

## ON HOMEWORK ROLE IN MATHEMATICS TEACHING AT RIGA TECHNICAL UNIVERSITY

Natalja Budkina, Gerda Dubkevicha, Aija Pola

Riga Technical University, Latvia

natalja.budkina@rtu.lv, gerda.dubkevica\_1@rtu.lv, aija.pola@rtu.lv

**Abstract.** The debate about homework effectiveness as a learning tool has continued for more than a century. There are many papers about homework effect on the learning process of schoolchildren. The aim of this article is to analyse the role of homework in the process of mathematics teaching at universities on the basis of the authors' experience working with students from three faculties of the Riga Technical University. The report includes a description of the system of homework assignments and their weight in the evaluation of students in mathematics courses. Some types of homework are mandatory for first-year students in all mathematics courses regardless of level, number of hours, or topics included in the course. The authors of the paper review the advantages and disadvantages of these types of homework. The influence of homework on student knowledge and skills is analysed in the article. Two similar surveys about the role of homework in the mathematics teaching-learning process were conducted for groups of students of different specialities of RTU before and after the COVID period (at the beginning of 2020 and the end of 2023). The results of these surveys are also analysed in this paper from two perspectives: to understand the role of homework in the teaching process and to analyse the influence of the online study period during COVID-19 on the completion of homework assignments by students. The report also includes a discussion of using ChatGPT in homework. The conclusion of the necessity of homework is mainly driven by the analysis of the surveys and the detected correlation between the students' homework results and results in the tests and exams.

**Keywords:** mathematics teaching, homework, survey.

### Introduction

An educated, competent person is the determining factor in the competitiveness of a country. The demand for qualified engineering and technical workers who can quickly manage the latest scientific developments, modern technologies and materials has increased significantly. The most important task in the sphere of education is the preparation of such highly qualified specialists. Unfortunately, in most European countries, there is still a small number of students interested in studying or pursuing a career in STEM fields (STEM – Science, Technology, Engineering and Mathematics). To improve the situation, the development of STEM education in most countries has been considered as one of the national priorities for the coming years. This education is impossible without deep learning mathematics because even when using new technologies for modelling and computing to solve many real-life problems and analyse and interpret the results accurately, some level of understanding of mathematics is needed. Thus, attention to teaching mathematics in universities is significantly increasing.

When discussing teaching mathematics, some factors that essentially complicate the study process should be taken into account. The first one is that the level of preparedness and attitude of students to mathematics is bad. Teenager mathematics skills are in an unprecedented decline across dozens of countries, and COVID school closures are only partly to be blamed, the Organisation for Economic Cooperation and Development said in its latest survey of global learning standards [1]. Students in the first study year do not see why they need mathematics in their specialty, so they have low motivation to study it. Additionally, the teachers see students' poor ability to learn systematically. The second factor that impacts the teaching of mathematics is the content of mathematical courses and the number of so-called contact hours provided by the curricula for higher mathematics at RTU. The problem is that this number of hours has been reduced twice compared with the 90-ies; however, the content of courses at RTU has changed insignificantly. At the same time, additional hours for independent work of students have been included in the modern curricula. Therefore, an additional burden falls on the teaching staff: to explain the concepts of elementary mathematics that would need to be mastered in high school and create at least some activities for independent work and check the results of them.

This paper is devoted to the analysis of the role of homework assignments in teaching/learning mathematical courses at RTU. The authors of the research consider homework as tasks assigned to students by lecturers to be completed at home and submitted on paper or online. There are different aims of homework. Mostly, it is an opportunity for the student to practice and strengthen knowledge about

already learned material during the lecture. Sometimes, it is needed to independently master additional topics not covered during the lectures. Homework can also serve as an introduction to a new topic. The corresponding strategies should be taken into account when creating the homework assignments. Homework effectiveness can be achieved by determining the time and context in which homework is appropriate, using a strategic approach where distractions are limited and necessary materials are provided. When solving homework independently, students should optimally use their resources, solving moments should be combined with a few interruptions, solutions should be reviewed globally, attention should be paid to meeting the submission deadlines, and the advice of a knowledgeable person should be taken into account when submitting the result [2].

