

STUDY ON ENGINEERING STUDENTS EXPERIENCE IN MATHEMATICS LEARNING IN CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract. Nowadays the education systems are developing in accordance with the national and international strategies targeting the sustainable development, by providing competencies needed for sustainable socioeconomical and environmental development. A particular attention should be paid to mathematics as an instrument for sustainable development. To improve the studies of mathematics according to sustainable development trends, it is necessary to reflect the views of the students on the issues of mathematics learning experience and mathematics teaching at the university. The survey results, which was carried out at the Latvia University of Life Sciences and Technologies (LLC) and at the Riga Technical University (RTU), are analysed in this article. The questionnaire form includes six diagnostic blocks. In this article the results are analysed from three diagnostic blocks: “Mathematics learning experience” ($N = 2$), “Self-assessment of mathematics” ($N = 2$) and “Mathematics teaching at university” ($N = 5$). Students from two universities had to assess the statements by expressing their approval or disapproval on a 4-stage Likert scale: strongly agree, agree, disagree, and strongly disagree. The total sample of the research included 699 cases. The study data were analysed by the respondents’ professional field and self-assessment of competence in mathematics as well as by university. The key element of successful mathematics teaching and learning is the real-life contexts of mathematics studies, usage in a particular specialty, thus creating interest in students as well as motivating them to succeed in mathematics and developing competence.

Keywords: competences, engineering students, mathematics learning, sustainable development.

Introduction

In line with the Report of the World Commission on Environment and Development of 1987, “Our Common Future” [1], sustainable development is an integrated and balanced development of the welfare, environment and economy of the society, which ensures the satisfaction of today’s needs without endangering the needs of future generations. Sustainable development requires appropriate knowledge, skills and competences, including solving complex problems through comprehensive and systemic approaches, creating critical judgment in real-life issues, applying theory to practice and vice versa, collaborating and working in interdisciplinary teams [2]. Therefore, one of the factors that gives the society a successful long-term development is education. In September 2015, the United Nations (UN) General Assembly adopted 17 Sustainable Development Goals, one of which is to ensure inclusive and equitable quality education and promote opportunities for lifelong learning”, which envisages by 2030 ensuring that all learners acquire knowledge and skills, needed to promote sustainable development [3].

In the context of sustainable development, special attention is devoted to mathematics education. According to the UN Educational, Scientific and Cultural Organization (UNESCO), mathematics is an instrument for sustainable development, because in mathematical activities (counting, measurement and location), people are developing ways to effectively meet their needs, indicating a clear link between people and the environment [4]. Therefore, it is essential to prepare young specialists at university to have good knowledge of mathematics, to be able not only to solve classical tasks, but also more complex ones, to see mathematical problems in various situations of life and solve them. Some scientists have said that in the contemporary world of “rapid change” [5], especially technological change, the demand for mathematical skills is increasing [6-8]. For better preparing of the students for a number of disciplines, such as science and engineering, which rely heavily on mathematics and are in widespread demand, several international studies have emphasized the importance of developing the mathematical competence of students [9]. Scientists state that engineering as a profession requires a clear understanding of mathematics, sciences and technology, but engineering graduate acquires not only a practical, but also abstract understanding of mathematics [10; 11]. Therefore, it is crucial that at university level, most of study programs require mathematics, at which the ability to master mathematical skills are an important indicator of potential for students’ in all levels of academics’ endeavours. Taking into account the above-mentioned aspects and improving the study of mathematics according to sustainable development trends, it is important to

find out how strongly feel the students, who have already completed the higher mathematics course, and how they understand mathematical competence impact on personality development and their future careers. Thus, the aim of this study was to ascertain the extent to which students acquired their mathematical skills as well as identify the students' views on the organization of the current mathematical study process and approaches, used in the development of competences needed for sustainable development.

Materials and methods

To reflect the opinion of the respondents about the mathematical learning experience and the teaching of mathematics at the university, a survey was conducted at the Latvia University of Life Sciences and Technologies (LLU) and at the Riga Technical University (RTU). The survey questionnaire included several diagnostic blocks. This article analyses students' answers to questions about mathematics knowledge and skills assessment in relation to mathematics learning experience, teaching mathematics at the university and the importance of mathematical knowledge in the labour market. Questionnaires included various types of questions. Respondents were required to evaluate the expressions by expressing their approval or rejection after the 4-stage Likert scale (diagnostic blocks: "Teaching the University of Mathematics", "Competence in Mathematics") or the 5-stage Likert scale (Diagnostic Block: "Potential Mathematical Values"). Likert scales are widely used to measure attitudes and opinions [12]. Other questions were asked in the questionnaire – the questions with the given answers and one open question.

