

STUDY ON THE FACTORS CONTRIBUTING TO THE MOTIVATION OF MATHEMATICAL STUDIES AT THE UNIVERSITY

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ABSTRACT

The mathematics studies at university develop the cognitive abilities of the person, influence studies of special subjects as well as contribute to the development of professional competence. Nevertheless, several studies have been carried out to show that the quality of mathematical studies is decreasing and students' preparation and knowledge deteriorates. The article describes factors influencing the development of mathematics education, seeing motivation as a key element of successful teaching and learning. The article includes theoretical analysis of topical issues like the definitions of learning motivation, its influencing factors, which contribute to the development of mathematical thinking and competence, etc. Based on the analysis and evaluation of the scientific literature as well as taking into consideration the author's reflection, experience and observations, in the study the authors found out the factors influencing mathematics learning at the university, which include internal motives (attitude), rational thinking (potential values of mathematics and advantages in the labor market) and external factors (teaching of mathematics at the university). The findings illustrated by the results of the survey of the students from Latvia University of Life sciences and Technologies (LLU) and Riga Technical University (RTU) on the mathematics learning and teaching. The study proves that the higher the students' achievements in mathematics, the more positive attitude towards mathematics and mathematics studies at the university.

KEYWORDS

External Factors, Cognitive Abilities, Internal Motives, Mathematics Learning, Motivation, Rational Thinking

1. INTRODUCTION

Mathematics always has been an important factor for the person's intelligence and personality forming and development, as well as a key to understanding the world around us, a base for scientific and technological progress. In accordance with Servais (1957) mathematics develops intellectual qualities such as logical thinking - ability to reason deductively, ability to abstract, generalize, classify, ability to think, analyse, and criticize. He pointed out that mathematics plays an important role both in the development of intellect and in the development of personality. Mathematical knowledge is a fundamental basis for the person's cognitive development (Kangro, 2006). According to Evans (2000), mathematical knowledge is not only a fundamental basis for the person's scientific development, but it also relates to the area of specific emotional experience, which is characterized by clearness of mind, unexpected fantastic discovery and full comprehension. Mathematics is also viewed as a dynamic process in which a person creates and implements his mathematics according to his abilities and needs (Dunn et al, 2000).

The mathematics studies at university develop the cognitive abilities of a person, influence studies of special subjects as well as contribute to the development of professional competence ensuring highly qualified specialists for the knowledge-based, skill and technology-intensive industries. Practical contribution of mathematics as a tool to the idea of sustainable development of society, for example, is reflected in the Textbooks for pedagogues, curriculum leaders and ministries of education by UNESCO, highlighting the role of mathematics in providing decision-making tools and developing understanding of the complex system related to sustainability (Textbooks for sustainable..., 2017).

Taking into account the above-mentioned aspects, in the study process of mathematics, due attention should be paid to the development of intellectual potential of students, building and developing the qualities of mathematical thinking. In spite of the above mentioned, several studies have shown that the quality of the mathematics studies is decreasing and the level of students' preparation and knowledge is getting worse. There are several factors that influence the development of mathematics education.

First of all, a decreasing mathematical knowledge is observable among first year university students in recent years. The lack of mathematics prerequisite skills at tertiary level has been recognised as an issue since the late 1970s and is known as the 'mathematics problem' (Rylands & Coady, 2009). It's also a problem in Latvia.

Secondly, as mentioned above, mathematics is one of the essential knowledge necessary to live and work. Unfortunately, the research, made by the author, shows that more than one fifth of Latvian 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 math skills (Vintere, 2018).

Thirdly, it is well known 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 teaching of mathematics consists mainly of transmitting of main concepts to students, mostly focusing on task-solving techniques. Traditional teaching involves the passive transmission of abstract, symbolic and existing mathematical structures to students, thus forcing them to adopt thinking structures developed by others which do not motivate students to get better results. In turn, students are interested in explaining in detail how the particular mathematical calculation techniques are applied in real life context.

Many authors agree that there is a variety of factors and circumstances that have an impact on the teaching and learning, university life etc. (Kahu, 2013). Several studies show that motivation is a key element of successful teaching and learning. According to the Gould (2010), there are several reasons for low learning motivation of pupils and students, for example, the underestimation of the importance of mathematics education by the society in general, the crammed curriculum in schools and higher educational establishments, redundant content of appraisal and training materials, inability of training programs to meet the needs of students etc. (Gould, 2010).

For reasons above, the aim of this article, based on the literature review, to find out the factors contributing to the motivation of mathematical studies at the university. To illustrate the student's motivation to master mathematics based on the factors developed and to reflect students' views on teaching and teaching of mathematics, data from the survey carried out at two of the largest universities: University of Latvia's Life Sciences and Technology (LLU) and Riga Technical University (RTU) were used.