There are proponents of homework who say that it improves student achievement and allows for independent learning of classroom and life skills, and opponents of homework who think that too much homework may be harmful as it can increase stress and lead to cheating. The authors of this paper share the belief that completion of homework increases knowledge and skill acquisition, thus increasing academic performance, too (see, e.g. [3]). They analyse the influence of homework on the evaluation of students at RTU with the aims:

- to prove or decline their belief in the necessary homework;
- to get an understanding of student preferences in the types of homework (online, in-handed written on a paper, mandatory or not);
- to get student feedback about their habits and behaviour towards doing homework, forms of motivation to do homework regularly and reasons that influence performance.

Some research on the different aspects of homework at the university (not mandatory in math) is mentioned in this introduction to notify the spectres of the problems which can be taken into account in the analysis of the role of homework in teaching/learning. The authors try to consider these aspects in their research.

The roles of homework assignments differ depending on whether the homework is mandatory and should be handed in. As stated in [4], students who are required to fulfil homework are less likely to fail and quit the course and more likely to receive higher scores during the exam than those who have the same homework but are not required to hand it in. And effect is especially strong for students who initially have poor academic performance.

A survey of STEM students showed that after COVID-19, students found self-efficacy to be one of the most important factors during their studies and mentioned homework among the most effective study activities [5].

Since RTU mathematics courses include online assignments for students in the university online study system ORTUS, the role of technology cannot be ignored. Implementation of technologies in home assignments affects effort of students in homework, but there is no unique opinion of researchers about the difference in the effect on students with high or low inner motivation. A study on accounting courses showed that the online homework submission system seems interactive for students and associated with the shortcut of computing required homework, and they are more beneficial for students with low inner motivation than for students with high inner motivation [6]. However, there is also contradicted research on students of the algebra course showing that online homework is beneficial to higher-skilled students rather than low-skilled students [7]. Another study on first-year mathematics students concluded that online homework leads to higher homework grades but is not associated with higher grades at the exam [8]. Similar conclusions were made in [9].

The decaying effect of students forgetting their skills might be reduced by regular or more frequent homework. One more study on homework assignment frequency effect on student performance at the exam suggests that frequency of homework matters and has different effects on students with high and low previous academic performance. More frequent homework benefits students with lower previous academic performance by pursuing to develop learning habits and to save regular interaction with the course material. However, for students who enter the course with higher previous academic performance, frequent homework assignments are even harmful [10]. A more recent study on homework explained contradictory results on positive homework correlation with student performance with spaced repetition, which enhances better memorizing of material and, thus, better exam results [11].

The questions about frequency and the types of homework assignments are under consideration in this paper. Separate attention is devoted to the question of homework mandatoryness and its bonus. By comparison of the results of two surveys (2020 and 2023 years), the influence of COVID-19 is analysed.

### Materials and methods

The evaluation system is the same in all mathematical courses at RTU: the final exam accounts for 50% of the final grade, however, for getting a passing grade it is mandatory to pass the course. Apart from the final exam, students are given some in-class tests in the semester (their number is dependent on the number of credit points for the course and topics in it), and the average grade of them gives 35% of the final result, so-called mandatory homework assignments give 10% and additional 5% students can get from two online tests on theory. There are some homework assignments that should be submitted on paper with individual variants of tasks for each student, some online tests in ORTUS and two tasks in EXCEL (tasks with big calculations, using the approximation technique). The number of such assignments also depends on the volume and considered topics in the course. For example, the mathematical course with 13-14 ECTS has 7-8 homework assignments in the term (up to 15 in the study year). By taking into account that all homework assignments are divided into parts or online tests, a student has at least a few tasks as homework in each study week. The weekly homework, which is not included in the final evaluation, is offered too. The role of homework assignments is the aim of the analysis in this paper.

Are homework assignments needed in the course? Ten percent for homework in the final evaluation is sufficiently small but if homework is considered as the preparation for in-class tests and exams, maybe it is not necessary to put grades for it. Is the attitude of students toward the different types of homework the same, or do they have a preference? What do students think about using additional tools when doing homework? What is the main reason to do homework? To get the answers to these and other questions, the analysis of the grades was done and two similar surveys were conducted (before and after the COVID period, at the beginning of 2020 and the end of 2023) for groups of first-year students of the different specialities in three faculties of RTU: the biggest part of the groups of first-year students from the Faculty of Engineering Economics and Management (FEEM), the group of Financial Engineering from the Faculty of Computer Science, Information Technology and Energy (FCSITE) and some groups from the Faculty of Civil and Mechanical Engineering (FCME). There are groups where the authors of the paper work and have an interest in getting understanding of the situation with homework in these groups. Student surveys, as mentioned in [12], are one of the most commonly used instruments in higher education institutions for collecting a reasonable student assessment of various indicators, characterizing the quality of the studies and professional work of lecturers.