The survey sample was 699 respondents. 239 or 34.2 % of them were students of the LLU and 460 or 65.8 % – students of the RTU. It might seem that the number of respondents from both universities is not proportional, however, the sampling rate in each institution has been chosen by the regularity principle, taking into account that in the previous study year there were 14997 students at the RTU, but at the LUA – 4353 (which is 29 % of the amount of the students at the RTU). The questionnaire (in Latvian) is available at: <http://www.iipc.lv/surv/index.php/393736/lang-lv>. The characteristics of the survey respondents are given in Table 1. In the study a self-assessment method is used, therefore the results of the research are based on the opinion of the respondents. It should be noted that this was a case study, which only reflects the students' views.

Table 1

Characteristics of the research sample

Professional field	LLU	RTU	Total
Agricultural Engineering	4.83 %	0.00 %	4.83 %
Civil Engineering	8.18 %	8.18 %	16.36 %
Electronics, Computer science	0.37 %	18.59 %	18.96 %
Environmental Engineering	7.06 %	11.52 %	18.59 %
Food Technology	1.49 %	0.00 %	1.49 %
Human Resources	0.00 %	4.46 %	4.46 %
The others	6.69 %	6.32 %	13.01 %
Services	2.60 %	5.58 %	8.18 %
Social Sciences	1.86 %	7.06 %	8.92 %
Transport	1.12 %	4.09 %	5.20 %

Results and discussion

As mentioned above, mathematics is one of the essential kinds of knowledge necessary to live and work, ensuring sustainable socio-economic development and environmental safety. Unfortunately, the research results show that more than one fifth of the surveyed students (22.7 %) rate their knowledge in mathematics as insufficient, while 36.8 % of respondents – as satisfactory. Only 11.5 % of students, who have completed higher mathematics courses, are confident in their maths skills.

Despite the rather low self-esteem of mathematical knowledge, 68.8 % of students say they could solve a maths problem, if a proper description of the topic and formulas were given. Analysing these findings in relation to the professional activities of future specialists (especially engineers), there is

confidence that two thirds of the graduates will be able to understand the mathematical terms and symbols that will be used in professional literature and make the necessary calculations. It should be noted that mathematics is the basis of all technologies, therefore studying this knowledge should be considered as an important factor in socio-economic development. Comparing the survey results of the survey between the universities, it should be noted that the RTU students express more confidence about their mathematical knowledge (see Fig. 1.).

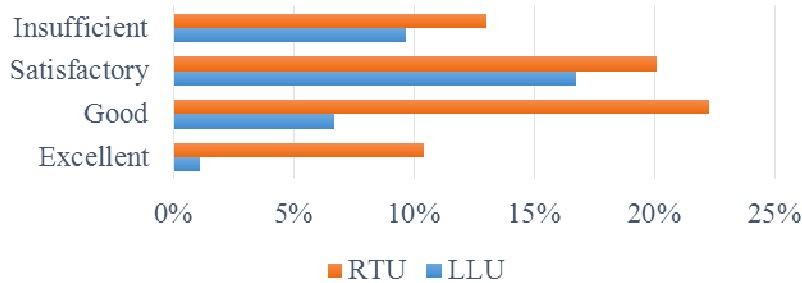


Fig. 1. Mathematical knowledge self-assessment comparison between universities

Self-assessment of mathematical knowledge by specialty is summarized in Fig. 2. The results show that students of social sciences and services are more confident about their knowledge of mathematics than engineering students. The highest self-assessment of mathematics knowledge was given by the students of the electronics and computer industry, of which only a little lagging behind civil engineering (construction, design) and environmental engineering students.

