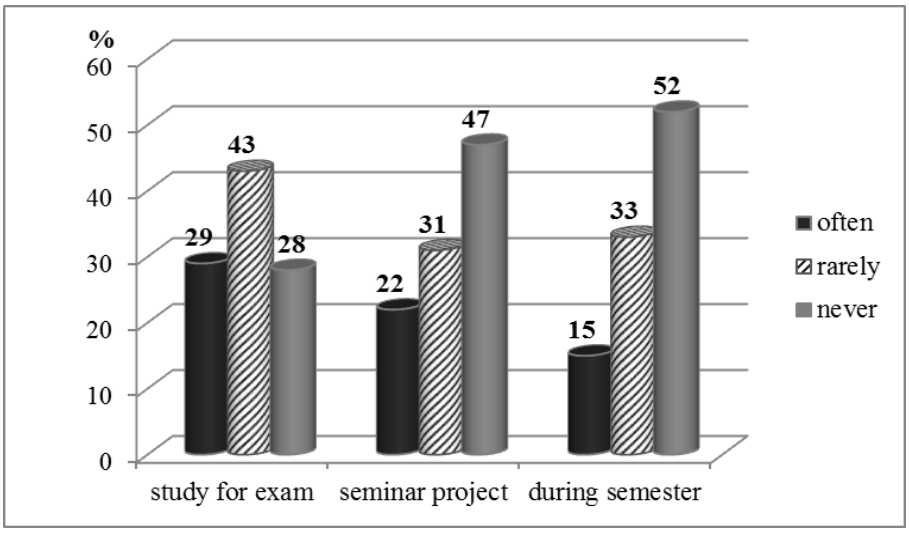

Figure 4. Frequency of the usage of LMS Moodle in mathematics study

Source: Own work

Question no. 3:

Please, declare your use of the learning resources in the mathematics study (together 100%):

a) Notes from classes,

b) Notes from lectures,

c) Printed textbooks,

d) Study materials in LMS Moodle,

e) Other resources (e.g. Internet, classmates ...)

In this question the students were asked to rate the extent of the usage of available learning resource in the study of mathematics. They proportionally divided the value of 100% and the results confirm (Figure 5) that they mostly use their own written notes from classes (43%) and lectures (28%). This is followed by printed learning materials (15%), and materials in LMS Moodle are used to a lesser extent (only 9%). This result corresponds to the character of the subject matter, because mathematics requires in particular the practice of computations in examples and graphical interpretation of mathematical objects (e.g. function graphs). This is also

the reason why students have assignments in LMS Moodle, math tasks and exercises in a print-ready format to use them in their homework and study.

In this research sample the results confirm that most students use general information from the University Information System (UIS), in which they also have e-mail accounts and access to e-mails of their teachers and classmates. They use LMS Moodle, but some of the activities are not mandatory, so they do not use them often during the semester or in the exam preparation. We assume that their activity can be increased and the created materials can be used to improve and motivate the individual study of students.