The grades of all students in the chosen groups were analysed. The students were not divided by their specialities but only by faculties. The statistics results were obtained from 25 students from FCSITE and 54 students of FCME who took the exam in the autumn semester of the 2019/2020 academic year and from 129 students from FEEM, 33 students of FCSITE and 62 students of FCME in the autumn semester of the 2023/2024 academic year.

Almost all of these students responded in the survey of the corresponding year. The questions in the questionnaire were divided into some groups. The first was about the necessity of homework at mathematics: "Are homework assignments in mathematics required in university?", "Did you do homework at secondary school?". The second was about types of homework and their usefulness: "Please evaluate the usefulness of the type of homework by choosing a number out of 10 (0 as the minimum)." Then some questions about the process of doing homework followed: "Are some aids used when doing homework?", "Is everything calculated by yourself?", "Did you work in groups?", "When is the weekly homework done?" and the question about using ChatGPT to solve the homework tasks in mathematics. The last group of questions is about motivation to do homework and reasons preventing from achieving higher results.

### Results and discussion

The research is started by a statistical analysis of the results of the students in the chosen groups. The coefficient of correlation is calculated for different pairs of grades (one of them is the final grade of

the course, and the other one is the average grade of the corresponding type of activity), as shown in Table 1.

As it can be seen from Table 1, there is a strong positive correlation between all pairs of these grades in the 2023/2024 academic year, except the correlation between grades of the test on Elementary Mathematics which was written in the first practical class to check the knowledge of Elementary Mathematics. The possible explanation for this exception is that students forget the skills they used during secondary school (unstable knowledge from secondary school, some students who graduated from secondary school some years ago).

Table 1

**Relationship between the final grades and the grades of different activities in the course**

Faculty/ Academic year	Final grade/All homework assignments	Final grade/ Online tests	Final grade/ Homework written on paper	Final grade/ Tests in- class	Final grade/ Test on Elementary Mathematics
FCSITE 19/20 a.y.	0.71	0.66	0.75	0.92	0.59
FCSITE 23/24 a.y.	0.77	0.75	0.74	0.95	0.53
FCME 19/20 a.y.	0.63	0.58	0.67	0.82	0.59
FCME 23/24 a.y.	0.89	0.87	0.85	0.95	0.35
FEEM 19/20 a.y.	0.86	-	0.80	0.82	0.57
FEEM 23/24 a.y.	0.86	-	0.86	0.89	0.47

The correlation between homework grades and final grades (it became stronger in the 2023/2024 academic year) shows that all types of homework assignments are done by students based on their level of understanding of the course, and all types of homework provide objective results. It should be mentioned that the analysis of the initial versions of the used online tests for RTU students was done in [13] with the same conclusion that properly compiled and used tests mostly provide objective results.

The results on the base of surveys are considered in the remaining part of this chapter. Due to limited space for the article, the results are shown in general form (for all students enrolled in the survey without division by faculties and sometimes only for the current academic year) to give readers the opportunity to consider the questions and answers of the students. The corresponding results were analysed for different faculties, and corresponding conclusions were made in dependence on the faculties, too.

The first questions in the questionnaire were about student general attitudes towards mathematics homework. As it can be read from the diagram of Fig.1, the largest part of the students (61% strongly agree and 27% agree) noted that they regularly did homework in mathematics at secondary school (the same tendency is in all groups). But it does not mean that they all, as the students in the first semester, consider that homework is really necessary in mathematics at the university. Most students still consider that homework is required but only 32% strongly agree with it (see Fig.2). The results of these questions are similar in different faculties and almost the same in the 2019/2020 academic year.