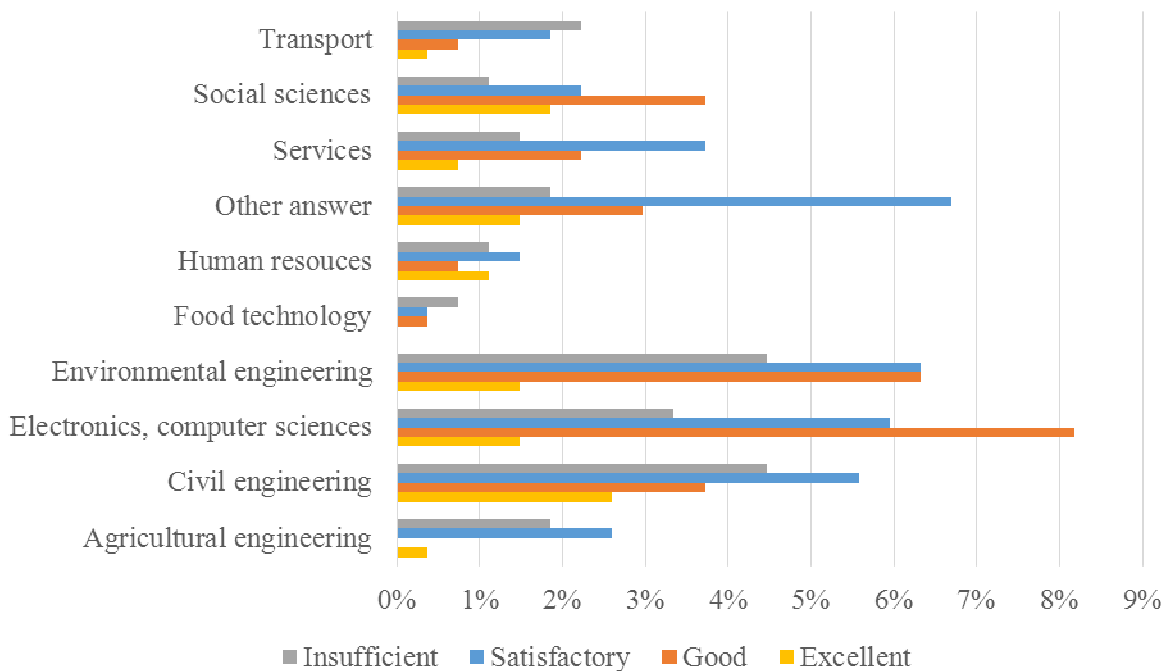


Fig. 2. Self-assessment of mathematical knowledge by specialty

In view of the results of the study in the context of the UN Sustainable Development Goals [13]: Goal 2 – to promote sustainable agriculture and Goal 12 – which aims to ensure sustainable consumption habits, concerns are raising because the lowest mathematics knowledge and skills self-assessment are for the students of agricultural engineering and food technology. Despite the fact that students in agricultural engineering and food technology do not have confidence in their knowledge of mathematics, more than half of students (agricultural engineering – 53.9 %, food technology – 50 %) argue that they could solve a mathematical task, if were given a description of the topic and formulas.

It should be noted that in recent years several universities have reduced the time allocated to mathematics studies, but the content has remained unchanged or even increased. Therefore, the situation is that lectures only explain the main concepts, focusing on task-solving techniques. In turn, students are interested in a detailed explanation of how precisely the particular mathematical

calculation methods are applied in practice. Several responses to the open question “What should be taught in mathematics at a university and how exactly should this be done to promote maths and competency building?” pointed to the need to link mathematics studies with the calculations that are actually used in a particular specialty. Students indicate that mathematics at universities should be taught in solving real-life problems with the help of mathematics. The lecturers should explain examples of real life, where the particular teaching substance is used. It could make easier to perceive and understand the mathematical concepts. According to the students’ opinion, otherwise the question arises, whether it is necessary at all. Students also draw attention to the need to demonstrate the connection of higher mathematics with other study subjects and their application in them. The study results show that giving only the formulas and their explanations is not enough. Teaching mathematics has to be concerned with the environment and the chosen future profession, with practical examples in life/profession, thus creating interest in students as well as motivating them to succeed in maths and develop competence. Several studies have shown that motivation is a key element of successful mathematics teaching and learning. It depends on the needs of the individual’s personal interest, depending on the results and practical application abilities.