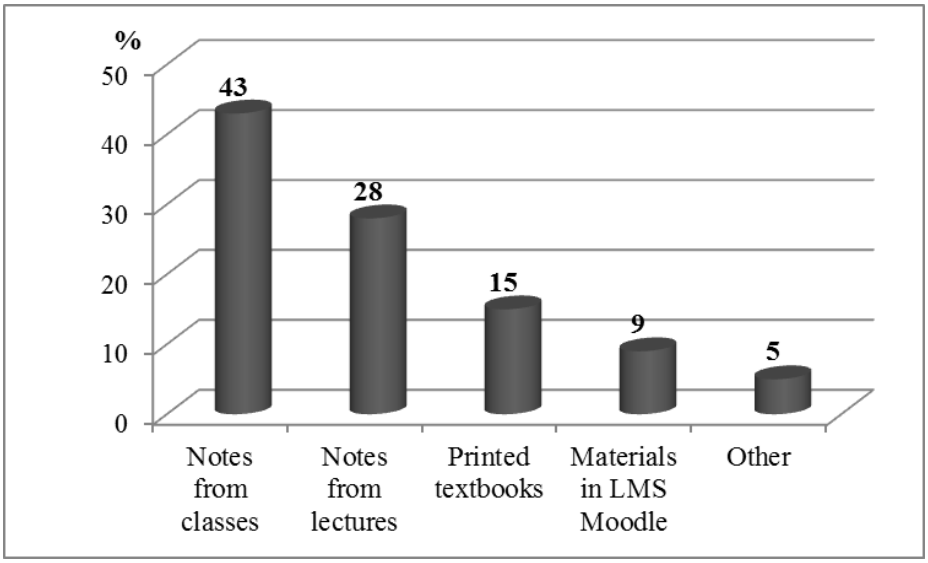

Figure 5. Usage of mathematics study materials

Source: Own work

3. ASSESSMENTS AND EXAMS IN MATHEMATICS

3.1. Analyzed research sample and statistical methods

During two academic years 2015/2016 and 2016/2017 a survey about exam outcomes was carried out at the Faculty of Economics and Management. The main objective was to compare the results of the exam grades of compulsory mathematical subjects. The research sample was created from students of this faculty, specifically of the study program "Business Economics" in the 1st year of bachelor degree study.

The statistical evaluation of the exam grades was realized via the two sample t-test. We tested the null hypothesis $H_0 : \mu_1 = \mu_2$ versus the alternative one $H_1 : \mu_1 \neq \mu_2$.

As a test criterion we applied:

$$t = \frac{\overline{X} - \overline{Y}}{\sqrt{S_p^2 \cdot \left(\frac{1}{n} + \frac{1}{m}\right)}},$$

where $\overline{X}, \overline{Y}$ are selection averages, S_p^2 is mutual variation. Critical region is the set $W_\alpha = (-\infty, -t_\alpha(n+m-2)) \cup (t_\alpha(n+m-2), \infty)$, where $t_\alpha(n+m-2)$ is the critical value of Student's *t*-distribution with $n+m-2$ degrees of freedom.

3.2 Comparison of exam outcomes in compulsory mathematical subjects

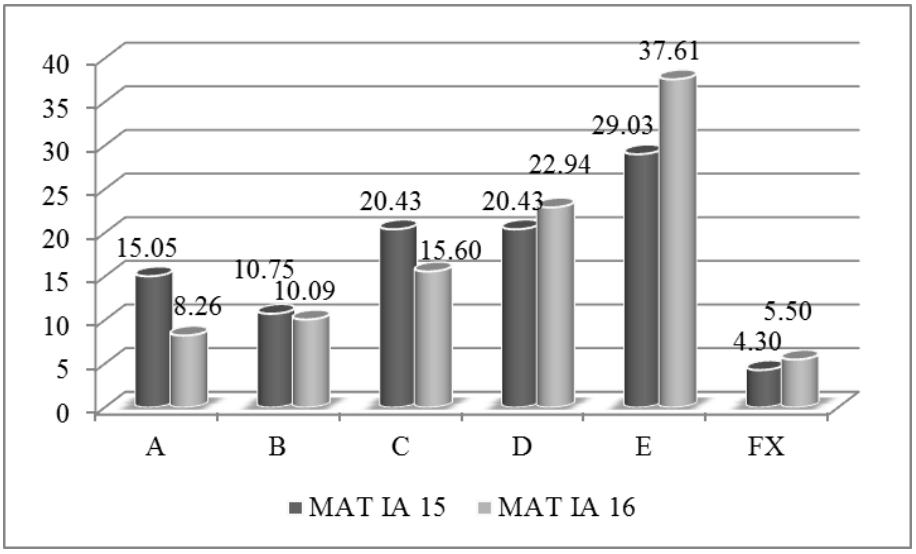

Figure 6. Comparison of exam grades in Mathematics IA (percentage)