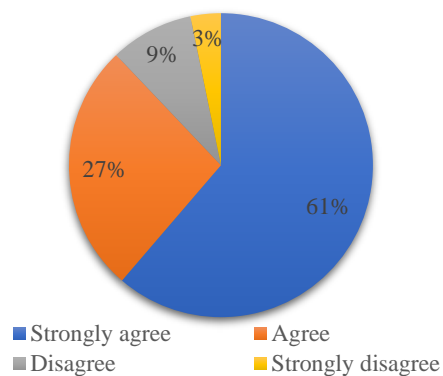


Fig. 1. I did homework in secondary school

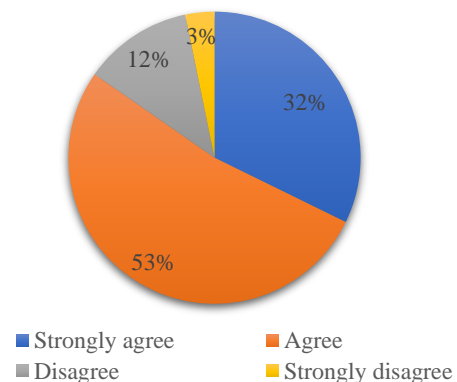


Fig. 2. Homework in mathematics is required at university

The usefulness of the different types of homework by choosing a number out of 10 (0 as the minimum) is dependent on the faculties (see Table 2) more than the previous results.

Table 2

**Average results of usefulness evaluation of the types of homework by scale of opinions (from 0 to 10)**

Faculty/ Academic year	Online tests	Homework written on paper (individual variants)	EXCEL tasks	Weekly homework
FCSITE 19/20 a.y.	7.5	7.7	6.6	7.1
FCSITE 23/24 a.y.	7.8	6.9	5.1	6.3
FCME 19/20 a.y.	7	7.7	5.1	7.2
FCME 23/24 a.y.	6.3	5.7	4.1	5.3
FEEM 23/24 a.y.	6.2	7.2	5	4.7

It can be concluded that there is a tendency to decrease the preference for individual homework written on paper in comparison to all other types of homework as it was in the 2019/2020 academic year. This tendency can be explained by the influence of COVID when online tests started to be used very actively and nowadays students understand them well and prefer them much better. The exception is only for economics students, which can be explained by the specific content of this individual homework with many tasks on applications to economics. The role of weekly homework is under-evaluated in the current year; less than half of students do it regularly (see Fig. 3) (and their percentage decreased from 72% in 2020). From the comments of students, it can be explained that most of them are not interested in doing homework, which is optional and do not give points for the final grade; they have no time for it. This conclusion matches [4] and [13] that homework assignment roles differ in depending on whether the homework is mandatory. The additional analysis in the group of Financial Engineering (FCSITE, 23/24) with many students with high inner motivation shows that the conclusion from [4] that homework itself as a mandatory part of the course does not increase student performance, however the effort the student put into the homework does, is also true for these students. The results of EXCEL tasks show that the students are not sure about the necessity of such tasks, and the authors' experience testifies to cheating in these solutions. So, a corresponding conclusion should be made regarding the necessity of using this type of homework in the future.

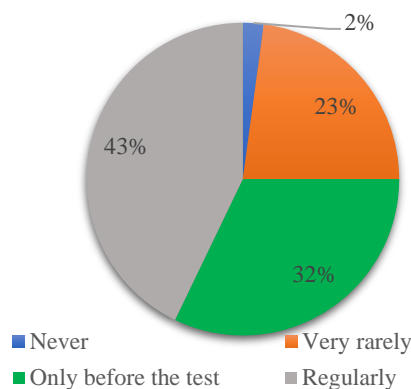


Fig. 3. When did you do weekly homework?

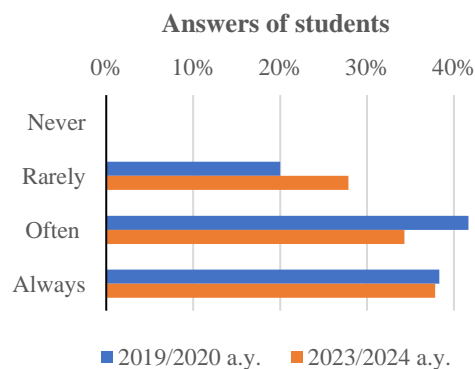


Fig. 4. Is everything calculated by yourself in the homework (without using a tool)?