2. MATERIALS AND METHODS

The problem has been approached by analysing and evaluating the scientific literature for the development of the methodological basis of this study. The article includes theoretical analysis of topical issues like the definitions of learning motivation, its influencing factors, which contributes to the development of mathematical thinking and competence, etc.

There are several approaches to motivation in scientific literature. One of the approaches defines motivation as a "need" that forces a person to do or not do something by looking at motivation as interconnectedness of beliefs, perceptions, values and interests. Seeing the need as the main motivation for learning, it is essential to identify the needs that encourage students to learn (Broussard & Garrison, 2004). In this context the main task of the study process is to develop competencies for the implementation of professional activities.

Another approach describes motivation as a psychologically and physiologically regulative process of dynamic, psychic human activity that determines its persistence, organization, activity and progress (Steinberga, 2013).

In Latvia, motivation is also defined as a set of certain motives that promote human behavior in a particular direction. Motivating is the intention to choose one of the alternatives to achieve personal goals" (Praude & Beļcikovs, 2001). The motivation is also the internal psychic forces of the person, which encourage this person to work (Renge, 2004).

Learning motivation engages students in the learning process and creates a lasting interest in it. With the increasing personal motivation, the productivity of the problem solution also increases - the content and structural properties of the intellectual activity are subordinated to the actions of the person (Kongro, 2010). The learning motivation is characterized by the education system, the organization of the educational process, the subjective qualities of the students - age, gender, intellectual development, abilities, a claim stick, self-evaluation, etc., teachers' system of the attitudes towards the student.

Learning motivation depends on different motivational factors: professional, cognitive, personal prestige, pragmatic (getting a diploma), with the first two being dominant among students with higher success (Ильин, 2002). According to Пуин (Ильин), the main factors in creating positive learning motivation are: (1) identification of the goals of the current and further studies; (2) the theoretical and practical significance of the knowledge to be acquired; (3) the emotional form of the presentation of learning material; (4) demonstration of perspective directions in the development of scientific concepts; (5) emphasizing the professional orientation of the teaching activity, (6) integrating the problem tasks into the structure of the learning activity, (7) securing the psychological climate based on curiosity and cognitive interest in the academic group. On the basis of the acquired motivation, students develop a definite attitude towards different study subjects, including mathematics (Ильин, 2002).

Several scientific studies have shown that emotions and motivation play an important role in the mathematics study process, considering them as factors characterizing the personal intellectual activities and development of mathematical thinking. Evans (2000), studying the relationship between emotions and mathematical thinking, recognized that the fear of mathematics is rather difficult to separate from other emotions that arise in the process of learning mathematics: confidence, diffidence, pleasure, dislike, anger, boredom (Evans, 2000). In turn, Wedege recommends solving emotion-related problems in mathematics through a contextual approach (Wedege, 1999).

Attitude is also considered to be an important factor in the development of mathematical thinking, with attitude being understood as an integrated personality trait, formed in a unit of life experience, knowledge acquisition, experience, and manifesting itself in values, goals, ideals, and norms (Kangro, 2010). Swedish researchers' findings show that in so-called school mathematics an encounter occurs between the subject of mathematics and people's attitudes, experiences, feelings and thoughts, which sometimes creates special problems in education. Many people associate mathematics with feelings of failure, anxiety, humiliation, suspicion and disassociation. The experience of school mathematics thus becomes a life-inhibiting stigma even creates learning blockades. A person who feels anxiety and suffers learning blockages when faced with this subject is therefore likely to conclude that the subject is meaningless; it neither improves understanding of the environment nor adds to practical knowledge (Gustafsson & Ouwitz, 2004).

The results of the survey of students from two major technical universities in Latvia: Latvia University of Life sciences and Technologies (LLU) and Riga Technical University (RTU) are used to illustrate students' motivation to learn mathematics and to reflect students' views on the current mathematical study process. The survey was carried out during May, 2017 - March, 2018. The survey questionnaire includes several diagnostic blocks, but this paper analyzes the answers to questions that describe the motivation to learn mathematics. Statements describing the motivation of mathematical learning, were grouped according to Muchinsky, who distinguishes three groups of the motivation: internal motives, rational thinking and external factors (Muchinsky, 2000). The factors influencing mathematics learning at the university are summarized in Table 1.