Studies show that in the mathematical studies mathematical subject encounters people’s attitudes, experiences, feelings and thoughts, which sometimes leads to specific, complex problems. On the one side, mathematics can create highly euphoric feelings of unexpected insight and overall understanding [14]. Sometimes mathematics is compared with hidden land high in the mountain of mind and fantasy, claiming that it is impressive and at any rate worth seeing [15]. On the other hand, many people have the opposite mathematics learning experience: they associate mathematics with feelings of failure, anxiety, humiliation and suspicion. Maths learning experience at school becomes a stamp for life, and sometimes it can even lead to learning blockages [16]. Typically, the attitude to maths is characterized by statements like or dislike, or willingness to engage in mathematical activities or not. A study by Estonian colleagues showed that a positive attitude to maths motivates learning more and making progress and better achievements [17]. The study also showed the opposite, namely, success raises a positive attitude towards mathematics.

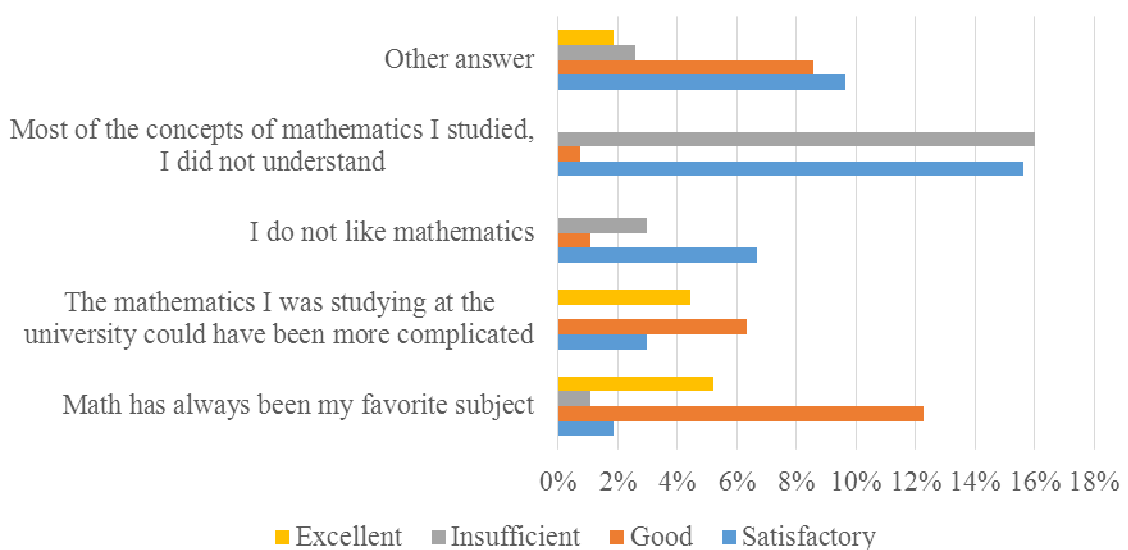


Fig. 3. Mathematical learning experience by knowledge self-assessment

Thus, in order to judge the impact of various factors on the development of maths competences in the universities involved in this study, respondents were asked to evaluate their maths learning experience by choosing one of four statements. 10.8 % of respondents do not like mathematics, but 20.4 % – mathematics has always been the favourite subject. 13.8 % of the respondents say that the mathematics they studied at university could have been more complicated, while 22.7 % did not understand most of the topics. Fig. 3 shows the learning experience of students in mathematics following the self-assessment of mathematical knowledge. The results confirm that the better success of mathematics, the more positive attitude towards mathematics and mathematics studies. However, 54 % of students, who did not understand most of the concepts of mathematics studied, were saying

that they could solve a mathematical task, if they were given a proper description of the topics and formulas. 86.5 % of students, who would be able to solve a mathematical task with description of the topic and formulas, claim that mathematics that was taught at the university could have been more complicated. For 42 % of the RTU student, who have assessed their knowledge of mathematics as excellent, mathematics has always been a favourite subject, and for 32.3 % of students mathematics at university could be much more complicated. In contrast, 70.5 % of students, who assessed their knowledge as insufficient, do not understand much of the mathematics concepts taught at the university.

In Fig. 4 the survey results are summarised on mathematics teaching at university by professional field. The results show that agricultural engineering, transport and food technology are three fields, where improvement of mathematics studies and modernization of the mathematics teaching and learning are urgently necessary. As mentioned above, human resources and social sciences students feel confident about mathematical knowledge and for them mathematical studies could be more complicated, but among engineering – for electronics and computer sciences the mathematics program should be refined to include additional units or deepen the existing studies.