The next questions were about the habits and behaviour of the students towards doing homework. When asked about the usage of some aids during the homework execution (notes, books, Internet), only 6% answered that they never do it, and the same number was of those who always do it. Other answers are divided between “rarely” and “often”. The situation is approximately the same in all faculties and in the previous survey. The changes happened in the context of using tools for calculation. Now, the number of those who use some tools has increased in comparison to the previous period (see Fig. 4). Most students use Photomath. Taking into account that there have been a lot of discussions about using ChatGPT recently, an additional question was added to the survey about using ChatGPT for homework

in mathematics. The percentage of the students who have tried to use ChatGPT for the solution of mathematical tasks depends on the faculty: only 17% of Economics students and 30% of Financial engineers have tried to use it, but for many students the practice was not very successful. The main conclusion: “ChatGPT can help understand the algorithm and rules to solve the task, but the final result often is not correct.” In one more question about the solution of homework in the group, the percentage of students who never did it decreased from 67% in 2020 to 59% in 2023. There also appeared students who do it regularly (3%).

The answer to the question “How regularly do the students solve homework assignments?” was investigated by the analysis of the frequency of taking online tests because most homework assignments in the mathematical courses for FCSITE and FCME are online tests (there are 15 tests for students of FCSITE and 18 for students of FCME).

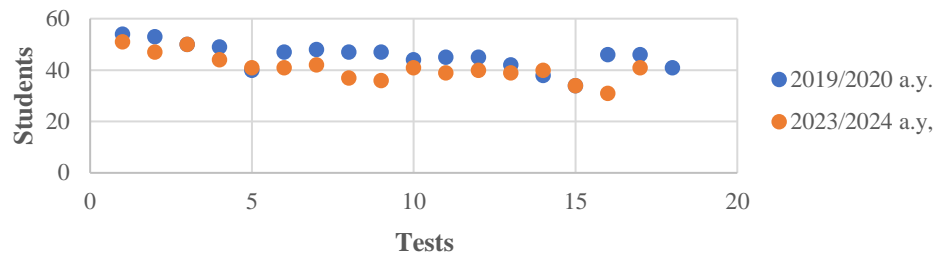


Fig. 5. Number of students of FCME performed tests in the autumn semester

It can be seen from Fig. 5 that most of the students took all these homework assignments during the first term, so the students worked regularly. These results contradict the results in [13], where the decrease in the number of such students during the autumn semester was very significant. A simple explanation can be offered: only since 2017/2018 the grades for the online tests have been included in the final result, so they have become a mandatory part of the courses.

The main reasons which encourage students to do homework were analysed. Most students mentioned that the main reason to do homework is the “grade” (39% in the current year), but it was not the most frequent answer. 49% of the students who responded said “The desire to fully understand the topic, to consolidate knowledge.” Few students mentioned that regular completion of homework is the basis for further successful completion of the course. A number of students answered that if they did not understand the topic in class, they did not do their homework either.

The last question in the questionnaire was about reasons preventing them from achieving higher results.

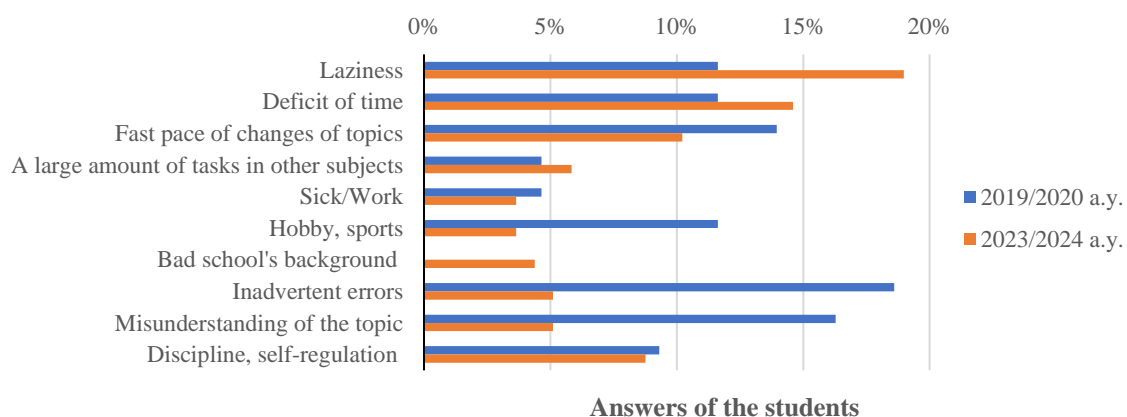


Fig. 6. Most frequent reasons mentioned in the questionnaire on the question “What prevented you from getting better results?”