Table 1. The factors influencing mathematics learning at the university

Groups of the motivation	Characteristics	Statements
Internal motives	Mathematics learning experience, attitude	a) Mathematics have always been my favourite subject b) Mathematics, which I studied, could have been more complicated c) I do not like mathematics d) I did not understand most mathematical concepts that I studied
Rational thinking	The potential values of mathematics	a) Mathematics was an interesting and meaningful subject b) Knowledge in mathematics helped me to understand other subjects c) The knowledge and abilities of mathematics, mathematical thinking helps me to achieve more in my life d) Mathematics develops thinking, helps to make a decision in a particular situation, find new ideas.
	Advantages in the labour market	a) The need for mathematical knowledge in the contemporary labour market b) Studying mathematics develops logical thinking, accuracy and concreteness of future specialists c) A person who understands mathematics will easily deal with tasks that require thinking d) Employers highly value people who have a good understanding of mathematics
External factors	Teaching of math at the university	a) Mathematics was taught formally and jadedly b) Most students do not understand math and try to learn the laws by heart c) Linking the course of mathematics with real-life situations d) Usage of mathematics in a particular specialty

3. FINDINGS

According to the survey results, the external factors, characterising by the teaching of mathematics at the university, are the most important factors that determine the motivation of mathematics learning. As the time allocated to mathematics studies in universities in Latvia has been reduced, with the same content remaining, teachers only explain the main concepts, focusing on task-solving techniques during the lectures. In turn, students are interested in a detailed explanation of how precisely the particular mathematical calculation methods are applied in practice. Survey results show that there is the need to link mathematics studies with the calculations that are actually used in a particular specialty.

According to the students' answers, mathematics at universities should be taught in solving real-life problems with the help of mathematics and the lecturers should explain examples of real life where the particular teaching substance is used. According to students' opinion, it could make it easier to perceive and understand the mathematical concepts. Students also draw attention to the need to demonstrate the connection of higher mathematics with other study subjects and its application in them. Study results show that teaching mathematics have 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 mathematics and competence development (Vintere, 2018).

Students recognized internal motives (mathematics learning experience) in the second place. The study demonstrates the coherence of students' mathematical competence with self-esteem learning experience and attitude. The higher the student values his knowledge in mathematics, the higher the self-assessment of mathematical competence (Vintere, 2017). Respondents evaluated their knowledge of mathematics by excellent, good, satisfactory and in-sufficient. The results of students' mathematical competence self-assessment, which see their mathematical knowledge as excellent, are shown in the figure 1.

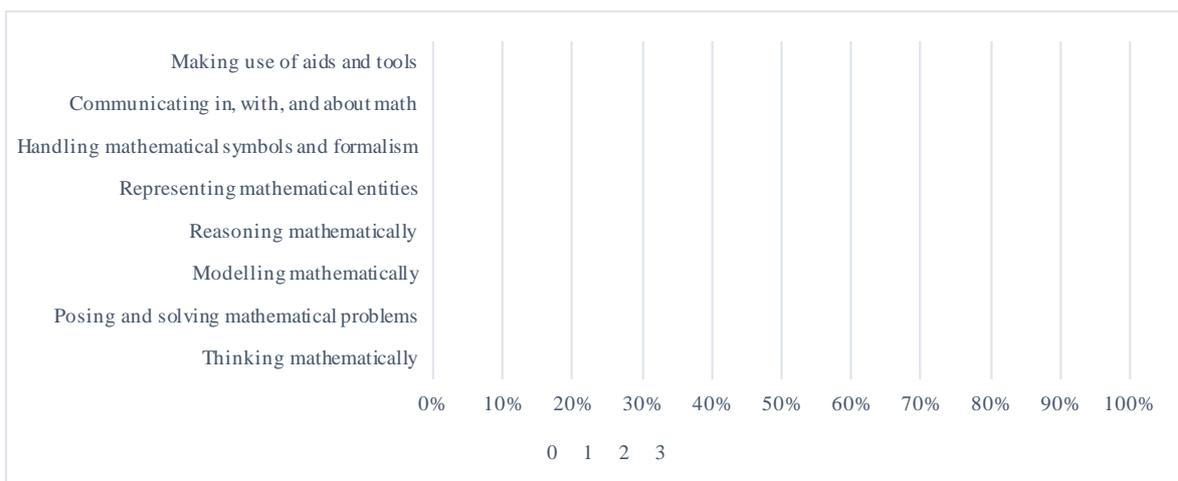


Figure 1. Self-assessment of mathematical competence of students with excellent mathematical knowledge (N=261)

The concept "mathematical competence" is based on Danish KOM (Competencies and the Learning of Mathematics) project. The respondents were asked to assess their mathematical competence on a 4-stage Likert scale, by writing in the questionnaire numbers from 0 to 3, where 0 – "I have not mastered this skill", but 3 – "I can apply mathematical knowledge in different situations of life, etc."

More than two thirds of students claim that their mathematical knowledge can be applied in different life situations and they can formulate a mathematical problem, as well as solve it. 78% of students, who rate their knowledge in mathematics as excellent, have obtained competence of "thinking mathematically" which include abstraction and generalisation of results; understanding of the certainty mathematical considerations. Almost 69% of these students can identify and specify mathematical problems; solve mathematical problems, have personal capabilities to decide if the question is considered as a problem.