Source: Own work

In study programme "Business economics" there are involved two compulsory mathematical study subjects: Mathematics IA (MAT IA) and Mathematics IB (MAT IB). We present the statistical analysis of exam grades of these subjects taught in academic years 2015/2016 and 2016/2017. We have two statistical samples of range $n_1 = 180$ (in academic year 2015/2016) and $n_2 = 208$ (in academic year 2016/2017). We analyze two statistical attributes – the first one signed by MAT IA is the exam grade of the subject Mathematics IA (winter semester), the second one signed by MAT IB is the exam grade of the subject Mathematics IB (summer semester). The standard evaluation scale is from A(1) to E(3) and FX(4) mean failed. Figures 6 and Figure 7 display the graphic presentation of exam outcomes in academic years 2015/2016 and 2016/2017. To compare the success of the students on the exam, we have expressed the number of individual grades in percentage.

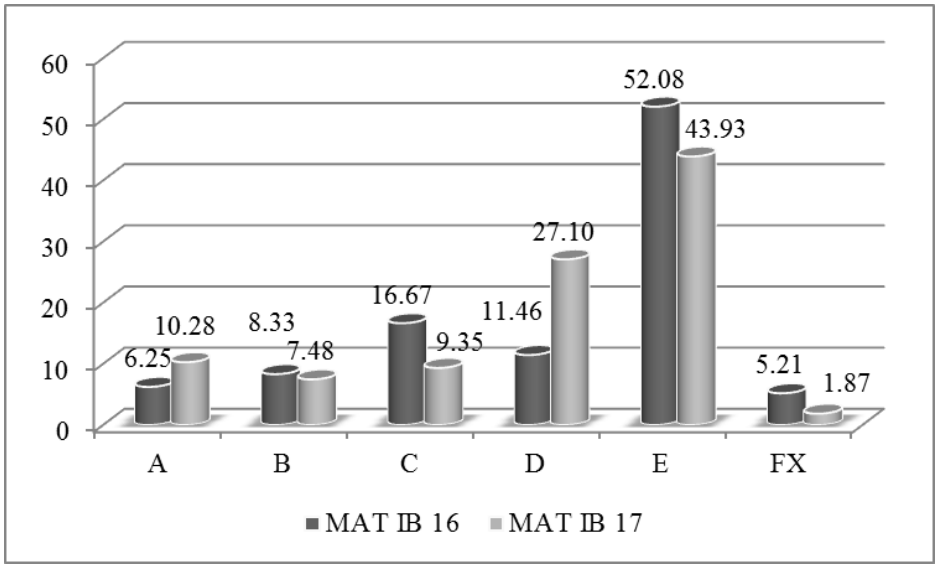

Figure 7. Comparison of exam grades in Mathematics IB (percentage)

Source: Own work

In the Table 1 there are average grades of analyzed study subjects. We can also conclude the decreases in the value of the average mark between study subjects, even between years (Table 1).

Table 1.

Average grades in study subjects Mathematics IA and IB

Year	**2015/2016**		**2016/2017**		**2015 - 2017**	
Subject	MAT IA	MAT IB	MAT IA	MAT IB	MAT IA	MAT IB
Average grade	2.2	2.5	2.38	2.44	2.29	2.45

Source: Own work

It is evident that in both academic years the final exam evaluation by the grade E(3) is the most common in examined subjects (Figure 6, Figure 7, Figure 8).

The presented comparison confirms that in the summer semester students have worse grades evaluation (MAT IB) than in the winter semester (MAT IA). Average grades are in the range from 2.2 to 2.45, which is approximated by the exam grade D (2.5). Very important is the fact that a part of students drop out after the first semester because they have inadequate knowledge and study habits from the secondary school.