One can see that the most frequent reasons mentioned in both surveys are mostly the same, but the proportions for some are completely different. Laziness was mentioned sufficiently often in both surveys as the main reason for preventing students from getting the best results. The students understand it. It is

interesting that no students talked about bad school background in the previous survey, but there are sufficiently many such students now.

### Conclusions

1. Most students understand the necessity of homework in mathematics courses at university.
2. The results of all types of homework assignments have a strong correlation with the final results of the course in the current academic year, and this relationship has become stronger in comparison to the previous investigation period. Students who show good results in homework are successful in the course as such.
3. Students prefer performing the tests online rather than handing in the homework on paper.
4. Homework assignment roles differ depending on whether the homework is mandatory; students hardly ever do homework that does not affect the final grade of the course.
5. The students are mostly interested in completing homework with tasks closely connected with their speciality.
6. ChatGPT is not so useful for solving mathematical tasks. It can help understand the algorithms and rules to solve the task, but the final result often is not correct.

### Author contributions

Both authors have contributed equally to the study and preparation of this publication. Both authors have read and agreed to the published version of the manuscript.

### References

- [1] PISA 2022 Results (Volume I): The State of Learning and Equity in Education, PISA, OECD Publishing, Paris, 2023. [online] [15.04.2024.] Available at: <https://doi.org/10.1787/53f23881-en>.
- [2] Frasineanu E. Homework management in academic learning. *Series Psychology- Pedagogy*. vol.45, 2023, pp. 38-52.
- [3] Zhang, Yuhuan, et al. More Homework Improve Mathematics Achievement? Differential Effects of Homework Time on Different Facets of Students' Mathematics Achievement: A Longitudinal Study in China. *British Journal of Educational Psychology*, vol. 94, no. 1, Mar. 2024, pp. 181–197.
- [4] Grodner, Andrew, and Nicholas G. Rupp. The Role of Homework in Student Learning Outcomes: Evidence from a Field Experiment. *Journal of Economic Education*, vol.44, no.2, 2013, pp. 93–109.
- [5] Petrulis R., Gholizadeh S., Gatzke Ed. Student Persistence Factors for Engineering and Computing Undergraduates, 2023 ASEE Annual Conference .
- [6] Peng, Jacob C. Using an Online Homework System to Submit Accounting Homework: Role of Cognitive Need, Computer Efficacy, and Perception. *Journal of Education for Business*, vol. 84, no. 5, May 2009, pp. 263-68.
- [7] Mathai, Elizabeth, and Darlene Olsen. Studying the Effectiveness of Online Homework for Different Skill Levels in a College Algebra Course. *Primus*, vol. 23, no. 8, Jan. 2013, pp. 671–82
- [8] Lenz, Laurie. The Effect of a Web-Based Homework System on Student Outcomes in a First-Year Mathematics Course. *Journal of Computers in Mathematics & Science Teaching*, vol. 29, no. 3, July 2010, pp. 233–246.
- [9] Pavlenko, O. Lower Weight for Exam Grades – Better Academic Performance? Proceedings 18th Conference on Applied Mathematics (APLIMAT 2020), Slovak Republic, Bratislava, February 4-6, 2020, pp. 872-877.
- [10] Al-Bahrani, Abdullah, et al. Helping Some and Harming Others: Homework Frequency and Tradeoffs in Student Performance. *Journal of Economic Education*, vol. 53, no. 3, July 2022, pp. 197-209.
- [11] Green A. Are we doing homework wrong? The marginal effect of homework using spaced repetition. *International Review of Economics Education*, vol. 46, 2024
- [12] Dzenīte I., Čerņajeva S., Matvejevs A. Influence of Students' Surveys on Teaching Mathematical Subjects at Riga Technical University. Proceedings of 17th International Scientific Conference "Engineering for Rural Development", Latvia, Jelgava, May 23-25, 2018, pp. 1049-1054.
- [13] Volodko I., Čerņajeva S. Assessment of Students' Knowledge by Means of Tests. Proceedings of the 9th International Scientific Conference "Rural Environment. Education. Personality". (REEP), Latvia, Jelgava, May, 13-14, 2016, pp. 328-333.