The results of students' mathematical competence self-assessment that see their mathematical knowledge as insufficient are shown in the figure 2. Only 7% of these students can apply mathematical knowledge in different life situations. The worst skill gained is an ability of reasoning mathematically (Niss, 2003): ability to understand and assess already existing math argumentation and the notion of proof and to recognise the central ideas in proofs; knowledge/ ability to distinguish between different kinds of math statements; construction of chains of logical arguments and hence of transforming heuristic reasoning into own proofs (reasoning logically).

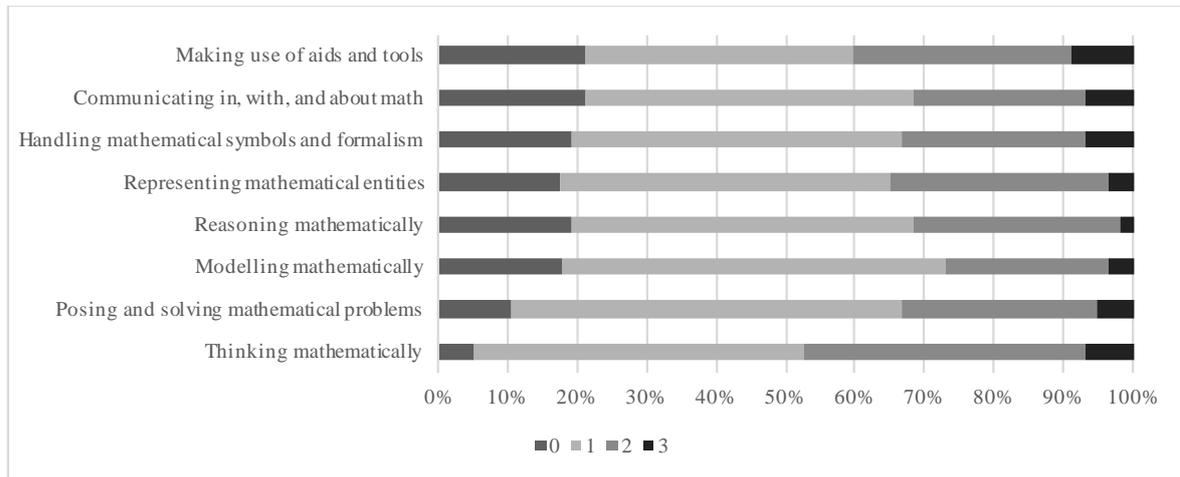


Figure 2. Self-assessment of students' mathematical competence with insufficient mathematical knowledge (N=461)

Rational thinking is, according to students, only a third factor. Evaluating students' attitude towards the potential values of mathematics, it should be noted that for 76.9% of students, who rate their knowledge in mathematics as exalted, mathematics helped to understand other subjects. Their mathematical competences which are characterized by abilities to ask and answer questions in and with mathematics are very high.

According to a study by Havighurst (1972) on the relation between different life cycles and educational needs, at the age of 18-30, education is usually linked to career prospects and employment prospects. Mathematics is an area that needs to be as knowledgeable as possible so that an individual can successfully pursue his or her career. However, in this study, only 54.7% perceive the need for mathematical knowledge in today's labour market conditions, while 18.2% of respondents deny the connection between mathematical knowledge and employment, which undeniably reduces student motivation for achieving good results. An average 56% of respondents agree or even strongly agree with the statement "Mathematical thinking helps solving life and professional problems", 44% of them have the opposite opinion. 68% of total respondents agree with the statement "People who understand mathematics will easily deal with tasks that require thinking". Only 33% of students from computer sciences and information technologies specialties recognize the role of mathematical thinking in solving various problems.

4. CONCLUSION

Motivation is a key element of successful mathematics teaching and learning - a positive attitude to maths motivates learning more and making progress and achieving their goals.

The study shows that the first factor influencing mathematics learning at the university is internal motives (mathematics learning experience, attitude), second - rational thinking (potential values of mathematics and advantages in the labour market) and third - external factors (teaching of mathematics at the university).

Based on the students' views on the teaching mathematics at the university, the learning result could be more correlated not only with the repetition of a rule, algorithm solving examples, but it should be correlated with a deeper understanding of mathematics; the methods of teaching/learning of mathematics have to conform to the student's expectations, the process of learning should be more involving, interesting.

In order to influence motivation of the mathematics learning at the university it is important to develop positive attitudes of students towards the relevance of mathematics in professional activities and to enhance learning motivation on this basis.

Practical impact - the methodology and factors that influence the teaching of mathematics at a university described in the study can be used to promote and evaluate the motivation for learning other subjects.

Self-assessment method used in the empirical study. Therefore, the results are based on respondents' opinion.

It was a case study, and it only reflects the views of students who participated in it. The results were used only to illustrate findings. They do not provide generalization.

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