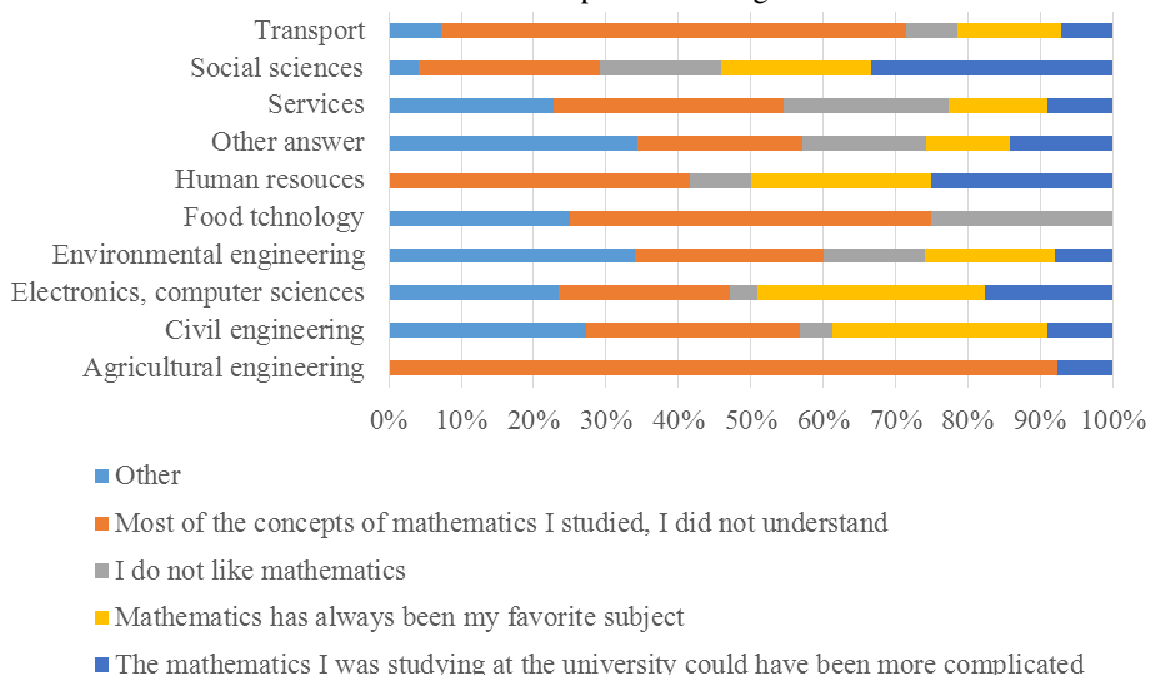


Fig. 4. Assessment of mathematics teaching at university by professional fields

Improvement of mathematics studies towards understanding mathematical concepts and application in specialty has to be done in transport and environmental sciences at the RTU, but at the LLU – the most critical situation is in food technology and agricultural engineering. At the same time, the deepening of mathematical studies would be desirable in the civil engineering and environmental sciences programs at the LLU, and in electronics and computer sciences at the RTU.

Conclusions

1. The research results show that one fifth of the surveyed students rate their knowledge in mathematics as insufficient, but only 11.5 % of the students, who have completed higher mathematics courses, are confident in their maths skills.
2. Comparing the survey results of the survey between the universities, it should be noted that the RTU students express more confidence about their mathematical knowledge.
3. The study proves that the higher the achievements, the more positive attitude towards mathematics and mathematical research.
4. As the time for mathematics studies at universities has been reduced and during the lectures explanations of the main concepts and task-solving techniques are given, the most of the students are aware that they could solve mathematical task with the help of given description of topics and formulas.

5. Agricultural engineering, transport and food technology are three fields, where improvement of mathematics studies is urgently necessary.
6. In order to promote the competences necessary for sustainable development, the LLU and the RTU mathematics study programs need improvement. In some specialties improvements should be directed towards improving the teaching of mathematics in order to promote the understanding of the concepts to be taught and the use of different calculations in the specialty, while in others it is necessary to deepen the learning of mathematics or to add new topics or applications.

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