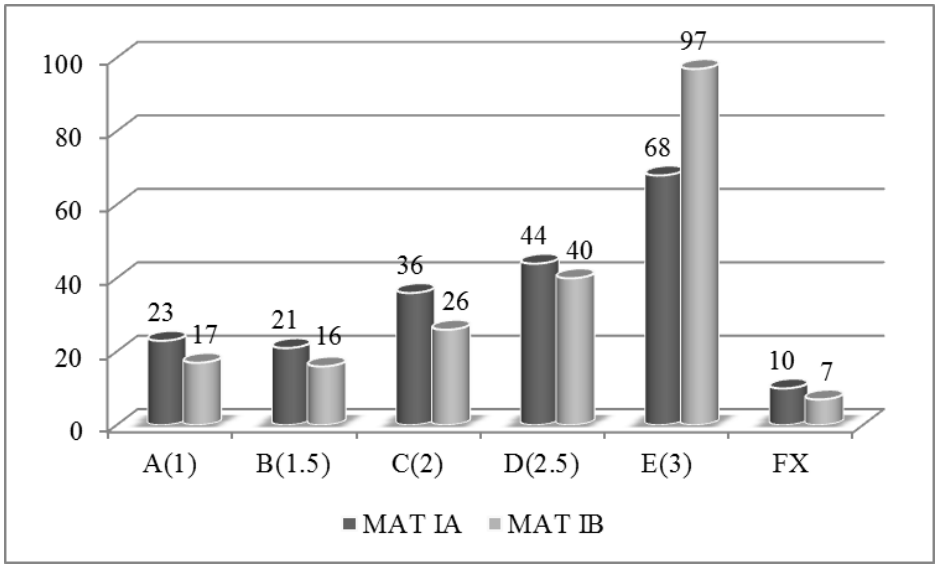

Figure 8. Exam grades in MAT IA and MAT IB (absolute frequency)

Source: Own work

3.3 Statistical analysis of exam grades

Using the method of a two sample t-test (listed above) we verified null hypothesis.

H_0: Students achieve the same level of exam assessment in Mathematics IB as in Mathematics IA.

In the Table 2 there are summarized presented results of statistical hypothesis testing. The level of assessment is represented by exam grades in mentioned study subjects. We tested the data about students' exam grades and we did not take into account the evaluation FX. The calculations of statistical characteristics were performed using the table processor MS Excel 2010.

In the academic year 2015/2016 the null hypothesis is not accepted at the significance level $\alpha = 0.05$ because the value (two-tail) $P = 0.003 < 0.05$; therefore differences between exam grades in Mathematics IA and Mathematics IB are significant.

In the next academic year 2016/2017 the null hypothesis cannot be rejected at the significance level $\alpha = 0.05$. We have obtained the result for P value (two-tail) 0.48 > 0.05; therefore differences between exam grades in given subjects are not significant. Because the calculated value of the test criterion $t = 0.697$ did not exceed the critical value of Student t-distribution 1.971, the null hypothesis cannot be rejected.

Table 2.

Results of two-sample t-test on exam grades in Mathematics IA and IB

Year	2015/2016	2016/2017	2015 - 2017
Observations	MAT IA: 89	MAT IA: 103	MAT IA: 192
Observations	MAT IB: 91	MAT IB: 105	MAT IB: 196
t Stat	-2.98	-0.697	-2.52
P(T<=t) one-tail	0.0016	0.24	0.006
t Critical one-tail	1.65	1.65	1.64
P(T<=t) two-tail	0.003*	0.48	0.012*
t Critical two-tail	1.973	1.971	1.966

Source: Own work

When we tested exam grades together for both years, 2015/2016 and 2016/2017, we found that the differences in grades are significant. The null hypothesis cannot be accepted at the significance level $\alpha = 0.05$ because the value (two-tail) $P = 0.012 < 0.05$. The test criterion $t = 2.52$ exceeded the critical value of Student t-distribution 1.966 and therefore we reject the null hypothesis.

The winter and summer term are interconnected in different thematic areas. For example, properties and function graphs in the theory of functions (winter term) are used in the tasks with definite integrals for calculating the area of planar body. The graphical outputs for this issue are available to students in LMS Moodle courses. The assessment of the students' knowledge level is the important part of the educational process. However, the obtained data indicate that teachers and students cannot be satisfied with study outcomes, especially with the average exam grade.

4. DISCUSSION

Průcha (2005) defines the effects of education as "indirect implications of the interaction between learning outcomes and the social environment". He further states that the education has a considerable impact in many practical fields: professional careers, the complexity of the work performed, wages of workers, employment, education and media behavior of people and others. Changes in demographic trends, the structure of population, the population mobility and other factors influence the process of university education in its qualitative and quantitative aspects (Papcunová and Gecíková, 2012).

Majherová (2010) states that technologies have become the part of the implementation of many tasks contained in current education. And the author continues that the findings of the revised Bloom's taxonomy extend the digital application of the Bloom's taxonomy for new learning conditions, created by the Churches (2008). It consists in interconnecting the individual levels of Bloom's taxonomy to specific pupil's/students' activities when using ICT; e.g. digital extension of the level "remember" means "find, highlight and create a bookmark".

The digital literacy includes the ability to understand information and use it in various formats from various sources presented through ICT. Based on Bloom's digital taxonomy via e-learning we can effectively apply such activities as: "apply, understand and remember" also in mathematics.

As Burgerová and Adamkovičová (2014) report, e-learning is the education realized in an environment supported by information and communication technology (ICT); this form of education is applied in university education especially for the following reasons:

- Reduction of hour range of the contact teaching,

- Increased requirements for self-study and individual student activities,

- Innovation of study programmes,

- The new demands of the young generation on education,

- Faculties' sustainability due to the demographic decline in the number of students,

- Virtualization of the learning process as well as the processes of everyday life.

Education becomes the key factor in the information society, and its aim is to ensure that people are able to find and understand the information, and then apply them correctly. A great advantage of the implementation of IT tools into the process of mathematics education is better explanation and visualization of the mathematical concept (Országhová, 2017).

The contemporary educational process includes more and more effective and different teaching and learning tools. Pupils in elementary and secondary schools have experience with educational games which can eliminate cognitive shortcomings in attainments (Hosťovecký et al., 2015). Interactive tasks that use information technology, mathematical software and programming elements have practical applications in computational modeling that helps solve practical issues with scientific methods (Kočí et al., 2017).

Many research studies compare used media in e-learning; the research with meta-analysis of obtained data indicates that games as a special medium of education assist in efficient learning (Clark et al., 2016). In the university study the application of mathematical programs, online calculators and interactive tools is the part of many taught subjects (Majovska, 2017).

We suppose that the phenomenon of e-learning approach will become increasingly important in the modern education. Therefore it is necessary for both teachers and students to have necessary information competences and skills.

CONCLUSION

Information technology tools create conditions for changes in the process of teaching and learning. The university mathematics education is not possible without information technology tools. The current generation of students is technologically capable, they perceive electronic learning positively. Self-learning methods associated with e-learning mean searching for knowledge, their targeted processing by subjects of learning, and the creation of new knowledge through student activities.

In mathematics an e-learning approach means the detailed explanation of studied topics for students. Activities for "applying, understanding and remembering" are available in electronic courses and study materials that are created with an aim to increase the success of students in the mathematics study and in the preparation for the exam.

The presented results of the survey on the mathematical electronic courses in LMS Moodle have shown that the students' usage rate is low; 22% of students use available materials in the seminary project preparation and 29% of students in the exam preparation.

One possible solution of how to stimulate interest of students in e-learning activities is to incorporate them in the education as mandatory; their evaluation will give students the opportunity to gain points that can improve their final exams.

Using the two-sample t-test we tested the differences in exam grades between compulsory study subjects Mathematics IA and Mathematics IB. The results form academic year 2016/2017 proved that differences in exam grades are not significant. In two cases, the significance of the differences in given grades was confirmed; in academic year 2015/2016 and in the case of a sum of exam grades for both academic years together.

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